

Smallholder dairy production and marketing—Opportunities and constraints

Proceedings of a South–South workshop held at National Dairy Development Board (NDDB) Anand, India, 13–16 March 2001



National Dairy Development Board



Australian Centre for International Agricultural Research



International Livestock Research Institute

Smallholder dairy production and marketing—Opportunities and constraints

Proceedings of a South–South workshop held at
National Dairy Development Board (NDDB)
Anand, India, 13–16 March 2001

editors

D. Rangnekar and W. Thorpe



National Dairy Development Board
P.O. Box 40, Anand-388 001, Gujarat, India



Australian Centre for International
Agricultural Research
P.O. Box 1571, Canberra ACT 2601, Australia



International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

Table of Contents

Acknowledgements	vi
Background and rationale for South–South workshops—an introduction to the workshop on smallholder dairy production and marketing—Constraints and opportunities	vii
Welcoming address	viii
<i>A. Patel</i>	
Opening address	xiii
<i>D. Taylor</i>	
Executive summary	1
Theme 1: Country and regional overviews	
Smallholder dairy production and marketing in Bangladesh.	7
<i>M. Saadulah</i>	
The current status of smallholder dairy systems in Sri Lanka	22
<i>B.H.W.M.U.S. Bandara</i>	
An overview of smallholder dairy production and marketing in Nepal	33
<i>D.D. Joshi and K.C. Tarak Bahadur</i>	
Pakistan smallholder dairy production and marketing	47
<i>R.H. Raja</i>	
Smallholder dairy production and marketing in India: Constraints and opportunities	65
<i>M.P.G. Kurup</i>	
Problems and prospects of smallholder dairy production and marketing in South Asia: An overview	88
<i>K. Singh and R.S. Pundir</i>	
Dairy development in Thailand and a case study on environmental impacts of peri-urban dairy colonies. Part I. Smallholder dairy development	105
<i>C. Chantalakhana and P. Skunmun</i>	
Current situation and prospect for dairy production in China	116
<i>J.X. Liu, Y.M. Wu and Z.E. Zhou</i>	
The smallholder dairy production and marketing systems in Vietnam	130
<i>N.Q. Suc and D.V. Binh</i>	
Smallholder dairy production systems in East and South-East Asia: Expanding importance, environmental impacts and opportunities for improvements	141
<i>C. Devendra</i>	
Smallholder dairy production and marketing in Kenya	160
<i>H.G. Muriuki</i>	
An overview of dairy development in Tanzania	174
<i>L.R. Kurwijila</i>	
Smallholder dairy production and marketing in eastern and southern Africa: Regional synthesis	185
<i>H.G. Muriuki and W. Thorpe</i>	

Smallholder dairy production and marketing constraints in Nigeria	201
<i>M.L. Yahuza</i>	
Smallholder dairy production and marketing in Ghana	215
<i>E.O. Otchere and S.A. Okantah</i>	
Theme 1: Country papers and regional overviews	225

Theme 2: Implications of international trade regulations for smallholder dairy production and marketing

Implications of international trade regulations (World Trade Organization Agreement on Agriculture and Codex Standards) for smallholder dairy development	231
<i>V.P. Sharma</i>	
The competitiveness of smallholder dairy production: Evidence from sub-Saharan Africa, Asia and Latin America	250
<i>S.J. Staal</i>	
Theme 2: Implications of international trade regulations for smallholder dairy production and marketing	265

Theme 3: National dairy policies (including policies related to research, extension, development and training) for smallholder production and marketing

National policies supporting smallholder dairy production and marketing: India case study	271
<i>S. Parthasarathy</i>	
A case study on environmental impacts of peri-urban dairy colonies in Thailand: Environmental impacts of old and new dairy farms	282
<i>P. Skunmun and C. Chantalakhana</i>	
Evolution of dairy policies for smallholder production and marketing in Tanzania	298
<i>L.R. Kurwijila</i>	
Theme 3: National dairy policies (including policies for related research, extension, development and training) for smallholder production and marketing.	320

Theme 4: Institutional structures to sustain smallholder dairy marketing

Small-scale processing and marketing in Bangladesh including reference to micro-credit facilities (good market access)—Milk Vita: A case study.	327
<i>G.C. Saha and S.A.M.A. Haque</i>	
Institutional structure to sustain smallholder dairy marketing—The Amul model	342
<i>B.M. Vyas</i>	
Small-scale milk marketing and processing in Ethiopia	352
<i>Tsehay Redda</i>	

Impacts of liberalisation in Kenya's dairy sector.	368
<i>J. Omiti</i>	
Institutional structure to sustain smallholder dairy production and marketing in China	380
<i>J.X. Liu and Z.E. Zhou</i>	
Theme 4: Institutional structures to sustain smallholder dairy marketing	388
Theme 5: Effective and efficient livestock services for smallholder dairy production	
Package of improved livestock services through co-operatives: A case study of the Mehsana District Milk Producers' Union Ltd., Gujarat, India.	393
<i>M.P.G. Kurup</i>	
Contributions of Heifer Project International (HPI) to small-scale dairy development in Cameroon	414
<i>R.M. Njwe, L.N. Kwinji, A.L. Gabche and E.N. Tambi</i>	
Impact of integrated dairy and crop production technologies on smallholder dairy production in Haryana, India	431
<i>B.N. Mathur and R.V. Singh</i>	
Decentralisation of services in Uganda: The formation of National Agricultural Advisory Services (NAADS)	445
<i>S.N. Nahdy (author not presenter)</i>	
Theme 5: Effective and efficient livestock services for smallholder dairy production	464
Theme 6: Making the research and extension paradigm responsive to farmer needs	
Forage legume technologies: Participatory experiences with farmers and community-based organisations in Central Kenya	469
<i>D.M. Mwangi and C Wambugu</i>	
A case study on adoption of urea molasses mineral blocks	484
<i>I. Patel</i>	
Farmers' perceptions of service delivery and policy support from smallholder dairy in Nepal: Nepal case study.	499
<i>D.D. Joshi</i>	
Participatory research and extension for dairy technology development and transfer in Vietnam: A case study.	508
<i>D.D. Vu and D.V. Cai</i>	
Theme 6: Making the research and extension paradigm responsive to farmers' needs.	514
Recommendations of the workshop	518
List of participants	521

Acknowledgements

The workshop organisers wish to thank Dr Amrita Patel (Chairman, National Dairy Development Board, NDDB), Mr Deepak Tikku (Managing Director, NDDB), Dr Hank Fitzhugh (Director General, International Livestock Research Institute, ILRI) and Dr David Taylor (Deputy Director General, ILRI) for their strong support and encouragement during the planning and implementation of the workshop.

The organisers and participants are grateful for the financial support provided by NDDB and the Australian Centre for International Agricultural Research (ACIAR) which made the workshop possible. ILRI also acknowledges the financial support of all its investors, particularly those providing unrestricted support which contributed to the preparation of the workshop and these proceedings.

Workshop organisers:

Dr A.K. Joseph (NDDB); Dr Datta Ranganekar (NDDB); Dr N.V. Belavadi (NDDB); Dr B.K. Patnaik (NDDB); Dr H.A. Nadiadwala (NDDB); Dr William Thorpe (ILRI) and Dr Michael Smalley (ILRI)

Language editors:

M. Smalley, A.M. Nyamu, Mulugeta Bayeh, Tesfaye Jemaneh, Mezgebu Abegaz, A.S. Ngu and B. Waites

Background and rationale for South–South workshops—an introduction to the workshop on smallholder dairy production and marketing—Constraints and opportunities

Many national, regional and international organisations are working in partnerships using development-oriented livestock research to achieve sustainable improvements to the livelihoods of resource poor livestock keepers in developing countries, to make animal products more affordable and accessible for the poor, and to conserve natural resources in developing countries.

Many of these key partners are from developing countries—the ‘South’. Despite the importance of livestock research for national economic and social development, and the scarcity of national and regional resources to implement research and development (R&D), many institutes and countries research the same constraints and issues without learning what has been done by others—what has worked and why, and what has not worked and why. And without agreeing procedures that will permit comparisons and the exchange of information across regions.

Whilst there are some opportunities for national scientists, development specialists and policy makers to meet and discuss within countries, there are few opportunities for people to meet within regions and even fewer opportunities for colleagues from different regions to meet and share experiences. Discussions and exchanges of ideas across regions that share common R&D opportunities are particularly important because they encourage wider learning from what has been done, and encourage new partnerships between those working on shared problems.

The International Livestock Research Institute (ILRI) is working with others to organise a series of South–South workshops which will provide a setting and programme that encourages participants to share experiences, both successful and unsuccessful, that have addressed common technical and policy constraints, and on the methodologies and tools that were developed and tested while acquiring those experiences.

The workshops are expected to result in agreement on shared policy, R&D issues for the next 5–10 years, identify opportunities for new joint R&D project activities, and help ILRI develop its own research agenda and partnerships.

The first South–South workshop, on ‘Smallholder dairy production and marketing—Constraints and opportunities’, was jointly organised by ILRI and the National Dairy Development Board (NDDB) of India, with financial support from NDDB and the Australian Centre for International Agricultural Research (ACIAR). The workshop was held in Anand, headquarters of NDDB, from 13th to 16th March 2001.

Welcoming address

A. Patel

Chairman, NDDB

It is indeed a privilege to welcome all participants to this workshop. This is a moment that those involved in the preparations have been looking forward to for close to two years and we are particularly pleased that there are colleagues from so many countries in Africa and Asia participating in this South-South workshop, and whose papers will form such an important part of the workshop over the next three days.

May I particularly welcome you to Anand and to the institutions that make this small town such an important part of dairying in India. We are fortunate to be able to use the facilities of the Institute of Rural Management. The Institute was promoted by the National Dairy Development Board (NDDB) of India to prepare managers to serve smallholder enterprises. Every year 60 or more young women and men graduate with postgraduate diplomas in rural management and a number of them go on to serve in rural institutions.

It was the success of the Kaira District Co-operative Union, popularly known as Amul, that has inspired the co-operative dairy programme in India over the last five decades. It has also led to the creation of organisations like the Gujarat Co-operative Milk Marketing Federation Ltd, which is responsible for marketing the products of all the co-operative's dairies in this particular state. The Tribhuvandas Foundation, which is Asia's largest NGO, works in over 600 villages in the State in the field of maternal and infant care. What is unique about the programme of the Foundation is that it rides on the back of milk. It is the village milk co-operative that appoints a village health worker and pays an honorarium to the village health worker to undertake the work. So it is milk paying for health. We hope you will share our belief that smallholder dairying can transform the lives of millions of people. Most of the co-operatives, health care and education in this area of Gujarat result from smallholder dairy farmers joining together to create resources, not only benefiting themselves but also creating a better community for all.

It is what has happened in Kaira District, and today throughout India, that convinces us that smallholder dairying holds enormous untapped potential to benefit tens of millions of families not only in our country but also throughout the South. Dairying in India and, we understand, in other parts of Asia and Africa, is predominantly an occupation of the small farmer. Seventy-five per cent of the close to 10 million dairy co-operative members in India are small, marginal and even landless producers. For these members dairying has provided employment, generated incomes and opened the doors to a better life.

We are particularly anxious that more and more women associate themselves with co-operatives, not just as members, but also willing to take a role in governance. Through participation and thrift groups promoted by the dairy co-operatives women are already taking steps on the road towards empowerment. More and more girls are being educated in villages with milk co-operatives.

When this workshop was first proposed, the NDDB was happy to support it. Just as we believe that smallholder dairying offers millions a road to a better life, so also do we recognise that this road is not a smooth one. It is in fact filled with obstacles that must be overcome if the potential of smallholder dairying is to be fulfilled. I hope this workshop will focus our collective attention on a wide variety of experiences with smallholder dairying: the obstacles that have been faced, and the ways in which they have been addressed and overcome.

We must also draw on our experiences to develop an agenda for the future. Our hope is that there will be some very important outcomes from our discussions over the next three days. First, we will all learn from each other and, I trust, be inspired by what has been achieved in different parts of Asia and Africa. Second, we will draw attention to priority areas of research. Let me stress that by research NDDB means far more than breeding, feeding and the management of animals. Rather we include the process of adoption of innovations; the economics of smallholder dairying; the implications of international trade regimes; and, most importantly, the development of institutions and structures outside government to effectively serve smallholder milk producers.

The real challenge we need to address over the next three days is the approach to sustainable dairy development recognising that fundamental to all our planning and programme implementation are the limited natural resources that are available, and that the most important, water, is in serious jeopardy in almost every country.

May I now speak briefly about NDDB and our support to this workshop. As I mentioned, the success of the Kaira District Union inspired the development of smallholder dairying in India. The vehicle for that development was the National Dairy Development Board, a creature of government founded in 1965 and which, over the last 36 years, has worked to promote, finance and support dairy co-operatives throughout India. During that time, we have gained considerable experience in applied dairy science, in the design, construction, operation and maintenance of dairy plants, in animal feed and nutrition, and in the marketing of milk and milk products. We are proud of what we have achieved and prouder still of India's milk producers for what they have achieved. Yet we realise that although much has been done it is just one step on a very long journey.

Regrettably, far too often the results of good research seem to fail to reach the large numbers of milk producers who might benefit. Poorly focused research also takes place because a scientist pursues her or his own interest rather than learning from the milk producers what they need. Products are developed which the market rejects while there may well be demands that we fail to recognise. It is of the utmost importance that we find ways to link scientists and technologists with the farmers and the consumers to ensure that the powerful tools of science and technology produce the greatest benefits for the greatest numbers. This is not to discount the rights and responsibilities of scientists to pursue their own directions and ideas. Some of the greatest contributions to mankind have come from such lonely and even courageous efforts, but at the same time we must recognise that tens and even hundreds of millions of rural families live at the edge of hunger and endless privation. Our first responsibility as an educated elite is to help them become productive and find the means to a better life.

This, I hope, will be the underlying theme of the workshop deliberations. The workshop has brought together a wealth and wide diversity of experience in smallholder dairying. We, at NDDDB, are excited by the opportunity the workshop presents for us. We will be listening and learning from all of you. Your experiences, and the challenges you have faced and overcome will provide us with insights and new ways of looking at old problems, not to mention alerting us to new challenges and opportunities. I know our colleagues from ILRI are equally excited to have the opportunity to listen to and learn from scientists and policy makers from so many nations.

If I may, I would like to mention a subject which greatly concerns NDDDB. The subject that concerns me, that concerns all dairymen in India is the evolution of the rules of international trade. We are concerned that the way these rules are developing poses a serious threat to smallholder dairying. If dairying did not offer such an important vehicle for equitable economic growth we would not be so apprehensive. But we remain convinced that dairying can and should benefit rural people throughout the South and that unless we all speak more forcefully and with a single voice the tremendous potential that exists may be extinguished before its impact is even visible.

As some of you may know India's dairy development was implemented through a programme called Operation Flood, a programme that extended over 25 years and which used donated dairy commodities to build markets and to generate the resources needed to promote co-operatives, to provide inputs and services to farmers to build dairy plants, and to carry out supporting research. The policies of our government gave a preferred role to dairy co-operatives along with the substantial responsibilities for the delivery of services. They also importantly protected India's young dairy industries from external competition. Commodity imports were channelled through the Dairy Board. These imports were sold at prices comparable to farm-gate milk prices, and not used to subsidise our urban consumers. As a consequence we were able to develop dairying to the point where we, along with New Zealand, enjoy a comparative price advantage.

For today's economists and free marketeers, these policies are not acceptable. Yet we have to recognise that these very policies transformed unemployment in our country into employment, and provided incomes for millions of our rural producers.

Today the World Trade Organization would prefer never to see another Operation Flood with its limit on imports. In fact, probably every country represented at this workshop has agreed to allow free trade in milk and milk products and probably most countries represented in the workshop have low tariffs on dairy commodities, far lower than in the European Union and North America. That is despite the fact that none of the countries represented at this workshop can afford to subsidise milk production and dairy commodity exports to the massive extent done in Europe and North America. And while the Uruguay Round did result in agreements to reduce such subsidies the effect was tokenism and not substantive.

However, not satisfied with these comparative advantages, the effort is now to use international bodies such as Codex to legitimise non-tariff barriers that would otherwise be unsustainable. I will not go into the details of these various attempts to skew international trade in favour of the North because there is a session devoted to this, but NDDDB asks that if you are seriously committed to smallholder dairying you carefully study the potential

destructive force that the international trade regime can unleash against your efforts, and that you prevail upon your governments to be watchful.

Today, as we begin this workshop, participants come from many different countries, each with a different perspective. By and large, there have been few if any similar opportunities for such a meeting in the past. If we simply exchange ideas, build relationships and identify a research agenda we will no doubt have served an important purpose. I hope, however, there will be one more outcome, possibly even more significant in the long term. It is my hope that this South-South workshop will find more common themes, common purposes and common goals than we find differences. It is my hope that these will become the foundation for a whole new dream. A dream of what dairying can do to improve the lives of millions throughout the South and, because a dream is not enough, I hope we will begin to take the first steps to work together, to think together and to speak together as a voice for smallholder dairying throughout the South. It is only such a voice, the voice of all of us that will slow what will otherwise be inexorable progress toward total domination of dairying by the North.

Let me then close with a thought, that this meeting can be the moment when smallholder dairying emerged from the background and began to achieve its potential throughout the South. Those of us gathered here can create the force and momentum for this to happen.

Let us seek, therefore, to find our common voice for the good of our smallholder brothers and sisters throughout the world.

Thank you.

Opening address

D. Taylor

DDG(P), ILRI

Thank you Dr Patel. It is my privilege to respond to your very warm introduction. I will start on behalf of all the participants by thanking you and your colleagues in NDDB (National Dairy Development Board, India) for the hospitality and the warm welcome you have shown all of us.

As we have heard, this meeting is going to be a model for future interactions. But we cannot organise these important events without financial support so immediately I recognise the financial support from NDDB and from ACIAR (Australian Centre for International Agricultural Research) and thank both for their support; we also appreciate the participation of Dr Bill Winter from ACIAR.

This is the first of a number of South-South workshops that ILRI will plan and implement with partners. Because of the way ILRI is evolving this type of workshop will become more important in the future. As Dr Patel pointed out, all of us must interact with and learn from our end users, including dairy producers and consumers. This is just as important to ILRI as is our interaction with our partners at the high technology, high science end of ILRI's work. Increasingly ILRI will place emphasis on what the farmers say to us and what they want. ILRI will be developing a research programme and activities with that goal in mind. We will, I hope, be acting as a conduit between the smallholder and advanced research institutions wherever they may be, be it in Oxford or Cambridge in UK, Harvard in USA or Hyderabad in India. So ILRI's role will include being a facilitator. The facilitation may include only a minor role for ILRI but nonetheless we hope we will be an important and a friendly partner. ILRI is a research institute, but one that uses research for sustainable development.

ILRI comes to this South-South workshop to learn about the experiences of colleagues in India, and from the other countries in Asia and in Africa represented in the workshop so that we can bring these lessons to bear on our evolving research agenda on the constraints to sustainable smallholder dairying in the countries of the South. We also want to reinforce our partnerships, and form new ones, for the design and implementation of our work. The smallholder dairy subsectors of developing countries are an important component of ILRI's agenda.

Dr Patel used the phrase 'milk paying for health'. This is a very important strategy. We cannot underestimate the value of milk in the early protein nutrition for young children. The consumption of milk by young children provides good nutrition and resistance against disease, and it also supports the development of the child's cognitive responses. This is something that has been ignored for many years but today it is absolutely clear that there are certain micronutrients essential for the full development of cognitive abilities which are

best obtained from animal products, including milk. And the full development of these cognitive skills is one more factor which will allow individuals to climb out of poverty.

ILRI anticipates that the discussions over the next three or four days will be marked by the exchange of information and experiences across the regions of Asia and Africa and that the resulting information will allow us to better fulfil our mandate.

ILRI agrees with NDDDB that research for the development of smallholder dairying must look very carefully at all the issues, including the technologies and policies needed to allow smallholder farmers to get their product to market and build their assets.

ILRI also agrees with Dr Patel in wanting this workshop to produce a clear agenda of priority issues. This is important for ILRI because on the basis of those priorities both ILRI and its partners in this research will identify and build its research agenda for the benefit of smallholders, and see where there are the best practices and where we can learn from other institutions. This workshop is also important because it will provide ILRI with an opportunity to strengthen our partnerships.

Dr Patel described the challenges from the evolving rules for international trade being promoted by the World Trade Organization. I know it is a concern to our colleagues in sub-Saharan Africa and South-East Asia. ILRI is not a political organisation, but it is an organisation involved with policy research. It is not for ILRI to dictate a research or development agenda to any nation, but ILRI can facilitate discussions and the gathering and interpretation of information. ILRI facilitates and implements research on controversial and difficult issues, like world trade and smallholder dairying, to provide data and information for others, including our partners, to use and reach their decisions on policies and best practices. ILRI must be in a situation where it provides accurate information for national policy and decision makers to allow them develop their own policies.

Once again, thank you Dr Patel for your opening remarks and thanks to the organisers of this meeting for bringing us together and arranging a programme which will encourage the exchange of information and experiences across country and regional boundaries for the benefit of smallholder dairy producers.

Executive summary

Identifying the major issues affecting dairy's contribution to the improvement of the livelihoods of the poor in countries of the South is a major challenge faced by many governments and development agencies. To contribute to meeting that challenge, India's National Dairy Development Board (NDDB) and the International Livestock Research Institute (ILRI), co-sponsored by the Australian Centre for International Agricultural Research (ACIAR), hosted a South-South workshop on smallholder dairy production and marketing—Constraints and opportunities in March 2001. The workshop was held at NDDB's headquarters in Anand, India.

Participants were drawn from countries in sub-Saharan Africa (SSA) and Asia; their backgrounds reflected the contrasting dairy development scenarios seen in SSA and Asia. They were joined by representatives from ACIAR, ILRI, NDDB and Switzerland.

The workshop objectives were to:

- Facilitate information exchange and discussion amongst smallholder dairy research scientists and development specialists from Asia and sub-Saharan Africa
- Share the successful and unsuccessful experiences gained from addressing constraints (including policy and institutional issues) to, and opportunities for, smallholder dairy production, processing and marketing
- Describe the methodologies and tools that were developed and tested
- Agree on the major research and development (R&D) issues (including those related to policies and institutions) for the next 5–10 years and
- Identify opportunities for new partnerships for R&D activities to address the agreed issues.

The workshop was structured around six themes within which invited papers were presented. The papers were followed by plenary and group discussions.

The themes were:

1. Regional and country overviews
2. International trade regulations
3. National dairy policies
4. Market institutions
5. Livestock services and
6. The research and extension paradigm.

Papers were contributed from 16 countries: West and Central Africa: Cameroon, Ghana, Nigeria; Eastern and Southern Africa: Ethiopia, Kenya, Tanzania, Uganda; South Asia: Bangladesh, India, Nepal, Pakistan, Sri Lanka; and South-East and East Asia: China, Malaysia, Thailand, Vietnam.

The papers and the extensive discussion that focused on the six workshop themes demonstrated:

- the commonality of many of the issues related to smallholder dairy production and marketing in the countries of the South
- the richness of the experiences in the South applicable to the improvement of the livelihoods of the landless, the marginalised and smallholders through dairy
- the key role that market-orientation and participatory approaches play in fostering effective efforts in support of dairy development
- the large benefits, actual and potential, of exchanging experiences amongst the countries of the South
- the importance of taking advantage of the new generation of information technologies to ensure more effective exchange of information within the South and
- the willingness and enthusiasm of the participants to work together to plan the agreed actions and to mobilise the resources required for their implementation.

The following four major R&D issues related to the development of smallholder dairying and its competitiveness in countries of the South were identified for follow-up.

South–South information exchange and networking

The need for continued sharing of information, experiences and research findings with emphasis on networking among the countries of the South was considered very important. ILRI (www.cgiar.org/ilri), offered to assist in establishing a network through exploring opportunities with FAO (www.fao.org). Participants agreed that the need for information exchange and networking was particularly relevant for issues related to:

- **Collective-action groups:** The collective action of smallholders (such as that practised in the Anand model in India) was seen by workshop participants as an important mechanism for successful dairy development. Information exchange on the strengths and weaknesses of the approach was needed with emphasis on identifying the principles and best practices that determine the successful adoption and adaptation of the approach (see below).
- **Participatory research and extension:** The lessons from participatory research and extension approaches and methodologies presented to the workshop particularly interested the participants. They wanted more information about and contact with programmes in developing countries practicing participatory approaches to the development, testing and transfer of productivity-enhancing technologies. The workshop participants were particularly interested in testing the approaches, methods and tools to crop–dairy systems and to improving integrated nutrient management.

It was suggested that links were established with the CGIAR's System-wide Program on Participatory Research and Gender Analysis (PRGA) led by Centro Internacional de Agricultura Tropical (CIAT). The PRGA website (www.prgaprogram.org/prga/) provides access to information on participatory research and extension approaches,

methodologies and tools, and to current examples of their application to livestock-related constraints and opportunities.

- **Milk marketing research:** The over-riding importance to smallholder dairy development of effective milk collection and marketing strategies was highlighted in the workshop presentations and in the discussion sessions. Information exchange and networking on the lessons learnt on appropriate marketing strategies was therefore a key topic to be addressed through the continuing interactions amongst the countries of the South.
- **Policy research:** In the same way, the workshop participants agreed the importance of sharing the lessons learnt from policy studies as related to dairy development, role of governments etc. Participants stressed the need for exchanging information on approaches and methods for carrying out policy research, for the presentation of the research outcomes to policy makers and their advisers and for advocating policy reforms related to smallholder dairy production and marketing.

Championing the collective action (co-operative) approach

As mentioned above, an important conclusion of the workshop was that the time-tested Anand model of dairy co-operatives, with changes as may be necessary to suit local environments, was a good model for smallholder dairy development in countries of the South. NDDB (www.nddb.org) agreed to play the lead role in information dissemination and supporting the development of farmer organisations.

Enhancing the understanding of WTO regulations and their implications for smallholder dairy development

The representatives from most of the participating countries wanted to be kept well informed and updated on a continuing basis of the implications for smallholder dairy production and marketing of the World Trade Organization (WTO) regulations. The Institute of Rural Management (www.irm.ernet.in), Anand, (IRMA) and NDDB offered to provide a forum for articulating the issues affecting smallholder dairy development in countries of the South and to help draw up plans of action.

Improving research and extension (R&E) systems to serve smallholder dairying

A major issue highlighted by the workshop participants was the need for more effective R&E systems, including the delivery of livestock services (e.g. veterinary and artificial

insemination; AI), to support smallholder dairy development. It was proposed that one way forward was to study and understand the successes and failures of the different approaches tried in various countries and to share those lessons through the proposed South–South information exchange and networking (see above). It was agreed that NDDDB and IRMA would collate information from South Asia, while ILRI (subject to funding) would mount a parallel effort in sub-Saharan Africa.

The details of the issues, concerns and opportunities discussed by participants for each theme are reported in the following pages of the proceedings:

Theme 1. Regional and country overviews, pages 7–228

Theme 2. International trade regulations, pages 231–268

Theme 3. National dairy policies, pages 271–323

Theme 4. Market institutions, pages 327–390

Theme 5. Livestock services, pages 393–466

Theme 6. The research and extension paradigm, pages 469–517

The recommendations of the workshop are reported on pages 518 to 520.

Finally, it was agreed that the proceedings of the workshop would be produced in three formats: a conventional book; a multi-layered CD with linkages to resource materials on the workshop themes and on the major R&D issues identified by the participants; and, in electronic form on the NDDDB (www.ndddb.org), ILRI (www.cgiar.org/ilri) and related websites.

Theme 1: Country and regional overviews

Smallholder dairy production and marketing in Bangladesh

M. Saadullah

Department of Animal Science, Bangladesh Agricultural University,
Mymensingh, Bangladesh
E-mail: msaad@royalten.net

Introduction

Dairying is nearly always a part of mixed farming systems in Bangladesh. It has a direct impact on income generation, poverty alleviation and availability of animal protein. Quantification of the contribution of livestock, including poultry, shows that dairying is the predominant source of income generation (Miyan 1996). Although the supply of domestically produced animal products (milk, meat and eggs) has increased by about 1.2% annually (DLS 2000), the per capita daily availability of milk and meat is only 32.6 ml and 10.2 g against the requirement of 250 ml and 120 g, respectively. Consequently, consumers face an acute shortage of livestock products like milk, meat and eggs for which supply fails to meet the requirements of 85, 89 and 75% of the population, respectively. The major constraints to dairy cattle production are the shortages of quality feeds and fodder, the breeds of cattle, poor management practices, limited access to veterinary care and disorganised marketing systems. In addition, there is a lack of institutional support, research and training, which would be beneficial to the farming environment.

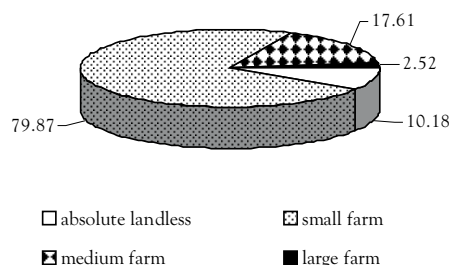
Livestock population

Population: Presently, there are about 23.4 million cattle, 0.82 million buffalo, 33.5 million goats, 1.11 million sheep, 138.2 million chickens and 13.0 million ducks (DLS 2000). It has been reported by the Bangladesh Bureau of Statistics (BBS 1999), that 52.0% of male cattle, 62.3% of female cattle and 60.9% of cattle <3 years old are raised by small- and medium-sized farms.

Farm characteristics

Types of farm household

Figure 1 shows data from the national census of agriculture in which households are classified by size of landholding. Data indicate that 79.9% of households are small-scale



Source: National Census Data (BBS 1999).

Figure 1. Types of farm based on size of landholding as a percentage of the total number of households in Bangladesh

farmers holding 0.05–2.49 acres of land, whilst 10.2% of households have no land (BBS 1999).

Average herd size

Table 1 shows the average livestock herd size by type of livestock farm. Data are based on a recent survey carried out at seven locations across the country (Saadullah and Hossain 2000).

Table 1. Average herd/flock size (number of animals) in different types of livestock farm households: landless (28.5% of livestock farm households) = 0–0.049 acres; small (39.6%) = 0.05–2.49 acres; medium (23.5%) = 2.50–7.49 acres; and large (8.4%) $\geq$ 7.50 acres.

Type of livestock	Average herd/flock size (number) by type of farm household				Overall average herd/flock size (number)
	Landless farm	Small farm	Medium farm	Large farm	
Cattle	2	2.9	3.7	4.4	3.5
Goats and sheep	4.8	12.1	11.7	1.2	7.45
Poultry	8.6	14.9	14.7	7	11.3

Source: Saadullah and Hossain (2000).

Contribution of cattle in smallholder systems

Energy balance of cattle

Table 2 presents an energy balance sheet for cattle in Bangladesh (Reza 1986). About 44, 53 and 78% of the energy consumed in feeds and fodder by adult male, female and immature cattle is used to meet their needs for maintenance and growth. The remainder of energy intake is used to produce products that are of use to humans, such as milk, draft power and dung.

Cows as a source of draft power

It has been reported that 36% of cows between 3 and 10 years old and 60% of cows >10 years are used for milk production and draft power (BBS 1986). Saadullah (1995) found that the work involved in moving draft loads significantly decreased cows' milk yields; however, the situation could be improved in terms of milk yield by supplementing improved diet during work.

Table 2. *Energy balance sheet for cattle in Bangladesh.*

Category of cattle	Energy input	Energy output				% used for self maintenance
		Amount of energy (kcal/day per animal)				
	Intake (kcal/day per animal)	Work	Milk	Dung	Total	
Adult male	9489	602	-	4638	5240	44
Adult female	10,756	545	825	4351	5721	53
Immature	7200	-	-	2805	2805	78

Source: Reza (1986).

Cattle as a source of fuel and fertiliser

As an input to cropping systems, manure continues to be an important link between crop and animal production in Bangladesh. The yearly total cattle manure/dung production in Bangladesh is estimated to be 80 million tonnes of which 68 and 52% is used as manure in rural and urban areas, respectively. The use of dung as a household fuel is mostly on small farms and represents 25% of total production (DLS 2000).

Employment generation

The livestock sector generates 20% of full-time employment in Bangladesh (DLS 2000). Generation of self-employment and the total income shares of dairy cows and goat raising tend to increase with a decrease in farmer's resources, especially land area, suggesting that animals are of particular importance for landless and small-scale farmers (Alam 1994). The pattern of utilisation of labour on dairy farms (Alam 1994) is shown in Table 3. Alam (1994) also reported that, on average, each mini dairy farm created the opportunity for employment of 1.78 man-days/day. The number of employed labourers was highest with large farms (2.50 man-days/day) followed by medium (1.65 man-days/day) and small farms (1.50 man-days/day). On average, each farm employed 1.07 male labourers and 0.71 female labourers each day. The use of female family labourers was highest (1 labourer/day) in the case of small farms. Alam (1994) did not interpret his findings in terms of labour used per livestock unit.

Table 3. *Pattern of utilisation of labour on dairy farms.*

Type of farm	Man-days used/farm family per day						Total (man-days)		Overall total (man-days)
	Family labour		Casual labour		Permanent labour				
	Male	Female	Male	Female	Male	Female	Male	Female	Male + female
Large	0.25	-	0.5	-	1.5	0.25	2.25	0.25	2.5
Medium	0.5	0.75	0.4	-	-	-	0.9	0.75	1.65
Small	0.5	1	-	-	-	-	0.5	1	1.5

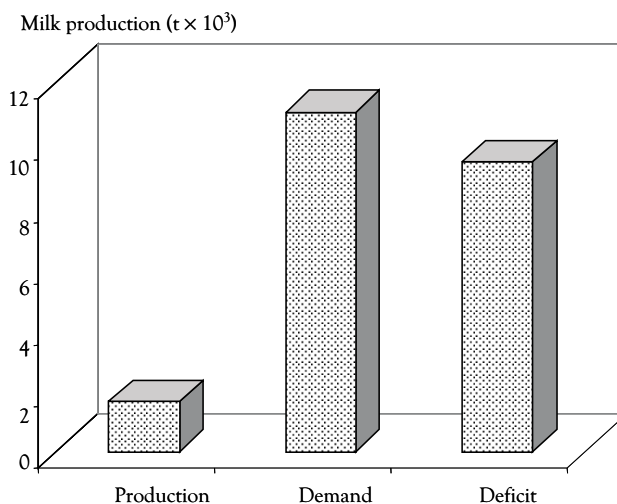
Source: Alam (1994).

Dairying as a means of livelihood

Rearing of dairy cattle has been increasingly viewed as a means of alleviating poverty in Bangladesh and is believed to improve the livelihoods of landless and small households. Many non-governmental organisations (NGOs), such as Proshika Manobik Unnayan Kendra (PROSHIKA), BRAC (Bangladesh Rural Advancement Committee), Grameen Bank and Aftab Dairy, are involved in the promotion of micro-credit for small livestock enterprises including dairy cattle, poultry and goat production. Many smallholders, particularly in mixed farming systems, prefer the flow products (milk, draft power and manure) rather than the end products (meat, hides and skins) since selling their animals for slaughter entails the permanent loss of flow products. Individuals can expand their labour force by raising cows and processing primary products into marketable secondary products, such as butter, cheese and yoghurt and by selling manure as fuel and fertiliser. Income from the sale of these primary and secondary products and by-products can be used to meet/provide farm household expenses, savings, investments and insurance, and its value tends to increase over time.

Feeding systems

Cattle and buffalo are fed principally on agricultural by-products, such as crop residues. They are grazed on natural pastures of non-arable land. During the day, they are allowed to graze on communal grazing land, natural pasture, homestead forest or fallow land. Sometimes, cows with calves are kept tethered just outside the house. Since no arable land is available for livestock feed production, non-arable land contributes most of the green fodder for ruminant animals. Non-arable land outside the farm is usually public wasteland found around canals, rivers, roadsides and railways. Using shrub and tree leaves, and tender shoots and twigs as fodder is traditional in the villages. Recently, there has been increasing recognition of the use of shrub and tree fodder as livestock feed (Saadullah 1989).



Source: Ahmed (2000).

Figure 2. Production, demand and deficit of milk in Bangladesh.

Dairy consumption

Milk production in Bangladesh is reported to have increased from 14.9 thousand tonnes in the year 1993–94 to 16.2 thousand tonnes in the year 1997–98 (Ahmed 2000). This increase was due to recent government policy and to NGOs involvement (e.g. subsidies to establish small dairy farms, soft fund loans from the government as well as NGOs and improved veterinary health care) in dairy development activities. The same report also indicated that milk, milk products and meat from cattle contribute 58% of total available animal protein followed by 28% from poultry meat and eggs, 8% from goats, 5% from edible meat offal and 5% from sheep and buffalo.

Estimated total milk production (based on the average milk production of local and crossbred milking cows), demand and deficit in the country are shown in Figure 2 (Ahmed 2000). Data indicate that there is a shortfall between production and demand for milk in Bangladesh.

Compared with the number of dairy cows in the country the estimated total milk production is low due to low milk yields and feed constraints. Per capita need was assumed to be 250 ml of milk/day but availability of milk is only 32.6 ml/day. However, one should be careful when using the term ‘demand’ for milk because total requirement does not represent the market demand for milk. Ahmed (2000) suggested that for the development of demand, the market segment must have the willingness and economic ability to buy the product. In this sense, the demand for milk will be lower than the estimated amount (11.04 millions tonnes) as the majority of people do not have adequate buying ability. Nevertheless, the gap between availability and demand is very pronounced because of the low levels of milk yields and the increasing human population. This indicates a strong need for increased milk production in the country through an appropriate breeding programme and optimum utilisation of local feed resources.

Present status and impacts of dairy production on smallholder dairy systems

The majority of dairy farms in Bangladesh are privately owned. Entrepreneurs are also getting involved in small-scale and commercial dairy farming in urban and peri-urban areas through micro-credit programmes, provided by Grameen Bank and NGOs, which are aimed at poverty alleviation. On the basis of primary use of cows, farm size and use of dairy products, dairying may be classified into the following four categories (i) dairying for home consumption, (ii) production from dual-purpose cows (draft and milk), (iii) small-scale dairy farming and (iv) commercial dairy farming (Table 4).

There are eight government owned dairy farms in Bangladesh. These are mostly used as breeding farms and for the supply of heifers to small-scale farmers. Moreover, various NGOs in the country, such as Grameen Bank, BRDB (Bangladesh Rural Development Board), PROSHIKA and BRAC have very large livestock development projects. These projects target landless and marginal farmers, particularly women, as part of their rural development and income-generation activities. Mostly, they provide credit facilities and some of them provide support services to small-scale dairy farms. These activities are implemented in collaboration with the Department of Livestock Services, Government of the People's Republic of Bangladesh.

Table 4. Classification of dairy farms based on primary use of cows, farm size and use of dairy products.

Farm type	Number of cows/farm	Ownership
1. Household dairy Milk produced for home consumption and surpluses of milk are converted into market sales	1-3	Usually large- and medium-sized households
2. Dual-purpose cows (draft and milk) Seasonal surpluses of milk are converted into market sales	2-6	All types of household as secondary activities
3. Small dairy farms Milk and milk products are converted into market sales	2-5	Small- and medium-sized livestock households (mostly with government incentive, NGO or co-operative support)
4. Medium dairy farms Milk and milk products are converted into market sales	6-25	Medium-sized household/private small commercial dairy farm (mostly with Government incentive, NGO or co-operative support)
5. Large dairy farms Milk and milk products are converted into market sales	26 and above	Private commercial dairy farms

Economics of smallholder systems

Research on the profitability of rearing dairy cattle in Bangladesh is scanty. Alam (1995) reported that the production cost of milk (per litre) from local and crossbred cows was much

higher than the selling price. One of the important reasons for loss incurred by farmers in dairy farming was the low price of milk. Availability of large quantities of low price, imported powder milk in the local market has contributed significantly to the low price of milk. As a result, local producers and milk marketing organisations cannot compete with the milk importers. Another important reason for loss in dairy farming was the low milk yield per cow (1.5 litres/day for local and 2.5 litres/day for crossbred cows). In contrast, Kabir and Talukder (1997) reported that dairy farming with both local and crossbred cows was highly profitable in Bangladesh. The profitability of crossbred cows was, however, much higher than that of local cows. Based on a three-year sample survey of 19 dairy farms (7 with local and 12 with crossbred cows) in the Tangail District, Table 5 presents the estimated gross costs and benefits earned from dairy farming with 10 local or 10 crossbred cows over a period of three lactations.

The average lactation period and daily milk production of local and crossbred cows were 240 and 284 days and 4.8 and 6.7 litres, respectively. The total costs included feed, labour, veterinary care, artificial insemination (AI) and miscellaneous costs. The returns included the value of the milk, dung and calves produced. The financial analysis of Kabir and Talukder (1997) also revealed that the earning capacity from investment in dairying far exceeded the opportunity cost of capital in formal capital markets. Moreover, it was noted that the financial incentive offered by the government has provided some stimulus to small private investors to undertake dairy farming. The sustainability of the outcome depends largely on the assured supply of accompanying inputs such as feed and veterinary services, and improved milk marketing facilities closer to the doorsteps of the farmers.

Table 5. *Estimated gross costs and benefits earned from dairy farming.*

Lactation year	Total cost (taka)		Gross return (taka)	
	Local (n = 10)	Crossbred (n = 10)	Local (n = 10)	Crossbred (n = 10)
1	54,524	58,179	4380	4380
2	92,585	98,798	148,636	247,966
3	117,054	124,911	173,007	297,117

Note: US\$ 1 = taka 57 at 2001 exchange rate.

Source: Kabir and Talukder (1997).

Participation of women in livestock production

In rural Bangladesh, women are major but largely unrecognised contributors to agricultural and economic productivity. The involvement of rural women in decision-making activities (independently or as part of a group), in particular in decisions relating to feeding, breeding, management, veterinary health care and marketing products of dairy cattle are illustrated in Table 6. Furthermore, Paul and Saadullah (1991) reported that women carry out 25% of crop, 17% of cattle, 21% of goat and 52% of milk sales.

Table 6. *Involvement of rural men and women in decision-making relating to different aspects of dairy cattle production.*

Activities	Decision-making pattern (%)			
	Spouse	Housewives	Family members	Collective*
Cattle feeding	21.5	49.8	21.1	6.2
Breeding	75.1	1.3	12.5	7.5
Management	13.1	48.8	19.6	12.4
Veterinary health care	34.5	2.9	19.2	11.0
Marketing	28.5	7.25	15.0	46.3
Milking	65	27	–	8
Milk selling	35	20	–	45
Cleaning the farmhouse	9	60	–	31

* Decision-making includes household's men, women, children and labourers.

Source: Islam et al. (1999).

Processing and marketing of milk

Marketing of livestock and their products is handled mainly by the private sector. Other than marketing by a few dairy-processing enterprises, marketing of milk and milk products from traditional small-scale dairies is carried out in an unorganised manner. Two different systems of milk marketing exist in Bangladesh (i) village systems—where milk from farmers is marketed to consumers by middlemen; and (ii) organised collection of milk from farmers for processing and marketing by private enterprises.

Smallholder village dairy systems

A chain of intermediate traders (Farias and Paikers) is involved in transferring milk and milk products from farmers (producers) to the consumers. This increases the cost for marketing and decreases the profit margin. Imperfections in the village marketing systems, which result in high prices for input and low prices for output, may discourage the development of dairy in Bangladesh. The milk production and marketing chain from farmer to consumer in the smallholder village dairy systems is shown in Table 7.

Table 7. *The milk production and marketing chain from farmer to consumer in smallholder village dairy systems in Bangladesh.*

Marketing chain	Activities
Smallholder village dairy Herd size: 2–6 cows	Raise dairy cattle, produce milk and sell their whole milk to travelling small-scale traders.
Travelling small-scale traders (Farias)	Visit the rural areas and advance cash to the village dairy for milk and in a few cases for maintenance of the animals. Sell their whole milk to distributing traders.
Distributing traders (Paikers)	Collect milk from travelling small-scale traders and sell it to retailers for the terminal market.
Retailers or sweetmeat traders	Mostly, sell processed milk products (such as sweet meats, dhai and ghee) to consumers.

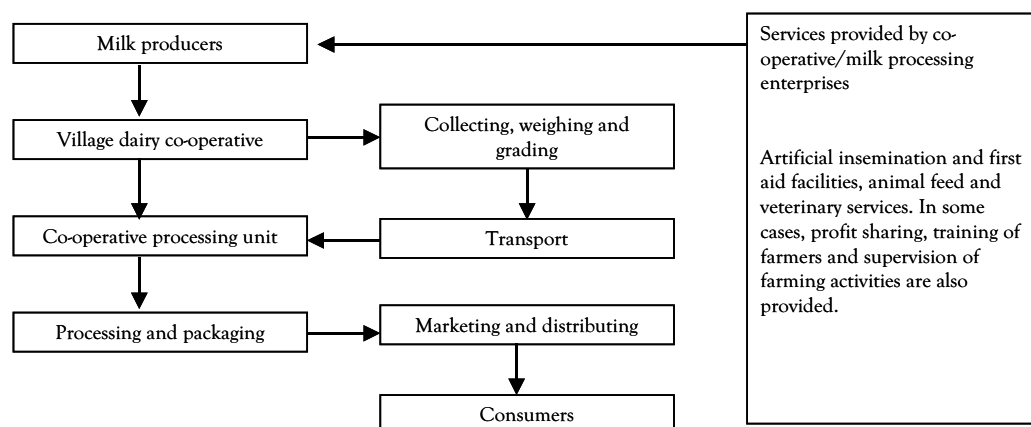


Figure 3. The chain of milk marketing from producer to consumer as developed by co-operative societies and large-scale milk processing enterprises.

Co-operative and private milk processing and packaging enterprises

Organised collection, processing and marketing of milk is accomplished by the Bangladesh Milk Producers' Co-operative Union Ltd, Savar Dairy Farm (government owned), BRAC, Aftab Dairy and a few private dairy enterprises in the country. The Bangladesh Milk Producers' Co-operative Union Ltd is the oldest dairy venture in the country and it provides feeds, vaccines and AI services for 40 thousand participants (personal communication). Very recently BRAC, Aftab Dairy and other small-scale milk processing enterprises have also become involved in collection of milk from contact farmers in urban and peri-urban areas for processing, packaging and marketing in peri-urban and urban areas. Private milk processing enterprises carry out their activities in limited areas and so are unable to provide services to dispersed dairy farms all over the country. The chain of marketing milk from producers (contact farmers with herd sizes of 4–15 cows) to consumers through co-operative and private milk processing is shown Figure 3.

Constraints to smallholder dairy production

Feed resources

Dairy farms face problems with the availability of feeds and fodder; there are problems with both quality and quantity and a lack of economical technology for optimum utilisation of local feed resources. Rice straw is by far the most important crop residue, contributing >90% of feed energy available to ruminants (Tareque and Saadullah 1988). However, animals fed on this diet fail to get adequate nutrients for maintenance and production. Efforts are being made to examine the possibilities and economic feasibility of utilising

non-conventional feeds, to improve feeding value of various agricultural and industrial by-products, and to prohibit the export of by-products such as bran, oilseed cake and molasses from Bangladesh. Furthermore, it has been established that fodder legumes can be integrated into rice production without having a negative impact on the yield of rice (Akbar et al. 2000).

Breeds of cattle

Cattle breeds available are mostly indigenous and only 2.8% of cattle are crossbred. The average level of milk production of the indigenous cows is about 221 litres/lactation (Miyani 1996). However, crossbred cows in some milk pocket areas produce 600–800 litres/lactation. The local cattle are nondescript and are crossbred with Sahiwal, Sindhi or Hariana. The major disadvantages of the local cattle are (i) low productivity, (ii) failure to let milk down without presence of the calf, and (iii) late maturation. However, these cattle are well adapted to the local feed resources, local housing facilities and scavenging systems. They have low nutritional requirements, heat tolerance, larger rumen volumes and possibly a more efficient digestion of low quality feed (Mould et al. 1982). Most importantly, their performance is also good in terms of feed efficiency (kg feed required/kg of product). Efforts are being made to improve milk production through crossbreeding with exotic breeds.

Artificial insemination (AI) and reproductive performance

Presently, AI activities are carried out by the Bangladeshi Government's Department of Livestock Services (DLS) from 22 centres, 423 subcentres and 554 AI point. The total number of AIs carried out each year is about 1.5 million (DLS 2000). In order to extend AI activities, a massive development project focusing on AI is being undertaken for the development of cattle for milk and meat production.

As regards the reproductive performance of dairy cows, Khan et al. (1999) reported that the number of services per conception, interval before first post-partum heat and calving interval, respectively, were 1.57, 138 and 450 days in Pabna (local cows), 1.63, 142 and 482 days in Sindhi crossbreds and 1.61, 185 and 532 days in Jersey crossbreds. Traits such as interval before first post-partum heat and calving interval differed markedly ($P < 0.01$) between the local and crossbred dairy cows. However, it has been reported that the management practices of the smallholder farms under scavenging conditions promote the occurrence of post-partum anoestrus and limit behavioural manifestations of oestrus (quoted by Ahmed 2000). Ahmed (2000) also concluded that detection of oestrus and of the return of oestrus after unsuccessful AI is clearly difficult under these conditions; he noted that such inefficiencies have been documented. Moreover, it was observed that cows managed intensively tended to conceive at a higher rate (53%) than those reared extensively (43%).

Climate and disease

Diseases present a major constraint to cattle production in Bangladesh; the extent of losses due to disease is very high. The country's climate, along with the poor nutritional status of cattle, contributes to a high incidence of cattle diseases, especially in the calves. The major diseases are anthrax, haemorrhagic septicaemia (HS), foot-and-mouth disease (FMD), black quarter (BQ), diseases caused by infestation with liver flukes and calf diarrhoea (Ahmed 2000). Khan et al. (1999) reported that most crossbred cows suffered very badly from parasitic infestations compared with the local cattle; moreover, they reported that the incidence of parasitic diseases was very high in calves. FMD was found to cause heavy loss to farmers. Incidence of some cattle diseases differs between the seasons. For example, the incidence of HS is highest in the rainy season. In contrast, the incidence of other diseases, such as anthrax and BQ, is sporadic. In response to the dire need for preventive vaccines against livestock and poultry diseases, 11 different types of vaccine (anthrax, HS, FMD, BQ and various poultry vaccines) are produced at two research institutes in Bangladesh. The total quantity of vaccine produced each year is about 250 million doses (DLS 2000). There are eight field disease investigation laboratories located in different parts of the country including a central laboratory in Dhaka; they are managed by the Bangladeshi Government's DLS. These laboratories serve as centres to help DLS veterinary officers to make correct and prompt diagnoses of livestock diseases.

Government policy and activities for dairy development

Recent livestock development activities of the Bangladeshi Government's DLS have attracted the attention of development partners, international organisations and NGOs. The livestock subsector has emerged as an important source of gainful employment and income for the vast majority of the rural poor for their poverty alleviation. Important features of government policies towards the livestock subsector include (i) the non-involvement of the government in production, processing and marketing activities, (ii) support of the private sector and NGOs in dairy development activities through research, extension, training, credit and the development of appropriate infrastructure, (iii) reduction of import tariffs on equipment, animals, raw materials and other inputs, and (iv) reduction and eventual elimination of subsidies on inputs, including veterinary drugs, vaccines and AI services.

The government has been providing subsidies for mini dairy farms since 1993. This policy resulted in an increase in milk production from 1.49 million tonnes in 1993–94 to 1.62 million tonnes in 1997–98 indicating a growth rate of 9%. In contrast, the annual growth rate was only 1.26% during the period prior to this policy (from 1987 to 1994). Due to increasing domestic milk production importation of milk decreased from taka 450 million in 1989–90 to taka 146 million in 1995 (Ahmed 2000). There were only 2490 dairy farms in 1990–91 but this number increased to 29.6 thousand by 1997–98 (DLS 2000).

The major activities of the DLS

The major activities of the DLS include (i) conservation of livestock (by providing veterinary health care/ensuring veterinary coverage), (ii) development of livestock (development of breeds, productivity and appropriate technology), (iii) provision of extension services (training, entrepreneur development, assistance to establish farms, feeds and fodder production, and technology transfer), and (iv) employment generation (assistance for credit, input supply and technical support to NGOs working with livestock development).

Institutional issues

The NARS (national agricultural research system) has the Bangladesh Agricultural Research Institute (BARC) as its apex body, and its affiliated research institutions are under the control of the concerned ministries, i.e. the Ministry of Agriculture and the Ministry of Fisheries and Livestock. The Ministry of Fisheries and Livestock controls the DLS with its affiliated research institutions (the Livestock Research Institute, the Animal Husbandry Research Institute, the Bangladesh Livestock Research Institute, veterinary colleges and the central cattle breeding centre).

University education and research is co-ordinated by the University Grants Commission, an autonomous body under the Ministry of Education. BARC also provides some funds to the universities for specific research projects under contractual arrangements. The majority of research in Bangladesh Agricultural University is of an academic nature. However, in some cases, researchers undertake specific project-based research funded by the Ministry of Science and Technology or other aid agencies (e.g. the World Bank, USAID (United States Agency for International Development), IFS (International Foundation for Science) and IAEA (International Atomic Energy Agency).

The Grameen Bank, a famous credit institution, is providing loan funds to the landless and to smallholders under a micro-credit programme on (i) general and processing, (ii) agriculture and forestry, (iii) livestock and fisheries, (iv) services, (v) trading, (vi) peddling, and (vii) shopkeeping. Yunus and Jolis (1998) reported that prior to May 1998, the value of loans disbursed by Grameen Bank, through 65,960 Grameen centres, exceeded US\$ 2.4 billion. The total value of loans that this bank disburses each year exceeds the combined total value of rural loans disbursed by all the other banks in Bangladesh. As of May 1998, Grameen Bank had 1112 branches serving 2.33 million borrowers at their doorsteps in 38,551 villages. In any working day, Grameen collects an average of US\$ 1.5 million in weekly repayment instalments.

In addition to credit services, as part of their rural development and income generation activities, BRAC, the Agricultural Bank, PROSHIKA and a few small-scale enterprises provide milk collection, processing and marketing outlets to small-scale dairy farms and supportive services for dairying to landless and small-scale farmers. These are implemented in collaboration with the DLS.

The Bangladesh Milk Producers' Co-operative Union Ltd is the oldest and only dairy venture in the country providing feeds, vaccines and AI facilities for a large number of

participants in selected milk pocket areas. However, this co-operative is incapable of providing feed, marketing and veterinary health care services to dispersed dairy farmers all over the country; therefore, milk collection, distribution, processing and marketing services in non-supported areas of Bangladesh are less organised.

Conclusions

Landless and small-scale farms own cattle (18.4% and 29.6% of cattle, respectively) and produce the bulk of milk. In relation to size of land holding, these small farms own more than their proportional share of livestock, while the opposite is true for the larger landowners. The major constraints on dairy cattle production are the shortage of feeds and fodder (both in terms of quality and quantity), the breeds of cattle available and poor management practices and veterinary health care, as well as the lack of marketing facilities.

Increasing milk production in small-scale dairy farms and enhancing livelihoods of farmers will depend mostly on the adoption of appropriate feed technologies. These need to be based on locally available feed resources and improved support services (such as improved feeding systems, appropriate breeding programmes, credit facilities, veterinary health care and marketing systems).

Because of their low level of milk production, indigenous cattle are often graded as inefficient when compared with western exotic cattle; however, classification on the basis of milk yield ignores the multipurpose utility of indigenous cattle, their energetic usefulness and adaptation to the local resources and environment. Therefore, efforts need to be made to improve the economic characteristics of indigenous cattle in Bangladesh.

The role of women in farm activities, especially dairying and investment in the homestead and cultivated lands, needs to be assessed for future research-oriented development activities in Bangladesh.

The marketing of animals and their products is disorganised. As a result of disorganised marketing systems, farms are struggling for existence and cannot pay back their bank loans, creating a threat to sustainable livestock development in the country. A chain of intermediate traders (Farias and Paikers) is involved in transportation of milk and milk products from the farmers to the consumers. This increases the marketing costs and decreases the farmers' profit margins.

The development of small-scale dairy farming operations (4–5 milking cows) remains at a very early stage although these farms are producing a reliable and steady source of cash income for their owners' subsistence. Establishment, by the rural poor, of small-scale dairy enterprise and processing units needs to be encouraged through appropriate policy and institutional support.

Research for development of small-scale dairying has been shockingly deficient in Bangladesh. For smallholders, technological change must serve to increase resource productivity and labour productivity. It should be characterised by low cost and low external input requirements in order to facilitate its adoption by small-scale farmers. Accordingly, efforts need to be made to develop linkages and co-ordination of research programmes among the national and regional research institutes or universities. In this respect, on-farm

research, which is based on farmers' perceptions and priorities rather than on scientists' professional preferences, criteria and priorities, has many advantages.

Acknowledgements

The author wishes to express his sincere thanks for the invitation and provision of travelling expenses to participate in this workshop.

References

- Ahmed N. 2000. Dairy development in Bangladesh: Prospect and constraint.
- Akbar M.A., Islam M.S., Bhuiya M.S.U., Islam M.R. and Hossain M.A. 2000. Integration of fodder legumes into rice-based cropping systems in Bangladesh: Production of *Lathyrus sativus* and its use as a supplement to straw-based rations of dairy cows. *Asian-Australasian Journal of Animal Sciences* 13:526–528.
- Alam J. 1994. *Economics of mini dairy farm in selected areas of Bangladesh*. Bangladesh Livestock Research Institute, Savar and Dhaka, Bangladesh.
- Alam J. 1995. *Livestock resources in Bangladesh—Present status and future potential*. University Press Ltd, Motijheel CA, Dhaka, Bangladesh.
- BBS (Bangladesh Bureau of Statistics). 1986. Report on Bangladesh livestock survey 1983–84. Bangladesh census of agriculture. BBS, Dhaka, Bangladesh.
- BBS (Bangladesh Bureau of Statistics). 1994. *Statistical Pocket Book of Bangladesh*. BBS, Dhaka, Bangladesh.
- BBS (Bangladesh Bureau of Statistics). 1999. *Structure of agricultural holdings and livestock population census of agriculture 1996*. Volume 2. BBS, Dhaka, Bangladesh.
- DLS (Department of Livestock Services). 1998. Development and activities of livestock. (in Bengali). *Department of Livestock Services—An overview*. DLS, Dhaka, Bangladesh.
- DLS (Department of Livestock Services). 2000. *Department of Livestock Services—An overview*. DLS, Dhaka, Bangladesh.
- Islam M.H., Rahman A.K.M.M., Hashem M.A. and Hossain S.M.I. 1999. Women's participation in dairying. *Bangladesh Journal of Animal Science* 28:1–2.
- Kabir M.H. and Talukder R.K. 1997. Returns from investment in dairying in a selected area of Bangladesh—a comparative financial analysis of local and cross breed dairy farms. *Bangladesh Journal of Agricultural Economics* 20(1):67–84.
- Khan A.A., Ali A., Hussain S.S. and Bhuiyan A.K.F.H. 1999. Reproductive performance of different genetic group of cows under farm condition. *Bangladesh Journal of Animal Science* 1:2.
- Miyani H.A. 1996. Towards sustainable development: The national conservation strategy of Bangladesh. Consultancy report on the livestock sector. Ministry of Environment and Forestry, Dhaka, Bangladesh.
- Mould F., Saadullah M., Haque M., Davis D., Dolberg F. and Orskov E.R. 1982. Investigation of some of the physiological factors influencing intake and digestion of rice straw by native cattle in Bangladesh. *Tropical Animal Production* 7(3):174–181.
- Paul D.C. and Saadullah M. 1991. Role of women in homestead of small farm category in an area of Jessore, Bangladesh. *Livestock Research for Rural Development* 2(3):23–29

- Reza A. 1986. Energetic Bangladeshi cattle in their environment: A report. University Grants Commission, Dhaka, Bangladesh.
- Saadullah M. 1989. Availability of shrubs and tree fodders for farm animals in Bangladesh. In: Devendra C. (ed), *Proceedings of a workshop on shrubs and tree fodders for farm animals in East and South-East Asia*. IDRC (International Development Research Centre), Singapore.
- Saadullah M. 1995. Working animal production and research in Bangladesh with special reference to working cows. International Conference on Increasing Animal Production with Resources (IAPLR), held 27–30 October 1995, Ministry of Agriculture, Zhanjiang, China.
- Saadullah M. and Hossain M.M. 2000. Report on the quantification of locally available feed resources and feeding systems of animal in different regions of Bangladesh. Bangladesh Agricultural Research Council, Dhaka, Bangladesh, and Bangladesh Agricultural University, Mymensingh, Bangladesh.
- Tareque A.M.M. and Saadullah M. 1988. Feed availability requirements for animals. In: Devendra C. (ed), *Consultation on expanding non-conventional feed resources and fibrous agricultural residues; Strategies for expanded utilization*. IDRC (International Development Research Centre), Singapore.
- Yunus M. and Jolis A. 1998. *Banker to the poor*. University Press Ltd, Dhaka, Bangladesh.

The current status of smallholder dairy systems in Sri Lanka

B.H.W.M.U.S. Bandara

Department of Animal Production and Health
P.O. Box 13, Peradeniya, Sri Lanka

Background

Sri Lanka lies just off the south east tip of India. The surface land area of the country is 65,525 square kilometres including inland water bodies. In 1999 there was an estimated human population of 19.04 million with a population density of 304 persons per square kilometre; a modest population growth rate of 1.4%; 72.2% of the people lived in rural areas, 21% in urban areas and 6.8% in the estate sector; 91.8% of the population over five years of age was literate; and life expectancy at birth was 72.5 years. Gross National Product (GNP) per capita in 1999 was US\$ 803, the average monthly income of an average household unit was US\$ 124.9 and the monthly expenses of the average household unit in the same year were US\$ 122.7 (Central Bank 2000). In the same year, 1999, average per capita expenditure on milk and milk products was generally low, particularly among the rural sector—the average expenditure on milk and milk products was 3.3% and on meat was 1.5% (MLDEI 2000). Under-nutrition (>30%), under-employment (>40%), unemployment (8.9%), inequity and food insecurity are serious economic issues. Therefore, there are serious economic issues that need to be addressed by any development programme, and the dairy industry is no exception.

The contribution of the agriculture sector to the Gross Domestic Product (GDP) was 20.7% in 1999 and the livestock sector contributed 8.0% to the agricultural GDP. The formal dairy sector contributed 11% of the livestock GDP and beef production another 15% (MLDEI 2000).

The dairy industry is important and has tremendous potential in developing the economy in the country. Milk production has been a traditional industry that has survived thousands of years. For many reasons milk, an important food item, needs to be available in the market with out any shortages. It plays a key role in infant feeding and alleviating nutritional poverty in all other age groups. Milk production is important not only because of the nutrition it provides to the people, but also due to the extensive employment opportunities the industry offers. For these reasons Government gives high priority to reaching self-sufficiency in milk production. While recognising the importance of active participation of the private sector in developing the dairy industry, the government has decided to play a leading role at the beginning and set the stage for rapid development (MLDRI 1995).

Production systems

Current status

The last National Agricultural Census was carried out in 1982 (DCS 1982) and population figures available since then are estimates and projections. According to the 1982 Agricultural Census there were 275,790 cattle holdings and 56,140 buffalo holdings in the country. Hundreds of thousands of smallholders who operate at near subsistence levels dominate local milk production in these systems at present (MLDEI 2000). The 2.2 million cattle and 0.98 million buffalo in 1989 has reduced to 1.62 million and 0.73 million, respectively, by 1999. However, there is an increasing trend in the percentage of upgraded dairy animals, including dairy buffalo, in the country. The number of cows in milk has also increased from 265.6 thousand to 338.7 thousand in cattle, and from 112 thousand to 117.3 thousand in buffalo during this period.

Dairy farming is predominantly a smallholder mixed crop-livestock farming operation. They mostly feed their animals on natural grasses available in common lands such as on road sides, railway banks, fallow paddy fields, tank beds and other vacant lots, all maintained under rain fed conditions (Presidential Sub-Committee Report 1997). This production system in the country can be classified into four main sub-systems as shown in Table 1.

Table 1. *Main dairy production systems in Sri Lanka.*

No	Production systems	Average daily milk production per cow (litres)	Popular management system
1	Hill country	6–8	Intensive
2	Mid country	4–5	Semi-intensive
3	Coconut triangle	3–3.5	Tethered
4	Low country dry zone	1–1.5	Extensive
5	Low country wet zone	3–3.5	Tethered

Source: MLDRI (1995).

Some important topographical and climatic information regarding these systems are given in Table 2.

Table 2. *Cattle and buffalo systems: Topography, climate and animal types.*

No	Production system	Rainfall (mm)	Temperature range (°C)	Animal species
1	Hill country	>2000	10–32	Pure exotic and crosses
2	Mid country	>2000	10–32	Pure exotic and crosses; some zebu crosses
3	Coconut triangle	1500–2500	21–38	Crosses of exotic breeds, zebu types, indigenous animals, buffalo
4	Low country dry zone	1000–1750	21–38	Zebu types, indigenous animals and their crosses, buffalo
5	Low country wet zone	1875–2500	24–35	Crosses of exotic breeds, zebu types, indigenous animals, buffalo

Source: Ibrahim et al. (1999a and b).

However new sub-systems, such as peri-urban dairy buffalo, are also emerging. The breeds utilised, management system adopted, and agroclimatic conditions under which animals are being reared influence the particular production system (Bandara 2000).

Contributions

Dairy production plays a vital role in maintaining sustainability and crop yields in most smallholder mixed farming systems and has provided them with a source of regular daily income and a way of cushioning the risk of frequent crop and marketing failures. It also converts resources such as surplus green forage and crop residues available in and around household into cash products. These resources have limited alternative uses and the opportunity cost can be considered near zero (SAEC 1998).

Constraints

During last few decades, significant changes have occurred in smallholder mixed crop-livestock farming systems, but little is known about the relative contribution of the agro-ecological, technological and socio-economic features affecting these changes. Discipline specific component research is more common in the dairy sector, and relatively little research work has been completed on the interactions between the dairy and other components in most of these mixed farming systems. Policies, and research and development programmes have so far not adequately recognised the strong linkage between crop and dairy production; the complexity of the system; the importance of understanding the rationale for the management systems that account for the striking variations that occur in these mixed farming systems; and the need for different interventions for different systems. As a result there are problems with smallholders utilising technologies and with policy interventions (SAEC 1998).

Recent negative growth rates of cattle population may become a serious constraint for future dairy development in the country (DAPH 1999). Cattle breeding has been recognised as a critical issue for the dairy sector (MLDRI 1995) with many programmes and schemes implemented during last few decades. Yet the expected improvements have not yet been seen. Consequently these issues need to be examined more carefully to see how these programmes can be made more effective (Ibrahim et al. 1999a and b).

Another area that has not been given adequate attention is buffalo development. Very few farmers (14%) milk their buffalo cows and there are too few breeding buffalo. Hardly any artificial breeding takes place; artificial insemination is constrained by difficulties in heat detection and present herd management systems. The National Livestock Development Board (NLDB) has also identified important institutional constraints (Ibrahim et al. 1999a and b).

There is a serious problem in exploiting the genetic potential of improved dairy animals due to the lack of good quality year round feed at the farm level. This is primarily the result of pressure on agricultural land and competing opportunities for labour. There is significant seasonality of fodder supplies and concentrate prices, especially in hill and mid

country areas, which is where most of the upgraded dairy animals are found. Many of these upgraded dairy animals depend on bought-in concentrate feed even to meet some of their maintenance requirements during the driest months of the year. Management of common grasslands such as communal grazing land, public land, roadside etc. is also weak.

Hardly anything worthwhile has happened in the fodder development in the country. Land is not specifically allocated for forage, and grasses are not accepted as a 'crop', even though farmers do not fully utilise available local feed resources for many reasons (MLDEI 2000). As a result available local feed resources are being wasted in large quantities at present.

Compound cattle feed is not popular among most smallholders. Instead they use feed ingredients such as coconut cake and rice bran. Few large scale feed millers control the feed industry in the country at present. Rapid growth has been seen in the production of poultry feeds. However over 80% of the ingredients are imported and so production of compound feeds is an externally dependant system and vulnerable to changes in the world market.

Milk production and marketing

Current status

The average producer price of milk is around US\$ 0.12/litre. The average cost of production ranged from US\$ 0.09/litre in hill country to US\$ 0.05/litre in the dry zone. The average net revenue of milk is low and ranged from US\$ 0.05/litre in hill country to US\$ 0.07/litre in the dry zone. Average price of fresh milk has increased from 8 Indian rupees (Rs)/litre in 1994 to US\$ 0.24/litre in the year 2000. Prices of powdered milk have increased by 50% during this period on an average (MLDEI 2000).

The growth rate of the local dairy industry over the last decade has been estimated to be around 2.5% per annum, in contrast to the projected market growth rate of 5.2%. During the same period average monthly milk production of cow milk has increased from 14.4 to 21.7 million litres and, for buffalo milk, from 5.4 to 6.9 million litres. Much of this productivity change has resulted from the proportion of upgraded animals and low disease challenges for these upgraded dairy animals. In 1998 the per capita availability of cow and buffalo milk was 8.15 kg and 3.60 kg respectively. Per capita consumption of milk increased from 13 kg in 1981 to 36 kg in 1999. However, the Medical Research Institute recommendation is to have a minimum 60 kg of milk and milk products per capita in the country (MLDEI 2000).

It is estimated that the formal milk processors used one-third of the domestic milk production with an equal percentage being used by the informal sector. Milk collecting organisations and private milk collectors play a key role in the formal milk collection network while small scale processors, restaurants, hotels, canteens, neighbouring consumers etc. are dominant in the informal milk market. The increase in domestic milk production has not been reflected in the formal milk market and most of the growth in the domestic production has gone to the informal milk market (Ibrahim et al. 1999a and b).

Within the next five years domestic milk production will cover only 25% of the requirements of the formal milk market, and the balance will be imported from overseas. The

import bill to import 429 thousand tonnes of infant milk powder and another 54 thousand tonnes was US\$ 107 million in 1999. There is a rising trend for the amount of milk imports. However, there is no significant change in the percentage (45%) covered by the imports to the total milk available in the country during last two decades (Ibrahim et al. 1999a and b).

Opportunities

Assuming a 4% rate of real GDP growth, income and population growth alone will generate an increase in aggregate demand for dairy products of slightly over 14 million tonnes by 2010. This increased demand provides important opportunities for domestic producers to increase their production (NDDDB 1998).

Imports of dairy products remain vulnerable to macro-economic factors. Changes in prices of the world milk powder market and local exchange rates (with the recent introduction of free floating Indian rupees against foreign currencies) will challenge the competitiveness of the imported dairy products in the future.

Unlike milk powder, the consumption of fresh milk appears to increase with income suggesting that as incomes increase over time demand could shift toward liquid milk. This will present good opportunities for smallholders who are involved in domestic dairy production. Domestic producers have a comparative advantage in the liquid milk market as reconstituted milk is not a good substitute. Therefore, the means to increase the market for such sales need to be considered (Ibrahim et al. 1999a and b).

The informal milk market plays a larger role than many have assumed. This is an important outlet for many smallholders. It provides much valuable income generating opportunities for small entrepreneurs. Further, the informal market is crucial for ensuring the economic viability of dairy production for many producers as it typically provides higher prices (Ibrahim et al. 1999a and b).

Constraints

In spite of the fact that the Medical Research Institute recommends a consumption level of 60–65 kg/person per year, per capita availability is only about 36 kg/person per year. Therefore Sri Lanka has the lowest milk-consumption in South Asia at present (MLDEI 2000).

Powdered milk is more popular among consumers mainly due to the fact that it guarantees quality, convenience in handling and has the possibility of storing under room temperature for several weeks. Because of this popularity, large-scale processors are compelled to convert liquid milk in to powdered milk and incur heavy costs for transport of liquid milk from rural areas to their processing factories (MLDEI 2000).

Pricing systems prevailing in the country are biased towards satisfying millions of consumers rather than the producers. Relatively, the high opportunity cost of labour relative to the farm gate price of milk discourages farmers from being involved with intensive dairy farming. A rough estimate of farm gate price of milk to wage ratio is 1:13 at present. Then the value of one litre of milk sold at farm gate is only 1/13th of a daily casual

wage. As a result farmers are unwilling to spend time on activities related to intensive dairy farming (Ibrahim et al. 1999a and b).

As the profit margin is very low there have not been adequate incentives offered to the producers to invest in dairy herds. Adequate recognition has not been given in the past to the important role played by smallholders despite the difficulties they experience in operating at near subsistence level. As they have very limited economic opportunities many of them will continue to remain in the dairy farming for many more years to come (SLVA 1995).

The intense advertising efforts by importers of milk powder extolling the virtue of imported milk have weaned the consumer away from the consumption of local milk. Finding effective alternatives for highly promoted, heavily subsidised, cheap imported milk powder can be considered as one of the biggest challenges any dairy development programme has to face at present (MLDEI 2000).

Unhealthy competition among milk collectors at the grass roots level has created another set of problems for the quality of milk collected and to the viability of running a collection programme. The lack of satisfactory milk testing facilities at village level milk collecting centres has added further to the deteriorating situation.

Most farmers produce buffalo curd under very poor hygienic conditions. As a result the quality of these product is questionable and poor. Many pathogenic microbes such as *E. coli*, *Staphylococcus aureus*, fungi and mould species at levels way above safety levels have been found in many curd samples obtained from the market (Bandara 2000).

There is no responsible regulatory system in place to ensure the quality of milk collected and marketed in the country (MLDEI 2000).

Institutional infrastructure and livestock services

The institutional support is provided both by public sector as well as private sector institutions. The public sector is mainly engaged in providing public goods and supply of inputs whilst the provision of necessary marketing facilities is mainly handled by the private sector.

Current status

The Ministry of Livestock Development and Estate Infrastructure (MLDEI), provincial ministries responsible for livestock development in the provinces, Department of Animal Production and Health coming under the central Government (DAPH), the Provincial Departments of Animal Production and Health (PDAPH), National Livestock Development Board (NLDB) and Kiriya Milk Industries of Lanka Organisations are the main public sector organisations responsible of dairy development. However, many other government institutions including the Ministry of Agriculture, Ministry of Land and Environment, Central Environment Authority, Mahaweli Authority, Coconut Research Institute, Department of Agriculture, universities etc. all have direct involvement in developing the livestock sector in the country (Ibrahim et al. 1999a and b).

With the establishment of provincial councils in 1988 the smallholder dairy sector is supported by a state sponsored service delivery system provided by the PDAPH in the provinces. They provide these services through 212 government veterinary offices established all over the country. Each veterinary office is manned with a veterinary surgeon and three livestock development instructors on an average. They are further supported by 87 private artificial insemination technicians especially in the wet zone to implement AI programmes more effectively (DAPH 1999).

Constraints

The investment in the agriculture sector, including livestock, as a share of the public sector has declined from 18% in 1989 to 10% by 1999. One of the notable reasons for not adequately improving the dairy industry in the country has been the lack of substantial investment both by public and private sectors (MLDEI 2000).

Concessions have been given to the private sector under the Board of Investment (BOI) programme to use local milk and promote local dairy industry and local milk collection. However, almost all of the private sector imports almost all its requirements and so give an additional problem to local dairy industry. It seems that most collectors and processors are not much worried about problems of local producers (MLDEI 2000).

Livestock services

Current status

The Ministry of Livestock Development and Estate Infrastructure (MLDEI) and the provincial ministries are responsible for livestock development in the provinces and for developing necessary policies, and for finding and channelling funds coming through the public sector to implementing organisations and monitoring the dairy industry in the country (MLDRI 1995).

Present responsibilities of the DAPH include assisting ministries in policy planning and monitoring, man power training, backstopping provincial extension activities, managing the animal quarantine activities, production and distribution of vaccines, undertaking research into the problems of the livestock industry, administration of legislation related to livestock and co-ordination of special livestock development programmes.

All public sector field programmes are implemented through the field staff of the PDAPH and they are responsible for preventive and curative health care, artificial insemination and follow-up services, farmer education and training while participating in the implementation of special target oriented livestock development projects (MLDRI 1995).

NLDB has been principally involved in the operation and maintenance of livestock farms and issue of breeding materials including planting materials to the field programmes.

Except in the areas where farmers are being organised under the co-operative umbrella, the majority of smallholders are the suppliers to the collection network operated by the

Kiriya Milk Industries of Lanka Limited and Nestles Lanka Limited. These two processing establishments account for 75% of formal milk collection. The farmer co-operative organisations like Coconut Triangle Milk Union (CTMU), Mid Country Milk Union (MIDCOMUL) and a few others convert a small percentage of milk produced into value added products. Apart from two main processors there are a few other organisations like Araliyakelle milk processors, Kotmale dairy processors, New Lanka Dairies Ltd. etc. that have recently ventured into the milk processing market. The area served by these new processors is limited in extent (Ibrahim et al. 1999a and b).

Constraints

According to the present cost of living a minimum of US\$ 3 is needed for an average smallholder family to meet their minimum day-to-day requirements. This is one of the decisive factors in selecting suitable economic activities for their living. Therefore any smallholder oriented dairy development programme must have the capability of ensuring a reasonable contribution to relieve their economic burden within a short period of time.

Reasonably productive and healthy animals, quality feed in adequate quantities year round at affordable prices, dependable and fair marketing facilities, good cattle sheds with an adequate waste disposal system are some of the important essentials for smallholders to remain in the dairy industry.

There are programmes of varying magnitude to address most of these components. Most of these programmes are being implemented independently by different organisations or some time by separate divisions of the same organisation. As a result smallholder farmers do not have the opportunity to maximise the use of their resources and to exploit the complementary effects of these different programmes.

Disease constraints to dairy productivity are associated with the delivery of quality veterinary services, especially for prevention purposes. Though there are many new veterinary offices and alternative arrangements such as mobile veterinary clinics in place, the majority of farmers still find difficulty in getting prompt veterinary service especially in emergencies (MLDEI 2000).

High calf mortality rate (>25%) is a problem among upgraded animals. Calf diarrhoea, worm infestations and infectious diseases are the most common cause of these deaths. Poor calf management, inadequate calf salvaging and health care programmes also contribute to the situation (MLDEI 2000).

Restricted cattle movements and conflicts between crop farmers and buffalo owners have continued for a long time and trespassing by animals and the consequent crop damage frequently cause severe social problems.

Although the development of forages is essential, there are no strong institutional arrangements to spearhead a useful programme for this purpose (Ibrahim et al. 1999a and b).

Many organisations are involved in dairy development in the country. They do research, supply necessary inputs and services, formulate and implement policies, strategies and development plans. However, understanding, interaction and co-ordination among them is still weak (MLDEI 2000).

According to the cost of living and cost of milk production provided earlier in this paper a minimum of 15 litres daily production is needed to earn a reasonable income from dairy farming at the smallholder level. Three cow equivalents of upgraded dairy animals with an adequate cattle shed and a fodder plot of over twenty perches are needed to allow a smallholder to make this profit.

However, the majority of smallholders do not have these minimum requirements. There is a need to improve their dairy farms. On average a minimum of US\$ 500 of new investment is needed for each smallholder. However this is beyond their capacity at present due to their subsistence living conditions. Credit programmes are available in commercial banks. However, farmers have to pay back these loans within 3–4 years with an annual interest of 18–20%. More concessionary credit programmes are needed that take into account the prevailing returns and profit margins of smallholder farmers.

Manpower available in the public sector is grossly inadequate to cater to the service needs of the dairy sector. Inadequate participation of the private and co-operative sectors in the delivery of these services is a weakness of the industry at present (MLDEI 2000).

Co-operative development in the dairy sector has been occurring for a number of years particularly during the past three decades. Yet today only about 16% of the farmers are members of such co-operatives. There is a possibility of implementing certain components of the public sector development programmes through these organisations. However, the lack of trained staff, questionable accountability, transparency and financial discipline of some of these organisations have a negative effect of entrusting them with such responsibilities at present.

Most of the private sector institutions that are involved with milk collection and processing have not shown much interest in delivering other services to their suppliers. Also public sector institutions have not tried to develop their programmes with the ultimate objective of handing over those programmes to the private sector within a specified time period, or to implement joint programme with the private sector keeping similar objectives in mind (MLDEI 2000).

Researchers in many areas have developed beneficial technologies. However, due to the absence of demand and farmer-driven research–extension–farmer linkages, the benefits of these innovations have not been fully exploited (MLDEI 2000).

The lack of focus on measurable performance indicators, other than supporting large unconnected aspects of dairy development, and the absence of a regular monitoring programme to assess the impact of dairy development is another serious obstacle to present development efforts (MLDEI 2000).

Research systems

The Council for Agricultural Research Policy (CARP) is the principal organisation that finally decides research policy and priority areas for research activities in the agriculture sector including livestock. The Veterinary Research Institute (VRI) has leadership role for animal health research related to the dairy sector. The VRI has also undertaken many collaborative research programmes with other national and international agriculture

research institutions and academics. They identify research needs mainly by interacting with staff of the DAPH and PDAPH who are involved with field programmes. The existing field network in the PDAPH is used for technology transfer.

Policy issues

The policy framework for dairy development has been designed in accordance with the macro-economic policies of the government. Accordingly, the main objective of the policies is to provide public goods by the state and to allow the private sector to cater to the provision of private goods. Hence the Government is keen to facilitate the activities of the farmers and private sector agencies in dairy production, marketing, and to create a competitive industry structure for the dairy sector. The promotion of liquid milk consumption is also a major objective of the present policy framework. Because of the current economies of scale the state is obliged to continue to provide some services to dairy farmers (MLDEI 2000).

The Government has adopted open market policy in trading dairy products. However, there is a 10% duty rate and 5.5% defence levy in addition to the 2.5% of stamp duty on imports of dairy products at present. With the implementation of international trade agreements such as the World Trade Organization (WTO), the South Asian Association for Regional Co-operation (SAARC) Preferential Trading Arrangement (SAPTA) and the South Asia Free Trade Area (SAFTA), it is likely that the international prices of dairy products will increase in the world market. Therefore, the present effective rate of taxation of dairy products at nearly 19% may be sufficient to give the required protection for the domestic dairy industry unless market conditions change (Ibrahim et al. 1999a and b).

The government policy on animal feed is to promote a competitive animal feed industry. Accordingly the government has allowed free trading of animal feed ingredients except maize and by-products of animal origin for the manufacture of livestock feed. However, the use of manufactured cattle feed has remained at a negligible level. One contributing factor to this is the Goods and Services Tax (GST) charged at 12.5% on the value addition. However, because milk is not subject to GST, farmers do not have the opportunity to obtain a credit for the GST charged for the manufactured feed they use (Ibrahim et al. 1999a and b).

Dairying is not the main source of income for most of the smallholders and, in most instances, it is not the activity of the husband of the family. In fact housewives do most of the dairy related activities while also attending to their other family obligations. Although nearly 40% of the members of registered dairy co-operatives are women they are rarely represented in the management or executive committees of these organisations. However, when housewives do have a role in managing household dairy activities and their dairy co-operative a substantial improvement can be seen in the economy of the family and the organisation.

Dairying is generally a component of a partially closed mixed farming system at the smallholder level. Some of the waste of the dairy unit such as dung, urine and wasted feeding materials are used as manure for crop farming and some of crops and crop wastes are fed to the animals. In addition the cultivation of forages has helped to control soil erosion and improve soil fertility. Hence dairying at smallholder level is an environmentally friendly activity when it is properly managed within the farming system (SAEC 1998).

References

- Bandara B.H.W.M.U.S. 2000. Current status of buffalo production in Sri Lanka. In: *The Proceedings of the third Asian buffalo congress, held in Kandy, Sri Lanka, 27–31 March 2000*.
- Central Bank of Sri Lanka. 2000. *Sri Lanka socio-economic data 1982–2000*.
- DCS (Department of Census and Statistics). 1982. *Agriculture census and statistics*.
- DAPH (Department of Animal Production and Health). 1999. *Livestock Data 1999*. Livestock Planning & Economic Unit, DAPH, Colombo, Sri Lanka.
- Ibrahim M.N.M., Staal S.J., Daniel S.L.A. and Thorpe W. 1999a. *Appraisal of the Sri Lanka dairy sector. Volume 1*. Synthesis report. Department of Animal Science, University of Peradeniya; ILRI (International Livestock Research Institute), Nairobi, Kenya; and Ministry of Livestock Development and Estate Infrastructure, Colombo, Sri Lanka.
- Ibrahim M.N.M., Staal S.J., Daniel S.L.A. and Thorpe W. 1999b. *Appraisal of the Sri Lanka dairy sector. Volume 2*. Main report. Department of Animal Science, University of Peradeniya; ILRI (International Livestock Research Institute), Nairobi, Kenya; and Ministry of Livestock Development and Estate Infrastructure, Colombo, Sri Lanka.
- MLDEI (Ministry of Livestock Development and Estate Infrastructure). 2000. *Policy strategy for dairy industry*. Ministry of Livestock Development and Estate Infrastructure, Colombo, Sri Lanka.
- MLDRI (Ministry of Livestock Development and Rural Industry). 1995. *Policy and programmes*. Ministry of Livestock Development and Rural Industry, Colombo, Sri Lanka.
- NDDB (National Dairy Development Board). 1998. *An investment proposal for the dairy development project in Sri Lanka*. NDDB, Anand 388001, India.
- Presidential Sub-Committee Report. 1997. *Dairy industry in Sri Lanka: Status, limitations and suggestions for revival*. Presidential Sub-Committee on Animal Production and Health Sector, Colombo, Sri Lanka.
- SAEC (South Asia Eco-regional Consortium). 1998. Increasing livestock productivity in mixed crop–livestock farming systems in South Asia. SAEC, New Delhi, India.
- SLVA (Sri Lanka Veterinary Association). 1995. *Strategies for revitalizing the dairy industry*. SLVA, Colombo, Sri Lanka. 48 pp.

An overview of smallholder dairy production and marketing in Nepal

D.D. Joshi¹ and K.C. Tarak Bahadur²

1. Director, National Zoonoses and Food Hygiene Research Centre (NZFHRC), Tahachal, GPO Box 1885, Kathmandu, Nepal

2. Executive Director, National Dairy Development Board (NDDB), Kathmandu, Nepal

Introduction

Background information about the country

Nepal is located in the South Asia Region. It is landlocked between its two large neighbours, India and China. It is a small country with a land area of 147,181 km² inhabited by more than 23 million people. As per United Nations criteria, it is a least developed country with a gross national product (GNP) per capita of about US\$ 210 in 1997. The country is one of the poorest in the world. Literacy rate was 41% for males and 14% for females in 1995 (World Bank 1998). Eighty-nine per cent of the population lives in rural areas and agriculture, engaging about 81% of the population, contributes about 40% of gross domestic product (GDP).

Nepal can be roughly divided into three geographic ecoregions, each with its own distinctive environment, peoples, economy, customs and culture. Different landscapes have shaped different lifestyles. The first geographic ecoregion, the Terai Region, is the narrow strip of flat land running along the southern border; it averages only 20 km in width and constitutes less than one-fifth of Nepal's total area. Yet the flat, fertile Terai contains virtually the only reasonable farmland in Nepal and supports nearly half of the population. Seventy per cent of the country's arable land is in the Terai; over 60% of its grain is grown here. The hot lowland Terai is a geographic extension of northern India's Gangetic Plain, and Indian influences have shaped its cultures and societies. The second geographic ecoregion, the Hill Region, is a rugged Region with deep valleys and terraced ridges covering about half of its total area. The name is misleading since Nepal's hills would rank as mountains anywhere else. About 45% of the population lives in this 'up and down' Region, farming terraced fields patiently carved out of the hillsides by generations of farmers. The third geographic ecoregion, the Mountain Region, includes the Himalayan Mountains. This Region welds the Indian subcontinent to Asia, extending over 3800 km in a great arc from the Hindu Kush range of Afghanistan to eastern Tibet. Twice the height of the Alps, it is the undisputed king of mountain ranges, claiming the world's 86 highest peaks before another range manages to interject a contender.

Nepal's Living Standard Survey (1996) showed that 42% of the population lives below the poverty line (NPC 1996). Moreover, the CBS Agriculture Census (1991) showed that 43.5% of the population hold less than 0.5 ha of land, indirectly endorsing the poverty estimate. Nepal, at present, has three attractive sectors to exploit for her development: first, agriculture, secondly water resources and thirdly tourism.

Background information about livestock

Livestock keeping has been an integral part of crop agriculture. Cows and buffalo are raised for draft power (oxen/male buffalo), production of animal manure and the supply of animal protein (cows for milk, and buffalo for both milk and meat). Goats, poultry and other animals are also raised but the large animals are predominant. Animal manure is the major source of fertiliser for the crops. Use of chemical fertiliser is low, about 30 kg/ha. The livestock sector contributes about a third of agricultural GDP and 4% of total exports for the nation. The national average per family livestock holding includes 3.8 cattle/buffalo, 2.2 goats and 4.5 poultry, which is high compared with other countries. Moreover, the total population of yak and chauri (crossbred animals between yak and local hilly cattle) is about 60 thousand out of which 10 thousand are producing milk. The yearly productivity is, however, very low. For example, average annual milk yield is 378 and 810 kg per milking cow and buffalo, respectively (Table 1). The milk yield for yak is even lower at 232 kg/year. Similarly, level of annual meat production per unit buffalo, goat, pig and fowl is low at 56, 6, 18 and 0.7 kg, respectively. Egg production per hen is also low at 84 eggs/year. Overall agricultural growth during the last 10 years (1990–99) has been low at 3.0% per annum and livestock sector growth has remained at 2.8% per year. The Nepal Agriculture Perspective Plan (APP) with a horizon of 20 years has been effective in the country's agriculture sector since 1997/98 (MoA 1998). The plan emphasises milk and associated meat production.

Table 1. Milking cow and buffalo populations, total milk production/year and annual milk production/animal.

Area	Number of milking cows	Number of milking buffalo	Total annual cow milk production (kg)	Total annual buffalo milk production (kg)	Annual milk production/milk animal (kg)	
					Cow	Buffalo
Hill	428,274	527,808	152,455	403,075	366	764
Mountain	98,087	70,433	32,027	48,908	327	694
Terai	258,579	222,679	112,138	212,957	434	956
Total	784,940	820,920	296,620	664,940	378	810

Source: MoA (1997).

Growth of GDP during the last 5 years has been 2.7% per year. APP has considered the livestock sector as a demand-driven product and aims to attain a growth rate of 3.6% during the first phase of the plan.

Milk consumption pattern

Fluid milk consumption among households in urban areas is widespread. About 88% of urban households consume fluid milk regularly and another 7% occasionally. The average quantity purchased is 1.03 litres/day per household, with 1.1 litres in the Hill and 0.9 litres in the Terai regions. However, the habit of drinking milk regularly has not yet been developed in Nepal. Milk is drunk regularly by family members of less than 20% of households. Even among children, the percentage of regular consumers of milk is low at 18%. In urban areas, the use of milk for tea is popular; about 94% of households use milk for tea whilst 60% drink it as milk.

In terms of brand, consumers preferred milk from the Dairy Development Corporation (DDC) and from farmers (42% and 36%, respectively). Consumer preference for the brands from the private sector was much lower. The favoured packaging was the inexpensive plastic pouch (by 58%) and the favoured portion size was half a litre. Milk sold from the formal sector was bought mostly (about 80%) by consumers at a cost of approximately 20 Nepalese rupees (NRs) per litre (US\$ 1 = NRs 76 on 1 November 2001). Higher prices were paid for milk bought from the informal sector. There were also systems of 'udder to consumer's pot' milk supplies at NRs 24–30/litre, depending on the place. Most of the consumers (about 80%) were paying the DDC price (NRs 22/litre) for their milk.

Consumers have the tradition of boiling their milk; they are aware that the quality of milk is low and that they need to repeatedly boil their milk during the day. There is a need to improve the safety of milk. The share of milk consumed by children and elderly people seems to be low. For this reason, it is necessary to advertise and promote the nutritional qualities of fresh milk for key age groups of consumers. Children would be an important target group. For milk products, consumption is primarily concentrated on traditional products like ghee (45% of households) and yoghurt (33% of households). Proportions of households consuming other milk products are very small, e.g. dairy whiteners 6%, butter <3%, cheese <3%, sweets <3% and other products <1%.

Demand for and supply of dairy products (milk and milk products)

Present production pattern in dairy

Dairy development activities by His Majesty's Government (HMG) in Nepal began in 1952 with the establishment, under the Department of Agriculture, of a small-scale milk processing plant on an experimental basis in Tusal, a village in the Kabhrepalanchok District. Yak cheese factories were also started with FAO (Food and Agriculture Organization of the United Nations) assistance, the first one being set up in Langtang, Rasuwa District, between 1952 and 1953. In 1995, the Dairy Development Section was established under the Department of Agriculture. Moreover, a Dairy Development Commission was formed in 1955 to guide the dairy development activities. With the

growing prospect of expanding the dairy sector, the First Five-Year Plan (1952–57) stressed the need for developing a modern dairy industry. The Dairy Development Commission was converted into the Dairy Development Board in 1962. In order to meet the growing milk demand in Kathmandu, the board was converted into the Dairy Development Corporation (DDC) in July 1969 under the Corporation Act of 1964.

The DDC gradually established various milk supply schemes to meet the growing demand for processed milk and milk products. The Biratnagar Milk Supply Scheme was established in 1973, the Hetauda Milk Supply Scheme in 1974, the Kathmandu Milk Supply Scheme in 1978, the Cheese Production and Supply Scheme in 1979 and the Pokhara Milk Supply Scheme in 1980. The schemes were involved both in milk collection and processing of milk products. In 1989, many of the schemes of the DDC were rehabilitated with assistance from the Danish International Development Agency (DANIDA). Dairy plant capacities were increased from about 74 thousand to about 180 thousand litres/day after the rehabilitation. In 1990, the Ten-Year Dairy Development Plan for 1991–2000 (TYDDP) was designed (DANIDA/MoA 1991) and approved. As recommended by the TYDDP, a skim milk power plant was established in Biratnagar in 1991.

At present, the DDC has a milk collection network in 36 districts throughout the country. The amount of milk collected annually by the DDC for the years between 1989 and 1998 is shown in Figure 1. The DDC and private sectors are involved in collection and processing of milk supplied from the rural areas; their respective shares are roughly 50:50 (Figure 2). The milk sheds have over 900 Milk Producers' Co-operatives (MPCs) with approximately 100 thousand producers. There are as many as 75 thousand farm families supplying 214 thousand litres of milk/day to collection centres. Each farmer supplies about 3 litres of milk/day. Approximately 50% of the milk produced in Nepal is produced in districts within the existing DDC grid. Current chilling capacity in the milk grid is approximately 320 thousand litres/day. The formal sector collects about 20% of the milk produced in the existing four milk sheds.

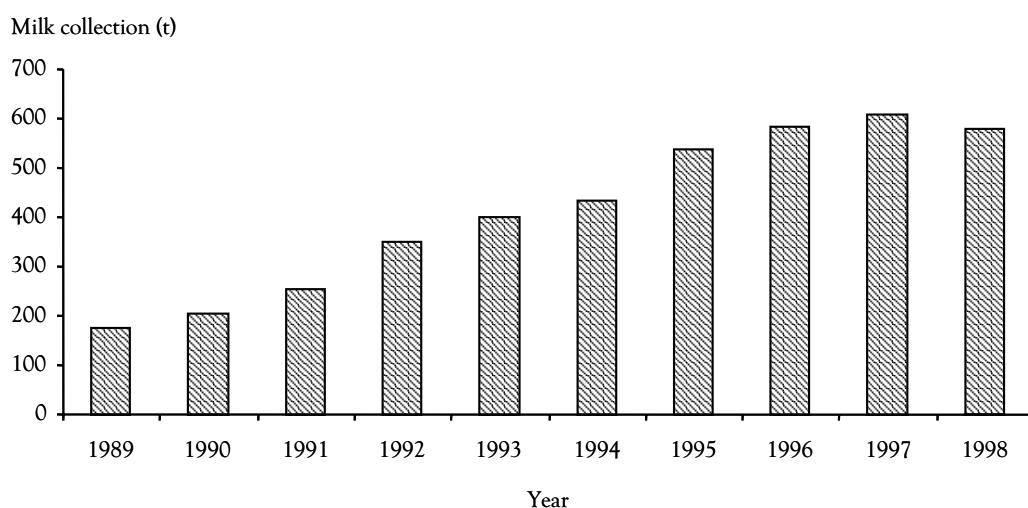


Figure 1. Total milk collection by DDC.

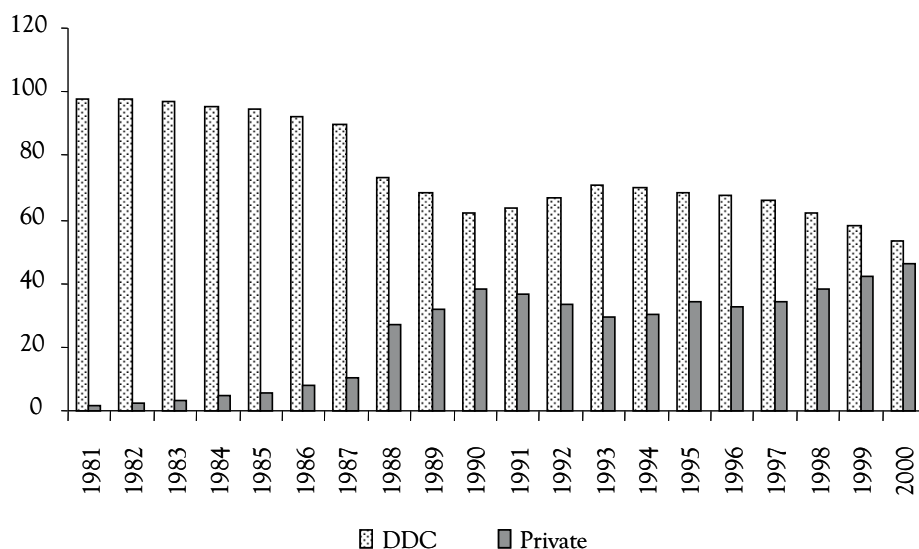


Figure 2. Market share (%) of the DDC and the private sector in milk sales for 1981–2000.

The DDC has an installed minimum capacity of 182 thousand litres/day and maximum processes 214 thousand litres/day in the peak season with an average of 198 thousand litre/day per day. The private sector has an installed capacity of 384 thousand litres/day but is only utilising 167.2 thousand litres/day in the peak season with an average volume processed of about 156 thousand litres/day. Processing capacity of the sector is not being utilised (DDC 1999).

The private sector share in the market has been increasing steadily. It was less than 2% in 1980. Presently, the private sector share has reached 46% with a yearly growth of about 15%. However, the private share involvement is mostly (72%) in the central region.

Regional milk production trends indicate that the eastern, central and western regions each produce between 22 and 27% of milk and the mid-western and far-western regions produce about 12% each. Growth rate in milk production ranges from 2.2–5.3% per year with the highest growth in the eastern (4.01%) and far-western (5.3%) regions. By eco-region, the proportions of national production are 8, 56 and 35% for the Mountain, Hill and Terai regions, respectively. The corresponding growth rates are 1, 2.8 and 5.2% per year, respectively, with the highest growth in the Terai Region.

The MPCs collect milk from member farmers and supply milk to chilling centres owned by the DDC. The DDC has 43 chilling centres located in 28 districts, collecting milk from 34 districts and supplying milk to 6 different milk supply schemes. The milk supply schemes of the DDC also receive milk directly from the MPCs rather than via chilling centres. The milk collection channels for the private sector dairies are fairly similar to those of the DDC.

Very few private sector dairies own chilling centres or receive milk through chilling centres. Himalayan Dairy has seven chilling centres located in four districts and Sitaram Gokul Milks collects milk through eight chilling centres located in five districts. None of the other dairies have chilling centres but they collect directly from the farmers or from contractors and milk vendors.

Milk collection and cheese production in Himalayan Region of Nepal

All the milk produced by smallholder farmers is processed into cheese. Yak cheese is produced by the DDC as well as by the private sector. All the cheese plants are located in the alpine regions of the country, where cheese is stored under natural refrigeration. Cheese is produced using Swiss technology and the production is seasonal, meaning that cheese is produced only for seven months of the year and that the plants close down during the five months from December to April. Yak cheesemaking by the private sector is growing and the production has surpassed the DDC's production in the recent years. There are about 21 yak cheese producers in the private sector in four districts.

Milk pricing system

The pricing system established by HMG Nepal is based on content of fat, solids-not-fat (SNF) and total solids (TS) in the milk. The average milk-pricing programme presented in Table 2 was used during the lean and flush seasons of the year 2000.

Table 2. Milk pricing system during lean and flush seasons, 2000.

Component	Price (NRs)				Overall average
	Lean season range	Lean season average	Flush seasons range	Flush season average	
Milk fat (per kg)	143–166	155	135–160	147	151
SNF (per kg)	96–113	105	94–111	103	104
TS (commission to co-ops/kg)	11–19	15	11–19	15	15
TS (commission/litre of milk (5% milk fat, 8% SNF) to co-ops)		1.95		1.95	1.95 (10.6%)
Price/litre of milk to farmers		17.15		15.59	16.37 (89.4%)
Total cost/litre of milk		19.1		17.54	18.32 (100%)

SNF = solids-not-fat; TS = total solids.

Source: DDC (1999).

Prices do not reflect geographic location of production and consumption; there is no significant price differential between low and high production seasons, and no differentiation by quality and functionality of the raw milk for different end-uses. There is a lack of standards, lack of pricing systems for raw milk and lack of monitoring of quality on all levels. To secure sustainable development of the Nepal dairy industry it is imperative to give quality improvements a very high priority and to implement the necessary tools. In the year 1999, Nepal producers of buffalo milk (5.5% milk fat and 8% SNF) received NRs 15/litre, equivalent to US\$ 0.21/kg. The DDC retail price for milk in Nepal is NRs 20/kg for standardised milk containing 3% fat, representing a margin of NRs 5/litre (US\$ 7/kg). In the USA, the marketing margin for collection, distribution, processing, marketing and distribution of milk is five times greater.

The government policy of fixing the producer and retail prices is a major deterrent to the development of the dairy industry. Prices are set under a climate of political influence with no relevance to general market conditions inside Nepal or to border prices.

Projected demand and supply of milk

The institutional demand for fluid milk in urban areas is 226 thousand litres/day; the DDC supplies 46%, the private sector 31% and the farmers 23%. Demand for milk products varies by season and is influenced by festival periods. Eighty per cent of ice cream consumption and 65% of yoghurt consumption occurs in the summer months. The regional distribution of processing plant capacity is shown in Table 3.

In 1999, the National Dairy Development Board (NDDB)/DANIDA Support Project (DSP) conducted a benchmark survey of quality of milk and milk products in Nepal. The survey included the major milk processing and marketing areas of the eastern, central and western regions of the country and covered the milk chain, from the farmers to the retail outlets in the market place. The milk chain included smallholder farmers, milk co-operatives, traders, chilling centres, processing plants and the market. Quality checks were carried out for raw milk, pasteurised milk, cream, butter, ghee, cheese, paneer, ice cream and *dahi*.

Milk quality

The problem of milk quality worsens when there are deliberate attempts to reduce milk quality made with the intention of monetary gains. At some units, raw milk is exposed to various kinds of adulteration; substances are added to change the chemical composition of the milk to increase payments. At each point in the chain, quality control and monitoring activities are not performed effectively. The problem of quality in milk collection will be solved to a greater extent if chilling of milk can be performed as close to the milk production point as possible. Milk collection involves the maintenance of milk quality by maintaining the cold chain from the point of production until the point where the milk reaches the processing plant. The milk must be kept cool during transportation until it is pasteurised because the process of chilling retards bacterial growth.

Cost of milk production in Nepal is high because of factors such as low productivity per animal, poor feed and fodder supplies, inadequate extension services, poor research etc. The cost of producing one kilogram of milk in Nepal is between NRs 13.5 and 15.5 depending on the type of farm, location etc. Internationally, the cost of milk production in Nepal is higher (by 50% or more) than in countries such as New Zealand and Australia. The relatively high cost of producing milk of a general low quality is a major constraint in achieving the goals of the Nepalese dairy industry.

The Food Act 1966 was promulgated with the following objectives: to protect consumers against hazards to their health from adulterated food; to protect and safeguard consumers against fraudulent and malfeasant practices in the food business; to ensure fair practice by food handlers; to help minimise dumping of hazardous and substandard food articles; and to determine and maintain the quality and standard of food.

Table 3. *Regional distribution of plant capacity in Nepal.*

			Capacity	Utilisation	Difference
Region	Plant	Ownership	(litres/day)	(litres/day)	between capacity and utilisation
Eastern	Biratnagar Milk Supply Scheme	DDC	60,000	60,000	0
	Small and Mini Dairies	Private	10,000	7700	2300
		Total	70,000	67,700	2300
		Kathmandu Milk Supply Scheme	DDC	90,000	120,000
		DDC	18,000	12,000	6000
Central	Hetauda Milk Supply Scheme				
		Subtotal	108,000	132,000	-24,000
	Sitaram Gokul Milks	Private	80,000	30,000	50,000
	Himalaya Dairy	Private	80,000	30,000	50,000
	Integrated Dairy	Private	20,000	12,000	8000
	Bhaktapur Dairy	Private	30,000	5000	25,000
	Shree Ram Janaki Dairy	Private	12,000	8000	4000
	Kathmandu Dairy	Private	12,000	4000	8000
	Kharipati Dairy	Private	10,000	4000	6000
	Sainju Dairy	Private	12,000	6000	6,000
	Jai Ganesh Dairy	Private	12,000	4000	8000
	Manakamana Dairy	Private	6000	4000	2000
	Small and Mini Dairies	Private	43,000	33,100	9900
		Subtotal	317,000	140,100	176,900
		Processing by Co-operatives	Co-op	1500	600
	Total	426,500	272,700	153,800	
Western	Pokhara Milk Supply Scheme	DDC	12,000	20,000	-8000
	Lumbini Milk Supply Scheme	DDC	2500	2000	500
		Subtotal	14,500	22,000	-7500
	Siddhartha Dairy	Private	30,000	0	30,000
	Small and Mini Dairies	Private	17,800	13,700	4100
		Subtotal	47,800	13,700	34,100
	Processing by Co-operatives	Co-op	1500	800	700
		Total	63,800	36,500	27,300
Mid-western	Small and Mini Dairies	Private	4500	3500	1000
		Total	4500	3500	1000
Far-western	Small and Mini Dairies	Private	1900	800	1100
		Total	1900	800	1100
Total for the country			566,700	381,200	185,500

Source: NDDB/DSP (1999).

Government efforts in livestock development

The Department of Livestock Services (DLS) is a department of the Ministry of Agriculture and Co-operatives of HMG Nepal. It aims to increase the total contribution of the livestock sector to GNP by developing the livestock sector with diversification, commercialisation and conversion of livestock farming, particularly smallholder livestock production, into an income generating and prosperous profession. The objectives of DLS include increasing the production of milk, assisting in quality improvement of milk, helping in market identification and management, and encouraging the livestock base industries.

The Third Livestock Development Project, mainly funded by the Asian Development Bank, is currently ongoing in the DLS. The project has an agro-processing and marketing component, which focuses on development of milk collection, improvement of milk hygiene, improvement of manpower skills in the dairy industry, encouragement of small-scale dairy processors and on increasing the production of traditional dairy products.

The Nepal Bureau of Standards and Metrology (NABS) was established under Quality Standardisation Act 2037. The NABS is involved primarily in the preparation of national standards, implementation of national standards and certification, and providing analytical services through its laboratories. It also provides certification of private sector laboratories and certification of weights and measures, including legal and scientific metrology.

The Department of Co-operatives (DoC), which is a regulatory body assigned by the Co-operative Act 2048, is headed by the Registrar of Co-operatives. All the MPCs are registered at the DoC and they abide by the co-operative regulations. The National Co-operative Development Board (NCDB) was constituted following the NCDB Act, to formulate national level policy and planning for the promotion and development of co-operatives.

In the livestock sector, HMG Nepal has implemented the Livestock Sector Master Plan (LSMP) since 1993. The plan covered 10 years. In 1995, a Twenty-Year Agriculture Perspective Plan (APP) was designed with the strategy of agriculture led growth for rapid economic growth and poverty alleviation in the country. The APP envisaged an overall 5% annual growth in agriculture for the following 20 years. Broadly, the livestock sector strategy was designed in line with the LSMP, which was due to be completed by the year 2000. Livestock sector strategy under APP emphasised meat and milk production, animal nutrition (specifically nutritional fodder supply), animal health and marketing. The Ninth Five-Year Plan (1997–2002) in execution from 1997–98 has embraced the entire APP into the plan (NPC/HMG Nepal 1998). The ninth plan has also expressed a longer-term perspective in various sectors, particularly in the smallholder dairy farmer sector.

The TYDDP for 1990–2000 (DANIDA/MOA 1991) provides an extensive study of the dairy sector before 1990. The study includes a market analysis for milk and some milk products, the Livestock Master Plan 1993, the feasibility study for the Third Livestock Development Project 1995 and the various reports prepared by the NDDB and the DSP to the NDDB.

The NDDB was established in 1992 under a separate act, as a national body to formulate and recommend policies and plans for dairy development in Nepal, and to strengthen the dairy sector by co-ordinating the activities of private and public sector dairies.

Economics of the smallholder system

Agriculture is pivotal to poverty reduction in Nepal, as 89% of the population is rural and a large proportion of it is poor. In the long term, HMG Nepal has projected some key economic indicators for the smallholder livestock farmer population in particular and the rural population in general.

The influence of religion and cultural practices on the adoption and practice of dairy production and marketing by smallholders is favourable in the mid-Hill and Terai regions, whereas in the Mountain Region adoption is restricted only to the Sherpa community. At present, in all three regions, the smallholders have the opportunity to produce livestock products but lack, or have very little, scope to access markets or to achieve profitable prices for milk and milk products. The government or dairy industries must give thought to this aspect in order to improve the economic situation of these smallholder dairy farmers.

Policies for livestock environmental management in Nepal

There is little responsibility for the environmental aspects of milk production in the different areas of Nepal (World Bank 1998); however, certain assessments and studies are being carried out in the country, some of which are mentioned below.

Methane emissions

When combined with animal nutritional interventions, a programme resulting in disease eradication could produce an overall reduction in ruminant methane emissions of up to 42%. Thus measures which improve overall animal health would be expected to reduce ruminants' production of methane gas, resulting in improved efficiency of production as well as significantly lower levels of methane production/kg of milk, meat, or fibre produced (Heidmann et al. 2000).

In 1998, Appropriate Technology International-USA (ATI-USA) in association with Nepal's National Zoonoses and Food Hygiene Research Centre and NDDB formulated a proposal for greenhouse gas emissions reduction through enterprise development and for improved livestock feeding by using molasses-urea blocks (MUBs) in small-scale dairy production (Joshi et al. Unpublished). This proposal was based on earlier work by Joshi et al. (1997), which showed that by introducing MUBs milk production efficiency in dairy animals was increased and thus methane production was reduced.

Biogas energy

Biogas plants anaerobically convert animal dung, human excrement and other biomass wastes into combustible methane gas. This 'biogas' can be used effectively in simple gas

stoves and lamps to replace the use of scarce fuelwood, agricultural residues, 'dung cakes' and highly cost subsidised kerosene. In addition, the resulting slurry from biogas plants can be collected easily and used as a fertiliser to enhance agricultural productivity. The biogas technology is a proven and established technology in many parts of the world. The Biogas Support Programme (BSP) in Nepal, in its first and second phases, has successfully constructed more than 20 thousand biogas units in Nepal. Up to July 1998, a total of 37 thousand units had been installed under the BSP, benefiting more than 200 thousand members of rural households. From a local perspective, the use of biogas has helped to significantly improve the indoor air quality of homes employing biogas stoves in place of wood stoves. In addition, installation of biogas plants has resulted in better management and disposal of animal dung and human excrement (Mendis and van Nes 1999).

Environmental aspects including the transportation of milk in tankers from the milk collecting centres to the dairy processing plants

Environmental aspects include wear and tear of roads, air pollution from the trucks and energy use (diesel and oil). Major environmental issues in relation to processing and packaging of milk and milk products are: energy consumption (electricity and oil for boilers etc.); smoke from chimneys; wastewater which can contain chemical and milk residues etc.; noise from trucks, machinery etc.; whey from cheese production, if whey is discharged into the drains; consumption of wood (for boiling/heating of milk in very small dairy and cheese processing plants e.g. yak cheese plants in the mountainous region); and disposal of packaging materials for milk (plastic pouches, cartons etc.). Effluent from dairy plants, in particular from cheese processing plants, can be a source of heavy pollution to the environment. If untreated, wastewater from a dairy led into a nearby river can pollute the water very badly. As a result, the people who used to use this water for drinking and washing will lose their water source.

Some DDC processing plants have effluent treatment plants but they are not used, most probably because of the high cost of operating them. Unfortunately, none of the private dairies have installed effluent treatment plants. HMG Nepal does not have consistent policies regarding products and processing plants although there are various acts, standards and regulations that relate to environment pollution by the dairy industries in Nepal. It is important to examine the prevailing laws relating to the dairy sector and to assess their implementation with regard to environment pollution.

Constraints in livestock development

- inadequate delivery of animal health service
- lack of long-term appropriate livestock policy
- poor livestock farm management

- poor indigenous livestock and lack of exotic livestock/breeding stock in the country
- inadequate fodder resources
- lack of capital among the smallholder dairy farmers
- poor marketing facilities for live animals and animal products
- lack of supporting services such as research on farmer's problems; and,
- influence of socio-cultural values on livestock raising.

Beside the above-mentioned constraints, the following points could be the major issues or constraints for milk production, processing and milk marketing facilities in Nepal (DDC 1999; NDDDB/DSP 1999):

- Milk supply to the formal sector increases during the flush season, but this sector does not have the capability to purchase all the milk that the smallholder dairy farmers produce, and because of this 'milk holiday' exists. The flush season starts around September and ends in February. The monthly collection is highest during January (9.6% of yearly collection) and lowest during April (6.8% of yearly collection). Collection during the flush season (six months) represents 55% of total annual collection, whilst collection during the lean season (the subsequent six months) represents about 45% of the total.
- The government is not making transparent policy, and policy guidelines are not followed strictly. Therefore, the environment is not very conducive to private sector investment. As a result, the private sector is unsure about making investment. Issues, such as the lack of decision in DDC restructuring and price control by HMG Nepal through the DDC, are impeding private sector growth. At the current price structure, the cost of raw milk is higher in Nepal than in India. Dairy plants have to manufacture various dairy products utilising expensive raw materials and later compete with similar products in the market that are manufactured from lower cost raw materials, manufactured by companies with better marketing networks. This puts the domestic industries at a disadvantage. Moreover, lack of quality control in the import of skim milk powder has resulted in the production of low quality of milk by dairies. Furthermore, in relation to legal issues, the implementation of the Food Act 1996 has been very weak.
- Milk as a political tool. Often the issues such as milk pricing, establishment of a dairy processing unit and welfare of farmers etc. are used as political tools. There is a great need to educate consumers and for dairies to launch new products, although market penetration will be tough.
- Problems for export. Although many concessions are provided by HMG Nepal for export-oriented companies, the conditions imposed recently by the Government of India on Nepalese agro-products make it difficult for export.
- Lack of a business approach. The DDC runs with a traditional production oriented approach without a market focus and consumer oriented culture. Both the DDC and the private dairy sector have concentrated on manufacturing basic dairy products, such as pasteurised milk in plastic pouches, and butter and ghee from the excess milk fat. So far, the dairy sector in Nepal has made little effort to find new markets for existing products.
- The private sector lacks manpower and technology for product diversification. Whatever has been done is based on experience rather than on the basis of formal

technical training. Product diversification needs investment and high quality raw materials; accordingly, many dairies find it a problem. Development of human resources and training is an important factor of the development of the dairy sector.

- Farmers are not as aware of co-operative principles. Appropriate mechanisms should be developed for creating awareness of co-operative principles and to make the co-operative movement successful. There are many weaknesses in the implementation part of the Co-operative Act 1992. Of all the co-operatives registered under the act, 80% are agriculture and rural based, about 28% of these are milk co-operatives. One of the critical issues is that there is a lot of confusion in operating the co-operatives at grassroots levels. Another problem is that the co-operative issues are politicised in many places. Milk Producers' Co-operatives are established with political colours and cannot fulfil their actual co-operative based objectives. There is a lack of co-ordination between the DoC that has regulatory functions and the National Co-operative Development Board (NCDB) that has promotional functions.
- Livestock insurance policy. Access to this insurance is very much limited to the rich dairy farmers. Smallholder farmers have very little access to the insurance agencies because they do not have capital to show against the loan taken from the Agricultural Development Bank and other commercial banking agencies in the country.

References

- CBS (Central Bureau of Statistics). 1991. *Agriculture Census Report 1991*. National Planning Commission, Kathmandu, Nepal.
- DANIDA (Danish International Development Agency) and MoA (Ministry of Agriculture). 1991. *Ten-Year Dairy Development Plan (1991–2000)*. MoA, Kathmandu, Nepal.
- DDC (Dairy Development Corporation). 1999. *Annual Report*. DDC, Lainchaur, Kathmandu, Nepal.
- Heidmann P., Sollod A.E. and Joshi D.D. 2000. Ruminant methane production and chronic disease. In: *Proceedings of the second methane mitigation conference held at Novosibirsk, Russia, 18–23 June 2000*. Siberian Branch of Russian Academy of Sciences, Institute of Coal and Coal Chemistry, Novosibirsk, Russia. pp. 153–160.
- Joshi D.D., Stem C., Orlic M., Worth T. and Sollod A.E. 1999. Improving dairy efficiency and reducing methane production in Nepal. In: Chattarjee K. (ed), *Proceedings of the AIJ conference held in New Delhi, India, 8–10 January 1997*. Development Alternatives, New Delhi, India. pp. 226–239.
- Mendis M.S. and van Nes W.J. 1999. The Nepal Biogas Support Program: A case study on the use of animal dung for rural household energy and greenhouse gas (ghg) mitigation. In: *Proceedings of the second methane mitigation conference in Novosibirsk, Russia, 18–23 June 2000*. Siberian Branch of Russian Academy of Sciences, Institute of Coal and Coal Chemistry, Novosibirsk, Russia. pp. 199–206.
- MoA (Ministry of Agriculture). 1997. *Statistical information on Nepalese agriculture*. MoA, Kathmandu, Nepal.
- MoA (Ministry of Agriculture). 1998. *Nepal Agriculture Perspective Plan (1997/98)*. Ministry of Agriculture and Cooperatives, His Majesty's Government of Nepal, Singhadarwar, Kathmandu, Nepal.

- MoF (Ministry of Finance). *Economic survey report 1999*. His Majesty's Government of Nepal/MoF, Baghdarwar, Kathmandu, Nepal.
- NDDB (National Dairy Development Board)/DSP (DANIDA Support Project). 1999. *NDDB/DSP Report 1999*. NDDB, Kathmandu, Nepal.
- NPC (National Planning Commission). 1996. *Nepal living standard survey*. NPC, Kathmandu, Nepal.
- NPC (National Planning Commission). 1998. *Ninth five-year plan*. NPC, Kathmandu, Nepal.
- World Bank. 1998. *World Development Report 1998/99. Knowledge for development*. The World Bank, Washington, DC, USA.

Pakistan smallholder dairy production and marketing

R.H. Raja

Animal Husbandry Commissioner/Joint Secretary, Ministry of Food,
Agriculture and Livestock (Livestock Wing), Islamabad, Pakistan

Introduction

Animal husbandry, more precisely the keeping of domestic buffalo, cattle, sheep and goats, provides the population of Pakistan with a variety of commodities essential for its nutrition. Milk and milk products are the most important and with an annual combined consumption of more than 12 million tonnes, Pakistan maintains the highest consumption level per capita of all Asian countries.

There are about 5.5 million livestock production units, most of them represented by smallholders who often do not even own or lease land, responsible for this output. Fresh milk and its preparations are appreciated and consumed by almost everyone. Therefore, many of the family units keeping only a few milch animals need the entire milk produced for their own consumption. This explains why the major part of fresh milk is not sold. The 5.5 million production units have to feed some 50 million household members and very likely to give milk to another 10 to 20 million persons, either in exchange for services rendered or for charitable reasons.

The traditional raw milk marketing system is supplying rural and urban consumers quite effectively but its capacity is limited by the perishability of the product. Seasonal fluctuations in raw milk supply are met with dilution (lean season) during the marketing process or reduced procurement (flush season).

Occasional shortages in fresh milk supply, high production costs in the peri-urban areas and the availability of dried milk powder in the market have led to a partial substitution of fresh milk by reconstituted milk. Nevertheless, the fresh milk equivalent of imports has never exceeded 4% of domestic milk production.

In addition to traditional raw milk marketing and cottage or household manufacture of dairy products like yoghurt, ghee and sweetmeats, a number of modern industrial dairy processing units have been established, competing with traditional traders for market share.

Present supply of milk

Domestic production

In 1999–2000, about 25.6 million tonnes of liquid raw milk were available in Pakistan for human consumption. Smallholders, keeping one or a few milch animals, produce 65% of all buffalo and cows' milk.

Seasonal fluctuation in milk production are the result of changing climatic conditions in the course of a year, and seasonal factors affecting parturition date and feed availability (and the lactation cycles of milch animals). It is common knowledge in Pakistan that production is highest during the winter months and lowest in the summer. The magnitude of these fluctuations, together with demand, is discussed further.

Imports

Total imports of dairy products for the fiscal year (FY) 1999–2000 were 15,768 t worth 1214 million Pakistan rupees (US\$ 1 = 51.8 Rs., 1st January 2000).

Present consumption of milk and dairy products

Milk consumption

Consumption estimates for milk and dairy products in 1999–2000 are as follows:

Table 1. *Milk consumption pattern 1999–2000.*

Product	($\times 10^3$ t)
Fresh milk	1006
UHT* milk	69
Butter	60
Ghee	177.04
Other dairy products	82.5

* UHT = ultra heat treated.

Seasonal fluctuations in milk production and consumption

The production (supply) and consumption (demand) for milk and milk products in Pakistan are characterised by conflicting seasonal fluctuations. Milk production is at its maximum during the period between January and April and at its minimum during May–August when fodder is limited. Milk consumption is at its peak in summer. At this time, because of the warmer ambient temperatures, people increase their milk intake and consume a greater range of dairy products including ice cream and yoghurt.

Figure 1 illustrates the fluctuations in supply and demand over a given year, using supply data for 1986 and 2000. Milk supply from rural animal holders decreases by half in mid-summer. In contrast, the peri-urban producers (13% of all producers) have better control over their contribution to supply, which fluctuates less through the months. It is assumed that the overall supply reaches a low point in mid-June; at this point, supply represents only 55% of that during the peak period in mid-February. Based on preliminary results from several small surveys, the overall demand varies from its highest point in June to an estimated low of 60% in December. Figure 1 shows the magnitude of the surplus supply in winter and excess demand at other times. The best available approximation of the size of the excess demand is the volume of dairy imports, which is less than 4% of the estimated available production.

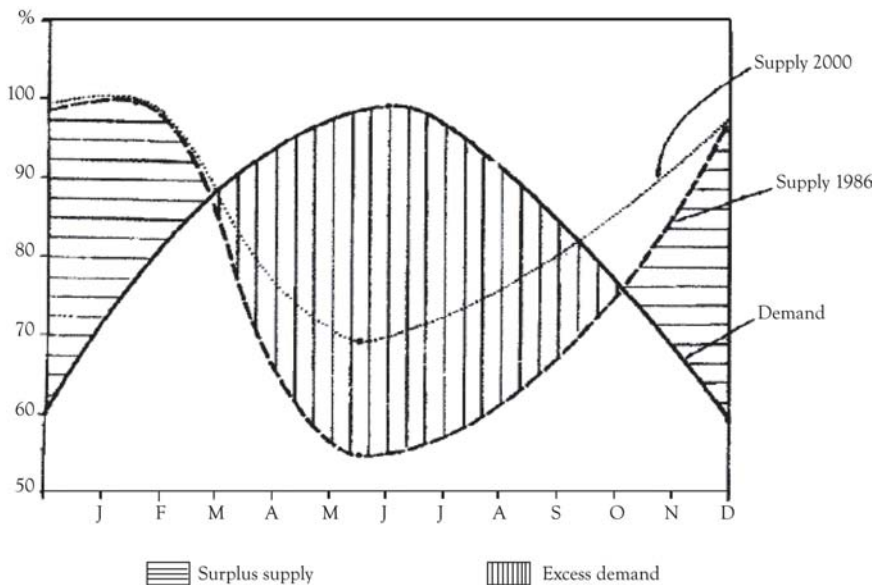


Figure 1. Seasonal fluctuations in milk production and consumption.

The areas of surplus supply in Figure 1 represent the milk production that cannot be marketed and, therefore, represent an opportunity cost to producers. The establishment of milk powder plants would allow preservation of milk in surplus periods for consumption in times of excess demand.

Production systems

Except for some nomadic sheep, goats and camels, and some peri-urban milk units, all existing ruminant production is closely integrated with crop production. Traditionally, the raising of livestock has been based on free grazing. In consequence, livestock keeping families are accustomed to devoting a lot of family labour to this activity. As production becomes

commercialised and home produced or purchased feeds take the place of grazing, families tend to retain their customary approach to labour without thought to the returns involved.

The following production systems are practised:

- Cattle
 - Smallholder irrigated areas
 - Smallholder *barani* (rainfed) areas
 - Progressive farming of crossbred cattle
- Buffalo
 - Peri-urban commercial and household
 - Rural smallholder—market oriented
 - Rural smallholder—subsistence
 - Rural commercial

Cattle

Traditionally, cattle are kept by about 5–6 million rural households, primarily to provide draft power for crop production with milk as a by-product for family consumption or for sale. Some cattle are kept in peri-urban milk units along with buffalo. There is also a new progressive class of cattle farmer developing commercial production with improved crossbred type cattle. So far, this category represents an insignificant part of the national herd and milk supply; however, it could provide the model for long-term development of milk production in the country. Cattle production systems are described for rural small-scale units in irrigated and in *barani* (rainfed) areas, and for the progressive type of farmer.

Irrigated areas

About 55% of the indigenous cattle population is kept by 2.5 million small mixed crop–livestock production units in the irrigated areas; of these 60% are in the Punjab, 20% in Sind and 14% in NWFP (North-West Frontier Province). Traditionally, male cattle have been kept primarily to provide farm traction and the female herd needed to produce the working animals has also produced some milk as a by-product for human consumption. With the introduction of tractors, the importance of work animals is declining, milk and meat production are becoming relatively more important and the genetic weaknesses of indigenous animals for these purposes are becoming more apparent.

In irrigated areas, the typical unit consists of three cattle, kept alongside buffalo that are raised for milk production. Most cattle are of non-descript type, but some pure indigenous milk breeds are included. On average, the cattle herd includes about 40% adult females and 20–25% adult males; the remainder are calves and followers. As far as possible, feed is derived from grazing. About 25% of total feed comes from straws, 60% from fodder crops and <10% from purchased concentrates. With current yields of fodder crops, these cattle units require fodder production from about 0.7 ha of land during the *rabi* (spring) and *kharif* (autumn) seasons.

Rainfed (*barani*) areas

Cattle in *barani* areas are also raised primarily for draft use, but the keeping of buffalo in such areas is less common and cattle herds with an average size of about five head are often the only large ruminants kept. About 30% of the typical herd is adult females and 40% is adult males; the balance is calves and followers. Following the onset of the rains and the harvest of cereals, grazing of crop stubble, waste areas and pasture provides 40–50% of total annual feed. The remainder of the feed is provided by straws, some cut green fodder and a small amount of concentrates, usually for working draft animals. These cattle require the fodder production from about 0.14 ha of land.

Progressive farmers, crossbred cattle

A few progressive farmers are developing commercial milk production units based on the use of artificial insemination (AI) to produce Friesian crossbred progeny. These farms may be devoted entirely to milk production or may be part of larger mixed crop–livestock units. Currently, they are very few in number but the system used could be important as a model for future development.

Buffalo

About 5.4 million households keep buffalo, almost all for milk production. Small-scale rural units of less than six head account for roughly 4.8 million and peri-urban units a further 0.6 million of these households. There are also a few rural commercial production units, which have been established very recently.

Peri-urban milk production

This centuries-old system has grown in recent times in response to increasing price and demand for milk in urban markets, as well as because of difficulties in collecting and transporting milk from rural areas. Production growth has been aided by development of motorised road transport and an effective input supply network. The system embraces production unit types ranging from large exclusively commercial and somewhat exploitive enterprises, such as at the Landhi Cattle Colony near Karachi, to small village merchants or shopkeepers who keep one buffalo at their house to satisfy family milk requirements.

Commercial scale units located around the main cities, especially in the Sind Province, in general have herds ranging from 10–200 head (average 50). Almost all the animals are adult females, 90% are buffalo and 95% of these are actually in production. Turnover of animals is high. Selected third or fourth lactation females are purchased either close to calving or with calf at foot. Because of the high value of milk, calves remain with their mothers for only four to seven days before, in most cases, being sold for slaughter. Even in

the absence of the calf, the high level of feeding encourages the cow to letdown her milk. The lactation period lasts for 250–300 days and the animal, when dry, is sold for slaughter (about 50% of cases) or is returned to the rural areas until again ready to calve. Replacement cows are purchased according to need for milk sale contract obligations. As few entire breeding males are kept and pregnancy depresses milk yield, many cows are not mated during lactation. Of those returned to the rural areas, no more than 50% are in calf. With the growth of AI, the number of cows served and subsequently salvaged from slaughter is however increasing slowly.

Commercial units employ family and hired labour, which must be paid at rates applying in urban areas. The system depends on: investment in or hire of buildings, and simple equipment; delivery of milk to market twice daily after milking; and payment for veterinary medicines, electricity and water municipal charges, and milk transport. Some income is earned from the sale of farm-yard manure.

Small peri-urban units exist in the major centres but are more prevalent in the smaller centres and villages. Distances travelled to obtain replacement cows and feeds are shorter than for commercial units, but production costs and milk prices are generally lower with the result that production techniques are less intensive and exploitive. Calves are suckled while cows are in milk and many cows are mated if bulls or AI services are available in the village. When dry, most cows are returned to the rural supply areas; if male, their calves are sold for slaughter and, if female, the calves are sold or sent to the rural areas for growing-out as replacement stock. Milk is used primarily to satisfy family needs and the surplus, if any, is delivered to households or shops.

Smallholder rural milk production

Almost 80% of total milk supply is derived from about 5.4 million mixed crop–livestock units mostly in irrigated areas, which keep buffalo primarily for milk production and indigenous cattle for draft purposes with milk as a by-product. Production units are small-scale with about 75% of all buffalo and cattle in herds of no more than six head. Rural milk production is predominantly a subsistence activity; about 56% of all milk produced is consumed on the farm. Access to milk markets, however, influences consumption patterns and production methods. Thus, rural smallholder production is categorised broadly into: (a) market oriented; and (b) family subsistence. Within these two categories, there are further subcategories, namely land owning, sharecropping and farm labouring which influence the management techniques employed.

Smallholder market milk production

Smallholders owning buffalo and cattle in rural areas with satisfactory milk market access, who are able to produce milk in excess of family requirements, have introduced some changes in traditional production methods. The typical family production unit consists of five buffalo, which include three adult females, one to two female followers and occasionally a male calf but rarely any adult males. With a calving interval of two years,

normally half the adult females are in production at any time; however, the situation can vary widely.

Smallholders, who are also owners of land, devote 10–20% of their crop area to forage crops and are able to provide more of the total feed requirements from this source. Sharecroppers are obliged to give working animals first priority in use of fodder crops, whilst landless families must purchase fodder as well as straws. In such cases, a significant part of the feed supply is provided by hand weedings from *rabi* and *kharif* cereal crops.

Smallholder, subsistence milk production

Smallholders in rural areas with no satisfactory milk market aim to produce enough milk for family requirements at minimal cost. They are generally not prepared to spend cash on inputs but as milk is an important item of subsistence, they are prepared to allocate non-cash resources of land and labour to its production. About 70% of smallholder milk producers fall into this category either because no satisfactory market exists in their village or because they have not got the resources to enable them to produce a marketable surplus.

The average subsistence unit consists of about three buffalo, including up to two adult females. Grazing provides 50–60% of total feed requirements at zero cost, straws (*bhusa*) provide about 25%, green feed crops provide 10–15% and purchased concentrates provide < 5% that is used exclusively for cows in milk. The system is traditional and makes heavy demands on family labour, largely in relation to livestock grazing.

Once a milk market is introduced, traditional farmers begin to sell surplus liquid milk. Family consumption tends to decline and some commercial techniques are adopted. Feeding is improved through greater use of green fodder crops and purchased concentrates, milk yields increase as a result of better nutrition, the interval between calvings decreases and eventually the percentage of productive animals in each herd is increased.

Rural commercial units

The emergence of a new commercial category of dairy farm is a recent phenomenon. Although very important as a future vehicle for extending improved production techniques, the number of producers in this category is ≤ 1000 and their contribution to total milk supply is small. The typical unit (90% buffalo and 10% cattle) consists of about 40 buffalo of which 60% are adult females and about 60% of these are producing milk. These production units may be part of a larger mixed crop–livestock farm or a specialised farm devoted entirely to milk production. Fodder crops provide more than 50% of total feed; straws, either home grown or purchased, provide about 35% and the remainder is purchased concentrates. In locations with rivers, rain or waterlogged areas, grazing is used as a substitute for some or all of the straw and green feed components of feeds for dry animals.

Marketing of milk and dairy products

Marketing of raw liquid milk

Because of the various systems of milk production in Pakistan and the task of supplying fresh milk regularly to consumers and manufacturers in both rural and urban areas, different marketing systems have been developed that often involve several intermediaries who form the marketing chain. Intermediaries are rural milk traders (*katcha dodhis*), highway collectors (*pacca dodhis*), rural vendors/processors, commission agents, urban wholesalers, shopkeepers/processors and street and door-to-door vendors.

The present annual net volume of raw milk marketed is estimated at 10.99 million tonnes or 43% of total domestic milk production. In handling this volume, the major marketing systems have approximately the following shares (see table 2).

Table 2. Marketing of raw liquid milk in 1999–2000.

Marketing system (intermediaries)	Volume of milk ($\times 10^3$ t)	Quantity marketed (% of total)
Rural milk trader – rural vendor/processor	1099	10.0
Rural milk trader – highway collector – urban vendor/processor	3297	30.0
Rural milk trader – collector – dairy processor	143	1.3
Collection centre – dairy processor	77	0.7
Urban contractor/wholesaler – vendor/processor	2198	20.0
Producer – rural/urban consumer – no intermediary	4176	38.0

Marketing through rural milk traders

Traditionally, the most important middlemen are the numerous rural milk traders, commonly called *katcha dodhis*. Equipped with a bicycle or horse cart, or in some cases now with a motorcycle and two to four milk cans, they make daily visits on average to 15–20 small milk producers, collecting some 75–90 litres of raw milk. This may take three hours and the distance cycled can easily be 20 km. Most of the *katcha dodhis* are independent, only a few are employed by larger highway collectors. Under the traditional system, women sell the milk.

Where competition is strong, usually in production areas with good access, the *katcha dodhis* often have contracts with the producers to secure milk supply for a certain period. Then the purchasing price may be fixed, interest free advances may be given or both ties will be used. The value of advances usually corresponds to the value of milk supplied within two to four weeks. As most *katcha dodhis* do not have sufficient resources to finance their suppliers, they in turn get advances from the larger collectors and sometimes from rural shopkeepers. If no advances are granted, payment is normally effected within one week after milk collection.

With a few exceptions, milk is collected only in the morning, the evening milk being used mainly for home consumption. Milk is always collected by volume, never by weight,

using measures of varying types and sizes. Milk producers normally supply pure, unadulterated milk; however, to prevent deterioration of the milk during their collecting tour, especially in the hot season, the *katcha dodhis* add certain quantities of ice to lower the temperature. The ensuing dilution may well result in a 10–20% increase of the milk volume.

Marketing through rural and highway milk collectors

The highway milk collectors, or *pacca dodhis*, obtain their supply of milk almost exclusively from the *katcha dodhis*. The daily volume collected by a *pacca dodhi* often exceeds 2000 litres, especially in the Punjab. The number of *katcha dodhis* supplying a single *pacca dodhi* ranges from 8 to 500, with a maximum of about 70 per collection point.

At their collection points along or near the main roads, most *pacca dodhis* check the milk visually, test fat and solids-not-fat contents with their fingers and measure the volume by pouring the milk into their own cans. If the quality meets requirements, the agreed price will be paid. In some cases, cream separation is carried out to check the fat content (110 litres of buffalo milk should yield at least one litre of cream) or the coagulation test is used to determine the content of total solids (evaporation of one litre of milk in an open pan). Collectors supplying dairy plants all use fat testing equipment.

The *pacca dodhis* do not own chilling facilities, but most of them have one or more motor vehicle. Only the smaller collectors send milk to town by public transport or join other collectors who own or hire a small pick-up truck. Before sending the cans to the urban vendors or processors, especially during the summer season, more ice is added to the milk; moreover, sometimes preservatives, such as hydrogen peroxide, are also added. Subject to the distance to be covered, the milk reaches the urban markets at times between 0900 and 1200 hours.

One *pacca dodhi* may supply between 1 and 40 clients, depending on the milk volume marketed and the demand of the individual contractor, milk shop or manufacturer. Advances from shopkeepers seem to be rare. Normally, the milk supplied is paid for upon the next delivery. Many collectors engage in fresh cream marketing. Principal clients are ice cream factories and butter or ghee manufacturers.

Both *katcha dodhi* and *pacca dodhi* add ice to the milk, which reduces the original fat and solids-not-fat contents by up to 20% but increases their margins. The rural collector has cash expenses of about Rs. 1/litre for ice and *octroi* (communal merchandise tax), the highway collector pays a similar amount and eventually Rs. 1/litre for hired transport. The vendor increases his margin through the sale of sweetened milk and the manufacture of dahi or sweetmeats.

If the *pacca dodhi* separates part of the cream from the milk traded, thus reducing the fat content to 4.3%, he can increase his margin through cream sales to about Rs. 1.04/litre sold. Consequently, the urban consumer pays Rs. 1.00 more per litre than the rural consumer does for milk of lower quality. Of course, farm-gate trader and consumer prices are subject to seasonal fluctuations. In summer, the urban consumer might well get milk with a fat content <4%.

Milk collectors supplying dairy processors

Since the establishment of milk processing plants, highway milk collectors have been their most important and effective suppliers. Despite rigid quality testing and payment according to butterfat content, plants procure the major part of their raw milk through the private milk collectors. This leads to difficulties during the lean production season when the supply gap results in price increases, which the manufacturers were not willing or able to pay.

Milk sale to collection centres of dairy processors

Neither factory linked livestock farms nor dairy co-operatives have managed to become major suppliers to dairy processing plants. Size and production of the commercial farms have limited their contribution. Of the milk marketed by the functioning co-operatives and Village Livestock Associations, created in some districts of Punjab to supply the Lahore Milk Plant (their designated long-term marketing partner), only a small proportion is channelled to the dairy plants.

To improve the handling of raw milk and achieve a better quality for processing at the plant site, some dairy plants have started to equip milk collection centres with chilling units and to use insulated road tankers for bulk transport from the centres to the plant. This enables them to buy milk direct from the *katcha dodhis*. Some plants already collect 80% of their procurement themselves. Large-scale collectors supply the balance milk.

Milk collection is undertaken by *dodhis* or co-operative organisations (e.g. at Renala Khurd), but the milk producers may also deliver to the centres themselves and this way may receive a higher price. The farm-gate price in winter is Rs. 8–10 and in summer Rs. 10–12 per litre (6% fat basis). A bonus of Rs. 1.00/litre is paid by some processing plants, if the milk is put into chilling tanks provided by the plants but operated by the producers.

Direct marketing and contract sale

Some producers manage to market their milk without the help of *dodhis*. They produce quantities large enough to contract fixed regular supplies with urban wholesalers/retailers or they sell straight to consumers (at the farm, in their own urban retail outlets or at the consumer's door).

The peri-urban milk producers, especially in Sind, sell most of their milk on a contract basis (one year, fixed price) to urban distributors, milk shops and institutional consumers (hotels and restaurants). Milk in excess of the contracted quantities is sold through commission agents in the 'free' wholesale market (auction sale). If a milk producer cannot supply the agreed quantity in full, he is obliged to make up the deficit from outside purchases (e.g. in the wholesale market). Some of the milk producers at Landhi Cattle Colony have established an association. Most peri-urban and rural commercial milk producers who market milk themselves do not maintain additional or better facilities than the *pacca dodhis*. Milk, with ice added, is transported in their own cans and usually with their own vehicles to the customers or the wholesale markets. Only a very few

producers (e.g. a dairy co-operative, a private cattle farm and some government dairy farms) use chilling facilities and insulated storage tanks. In general, milk is distributed in cans with volumes of 40–50 litres.

Milk producers who own transport facilities usually deliver milk to their urban contractor receiving about Rs. 14/litre of undiluted milk. Contractors are often milk shops converting part of the milk into customary products. In summer, the margins of the intermediaries are much higher as more ice is added to cool the milk.

Milk retailers

The final middlemen in raw milk marketing are the milk shops, which in urban centres often also exercise distribution functions (supply of the small retailers) and/or transform milk into local yoghurt (*dahi*), yoghurt drinks and a simmered, sweetened concentrate (*khoa*) for sweet dishes or ice cream. They often separate cream from part of the milk bought.

The major part of the raw milk reaching the milk shops is sold untreated within one to two hours after arrival. Some shops, particularly those operated by commercial milk producers keep the milk in cooling tanks (500–1000 litres contents) or fill a certain proportion into plastic sachets, which after sealing are kept in a refrigerator. Milk, which is not sold immediately, is boiled for sale later or converted into *dahi*, *khoa* etc. Nevertheless, the consumers boil all liquid milk bought before drinking.

Marketing of processed liquid milk

The only type of processed liquid milk that is found in markets all over the country is sterilised long-life (ultra heat treated; UHT) milk produced by eight domestic dairy plants. Standardised UHT milk is marketed in 200-ml, 250-ml, 500-ml and 1-litre packages, mostly tetrahedron or tetra briks. The 500-ml packages account for about 60% of the total quantity sold, 200- and 250-ml packages for 20–25% and the 1-litre tetra briks for 15–20%.

The marketing chain is short; from the factories, the milk is transported by truck to regional distributor–wholesalers who in turn supply general stores and supermarkets in the big cities. Regional distribution of sales demonstrates that the majority of milk is consumed within a limited area around the processing plants.

Ex-factory prices vary according to the destination of sales and freight costs involved. The distributor–wholesaler receives commissions of between Rs. 1.00 and 2.00/litre, depending on brand and package size. Most manufacturers refund or replace damaged and expired packages.

Compared with the margins in the marketing of raw liquid milk (especially the extra margins resulting from dilution), the margins on processed milk are much smaller and cannot be increased by adulteration. However, retailers do not deal exclusively in UHT milk, it is just one of many items sold; this applies to most wholesalers as well.

Marketing of dairy products

Traditional dairy products like *dahi* and *khoa* are manufactured and sold by most milk shops across Pakistan. On average, these shops convert about 20% of the raw milk purchased into *dahi* and/or *khoa*. During Ramadan and in summer, *dahi* consumption increases considerably.

Local or *desi* ghee is mainly produced by farmers in areas that are not penetrated by milk collectors. The major part of ghee is home consumed but an estimated annual volume of 34% is marketed through wholesalers, vendors and shopkeepers, both in rural and urban areas. Because of its relatively high price (consumers have to pay between Rs. 160 and 180/kg), it cannot compete with vegetable ghee or oil, which costs only a third of the price and is used increasingly as a substitute.

In contrast, *desi* butter seems to have a stable market, especially during the winter months. The quantity marketed may reach 60 thousand tonnes/year. The larger dairy shops in the cities and special creameries are the principal manufacturers of local butter. They usually buy cream from wholesalers or *pacca dodhis* and each day produce only what can be sold within one day.

Some milk processing plants have introduced a number of new dairy products into the market:

- Yoghurt (natural and flavoured)
- Drinking yoghurt
- Sweetened, flavoured milk
- UHT and pasteurised cream
- Butter
- Ghee
- Cheese and
- Ice cream mix.

The quantities sold, however, are very modest for most items; only yoghurt and butter sales have reached significant volumes. Three major yoghurt manufacturers sell about 4000 t annually. Consumer prices of Rs. 17–21 per 450 ml cup (3.5% fat) assure a good margin despite high packaging costs. The modern butter manufacturers produce about 800 t/year. It is mainly packed and sold in portions of 200 g with ex-factory prices from Rs. 30–35/pack and consumer prices from Rs. 35–40/pack.

The ice cream industry, producing 9–10 thousand tonnes of ice cream/annum, uses mainly dairy ingredients, especially fresh cream. Fresh milk is mostly substituted by imported milk powder.

Marketing of milk powder

In the past, more than 60% imports, mainly whole milk powder, was sold by the importers to wholesalers and then distributed to a large number of retailers (e.g. grocery stores) where the private households could buy it. About 2666 t, almost exclusively skim milk powder, were used by the poultry feed industry and food processors, the dairy plants consuming

some 1600 t and the ice cream factories approximately 1000 t. Since 1978–79 only licensed importers who obtain certain quotas are allowed to import milk powder. UHT milk plants are direct importers. The introduction of a fixed import duty for all kinds of milk powder has slightly increased domestic milk powder prices.

Milk marketing constraints

The marketing of raw liquid milk, principally produced by a large number of smallholders, is a difficult and time-consuming task, especially against the background of poor infrastructure, unfavourable climatic conditions during a major part of the year and a low technology level.

From production areas that have poor road access, marketable quantities of milk are not, or are only partly, collected. The *katcha dodhis* cannot spend more than three to four hours on one collecting tour because of the perishability of the produce. Poor transport conditions also increase their costs considerably (e.g. by necessitating frequent repairs). As the producers tend to meet their own milk requirements from the evening milk, virtually no *dodhis* go on a second collecting tour each day, although more milk would be available.

During the flush season of milk production, larger marketable quantities are not absorbed by the collectors, as with a copious supply it is more difficult to sell the milk with attractive margins despite lower farm-gate prices. Even the modern milk processing plants face problems relating to an over-supply in the flush season and during introduced milk holidays.

The quality of milk supplied to the consumers and many of the dairy processors is often very poor due to skimming, dilution and addition of dirty ice or chemical agents. At the critical points in the milk marketing chain (e.g. where the rural collectors sell to the highway collectors), chilling facilities are rarely available.

The conditions of milk handling are often unhygienic. Containers and cans are not well cleaned and lids are frequently sealed with a wad of straw. Despite the addition of ice or preservatives, bacterial activity can increase considerably. Although the Pure Food Ordinance and the Pure Food Rules require hygienic handling of milk and prohibit mixing, colouring, staining or powdering of milk with any matter or ingredient, high rates of adulteration are reported by the food inspectors. Severe penalties can be enacted but, in reality, only small fines are imposed with minimal impact on the unhygienic practices.

With few exceptions, milk producers have been unable to organise themselves, take over marketing functions and remove the deficiencies of the traditional marketing system.

The major constraints to the marketing of processed liquid milk are the higher price in comparison with that of raw milk and the often-quoted consumer dislike of heat-treated homogenised milk because of its taste and lower fat content. It is difficult to say which of the two constraints is more important in the stagnating of UHT milk sales. Definitely, the dairy processing industry could do more in terms of consumer education to overcome the quality prejudice.

Milk processing

During the last 25 years, Pakistan has seen many attempts to introduce modern dairy technology; these have been followed by almost as many disillusioned marketing attempts, endings with the closure of the plants. Previous to 1974, more than 54 modern milk processing facilities had been established, most of these were pasteurisation plants, the others specialised in dairy products like butter and ice cream. By 1974, less than half of the existing plants were operating and those in operation were running at a low production level. Eight years later, milk processing plants with an installed capacity of about 550 thousand litres/day were in operation, but were only utilising 43% of their capacity.

Existing milk processing plants

With the exception of army and Idara-e-Kisan dairy plants, the production of liquid pasteurised milk has ceased since the first units producing UHT long-life milk went into operation (after 1976). The most prominent plant to close was the government-owned Karachi Milk Plant. Tables 3 and 4 present basic information on the UHT milk-processing plants that are operating currently. The data in the table referring to installed daily capacity are based on shifts including preparation and cleaning.

Table 3. *Milk plants operating at low capacity in Pakistan.*

Projects	Products	Location	Year estimated	Rated capacity	Investment ($\times 10^6$ Rs.)
				per day ($\times 10^3$ litres)	
Green Dairies Ltd.	Cheese, pasteurised milk	Sahiwal	1970	12	8
Pakistan Dairies Ltd.	UHT milk	Sahiwal	1983	50	50
Prime Dairies	Yoghurt	Manga	1982	8	10
Monnoo Dairies	Pasteurised milk	Bhowana	1988	20	9
Pakistan Milk Food Manufacturing	Milk, powdered milk, food for infants and invalids, ghee	Jhang	1988	30	36

The low present utilisation of UHT milk processing capacities is not caused by insufficient supply of raw milk but rather by the saturation of the processed milk market. Production capacities have grown at a much faster rate than demand.

UHT milk production

UHT milk is 'toned' to a butterfat content of 3.5% and a solids-not-fat content of 8.9% (standardised milk). Assuming the supply of pure milk (either from buffalo or cows), the only adjustment needed before processing should be a reduction of the butterfat content by cream separation. In reality, the milk bought usually contains >3.5% fat but less than the required 8.9% solids-not-fat because of the dilution practised during milk collection.

Table 4. Milk processing plants operating at satisfactory levels in Pakistan.

Projects	Products	Location	Year estimated	Rated capacity	Present utilised	Investment (× 10 ⁶ Rs.)
				per day (× 10 ³ litres)	capacity (× 10 ³ litres)	
Chaudhry Fiesland Ltd.	UHT milk, milk powder	Bhaiphru	1986	80	60	90
			1991	150		150
Kabirwala Dairy Ltd.	UHT milk	Kabirwala	1983	50	20	50
Milkpak Ltd.	UHT milk, cream, ghee, butter, Nido, Cerelac	Sheikhupura	1979	150	95	150
Noon Pakistan Ltd.	Milk powder, butter, cheese, ghee	Bhalwal	1972	80	32	12
Idara-e-Kissan (Halla)	Pasteurised milk, yoghurt	Pattoki	1983	15	10	6
Milko Ltd.	UHT milk	Lahore	1973	25	21	35

On average, raw milk for processing contains 20–25% added water so that the critical solids-not-fat content oscillates between 6.75 and 7.2% (whilst the fat content is 4.55–4.85%). To make up for the deficit in solids-not-fat, skim milk powder is added (hence the term ‘toned’ milk). The minimum requirement in the given situation is 20 to 25 g of skim milk powder/litre of milk to be processed, but frequently more powder (and water) is added for production.

Raw milk procurement and chilling

At present, more than 60% of the milk supplied to processing plants is handled in the traditional way, i.e. ice is added to prevent deterioration. Only some 100 to 180 thousand litres/day are delivered to chilling centres peripheral to processing plants for later transport in bulk road tankers to the factories.

Nestle Milkpak operates 600–700 milk collection subcentres and about 3000 village collection points. Many of them are equipped with imported plate heat exchangers (chilling capacity 5000 litres/hour) and tank storage capacities of 10 to 40 thousand litres. For bulk transport, road tankers are employed; these may have to travel distances of more than 130 km (one way).

Constraints

Major constraints facing the milk processing industry in Pakistan are related to marketing. It is surprising to see how many UHT milk plants have been financed and implemented without conservative market analyses of consumer behaviour and without taking into account simultaneous efforts of the competition to establish new plants. The suppliers of plant equipment at least should have been able to foresee the development. They could have advised many investors to wait.

In spite of the comparatively high price of the finished product, low capacity utilisation prevents most UHT milk processing plants from recovering much more than their variable costs. Next to the raw materials, packaging is the most important cost element. Unfortunately, sophisticated and expensive packaging forms part of UHT technology. Alternatives to tetra packaging that meet the high requirements are scarce and do not offer substantial savings.

Import regulations do not permit the lease of machinery. Thus, UHT milk producers are tied to the equipment bought and the level of technology until they have written it off. Lease contracts would give them more flexibility, i.e. to return a packaging machine or exchange it against a more suitable one. Consequently, several plants suffer from the disadvantage of obsolete equipment (e.g. 200- and 250-ml tetrahedron packaging).

The slow growth of demand for UHT milk and the strong competition for market shares call for differentiation and a larger variety of products to improve capacity utilisation and processing margins. So far, only a few of the dairy plants have tried and managed to diversify their production and tap new markets (i.e. processing and packaging of fruit juices).

The supply of raw milk to UHT milk plants seems no longer to be a bottleneck as far as quantity is concerned. In fact, during the flush production season, available milk surpluses have not been bought by the processors because of the marketing problems mentioned previously. In contrast, quality of raw milk at the factory gate is often not satisfactory. Most of the UHT milk plants are not well located with regard to surplus milk production areas, exceptions being Pakistan Dairies, Kabirwala Dairy and to some extent Chaudhry Dairies. Long transportation distances and insufficient chilling facilities increase procurement costs and negatively affect milk quality.

Future demand for milk and dairy products

The demand for liquid milk and dairy products in Pakistan will definitely continue to increase, the most important reason being growth of the human population. Other variables influencing demand are the growth of personal incomes and the evolution of prices. The demand for 2010 has been predicted and the results are presented in Table 5.

Table 5. *Demand for milk and dairy products in 2010.*

Products	× 10 ³ t
Fresh and boiled milk	25,604
Dry and condensed milk	68
Butter	165
Ghee	327
Total (fresh milk equivalent)	36,900

For 2010, the demand for dairy products is projected to be 36.9 million tonnes (fresh milk equivalent), whilst the available production (after wastage and ice dilution) is projected at about 34.3 million tonnes. This suggests that, even assuming possible general

improvements in animal husbandry, Pakistan will still have an excess demand that will need to be met by imports, unless the human population grows at a lower rate than in the past.

Suggested strategy for the future development of milk marketing and processing in Pakistan

The dairy sector in Pakistan is challenged by a rapidly growing demand for liquid fresh and boiled milk. Although market production of commercial dairy farms is likely to become more important, the bulk of raw milk supply will continue to be provided by a large number of rural smallholders. Consumer behaviour, giving preference to liquid raw milk, is not expected to change fundamentally, but in the future, more attention will be paid to hygiene and quality.

The traditional milk collection and marketing system, despite some deficiencies, has served quite effectively as a link between producers and consumers. It would not be wise to replace it; however, to meet the future requirements some adjustments and improvements will be necessary.

Milk chilling centres

To procure as much as possible of the milk available for sale from the producers, collection activities will have to extend to the hitherto neglected areas with poor, time-consuming access and to include the surplus from the evening milking. Perishability of the produce necessitates cooling within four hours of milking. Therefore, the establishment of milk chilling facilities in close reach of a greater number of producers becomes essential.

Such facilities would serve the following functions: quality control of the milk delivered (e.g. density, acidity, fat content); cooling from ambient temperature to +4°C; and storage until collection for transport (in bulk or special containers), possibly to larger collection centres and then to processing plants or milk shops.

An ideal solution would seem to be the establishment and operation of chilling centres by the milk producers themselves. Despite the failure of dairy co-operatives and Village Livestock Associations, past experience indicates that this possibility of better integrating small milk producers, especially in remote areas, into the marketing system and strengthening their bargaining power should not be ignored. Encouragement and technical assistance could be given to the producers to establish their own milk collection systems.

Commercially organised dairy enterprises that produce milk on their own farms and/or collect milk from other producers to sell it subsequently to processors, milk shops or through their own outlets, are probably in the best position to invest in chilling centres.

Alternatively, milk chilling could be offered as a service to milk traders, processors (e.g. ice cream factories) and institutional consumers who are interested in a regular supply of quality milk. Such a chilling service might be operated, for instance, by a private enterprise specialising in storage and transport. However, potential investors would first have to be identified.

Institutional support for animal production development

Provision of services for the development of animal production is a provincial responsibility discharged through the ministry, directorate general or directorate of animal husbandry as the case may be. In each case, the organisation responsible is staffed and organised primarily for the provision of animal health services. Animal production services are secondary and consist mostly of:

- Breed improvement programmes
- Government farms
- Livestock production research
- Information services
- Livestock production extension and
- Training.

Government policies

In general, government policy towards the livestock sector is non-interventionist. The government is not directly involved in production enterprises and is disengaging itself from the few remaining government owned processing facilities. The private sector is encouraged to develop production, processing and marketing enterprises.

Increased supply for urban markets is to be developed from rural irrigated areas where there is thought to be untapped supply and a large demonstrated potential for increasing production. To encourage this development, dairy farms were exempted from income tax until June 1988; government land may be leased in large blocks for establishment of dairy farms; semen of exotic dairy breeds may be imported duty free and credit is available through the Agriculture Development Bank of Pakistan (ADBP). Furthermore, milk-processing plants qualify for a number of incentives, which include duty free import of machinery and equipment and restrictions on the import of dairy products.

Smallholder dairy production and marketing in India: Constraints and opportunities

M.P.G. Kurup

National Dairy Development Board (NDDB), India
e-mail: mpgkurup@wilnwtonline.net/mpgkurup@yahoo.com

Introduction

The Indian livestock system is the endeavour of smallholders; there are no big players in it. Livestock keeping is a centuries-old tradition for millions of Indian rural households and domesticated animals have been an integral part of the farming systems from time immemorial. While livestock do yield economic outputs, it is difficult to explain many aspects of household behaviour with respect to livestock, purely from the angle of economic rationality and maximisation. Consequently, treating the livestock production system as a pure input–output type economic system often misrepresents the Indian reality (GoI 1996). Traditionally, farmers keep livestock in proportion to the ‘free’ crop residues and family labour available in their own household production systems and convert these into food, fuel and farm power—making each household a virtually self-contained production system with no purchased inputs and few marketed outputs. This age-old trend has undergone rapid change in recent decades. Although the organisation of livestock production in small units persists, household production systems are increasingly becoming integrated into input as well as output markets. As a result of gradual transition from subsistence to market system, the economic dimensions of livestock keeping have assumed increasing significance in household behaviour. Thus, in understanding its true significance the livestock sector in India needs to be viewed as a sector linked with the livelihoods of millions of rural households—over 70% of all rural households—who depend on livestock farming for supplementary incomes.

The country and its attributes

India is a country of subcontinental size and character, a country of many contradictions, a melting pot of many cultures and races, a polyglot with many languages and dialects. The total land area is about 3.28 million square kilometre, made up of 28 states and 7 union territories. Together they have over 510 districts; their exact numbers changing, as many states are reorganising their district configuration. The population was 846 million in 1991, with some 75% of the people living in rural areas. Between 1991 and 2000 the population grew at the rate of approximately 1.57% annually and crossed the 1 billion mark in 2000. Forests account for 23% of the total land, while permanent pastures and grazing areas cover less than 4%. In 1996, the net sown area in the country was about 142 million hectares

(47%), the gross cropped area 187 million hectares (cropping intensity 1.3) and the gross irrigated area 71.5 million hectares (38%). India includes areas with widely varying climates and rainfalls. It is classified into 15 different agro-climatic zones ranging from alpine to desert; a very large part of the country can generally be described as semi-arid.

India has a thriving agriculture sector, predominantly rain-fed, with burgeoning outputs and food surpluses. While wheat and rice are the most popular crops, Indian agriculture has a rich diversity of crops ranging from cereals, millets, oilseeds, pulses, cotton, jute, tobacco, tea, coffee, fruits, vegetables, tubers, spices, flowers and aromatic and medicinal plants to a wide variety of plantation crops. Agriculture continues to be a major contributor to the gross domestic product (GDP): 24.7% in 1998–99 at constant prices (1993–94 base year). The agricultural sector is also the single largest employer, even in 1991 over 65% of the main work force were engaged in agriculture either as cultivators (107 million) or as agricultural labourers (74 million). However, at the turn of the century there are indications of a major shift in employment patterns with burgeoning opportunities opening up in the services sector. The Indian economy is robust; in 1999–2000 (at constant prices with 1993–94 as base year), the GDP and the national income both grew at 5.9% and the per capita income in real terms grew at 4.2% (Figure 1).

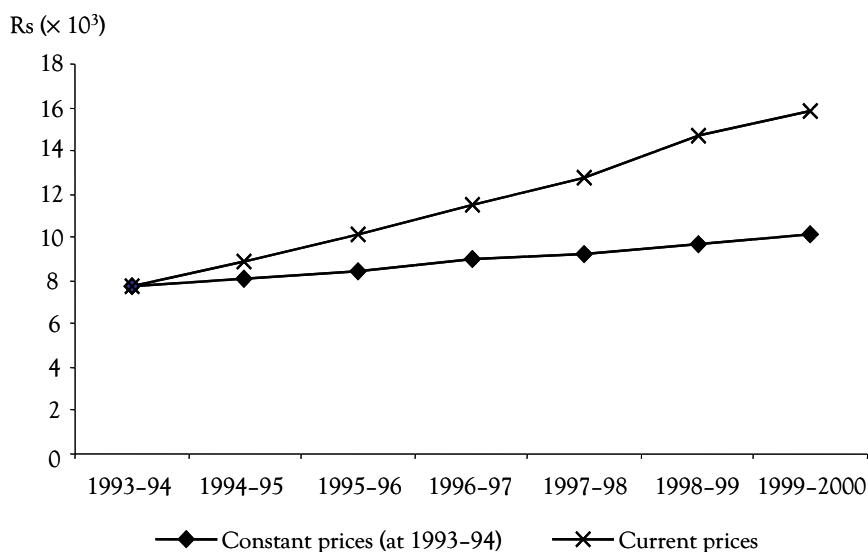


Figure 1. Per capita national income.

Smallholder profile

Land holdings in India are in general small and fragmented; medium and large holdings account for less than 10% of the holdings (Table 1). The predominant farming system across the major holding categories is mixed crop–livestock farming, in all regions of the country. Distribution of land, however, is grossly inequitable; marginal producers and smallholders account for over 78% of the holdings but they own or operate less than 33% of the total farm land.

Table 1. Distribution of land holdings (Numbers in $\times 10^3$ and areas in $\times 10^3$ ha).

Land holding category	Number of holdings (%)			Area operated (%)		
	1985–86	1990–91	% change	1985–86	1990–91	% change
Marginal	56,147 (57.8)	63,389 (59.4)	+12.9	22,042 (13.4)	24,894 (15.0)	+12.9
Small	17,922 (18.4)	20,092 (18.8)	+12.1	25,708 (15.6)	28,827 (17.4)	+12.1
Semi-medium	13,252 (13.6)	13,923 (13.1)	+5.1	36,666 (22.3)	38,375 (23.2)	+4.7
Medium	7916 (8.2)	7580 (7.1)	– 4.2	47,144 (28.6)	44,752 (27.1)	–5.1
Large	1918 (2.0)	1654 (1.6)	– 13.8	33,002 (20.1)	28,659 (17.3)	–13.2
All categories	97,155 (100)	106,637 (100)	+9.8	164,562 (100)	165,507 (100)	+0.6

Notes: Land holding categories: marginal <1 ha; small 1–1.99 ha; semi-medium 2–3.99 ha; medium 4–9.99 ha; large >10 ha.
Source: DoAC (1991).

With the relentless growth in human population, the number of holdings progressively increases. Consequently, the size of land holding in general has been shrinking steadily over the years, progressively making individual holdings unviable. In 1981, the average holding size for all categories together was 1.79 ha per holding (Reserve Bank of India 1981) in 1999. This had shrunk to 1.34 ha (Singh 2001). Diversification in agriculture thus became unavoidable for the vast majority of the farming community in order to protect livelihoods.

Livestock had all along been a part of the predominant farming system in India: mixed crop–livestock farming. Among livestock, cattle and buffalo are the preponderant and the most interactive species, subsisting on crop residues and contributing milk, meat, draft power and farmyard manure. Distribution of livestock holding in general and milch animal in particular appears to be far less unjust than distribution of land holding. For example, in 1992, marginal producers and smallholders together owned over 67% of the milking animals and constituted the core milk production sector in the country (Table 2). The Gini Coefficient representing the index of inequity in ownership of dairy stock shows perceptible decline from 0.43 in 1961, to 0.37 in 1971 and further to 0.28 in 1991.

Table 2. Distribution of milch animals in rural households (HH) by land holding category in 1992.

Land holding category	Number of HH ($\times 10^2$)	Total number of milch animals ¹ (per 100 HH)	Number of crossbred milch animals	Crossbred milch animals as a % of total	
			(per 100 HH)	All milch animals as a % of total	animals as a % of total
Landless ²	254,249	11	1	3.19	3.64
Marginal	561,777	68	8	43.40	57.10
Small	165,486	114	8	21.52	17.32
Semi-medium	112,911	136	9	17.52	13.30
Medium	57,369	168	10	11.00	7.51
Large	12,382	239	7	3.38	1.13

1. Milch animals comprise dry, in-milk and others (Livestock Census Classification: adult breedable females), including crossbreds.

2. Landless category includes HH with ≤ 0.002 ha of land, as well as those without any land.

Source: NSSO (1992).

Moreover, milk animals among crossbred cattle (78%) also tend to be concentrated in the marginal and small sized holdings. Bovine stock holding per household varies considerably with region, both in number and species held, but the average holding seldom exceeds three animals per household. Landless labourers also own milch animals and earn substantial additional incomes from sale of milk, particularly in the dairy co-operative society (DSC) villages and other areas where milk-marketing infrastructure exists. Bovine stock holding size as a rule is larger in Punjab, parts of Haryana and western Uttar Pradesh. There are a few large dairy farms in the country: these are mostly institutional farms or are commercial dairy farms for milk production in metropolitan cities and other major urban areas.

Livestock sector in India

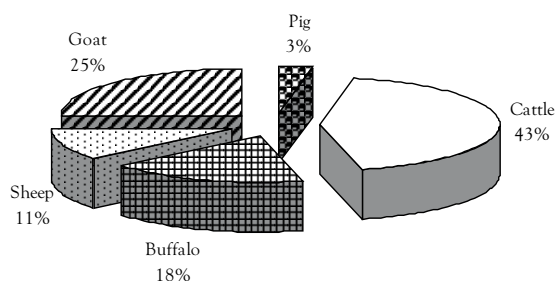
The livestock sector in India is characterised by very large numbers and very low productivity, across all species. The sector is highly livelihood intensive and provides supplementary incomes to over 70% of all rural and quite a few urban households. The livestock sector contribution to the overall GDP of the country has remained steady at around 6–7% (at constant prices 1980–81 base year; draft power output not included) over the last four decades, even as the Indian economy grew and diversified. Cattle are the most popular species and along with buffalo they are the species most widely kept by the farming community. Livestock production in rural India takes place as a household activity and seldom employs hired labour. The sector is highly gender sensitive and over 90% of the household chores related to care and management of livestock are carried out by the family's women folk.

Cattle and buffalo: The dairy stock

India had some 204 million cattle and 84 million buffalo in 1992. The livestock population of India and the percentage composition of the population by species in 1992 are presented in Table 3 and Figure 2. Cattle population grew by 33% during the four decades between 1951 and 1992; however, the rate of growth slowed visibly over the past decade (0.48% per annum between 1987 and 1992).

Table 3. Livestock population 1992.

Species	Number ($\times 10^6$)
Cattle	204.00
Buffalo	83.50
Sheep	50.80
Goat	115.28
Pig	12.79
Total livestock	470.14
Total poultry	307.07



Source: Department of AH&D (1998).

Figure 2. Livestock population (Percentage composition).

In contrast, buffalo population almost doubled over the same period, growing much faster (almost 2% per annum between 1987 and 1992). The justification for the uncontrolled growth of the cattle population had all along been the need to produce work animals in adequate numbers for the crop sector. This is no longer valid, as electrical and mechanical sources of power have largely replaced draft animals in the farm power sector and have progressively circumscribed their role in farm operations. The share of animals in farm power has decreased drastically from 72% in 1961, to less than 25% by 1991, even though the total energy input/hectare for crop production has increased three-fold over the same period. These changes are reflected in the dynamics of the cattle population including: a major reduction of work animal numbers (1992); a male:female ratio in the population that is progressively moving in favour of the female (1:0.8 to 1:1.3); a steadily increasing proportion of adult breedable females among indigenous females (slowed down from 1987 as crossbreds took over); and spectacular growth of the number of crossbred cows in the population. All these factors herald a perceptible shift in the priority of the farming community from production of work animals to production of milch animals. The buffalo is the mainstay of the Indian dairy industry and the growth in buffalo population is entirely demand driven. Buffalo population trends are in favour of an overall consolidation of the population as the predominant dairy stock; there have been steep reductions in the numbers of males and a progressively increasing proportion of breedable females among all females (Table 4).

Some 70% of the Indian cows and 60% of the buffalo have very low productivity. Organised breeding operations, particularly the artificial insemination (AI) services under the government departments, reach only about 20% of the breeding animals among cattle and less than 5% of the buffalo. In 1999, about 19 million AIs were carried out in the country by the state departments. These constituted 5 million AIs by the milk co-operative system (3.30 million in cattle, 1.68 million in buffalo) and 0.5 million together by non-governmental organisations, voluntary organisations and private AI practitioners, bringing the total number of AIs for breeding cattle and buffalo to about 24.5 million.

Table 4. *Growth of proportion of females among cattle and buffalo populations 1982–92.*

Animal category	Livestock Census Round 1982		Livestock Census Round 1987		Livestock Census Round 1992	
	Total	Adult females	Total	Adult females	Total	Adult females
Indigenous cattle ($\times 10^6$)	180.31	55.71	188.28	56.39	189.32	56.70
Crossbred cattle ($\times 10^6$) ¹	8.80	2.98	11.41	4.54	15.22	6.36
Buffalo ($\times 10^6$)	69.78	32.50	75.97	39.13	83.50	43.08
Indigenous cattle AGR ² (%)	–	–	0.88	0.24	0.11	0.11
Crossbred cattle AGR ² (%)	–	–	5.93	10.47	6.66	8.01
Buffalo AGR (%)	–	–	1.77	4.08	1.98	2.02

1. Crossbred cattle were enumerated separately only from Census Round 1982 onwards.

2. AGR = simple annual growth rate.

Source: animal numbers: Directorate of Economics and Statistics (1982, 1987 and 1992); AGR were derived from the census numbers.

The breeding policy recommended for cattle and buffalo in 1962 was: (i) selective breeding of the pure Indian dairy breeds of cattle for milk production and work; (ii) upgrading of the nondescript Indian cattle with selected Indian donor stock; (iii) selective breeding of the major buffalo breeds for milk; and (iv) upgrading of the nondescript and minor breeds of buffalo by the Murrah buffalo breed. The policy for selective breeding of the Indian breeds of cattle and buffalo, however, did not take off for various reasons: (i) improvement in production and productivity were gradual; (ii) absence of proven sires among the breeds; and, above all, (iii) the absence of Breeders' Organisations for each of the breeds in their respective home tracts.

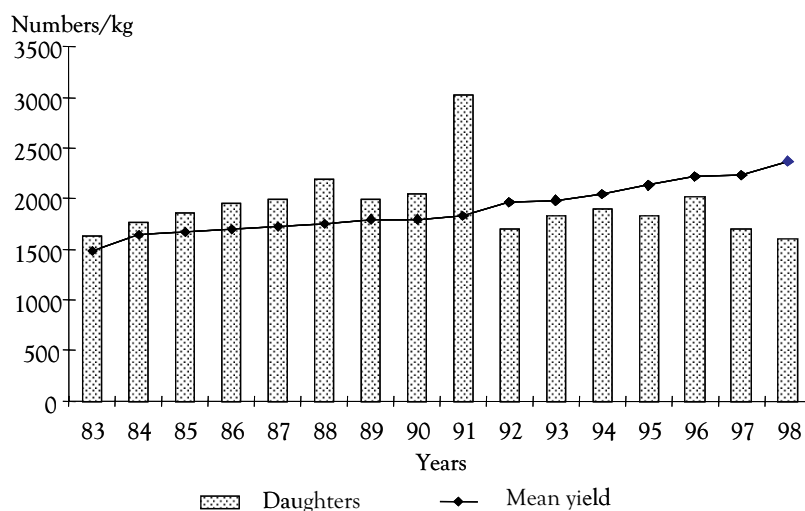
Crossbreeding of nondescript Indian cattle on field-scale started only in 1964 with the launch of the Intensive Cattle Development Project by the Government of India. By 1969, crossbreeding had become the official policy of the government. Pioneering work on large-scale crossbreeding in different parts of India by the Bharathiya Agro-Industries Foundation and the strong recommendations of the National Commission on Agriculture in 1974, laid all adverse criticism of the strategy to rest and legitimised crossbreeding as a powerful tool to rapidly enhance milk production in India. Crossbreeding gained momentum and economic relevance as the co-operative network under Operation Flood moved into providing the much needed market stimulus and price support for milk. The government had no intention to crossbreed pure Indian breeds of cattle, but in practice the spectacular increases in milk yields in crossbred progenies generated overwhelming demand and necessitated the expansion of the crossbreeding programme nation-wide even to the home tracts of the pure Indian breeds.

The technical programme for crossbreeding, approved by the government, was to use the nondescript Indian cattle as the foundation stock and to breed them with semen from exotic donor breeds to produce halfbreds, with equal inheritance from the two widely different parents, one contributing endurance and the other the much needed higher productivity. The policy thereafter, was to breed the halfbreds among themselves in subsequent generations, to create large inter-mating populations of halfbreds, perpetually

maintaining the share of inheritance half way between that of the Indian and the exotic parents. Genetic progress was to be maintained and promoted in the inter-mating populations through use of genetically evaluated halfbred sires for the *inter se* matings. The exotic donor breeds used initially were Jersey, Brown Swiss, Red Dane and Holstein-Friesian but the choice has now narrowed down to Jersey and Holstein-Friesian.

For *inter se* mating of halfbreds, genetically evaluated halfbred bulls are *sine qua non*, but they are precisely what India doesn't have (with the sole exception of those in Kerala State). While most states had been totally indifferent in managing the breeding policy as prescribed, Kerala State had been following the policy strictly, with commendable achievements. Punjab had completely deviated from the central prescription and has followed a policy of its own for progressive upgrading of the local cattle with Holsteins, taking into account the quality of farmers in Punjab and the resources available in the state.

In the absence of evaluated halfbred bulls, *inter se* mating in many states ran into disrepute, as progenies in successive generations started to produce yields far below the expected levels and the whole of the crossbreeding programme came to be regarded by many as a very expensive misadventure, while Kerala, a state with no natural attributes for dairy production, provided a living example of (i) the benefits of crossbreeding, (ii) sustainability of crossbreeding and (iii) the discipline with which crossbreeding should be managed. Kerala started with nondescript (scrub) cows and yet was able to replace some 70% of the nondescripts with crossbreds and to increase the state's total milk output from 0.22 million tonnes in 1964 to 2.53 million tonnes by 1998. Figures 3 (field data) and 4 illustrate the impact of selection (sire evaluation) on an *inter se* mated crossbred population. The steadily increasing mean milk yield of the test daughters is a measure of the genetic progress in the population.

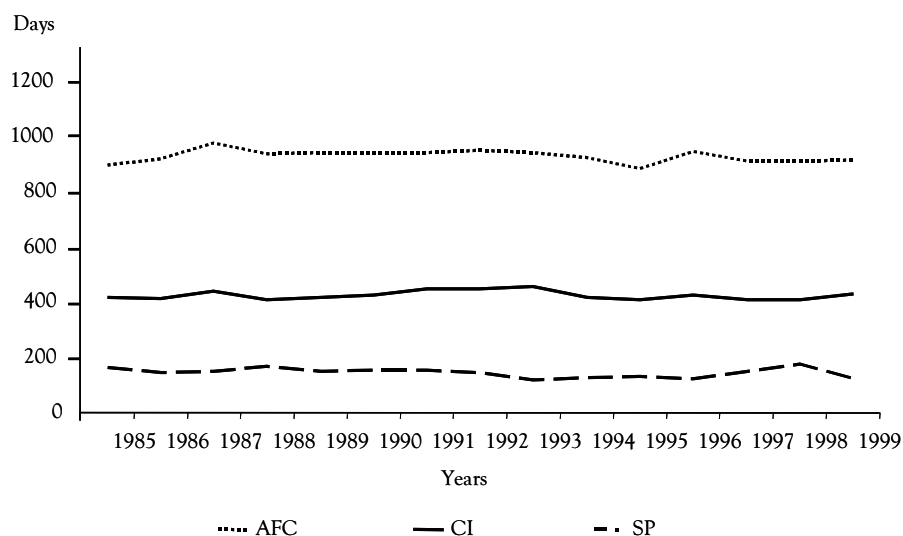


Source: KLDB (1998-99 and 1999-2000).

Figure 3. Mean milk yield of test daughters (Standard first lactation).

The behaviour of the *inter se* mated populations of crossbreds in Kerala with regard to the non-additively inherited traits (i.e. age at first calving, calving interval and service period)

shows higher variance over several generations of *inter se* mating (Figure 4), as well as the impact of selection mitigating the heterosis effect.



AFC = age at first calving; CI = calving interval; SP = service period (all mean values).

Data relate to institutional herds in the KLDB farms at Mattupatty, Dhoni and Peermedu.

Source: KLDB (1998-99 and 1999-2000).

Figure 4. General production traits of Sunandini cows (non-additive inheritance) from 1985-99.

Evidence of yield parameters from other states also shows that the performance of crossbreds in the field is generally at the levels expected and problems, if there are any, are grossly exaggerated. Proof of the success of crossbreeding, as a strategy, is that it is growing at a phenomenal rate of almost 10% per annum and that nearly 80% of the crossbred milch animals are held by landless, marginal and smallholder producers. Data from field milk recordings in selected states show the following yields: Andhra Pradesh 2345 ± 68 kg in 366 ± 4 days (Rao et al. 2000); Punjab (standard lactation) 2022 ± 48 kg (Garcha and Dev 1994); Tamil Nadu (standard lactation) 2075 ± 20 kg (Venkitasubramanian and Fulzele 1996); and Orissa (standard lactation) 1956 ± 32 kg (Orissa State Livestock Sector 1999).

Breeding and development of selected Indian dairy breeds of cattle and buffalo are part of the government policy, but only on paper. A few of the 26 breeds of cattle and 15 breeds of buffalo in India have the potential and attributes to become outstanding dairy stock (cattle breeds: Sahiwal, Gir, Rathi and Kankrej; buffalo breeds: Murrah, Jaffarabadi and Mehsani). None of these cattle breeds listed are covered under AI and of the buffalo breeds listed <5% are bred by AI, except the Mehsani. Moreover, with the exception of the Mehsani, none of the breeds have selection programmes nor is there any effort to generate adequate numbers of genetically evaluated AI sires for breeding them. Mehsani buffalo are bred with AI; furthermore, because of the work of the Mehsani Milk Co-operative Union, an effective selection programme is in operation and genetically evaluated sires exist in adequate numbers.

Milk production in India

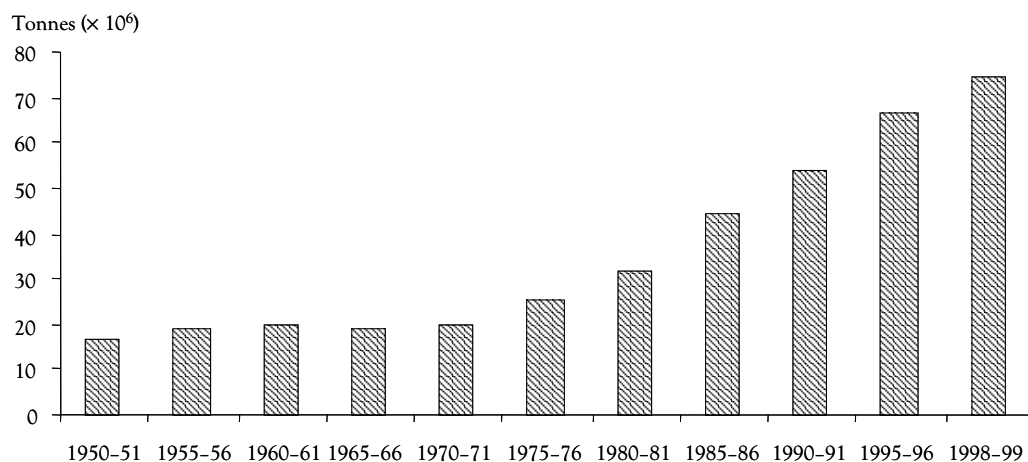
Milk production in India takes place in millions of small and very small holdings (approximately 70 million households (HH)) scattered across the length and breadth of the country. The marginal producers and smallholders, who account for some 78% of all land holdings, constitute the core milk production sector; they own over 60% of all milch animals (74% of the crossbred milch animals). The milk-animal group in India is made up of buffalo, cattle and goats, although goat milk is invariably for home consumption and if traded at all, it is mixed with cow or buffalo milk. In 1998–99, India produced some 74.7 million tonnes of milk. By species, buffalo produced 40.50 million tonnes (54%); cattle produced 31 million tonnes (42%); and goat produced 3.2 million tonnes (4%). In terms of their numbers, crossbred cows accounted for only about 15% of the total adult female cattle population in 2001 (projected numbers 9.35 million) (Department of AH&D 1998), but contributed over 10 million tonnes of milk, nearly 33% of the cow milk produced.

Planned development of the dairy sector started with the launch of the first five-year plan in 1951. Policies and programmes under the first three five-year plans (1951–66) were inadequate to influence milk production and milk output continued to be stagnant (3 million tonnes, from 17 to 20 million tonnes). By the end of the third five-year plan the inadequacies were apparent and the government made serious policy reorientation to engineer sustained increases in milk production. The plan ‘holiday’ between the third and fourth plans (during 1966–69) saw some of the most momentous policy initiatives by the government in the livestock sector, particularly for dairy development. Development of rural milk sheds through milk producers’ co-operatives and movement of processed milk to urban demand centres became the cornerstone of government policy. This single policy-making epoch in the late 1960s galvanised the Indian dairy industry to erupt into a growth path unprecedented in recent history in any country. This policy found institutionalisation in the National Dairy Development Board (NDDB) and was translated into action by the Operation Flood Project and the nation-wide milk co-operative network promoted under the project, for marketing the rurally produced milk. Milk production suddenly came alive; sluggishness gave way to rapid growth (Figure 5). Milk production increased from 20 million tonnes in 1970 to nearly 75 million tonnes in 1999, growing steadily at around 4–5% compound annual growth rate (CAGR) (Table 5).

Table 5. *Milk production: Compound annual growth rate (CAGR).*

Block years	CAGR (%)	Trend growth rate (%)	R ²
1971–99	4.80	4.75	0.98
1981–99	4.90	4.55	0.99
1991–99	4.16	4.11	0.99
1971–81	4.63	4.20	0.97
1971–91	5.06	4.95	0.99
1981–91	5.48	5.15	0.99

Source: Directory of Indian Agriculture (1997); Department of AH&D (Animal and Health Diseases) (1999).



Source: Directory of Indian Agriculture (1997); Department of AH&D (Animal Health and Diseases) (1999).

Figure 5. Growth in milk production from 1950 to 1999.

Productivity of milch animals

The National Council of Applied Economic Research (NCAER), New Delhi, carried out two nation-wide evaluation studies of the Operation Flood Project; first, a base-line study in 1988-89 and secondly an impact evaluation study in 1995-96. The studies included an analysis of productivity levels in milch animals. These estimates, however, were the milk yields/day of the animals in-milk on the day of the survey, in the households surveyed and as reported by the respondents. Milk recording in India is confined to institutional herds and the rare field records of test daughters under progeny test schemes. Therefore, the best possible productivity estimates are those of the NCAER discussed here and the sample surveys carried out periodically by the central and state departments of animal husbandry. Average lactation lengths of the various types of milch animals, based on field experience countrywide are as follows: indigenous cows 150-200 days; buffalo 200-250 days; and crossbred cows >300 days. The lactation yields of the different types of animals in milk exhibited in Table 6 were calculated by the author, based on the NCAER data of daily records presented; thus, these data are very rough estimates.

Table 6. Productivity of milch animals by zone for 1995-96.

Zone	Crossbred cows	Indigenous cows	Buffalo
	litres per day/litres per lactation (lactation length)	litres per day/litres per lactation (lactation length)	litres per day/litres per lactation (lactation length)
East	5.82/1746 (300 days)	3.01/452 (150 days)	5.39/1078 (200 days)
North	7.07/2121 (300 days)	3.29/658 (200 days)	5.25/1323 (250 days)
West	7.80/2340 (300 days)	3.19/638 (200 days)	4.51/1128 (250 days)
South	6.39/1917 (300 days)	3.35/503 (150 days)	3.96/792 (200 days)

Source: Shukla and Brahmankar (1999).

Services for dairy production

All services for dairy production come from the state governments through their departments of animal husbandry. The departments have very large networks of veterinary institutions (poly clinics, veterinary hospitals, veterinary dispensaries and livestock aid centres) spread throughout the states and provide free veterinary services. The total number of veterinary institutions in India in 2001 is about 51 thousand. The veterinary hospitals and dispensaries are staffed invariably by qualified veterinarians and the livestock aid centres by para-vets (livestock inspectors). For delivering these services, the state governments employ about 36 thousand qualified veterinarians and 70 thousand para-vets. Some 30 thousand of these institutions also provide AI services. The emphasis of these departments is on curative veterinary care as a welfare measure and they have grossly neglected preventive veterinary care. India, consequently, has several animal epidemics ravaging the animal populations and causing annual losses amounting to about 100 billion rupees (Rs), nearly 10% of the total output value of the entire livestock sector in India in 2001. Furthermore, the poorest of the poor in the country, the smallholders, bear the brunt of these avoidable losses.

The services of government institutions are delivered at the institutions; the farmers have to take their animals to the institution to receive the services. The departments of animal health have very severe budget constraints and they spend almost 90% of their budgets on salaries and other establishment costs. There is no money left for supplies and the institutions receive only a token supply of medicines and consumables for animal treatment. Consequently, the farmers have to buy their veterinary medicines and consumables from the local trade. The services are poor and because of institutional delivery they have only a limited reach. Because of the overwhelming presence of the governments in the service delivery sector, free markets for these services have not developed. There are only a few (insignificant numbers) private practitioners of animal health services. A similar situation exists for AI.

Other than the government, there is the milk co-operative system, which provides high quality livestock services, both veterinary and AI, to its members. These services are limited to the co-operatives' areas of operation and account for less than 10% of total services in terms of areas covered. In the case of AI, however, the co-operatives also have a large network of village-based institutions, consisting of over 12 thousand DCSs with AI facilities where farmers can get AI services delivered in their villages. There are also a few voluntary and non-governmental agencies providing livestock services, but they are so few that they present an insignificant percentage of the total.

India does not have a livestock extension support service except in the milk co-operative system.

Availability and consumption of milk

The output value of the milk group in 1998–99 was Rs 826.24 billion, some 67% of the total output value of the livestock sector (Rs 1230.76 billion at current prices). By 1999, milk had emerged as the single largest product in Indian agriculture (74.7 million tonnes/annum)

and India became the single largest milk producing country in the world. Per capita availability of milk decreased from 124 grammes/day in 1951 to 107 grammes/day by 1970, but grew steadily thereafter and reached 211 grammes/day by 1999, in spite of the growth of human population by some 250% during this period. Levels of milk consumption vary widely between regions and economic groups, and also between urban and rural households. The changing milk consumption pattern in households countrywide is presented in Table 7.

Table 7. *Milk consumption pattern.*

National Sample Survey Organization (NSSO) Round	Milk consumption ¹ litres/HH per month (grammes/capita per day)		Average size of HH number of persons	
	Rural	Urban	Rural	Urban
1987-88 = 43rd Round	16.25 (108) ²	20.06 (142)	5.08	4.71
1991 = 47th Round	18.71 (125)	22.80 (161)	5.00	4.73
1993-94 = 50th Round	19.29 (131)	21.79 (161)	4.90	0.50

1. Consumption figures are for the household segment and do not include consumption of milk products, or outside home consumption of milk or milk products.

2. Figures in parentheses indicate consumption in grammes/capita per day.

Source: Department of AH&D (1999).

The NCAER studies discussed earlier, among other things, also analysed the per capita milk consumption pattern by type of household and by membership of DCSs in Operation Flood areas. Over 75% of the member households surveyed belonged to the landless, marginal and smallholder producers. The council came to the conclusion that milk consumption levels in Operation Flood areas were substantially higher than national averages and attributed the higher consumption to the economic impact of Operation Flood on the economy of the landless, marginal producers and smallholders (Table 8).

Table 8. *Per capita milk consumption in Operation Flood areas 1989-96 (grammes/capita per day).*

Zone	Member household (HH)		Non-member HH		All HH	
	1988-1989	1995-1996	1988-1989	1995-1996	1988-1989	1995-1996
East	190	242	190	234	190	238
North	530	475	460	592	490	530
West	220	221	190	224	210	221
South	170	309	160	279	170	302

Source: Shukla and Brahmankar (1999).

Demand and supply for milk and milk products

Milk and milk products constitute an integral part of the daily diet of all Indian households, without exception, across all regions and all social and economic categories. However, consumption levels vary considerably, depending on income levels. Per capita availability of milk in India is approaching the nutritional norm, but consumption of milk and milk products is yet to reach its per capita potential. Rising incomes countrywide and

the high disposable incomes of the top 20% of the urban Indian population, are rapidly changing milk consumption patterns. End use of the national milk output is a measure of the diverse household preferences and priorities in the consumption of milk and milk products (Table 9).

Table 9. *End uses of milk.*

Product	Tonnes ($\times 10^6$) ¹	Percentage of total milk output (%)
Liquid milk	33.62	45.0
Butter	4.86	6.5
Milk powder	1.94	2.6
Cream	0.37	0.5
Ice cream	0.37	0.5
Ghee ²	20.92	28.0
Dahi	5.23	7.0
Khoa	4.86	6.5
Chhana/paneer/cheese	1.49	2.0
Others	1.27	1.7

1. Quantities based on percentage share in milk output in 1999 and worked out by the author.

2. Includes quantities produced in the traditional/unorganised sector.

Monthly private consumption expenditure of households across India on milk and milk products is second to that for cereals, accounting in 1993–94 for about 9.5% of the total expenditure of households in rural areas and 9.8% in urban areas (NSSO 1994). It has been rising steadily over the years. Wholesale prices of milk increased steadily and faster than the prices of food articles and all commodities until 1990, after which the prices of food articles started increasing faster (8.76% CAGR) than milk prices (6.70%). Milk and milk products are both income and price elastic in rural as well as urban India (more so in rural); the demand elasticity estimates of the Indian dairy industry for milk and milk products combined are 1.65 in rural and 1.15 in urban India (Datta and Ganguly 2002). Expenditure elasticity of demand for milk and milk products for the lower income class in India is considerably greater than two and therefore, rising incomes countrywide will maintain healthy demand and robust demand growth in the dairy sector. Demand forecasts for milk, based on differential growth rates of the GDP for the period up to 2020, are presented in Table 10.

Table 10. *Demand forecasts for milk 2000–2020.*

Product	GDP growth (%) ¹	2000	2010	2020
Milk	4	72.40	95.60	126.00
Milk	5	75.30 ²	103.70	142.70
Milk	7	81.30	122.00	182.80

1. GDP and national income have both been growing at the rate of between 5 and 6% over the past five years.

2. Actual production exceeded the forecast in 2000.

Milk processing, value addition and marketing

The milk market in India is predominantly in the non-organised sector and is traditional and fragmented. The organised dairy industry represents less than 20% of the total milk produced in the country and is made up of three distinctly different sectors: the government, the co-operative and the private. In terms of volumes of milk handled, installed processing capacities and marketing infrastructure, the co-operative sector is by far the largest. Furthermore, the co-operative sector includes some 10 million landless, marginal and smallholder milk producer families, all members in the nearly 82 thousand DCSs across the country. However, in terms of installed processing capacities alone, the co-operative and private sectors have more or less matching capacities and the government only a small presence (Table 11 and Figure 6). Together they have the capacity to process about 33% of daily average milk production in the country, but they actually handle <20%.

Table 11. *Milk processing capacity.*

Sector	Number of plants	Capacity ($\times 10^6$ litres/day)
Co-operative	218	32.47
Private	366	30.26
Government	39	3.87
Total	623	66.60

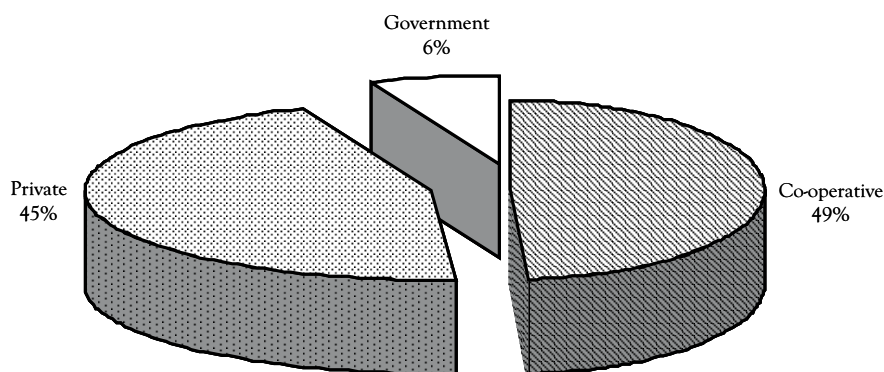


Figure 6. *Processing capacity (%) by sector.*

Much of the processing capacity created by the private sector in the wake of the liberalisation of the Indian economy in 1991 remains idle; only about 60% of the installed capacity of the private sector is operated on a day-to-day basis. In the government sector too, most of the primary processing facilities installed in rural areas (mainly milk chilling centres) are not functional and dairy plants in the smaller towns and cities are grossly under utilised. In the co-operative sector, all plants are used to their full capacity and remain under utilised only during the lean production season. A little over 30% of the milk produced is retained

in producer households. About 50% of milk is traded in through the traditional channels; about half of this is traded without any processing, whilst the other half, going into traditional product and sweetmeat manufacture, undergoes some traditional processing (acid coagulation and/or heat treatment) before it is traded.

These processing capacities include liquid milk processing and manufacture of products: milk powders, table butter and white butter, cheese, ghee, condensed milk and milk sweets. The special infrastructure for the dairy industry mostly belongs to the co-operative system and the NDDB, while the government and the private sector have only limited infrastructure, such as road milk tankers and a limited cold chain. The co-operative infrastructure covers all aspects of the industry including: milk collection (bulking, chilling and pre-plant transport, through a network of over 82 thousand DCSs countrywide); processing and value addition (liquid milk and milk products plants); transport (road, milk tankers, and broad gauge and metre gauge rail milk tankers); and cold chain/storage (cold stores, deep freezes, refrigeration trucks, warehouses and automatic milk vending units). In addition, there are thousands of shops selling milk-based sweetmeats, all privately owned, with their own traditional recipes, processes and products, which are outside the ambit of the organised dairy industry.

Some 45% of the milk produced (92 million litres/day in 1999) is consumed as liquid milk. The bulk of it is traded in the traditional channels, most of it through several tiers of contractors. Some 16 million litres is traded as processed packaged milk: 13.5 million litres by the co-operative sector and 2.5 million litres by over 300 private sector brands. A very large percentage of these private sector brands is substandard, often unhygienic, as quality and hygiene standards are seldom enforced. The co-operative network supplies wholesome milk to some 800 cities, towns and urban agglomerations daily, mostly as pasteurised, packaged milk but some in modern automatic bulk vending units in metropolitan cities.

Milk products from the organised sector are marketed through a vast network of wholesalers, distributors and tens of thousands of retailers, separate chains of them for each brand and company. By far the largest manufacturer of milk foods in the country is the Gujarat Co-operative Milk Marketing Federation (GCMMF), the apex co-operative body of the Gujarat milk co-operatives, which is also the single largest food company in India, with both national and global markets. Almost all of the milk and milk products produced in India are traded and consumed in India itself, with export forming a tiny share of the whole. Nevertheless, although the volumes are small, India now has a presence in the world markets and regularly exports milk products and long-life milk to countries in West Asia, South-east Asia, South Asia and North America. The GCMMF is the prime exporter; in 1999, it exported some 1700 t of milk powder, 400 t of ghee, 100 t of table butter, 25 t of cheese and some 100 t of other products. This constituted almost 80% of all exports in 1999. The total value of the exports for all exporters together was some Rs 466 million in 1999. The level of imports into the country during the same year was some 17,252 t of skim milk powder and 5224 t of butter oil. To complete the market picture for milk and milk products in India, a sample of the milk producer prices in the DCSs, and retail prices of milk and milk products marketed by the organised sector in the domestic markets are presented in Table 12.

Table 12. *Producer prices of milk in dairy co-operative societies (DCSs) and consumer prices in domestic markets: A sample.*

S. No.	Product	Price in Rs ¹
A	Liquid milk: producer prices in DCSs in December 2000	
1	Punjab: cow milk containing fat 3.8%, SNF 7.80%	7.61
2	Punjab: buffalo milk containing fat 7.0%, SNF 8.60%	11.51
3	Bihar: cow milk containing fat 4.50%, SNF 8.50%	10.82
4	Bihar: buffalo milk containing fat 6.10%, SNF 8.80%	11.29
5	Mehsana: cow milk containing fat 4.40%, SNF 8.60	8.81
6	Mehsana: buffalo milk containing fat 7.40%, 9.80%	13.69
7	Tamil Nadu: cow milk containing fat 4.40%, SNF 8.10%	8.90
8	Tamil Nadu: buffalo milk containing fat 6.70 %, SNF 8.90%	10.76
B	Liquid milk: consumer prices in metropolitan cities	
1	Delhi: FCM, TM, DTM in 500 ml sachets	FCM 17.00, TM 14.00, DTM 11.00
2	Calcutta: FCM, TM, DTM in 500 ml sachets	FCM nil, TM 13.00, DTM 11.50
3	Bombay: FCM, TM, DTM in 500 ml sachets	FCM 18.00, TM 13.00, DTM 10.50
4	Madras: FCM, TM, DTM in 500 ml sachets	FCM 16.00, TM 13.00, DTM 10.50
C	Milk products: consumer price in domestic markets	
1	Skim milk powder 500 gramme pack	63.00
2	Baby food 500 gramme pack	67.00
3	Dairy whitener 500 gramme pack	69.00
4	Cheese, Cheddar 400 gramme tin	75.00
5	Cheese, Cheddar slices 200 gramme pack	42.00
6	Cheese spread 200 gramme tub	26.00
7	Cheese, Emmental 200 grammes	60.00
8	Cheese, pizza 250 grammes	60.00
9	Ghee 500 gramme sachet	77.00
10	Brown beverages 500 gramme jar	75.00
11	Sweetened condensed milk 400 gramme tin	36.00
12	Paneer 200 gramme pouch	21.00

1. All prices as in December 2000. US\$ 1 = Rs 46; SNF = solids-not-fat; FCM = full cream milk; TM = toned milk; DTM = double toned milk.

Source: Datta and Ganguly (2002).

Impact of dairy production on the smallholders

Milk production in India is the endeavour of the marginal producers and smallholders; they constitute the core milk production group and own 66% of the 'in-milk' animals (NSSO 1992). The popularity of large ruminants (cattle and buffalo) with this class of landholders is primarily because of the complementarity between land and animals in their traditional crop-livestock farming system. The animals subsist largely on the free crop residues/crop by-products available in the household and in return, contribute dung for fuel/enriching the soil and farm draft power for crop production. With the increasing integration of these

farm households with the output markets, cattle and buffalo also generate substantial daily incomes for the farm family, enhancing the viability of both the household and the farming system. Dairy production in addition enables them to utilise the idle family labour and enjoy higher family nutritional standards.

Table 13. *Observations on milk producer households in dairy co-operative society (DCS) villages.*

Impact indicators	Observations	
1. Participation of weaker sections	Over 75% of the DCS membership are landless, marginal and smallholder producers	
2. Milk retention at home	47% of the milk produced is retained at home, daily	
3. Milk marketed	53% of the milk produced, daily	
4. Milk consumption/capita per day	339 grammes	
5. Milch animal holding	Animals per HH (number)	Percentage of animal holdings
5.1 Landless (15.3%) ¹	1.82	9.90
5.2 Marginal (38.2%)	1.63	39.80
5.3 Small (21.9%)	2.05	25.90
5.4 Semi-medium (10.3%)	2.45	12.20
5.5 Medium (4.2%)	2.88	3.30
5.6 Large (10.1%)	3.75	8.90
6. Family labour	Average time spent on livestock management: 4.3 hours/day (55%)	
7. Share of family labour for livestock care	Men 60% of their working time; women 35% of their working time	

1. Figures in parentheses are the percentage of DCS members by landholding category.

Source: Shukla and Brahmanekar (1999).

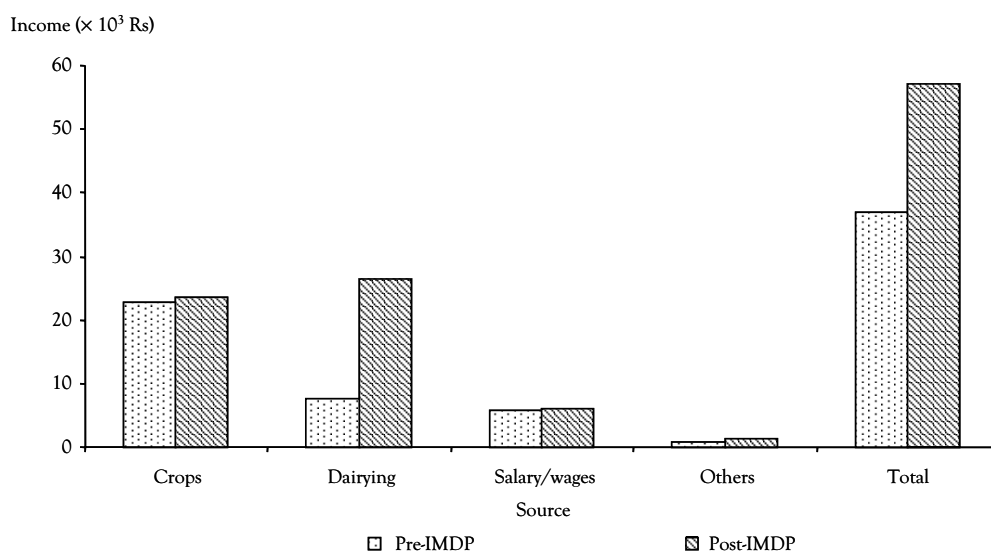
The impact study on Operation Flood (Shukla and Brahmanekar 1999) provides interesting insights into the impact of dairy production on the economy and behaviour of the smallholder producers in the DCS villages. In summary, landless, marginal and smallholder producers (the core group) accounted for over 75% of the membership of the DCSs; about 76% of the milch animals owned by DCS members belonged to the core group; a large number of landless producers owned milch animals and earned substantial incomes from dairy production; and dairy production contributed, on average, 40% of the household income in the East, 32% in North, 21% in the South and 34% in the West Zones.

Table 14. *Share of household income (%) from different sources.*

Household	Dairying	Crop husbandry	Others	Total
Landless	53.08	0.00	46.92	100
Marginal	30.14	46.55	23.30	100
Small	29.67	53.75	16.58	100
Semi-medium	26.25	58.98	14.76	100
Medium	25.33	62.77	11.91	100
Large	19.02	71.48	9.50	100
All	27.28	55.36	17.36	100

Source: Shukla and Brahmanekar (1999).

On the household economic front, there are many micro-studies establishing the impact of dairy production on household income in smallholder production systems. One of the most documented schemes in India on this front is the Intensive Mini Dairy Project of the Uttar Pradesh Dairy Development Department. This is primarily a rural employment scheme, enabling eligible milk producers in DCS areas access to commercial credit for replacing their local milch animals with two to four crossbred cows or improved milch buffalo, enabling better household resource utilisation. A comprehensive review of the project (impact study involving over 10 thousand project units) carried out by the Institute of Cooperatives and Corporate Management Research and Training (ICCMRT) (ICCMRT 1994) shows that introduction of two crossbred cows onto the farm dramatically increases the income from dairy production without altering the quantum of income from other sources (Figure 7).



IMPD = Intensive Mini Dairy Project.

Source: Based on data presented in ICCMRT (1994).

Figure 7. Rural household incomes: Influence of crossbred cows.

Constraints to smallholder dairy production

1. Milk production in India takes place in millions of small and very small holdings, both in terms of land and animals, scattered throughout the country. Reaching out to such a scattered smallholder population for technology transfer and extension support is, to say the least, a difficult task.
2. The progressively shrinking size and fragmentation of land holdings, render them increasingly unviable, driving large numbers of the holders at the lower end of the smallholder spectrum below the poverty line and making the government commit increasing amounts of funds, year after year, for poverty alleviation.

3. Institutional credit at the farm level for dairy production is extremely hard to access on account of procedural complexities, inordinate delays and high interest rates, despite the existence of tens of thousands of rural credit institutions including: rural credit co-operative societies, regional rural banks and rural branches of commercial banks. Lack of good quality credit circumscribes the potential of the smallholders for dairy production. Even at the turn of the century, over 50% of farm level credit for smallholder dairy production in India comes from traditional moneylenders.
4. Inputs and services for milk production enhancement are exclusively in the domain of the state governments (some 51 thousand veterinary institutions, 36 thousand graduate veterinarians and over 70 thousand para professionals and a host of production support institutions). Except in the areas covered by the co-operatives under Operation Flood, inputs and services are uniformly of substandard quality and are delivered at stationary centres requiring transport of animals to the centres for the services to be received. Public funds for the livestock sector are mostly squandered on services that are largely for generating private good (i.e. curative veterinary care, not preventive veterinary care).
5. India has many animal epidemics ravaging the cattle and buffalo populations but control of diseases is lowest among the priorities of the government (<3% of the government veterinarians engaged in disease control). This has resulted in enormous losses in terms of lost production (Rs 50–100 billion/year, nearly 10% of the output value of the livestock sector) and has precluded India from joining the global markets for dairy products. As smallholders own >70% of milch animals, they are the ones who bear the brunt of the avoidable production losses and the investment risks.
6. India has perhaps the largest single AI network in the world (63 frozen semen production stations, 33 million doses of frozen semen produced/year, 40 thousand AI delivery outlets and an army of AI professionals). However, it is also one of the most inefficient and poor quality AI services: <20% of the breeding cattle and not even 5% of the breeding buffalo are bred by AI; bulls used for AI are not genetically evaluated and so the AI system does not produce superior progenies generation after generation; in spite of over 25 million AIs in a year the system produces <2 million progenies/year (<10% conception); and the overwhelming presence of the state governments in AI services delivery has totally prevented the emergence of free markets for AI.
7. There are widening deficits in the supply of feeds and fodder countrywide (dry fodder such as straws/stover: production = 400 million tonnes, deficit 31%; green fodder: production = 575 million tonnes, deficit 23%; and feed concentrates: production = 46 million tonnes, deficit 47%). Demand estimates are based on nutritional requirements and are unrealistic. Enlarging ruminant populations compel smallholder producers to practice livelihood strategies inimical to nature, leading to enormous environmental costs for the burgeoning dairy production. Lack of adequate fodder and fuel wood supplies have compelled livestock owners to allow overgrazing on common property resources and forestlands, leading to denudation of common property resources and deforestation of forestlands. Nearly 100 million hectares have become wasteland, nearly a third of the total landmass of the country.

8. Government policies based on social and religious compulsions inhibit the alternate use of large ruminants, limiting the scope and viability of dairy production. These policies deny the smallholders of >40% of their potential income, which would have been available from the sale of male and unproductive stock as meat animals. These policies add untold numbers of unproductive stock to the bovine populations.
9. Large ruminants account for >90% of the livestock load on land. On a cattle equivalent basis, their numbers are already beyond the ability of the land to support and the continuing relentless increase in their population seriously threatens the sustainability of all animal agriculture.
10. Liberalisation of the Indian economy and the advent of the World Trade Organization (WTO) regulations opened up global competition in the dairy sector, exposing the smallholder producer to unfair and unequal market regimes. The Indian Government has fallen far short of providing them with the levels of protection and support measures permissible under WTO; thus, failing to create for Indian smallholder producers the much talked about level playing field even in their domestic markets.
11. The legal and regulatory framework of the government too has not kept pace with changes in the economic regimen and the WTO. The Co-operative Societies Act continues to be restrictive rather than enabling, even though the Anand Pattern Milk Producers' Co-operatives have emerged as the most stunningly effective institutional model for smallholder dairy production. Even though processing and value addition is pivotal to smallholder dairy production and only 15% of the milk produced in the country is processed by the organised dairy industry, the government has not liberalised its regulatory framework to attract the much needed capital into the processing and value addition sector.
12. After 50 years of planned development, the government still does not have a unified policy framework for its livestock sector and policies so far have been mostly *ad hoc* pronouncements to meet development needs. Policies, therefore, have only a marginal presence in the livestock sector, have often failed to galvanise purposeful action, have made extensive use of direct action by government departments and yet government presence is almost invisible in areas where it is most direly needed.

Opportunities in smallholder dairy production

1. Modifying the production organisation in the dairy sector in India, by enhancing milch animal quality and holding size within smallholder farming systems, will enable better utilisation of available family resources. It will enormously improve production and enhance viability across the system. The Punjab Model or the Intensive Mini Dairy Model of Uttar Pradesh, could be used in all the major milk sheds.
2. Improving the quality of farm level credit and access to credit will enable the lower 30% among the smallholder spectrum to move up from subsistence farming to progressively viable crop-livestock farming, adoption of intermediate technologies (like crossbred cattle) and achievement of progressively higher outputs and farm incomes.

Reorganisation of credit institutions, simplification of procedures, reduction of interest rates and removal of collateral security requirements, are all logical steps in the credit reform process.

3. Restructuring of the departments of animal husbandry in states, reorienting their mandate from curative to preventive veterinary care, moving delivery of livestock services away from the government, progressive privatisation of the services, a nation-wide programme for prevention and control of animal epidemics and creation of disease-free zones will all reduce avoidable production losses to smallholders, reduce investment risks for them, reduce the yield gap, improve output and will facilitate India's entry into global product markets, improving quality and viability of the entire Indian dairy industry.
4. Given the vast AI infrastructure, delivery network and manpower that India already has, newer institutional models, better delivery systems, better quality AI sires and more effective AI are all possible. The results would be superior progeny generations (larger numbers of crossbred cows and improved buffalo), better dairy stock, reduced costs and higher incomes for smallholders.
5. India has a vast scientific manpower and research infrastructure (13 animal sciences research institutes, over 900 animal scientists, some 1000 support staff, 17 agricultural universities and 34 veterinary colleges) under the Indian Council of Agricultural Research (ICAR) system, to provide the dairy sector research support. However, reorientation of their research priorities, greater user participation and industry funding of the research establishment will enable the growing of globalisation of the Indian dairy industry to gain immense cost and quality advantages.
6. With the waning demand for work animals for farm power, India now has a tremendous opportunity to reduce the overall cattle numbers through breeding better draft animals, encouraging sharing of draft animals and promotion of agro-service centres in major villages for custom hiring of tractors and farm implements. Reduction in bovine numbers will progressively reduce the adverse environmental impact of smallholder dairy production and will render the entire animal agriculture in India sustainable.
7. Restructuring the governments' legal and regulatory framework (modernising the Co-operative Societies Act, for example), thus liberating the co-operative movement, will enable smallholders to extensively adopt the proven Anand Pattern Producers' Co-operative Model to manage their assets and business interests. This will help them to vertically integrate production, processing, value addition and marketing of milk and milk products in domestic as well as global markets, converting India's comparative advantages in dairy production into globally competitive advantages.
8. Introduction of newer production technologies (like AI) and intermediate technologies (like crossbred cows) in mixed crop-livestock farming systems in India are not supported by extension services, which are essential for technology transfer. Though a fairly successful attempt to set up an extension support system for the livestock sector was made during the first two five-year plans, this gradually degenerated into service delivery by the departments of animal husbandry in almost all states. Absence of meaningful extension support in the livestock sector has undermined the potential of

the smallholder production systems and has rendered investment in the sector for production enhancement and technology transfer, at least in part, unprofitable.

References

- Datta T.N. and Ganguly B.K. 2002. *Analysis of consumer expenditure pattern in states with special reference to milk and milk products*. National Information Network, NDDDB (National Dairy Development Board) (In press). 20 pp.
- Department of AH&D (Animal Health and Diseases). 1998. *National Project for Cattle and Buffalo Breeding*. Department of AH&D, GoI (Government of India), New Delhi, India.
- Department of AH&D (Animal Health and Diseases). 1999. *Basic animal health statistics AHS series 6*. GoI (Government of India), New Delhi, India.
- Department of AH&D (Animal Health and Diseases). 1999. *Basic animal health statistics 1999*. AHS series 7. GoI (Government of India), New Delhi, India.
- Directorate of Economics and Statistics. 1982. *Livestock Census Tables*. Government of India, New Delhi, India.
- Directorate of Economics and Statistics. 1987. *Livestock Census Tables*. Government of India, New Delhi, India.
- Directorate of Economics and Statistics. 1992. *Livestock Census Tables*. Government of India, New Delhi, India.
- Directory of Indian Agriculture. 1997. Published by the Centre for Monitoring Indian Economy (CMIE), Mumbai (see <http://www.cmie.com>)
- DoAC (Department of Agriculture and Co-operation). 1991. *Agriculture census 1990–91*. GoI (Government of India), New Delhi, India.
- Garcha D.S. and Dev D.S. 1994. Factors affecting milk yield performance of crossbred cattle under field condition of Punjab. *Journal of Dairying, Foods and Home Science* 13(1):48–32.
- GoI (Government of India). 1996. *National Livestock Policy Perspectives: Report of the Steering Group (NLP)*, New Delhi, India.
- ICCMRT (Institute of Co-operative and Corporate Management Research and Training). 1994. *Evaluation study of the Saghan Mini Dairy Project Phase I. 1991–94*.
- KLDB (Kerala Livestock Development Board). Annual Report 1998–99 Thiruvananthapuram-27, Kerala, India (<http://www.livestockkerala.net/>)
- KLDB (Kerala Livestock Development Board). Annual Report 1999–2000 Thiruvananthapuram-27, Kerala, India (<http://www.livestockkerala.net>)
- NSSO (National Sample Survey Organisation). 1992. *Land and livestock holding survey: NSS 48th Round*. NSSO Report 408 (see http://www.nic.in/stat/stat_act_t13.htm)
- NSSO (National Sample Survey Organisation). 1994. *NSS 50th Round 1993–94*. (see http://www.nic.in/stat/stat_act_t13.htm)
- Orissa State Livestock Sector Review. 1999. Report of the Steering Committee, July 1999. (see <http://www.orissagov.com/ecosurvey/animal/A1.htm>)
- Rao S.J., Rao B.V.R. and Rao G.N. 2000. Performance of crossbred cows and buffalo under village conditions of Visakhapatnam District of Andhra Pradesh. *Indian Journal of Dairy Science* 53(3) 222–226.
- Reserve Bank of India. 1981. *All India Input Survey 1980–81*. (see <http://www.rbi.org.in/>)

- Shukla R.K. and Brahmanekar S.D. 1999. *Impact evaluation of Operation Flood on the rural dairy sector*. NCAER (National Council of Applied Economic Research), New Delhi, India (see <http://www.ncaer.com/>)
- Singh G. 2001. *Impact of mechanisation on draught power use in agriculture*. Central Institute of Agricultural Engineering (CIAE), Bhopal, India.
- Venkitasubramanian V. and Fulzele R.M. 1996. Factors influencing production performances of cross and indigenous cattle under field conditions. *Indian Journal of Dairy Science* 49(5):301–306.

Problems and prospects of smallholder dairy production and marketing in South Asia: An overview^{*}

K. Singh¹ and R.S. Pundir²

1. Reserve Bank of India Chair Professor-cum-Director

2. Research Associate, Institute of Rural Management, Anand 388001, India

Abstract

The dairy sector in the South Asian countries of Bangladesh, India, Nepal, Pakistan and Sri Lanka is characterised as follows: by small-scale, widely dispersed and unorganised milch animal holders; low productivity; lack of assured year-round remunerative producer price for milk; inadequate basic infrastructure for provision of production inputs and services, and for procurement, transportation, processing and marketing of milk; and lack of professional management. Other important characteristics of the dairy sector in these countries are the predominance of mixed crop–livestock farms and the fact that most of the milch animals are fed on crop by-products and residues, which have a very low opportunity cost. In addition, dairy development policies and programmes followed in these countries, including those relating to foreign trade, are not congenial to promoting sustainable and equitable dairy development.

Low productivity of milch animals is a serious constraint to dairy development in all the countries under review. This is due mostly to low genetic potential of the milch animals, and inadequate and inappropriate feeding and animal health care. The productivity of dairy animals in all five selected countries could be increased substantially through crossbreeding of the low yielding nondescript cows with high yielding selected indigenous purebreds or suitable exotic breeds in a phased manner and by better feeding, disease control and management. The cattle breeding policy should also provide for the production of good quality bullocks to meet the draft power requirement of agriculture. Upgrading of nondescript buffalo through selective breeding with high yielding purebreds should be given a high priority in all areas where buffalo are well adapted to the agroclimatic conditions. While fixing procurement price, producers' interest should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and provide a reasonable mark-up.

^{*} The authors of this paper are grateful to the authors of the India (Kurup 2002), Bangladesh (Saadullah 2002), Pakistan (Raja 2002), Nepal (Joshi and Tarak Bahadur 2002) and Sri Lanka (Bandara 2002) country papers, prepared for this South–South Workshop, for allowing them to draw upon their papers and to anonymous reviewers for their valuable comments on an earlier draft of the paper. However, they alone are responsible for the views and opinions expressed in the paper and for errors of omission and commission, if any, in the paper.

Dairy plants, cattle feed factories, technical inputs and services should be managed professionally and run as commercial enterprises and not as social welfare schemes. The role of governments in these countries should be to direct, co-ordinate and regulate the activities of various organisations engaged in dairy development, to establish and maintain a level playing field for all stakeholders and to create and maintain a congenial socio-economic, institutional and political environment for smallholder dairy development.

On the whole, the smallholder dairy sector has high potential to be a dependable source of livelihood for the vast majority of rural poor in the South Asian countries. The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years in India, offers an appropriate strategy for promoting sustainable, equitable and gender-sensitive smallholder dairy development in not only South Asian countries but also in all other developing countries of the world. The model needs to be replicated in these countries, with adaptations being made to suit the peculiar conditions of each specific country.

The new world trade regime ushered in by the World Trade Organization (WTO) poses several challenges and opens up many opportunities for smallholder milk producers in South Asian countries. There is need for these countries to enhance their competitive economic advantage in dairy products in terms of both quality and cost. Furthermore, it is high time that the South Asian governments formulated and announced comprehensive dairy development policies for each of their countries. These should form an integral part of their national development policies and due consideration should be given to their direct and indirect effects on other sub-sectors of the economy and vice versa.

Key words: smallholder, dairy production and marketing, constraints, opportunities, SWOT analysis, World Trade Organization, AMUL model of dairy development, South Asia.

Introduction

The livestock sector occupies an important place in the economies of South Asian countries. It contributes to their economies in four different ways, as it provides: (a) energy in the form of draft and traction power for various activities and fuel for cooking and other heating purposes; (b) food in the form of milk, milk products and meat; (c) raw materials in the form of wool, hair, skins, hides, bones, hoof and horns and a number of other products of pharmaceutical and industrial use; and (d) manure for crops. The livestock sector in the South Asian countries is characterised by the preponderance of smallholders typically possessing only one or two milch animals, low productivity, lack of proper feeding and animal health care, an inadequate supporting infrastructure for supply of feed and veterinary medicines, procurement, processing, storage, transport and marketing of milk.

There exists a vast untapped potential for increasing the multifarious contributions of the dairy sector to the economies of the South Asian countries. What is needed to realise this potential is, among other things, a comprehensive and integrated dairy development policy and determination and total commitment from politicians and bureaucracy at all levels in order to effectively implement the policy.

This paper presents an overview of the structure and performance of the dairy sector in five selected South Asian countries, namely, Bangladesh, India, Nepal, Pakistan and Sri Lanka. It identifies the problems and prospects of smallholder dairying with special reference to production and marketing. The paper is mainly based on the country papers of these five countries prepared for and presented at the South-South Workshop and partly on other relevant literature available to the authors and amenable to review and analysis within a few days. This overview begins with a brief demographic and socio-economic profile of the South Asian countries under review.

A profile of the South Asian countries

Table 1 presents a brief demographic and socio-economic profile of the South Asian countries under review. The five selected countries vary a great deal in terms of geographical area, total population, density of population and literacy rate. They are, however, comparable in terms of per capita gross domestic product (GDP), and the proportion of their population living below the poverty line. Moreover, culturally and historically they share many common features and could be considered as comprising the Indian subcontinent. Overall, they are all poor developing countries.

Table 1. *Some salient demographic and socio-economic features of the selected South Asian countries.*

Source of data	Feature	Bangladesh	India	Nepal	Pakistan	Sri Lanka
1	Total geographical area (million km ²) 1992	0.13	3.28	0.14	0.77	0.65
2	Total population (million) 1992 (% of rural population)	114 (52)	884 (74)	20 (55)	119 (67)	17 (78)
3	Density of population (no./km ²) 1992	791	265	142	149	257
4	Adult literacy rate (%) 1997	38.9	53.5	38.5	40.9	90.7
5	Per capita GDP (1987 US\$) 1997	218	465 ^b	219	417	551
6	Percentage of population below poverty line (US\$-1 a day 1985 PPP\$) (1989-94) ^a	28.5	35.97	53.1 ^c	11.6	4.0
7	Human Development Index (HDI) (1997)	0.440	0.545	0.463	0.508	0.721

a. Data refer to the most recent year available during the period specified.

b. Data refer to only part of the country.

c. Data relate to 1996.

Sources: Malhotra (1997) for sources 1-3; and UNDP (1999) for sources 4-7.

Salient characteristics of the dairy sector in the selected countries

The dairy sector in the selected countries has emerged as an important source of livelihood for a vast majority of the rural population, especially the poor. Besides being a source of supplementary income and nutrition, the sector also provides draft power, fuel and organic

manure. More importantly, the sector contributes significantly to the national economies of these countries; for example, milk is the single largest contributor (in the agricultural sector) to the national GDPs of India and Pakistan.

Milk is the cheapest source of all nutrients when compared with other food items. Thus, it has an important role in national nutritional programmes, particularly for those below poverty line, children and expectant mothers. It is a boon for South Asia, where per capita incomes are low and for about 40% of the region's population incomes are below the level necessary to ensure adequate nutrition.

Table 2 presents a few salient characteristics of the dairy sector in the selected countries. The dairy sector in these countries is characterised by small-scale, poor, scattered and unorganised milk producers and low productivity. Nevertheless, it contributes significantly to the national economies of all the countries in the region. In India, for example, marginal producers and smallholders together hold about 78% of the milking animals in the country. As per the findings of studies conducted by the National Council for Applied Economic Research, cited in the India Country Paper, over 75% of the milk producing households surveyed belonged to the landless, marginal and smallholder categories. The study revealed, *inter alia*, that landless, marginal and small producers accounted for over 75% of the membership of the dairy co-operative societies and some 76% of the milch animals owned by the members belonged to these groups of producers. According to the India Country Paper, milk production contributes, on average, 40% in the East Zone, 32% in the North Zone, 21% in the South Zone and 34% in the West Zone to the household income.

In India, some 70% of the cows and 60% of the buffalo are nondescript and have very low productivity. To convert this huge population of low producing milch animals into high yielding milch animals, India needs a sound breeding policy. As discussed in the India Country Paper, the breeding policy needs to consist of: (i) selective breeding of Indian dairy cattle for milk production; (ii) upgrading of the nondescript Indian cattle through breeding with selected Indian donors; (iii) selective breeding of the major buffalo breeds for milk production; and (iv) upgrading of nondescript and minor breeds of buffalo through breeding with the Murrah buffalo breed. Crossbreeding, as a tool to improve the quality of milch animals, is a time-tested technique in the country. However, organised breeding operations, mainly artificial insemination services under the government departments, reach only about 20% of the breeding animals among cattle and <5% of the buffalo. Kerala State in India, while having no natural attributes for dairy production, provides a living example of the benefits and sustainability of crossbreeding. Kerala has been able to replace some 70% of its nondescript cattle with crossbreds and to increase the state's total milk output from 0.22 million tonnes in 1964 to 2.53 million tonnes by 1998.

Evidence from other states in India also shows the positive yield performance of crossbreds. Proof of the success of crossbreeding as a strategy is the growing number of crossbred animals; numbers are increasing at the phenomenal rate of almost 10% per annum and 80% of the crossbred milch animals are held by the landless, marginal and smallholder producers.

Table 2. *Some salient features of the dairy sector of the selected South Asian countries.*

Source of data	Feature	Bangladesh	India	Nepal	Pakistan	Sri Lanka
1	No. of livestock holders (million)	9.7	70	2.98	5.5	0.43
2	Total milk production (million tonnes) 1997	2.16	72	1.08	20.96	0.26
3	Total cattle population (million) 1998	23.4	209.49 ^F	7.03 ^F	18.00*	1.6
4	Total buffalo population (million) 1998	0.85 ^F	91.78 ^F	3.4	21.21	0.72
5	Average number of milch animals (cows + buffalo) per family	4-3	1-2	3-4	3-4	2-3
6	Average milk yield 1998 (kg/annum) for cows	206	877	380	1039	322
7	Percentage of cropped area under fodder crops	n.a.	4	n.a.	n.a.	n.a.
8	Average price of milk in US cents (1993-94)	22.8	24.1	20.4	29.2	21.2
9	Average consumption of milk (g/capita/day) 1997	48	205	131	399	n.a.
10	Average consumption of meat (g/capita/day) 1997	9.68	13.27	26.44	42.52	14.03
11	Annual export of milk and milk products (thousand US\$) 1998	n.a.	6541	1051	1149	812
12	Annual import of milk and milk products (thousand US\$) 1998	111,717	1690	3416	52,762	186,722
13	Annual export of meat and other livestock products (thousand US\$) 1998	41	783,015	0	664	3124
14	Annual import of meat and other livestock products (thousand US\$) 1998	10,938	82	0	20	7038

n.a. = data not available.

F = FAO estimates.

Sources: 1, 5, 6 and 7 = Country papers: Bangladesh, India, Nepal, Pakistan and Sri Lanka; 2 = GOI (1999); 3 & 4 = FAO (1998); 9 & 10 = World Development Report (1998-99) & FAO (1999a); 11-14 = FAO (1999b).

Note: Data for export and import of meat and other livestock products include: (1) fresh, chilled and frozen meat (2) fresh bovine meat; (3) fresh sheep meat; (4) swine meat; and (5) fresh poultry meat.

According to the National Sample Survey Organisation (NSSO) in India, the average monthly private consumption expenditure of households on milk and milk products (1993-94) was 9.5% of total expenditure for households in rural areas and 9.8% in urban areas, and it had been rising steadily over the years (NSSO 1998). It was second in magnitude only to the expenditure incurred on cereals. Furthermore, the demand forecasts for milk at a GDP growth rate of 4% for 2010 and 2020 have been worked out to be 95.6 and

126 million tonnes, respectively, while at a GDP growth rate of 7% for the same period the forecasts are 122 and 182.8 million tonnes, respectively (Kumar 1999). As the expenditure elasticity of demand for milk and milk products for the lower income class in India is well over two, the rising per capita incomes for that class will sustain the current increasing trend in their demand (NDDDB 1997; cited in the India Country Paper).

Some 45% of milk produced in India is consumed as liquid milk. The bulk of it is traded through traditional channels, comprising several tiers of private milk vendors, contractors and mini dairies. Only about 16 million litres of milk are processed and packaged. Out of this, 13.5 million litres is processed in the co-operative sector and 2.5 million litres by over 300 million private sector operators. A large percentage of the milk handled by the private sector is substandard and often unhygienic, as quality and hygiene standards are seldom enforced in the private sector.

As regards exports of dairy products, India has made its presence felt in world markets. It regularly exports milk products and long-life milk to countries in West Asia, South-East Asia, South Asia and North America. The Gujarat Co-operative Milk Marketing Federation (GCMMF), which is the biggest food sector enterprise in India, is the major exporter of dairy products (for details see Vyas 2002). In 1999, it exported about 1.7 thousand tonnes of milk powder, 400 million tonnes of ghee, 100 million tonnes of table butter, 25 million tonnes of cheese and about 100 million tonnes of other products valued at 466 million Indian rupees. This constituted almost 80% of all exports in that year. During the same year, imports of dairy products into the country amounted to some 17,252 million tonnes of skimmed milk powder and 5224 t of butter oil (DGCIS, Calcutta; cited in the India Country Paper).

In Pakistan, there are about 5.5 million units producing livestock, most of them are smallholders owning one or two milch animals and no land. These smallholders produce about 65% of all buffalo and cow milk. About 56% of all milk produced in Pakistan is consumed by the producers themselves. After their own consumption requirements have been met, they sell milk to 10–20 million households, either in exchange for services or for charity reasons. About 5–6 million households in the country keep cattle, primarily to provide draft power for crop production, with milk considered a by-product. Some milch cows are kept along with buffalo in peri-urban milk units, which have grown in recent times in response to the increasing demand for and price of milk in urban markets. There are nearly 4.8 million small-scale rural units owning <6 head and 0.6 million peri-urban units. Almost 80% of the total milk supply is derived from about 5.4 million mixed crop–livestock farms located mostly in irrigated areas. These farms keep buffalo primarily for milk production and indigenous cattle for draft purposes.

The demand for liquid milk and dairy products in Pakistan is likely to continue to increase. The most important reason for this is the rapid growth of the human population. Other variables influencing demand are the growth of per capita income and the increasing price of milk. For the year 2010, the demand for dairy products is projected to be 36.9 million tonnes of fresh milk equivalent, whereas production is estimated at about 34.3 million tonnes. Unless the population grows at a lower rate than in the past, there will be a shortfall between supply and demand; the excess demand will have to be met by imports.

Livestock rearing is an integral part of the farming system in Bangladesh. Landless and small (0.05–2.49 acres) farmers, who account for 79.9 and 10.2% of all farmers, respectively, own 18.45 and 29.6% of the total cattle population and produce most of the country's milk. The Bangladesh Country Paper also reported that only 8.4% of the farms were large (>7.5 acres of land) and that these farms accounted for 32.4% of the total cattle population. Landless and small farmers depend largely on livestock for their subsistence. The self-employment generation and total income share of the animals tend to increase as the farmers' resources, especially land area, decrease. This suggests that animals are of great importance for landless and small farmers. In Bangladesh, livestock and poultry rearing are viewed as means of alleviating poverty and improving the livelihoods of landless farmers and smallholders.

As regards the production and demand scenario in Bangladesh, there is a shortfall in production. The present availability of milk/capita per day is about 32.06 g against a demand of 129 g. Alam (1995, as quoted in the Bangladesh Country Paper) reported that cost of production per litre of milk for local and crossbred cows was much higher than the price per litre of milk and thus milk production was a losing concern. One of the important reasons for the loss incurred by the farmers was the low price of milk, which mainly resulted from the cheap supply of imported milk powder.

As shown in Table 1, the GDP per capita in Sri Lanka in 1997 was US\$ 551, which is the highest among the five Asian countries reviewed. The average per capita expenditure on milk was generally low, particularly in the rural areas. The average expenditure on milk and milk products incurred by a spending unit was 3.3% in 1999. Presently, the country is facing serious economic problems including under-nutrition (>30), underemployment (>40%), unemployment (approximately 8.9%), and inequality of food security. The dairy sector holds high promise as a means of alleviating these problems.

Dairy farming is mainly a smallholder dominated mixed farming system in Sri Lanka. The agricultural sector's contribution to the GDP was 20.7% in 1999, while that of livestock to the agricultural GDP was 8.0%. The formal dairy sector contributes 11% of the livestock GDP and beef production a further 15%. In 1998, the average per capita availability of cow milk was 22.33 g/day and buffalo milk 9.86 g/day as compared with a minimum requirement of 164.38 g/day for milk and milk products in the country. The growth rate of the local dairy industry over the last decade has been estimated at around 2.5%, whilst the projected market growth rate is 5.2%.

Of the five South Asian countries under review, Nepal is the least developed with a per capita GDP of about US\$ 219 in 1997 (Table 1). Approximately 89% of the population of Nepal lives in rural areas. About 81% of the population is involved in agriculture and this sector contributes about 40% of Nepal's GDP. About 42% of the population of Nepal lives below the poverty line. Furthermore, concentration of poverty is greatest in the rural areas and in the entire agriculture sector.

In Nepal, the livestock sector contributes about one-third of agricultural GDP and 4% of the country's total exports. The average livestock holding is 3–4 cattle/buffalo per household, which is the highest among the five South Asian countries. However, productivity is very low at approximately 378 and 810 kg of milk/annum per milking cow and buffalo, respectively. The Dairy Development Commission, which was established in 1955 and converted into the Dairy Development Board in 1962, is mainly responsible for

guiding dairy development activities in the country. In order to meet the growing milk demand in Kathmandu, the board was converted into the Dairy Development Corporation (DDC) in July 1969. The DDC and private sector are involved in collection and processing of milk supplied from rural areas; their shares are roughly equal (50% each). About 75 thousand farm families supply 214 thousand litres of milk/day to collection centres. Each farmer may be supplying about three litres/day. Share of the private sector in the market has been increasing steadily; it was <2% in 1980 but presently has increased to 46%, indicating an average annual growth of about 15%.

As regards consumption, about 88% of urban households in Nepal consume fluid milk regularly and another 7% occasionally. The average quantity purchased is about one litre/day per household. In an international perspective, the cost of milk production in Nepal is about 50% higher than that in New Zealand and Australia. Furthermore, the marketing margins in collection, distribution, processing, marketing and distribution of milk are as low as only 20% of those in the USA.

Smallholder milk producers are vulnerable to fluctuations in the prices of both milk and the inputs that go into milk production. Due to these characteristics, they have very low or practically no bargaining power vis-à-vis those to whom they sell their produce and from whom they buy their supplies. Consequently, they are exploited on both fronts, i.e. selling their milk and buying their production inputs. This heightens the need for government intervention in the sector through policies aimed at equalising opportunities, at strengthening the bargaining power of milk producers in rural areas and at restraining the powerful from exploiting the weak. In fact, the governments have intervened in the dairy sector by launching rural development programmes in all the selected countries.

Milk production is less vulnerable than crop production to weather-induced risks and hence serves as an informal means of insurance for milk producers. Kurosaki (1995) in a study of risk and insurance in a rural household economy in Pakistan observed that livestock holding contributed to a reduction in income variability through the negative correlation of livestock income with crop income and through *ex-post* disaggregation of livestock assets contingent on a realised income in the crop sector. Empirical results of the study suggested that increases in the share of the livestock subsector in terms of agricultural value added should have improved the welfare of households with substantial livestock holdings. Furthermore, the study revealed that, since smaller farms have relatively larger livestock herds in the Pakistan Punjab, the recent phenomenon might have had an equity improving effect as well. Studies carried out by Rosenzweig and Wolpin (1993) and Townsend (1994) also corroborate these findings.

SWOT analyses of the dairy sectors of the selected countries

The dairy sector in the selected South Asian countries has many strengths and weaknesses. The new era characterised by privatisation and globalisation has opened up many opportunities but also poses many threats to the smallholders. This section attempts a brief

Strength, Weaknesses, Opportunities, Threats (SWOT) analysis of the dairy sector for each of the selected countries based on the information available in the country papers and other published sources.

Bangladesh

Strengths: Plenty of surface (river) water available for seasonal fodder cultivation on common lands; extensive waterways available for cheap transportation; very high rate of growth of buffalo population; good scope for establishing feed manufacturing plants; good scope for culling of less productive/unproductive animals; and a good stock of indigenous cattle breeds adapted to the local feed resources and environment.

Weaknesses: Small and scattered animal holdings; low milk yields; shortage of feed and fodder; lack of organised marketing of milk; low non-remunerative producer prices, leaving no incentive for producers to increase milk production; import of milk powder at low prices, which discourages indigenous production; high incidence of parasitic animal diseases; inadequate institutional and infrastructural facilities; inadequate public and private investment in the sector; poor quality of animal health care and breeding services; lack of professional management; and lack of a well-defined national policy for dairy development.

Opportunities: Substantial scope for increasing productivity and the production of milk through a producer-oriented price policy; substantial scope for adoption of modern production, processing and marketing technologies; huge unfulfilled demand for milk and milk products; and good scope for problem-solving and action-oriented research.

Threats: Heavy dependence on imports of dairy products; exposure of domestic milk producers to unfair competition from cheap imported dairy products; lack of incentives for increasing domestic production; and inadequate public and private interest in modernisation of the sector.

India

Strengths: Sizeable population of high yielding cows and buffalo; huge domestic market for milk and milk products; good infrastructural and institutional support for dairying; high producer's share (89%) in the consumer's price of milk; availability of all kinds of machinery and equipment for dairy plants at the most competitive rates in the world; a well-developed and professionally managed system of dairy co-operatives set up under Operation Flood; and the largest network of artificial insemination (AI) centres in the world.

Weaknesses: Small and scattered animal holdings; low milk yields; a large population of unproductive cattle; socio-cultural constraints on culling less productive/unproductive animals; shortages of feed and fodder in many milksheds; competition between man and animals for scarce land and water resources; undue interference by the government in the affairs of dairy co-operatives; lack of strict regulation by the government of the unethical practices of unscrupulous private operators; lack of access for smallholders to institutional credit; lack of professional management; and lack of a well-defined national policy for dairy development.

Opportunities: Potential for increasing the productivity of milch animals and export of high quality dairy products since the new world trade regime came into effect; scope for dairy sector reforms by restructuring the Departments of Animal Husbandry in Indian states and reorienting their mandates; good scope for problem-solving and action-oriented research funded by private agencies; and good scope for privatisation of animal health care services in selected areas.

Threats: Unregulated competition from national and multinational private companies; dumping of cheap dairy products on Indian markets by developed countries; unethical practices by unscrupulous private dairy operators; and inadequate public and private investment in modernisation of the sector.

Nepal

Strengths: Relatively larger livestock holdings compared with other South Asian countries; a high growth rate of livestock production; and promotion of dairy development by the government through investment.

Weaknesses: Small and scattered animal holdings; low milk yields; lack of basic infrastructure; poor quality of milk and widespread adulteration of milk by private milk vendors; no product diversification; inadequate processing capacity; lack of capital investment; low and non-remunerative producer prices; poor quality of animal health care and breeding services; lack of professional management; and lack of a well-defined national policy for dairy development.

Opportunities: Potential for increasing domestic milk production through improvement in the genetic potential of local milch animals, better animal feeding and disease control, and a producer-oriented price policy.

Threats: Imports of dairy products at cheap prices pose a threat to domestic milk production; and inadequate public and private investment in modernisation of the sector.

Pakistan

Strengths: Endowed with very good breeds of buffalo and cows; highest per capita consumption of milk in Asia; regular culling of less productive/unproductive animals; a high ratio of agricultural land to agricultural population; and emergence of commercial dairy farms on a large scale.

Weaknesses: Small and scattered animal holdings; prevalence of traditional raw milk marketing systems; poor quality of milk; lack of remunerative producer price for milk; milk processing predominantly dependent on obsolete UHT technology; mushrooming growth of cattle colonies in suburban areas; high cost of milk production; a long chain of middlemen; inadequate infrastructural and institutional facilities and support; low utilisation of installed capacity of dairy plants; the existence of the *bandi* system (under which the middleman predetermines the producer's sale price for the entire year at the rate most beneficial to him); poor quality of animal health care and breeding services; lack of professional management; and lack of a well-defined national policy for dairy development.

Opportunities: Huge unsatisfied domestic demand for milk and milk products; and substantial scope for increasing domestic milk production through improvement in the marketing system and by ensuring a year-round remunerative price to milk producers.

Threats: Unregulated imports of dairy products at cheap prices; inadequate public and private investment in modernisation of the sector; and vested interests in perpetuating the dependence on imports of dairy commodities.

Sri Lanka

Strengths: Plentiful supplies of coconut, molasses and rice bran available locally for feeding animals; high margins available to dairy processing plants; scope for fodder cultivation along with coconut cultivation.

Weaknesses: Small and scattered animal holdings; low milk yields; shortages of feed; poor infrastructural/institutional facilities and support; negative trends in cattle and buffalo population growth in the last decade; low utilisation of installed milk processing capacity; unhealthy competition among private milk collectors; poor quality of animal health care and breeding services; lack of professional management; and lack of a well-defined national policy for dairy development.

Opportunities: Scope for increasing domestic milk production through improvements in the genetic potential of local milch animals; and better animal feeding, disease control and management.

Threats: Heavy dependence on imports of dairy products at cheap prices; inadequate public and private interest in modernisation of the sector; and vested interests in perpetuating the dependence on imports of dairy commodities.

In summary, the dairy sector in the South Asian countries has only a few strengths but many constraints and weaknesses. The major weaknesses include low productivity, low non-remunerative producer prices for milk and a lack of basic supporting infrastructure. In rural areas, milk is mainly produced by small and marginal farmers, and landless and agricultural labourers. In many instances, the producer price does not even cover the out-of-pocket cash costs of milk production. This is mainly because of unregulated competition from heavily subsidised cheap imports of milk powder and butter oil from developed countries. While fixing procurement price, producers' interests should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and provide a reasonable mark-up. Studies on cost of milk production and its financial viability should be initiated by the Departments of Animal Husbandry or the Dairy Development Boards/Corporations in the selected countries. Such studies should be carried out in all major agro-climatic zones and be repeated at regular intervals of three years or so to determine whether milk production is profitable and to furnish an objective basis for fixing the producer price of milk. The studies may be entrusted to reputed universities or research organisations operating in the regions selected for the studies.

Other major constraints relate to the lack of appropriate means to transport milk to lucrative urban markets and the wide price spread between the producer and the consumer (see Table 3). The producer is usually exploited by the middleman, particularly during the

Table 3. Price spread for milk in selected South Asian countries 1993–94.

Country	Producer price for milk (US cents)	Consumer price for milk (US cents)	Percentage share of producer in consumer price	Percentage of locally produced milk to total consumption
Bangladesh	22.8	53.2	47	80.5
India	24.1	27	89	100.0
Nepal	20.4	30.6	67	99.5
Pakistan	29.2	55.2	53	99.2
Sri Lanka	21.2	40	52	37.8

Source: Malhotra (1997).

flush season. In many areas of Pakistan, a system of *bandi* exists, under which the middleman predetermines the producer's sale price for the entire year at the rate most beneficial to him/her.

Seemingly, environmental effects did not receive any explicit attention in the country recommendations for the design and implementation of dairy development policies and programmes. Concern over the environmental effects of livestock production and processing is a relatively recent focus. Nevertheless, in the authors' opinion, such concern is justified and should be translated into action in the form of policies and programmes that are environmentally friendly, and yet financially and economically viable and sustainable.

There are many grey areas in our knowledge of the nature and magnitude of the various constraints on smallholder dairy development in South Asian countries. What is needed is a long-term research programme aimed at identifying and quantifying both positive and negative factors affecting smallholder dairy development. The new research knowledge generated could then be utilised to design and implement appropriate dairy development policies and programmes.

India's AMUL model of dairy development: A boon for smallholders

The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years in India, offers an appropriate strategy for promoting sustainable, equitable and gender-sensitive smallholder dairy development, not only in South Asian countries but also in many other developing countries of the world. The genesis and basic ingredients of the model are discussed briefly in Vyas (2002).

The salient features of the AMUL model include: (1) a single commodity approach; (2) a three-tier organisational structure; (3) producer-elected leadership and decentralised decision making; (4) employment of professional managers and technicians; (5) accountability of professional managers, technicians and other employees to the member-producers through their elected leaders; (6) provision of all necessary inputs and services to member-producers at reasonable, often subsidised rates; (7) integration of production, procurement, processing and marketing functions; (8) continuous and

concurrent audit; (9) cash payment to producers for their milk—daily or weekly; and (10) contribution to village amenities (Singh 1999).

The Anand Pattern Dairy Co-operatives (APDCs) provide their members with a complete package of inputs and services necessary for enhancing milk production. The package includes animal health care through both regular as well as emergency visits by veterinary doctors, AI, balanced cattle feed, improved fodder seeds, and extension education and training. More importantly, the APDCs provide a year-round and assured market for the producers' milk at a remunerative price.

In summary, the AMUL model is producer-oriented, people-centred and holistic. It emphasises the integrated development of all the important facets of the dairy industry, namely: production, procurement, processing, pricing, marketing, training and management. Moreover, it advocates the use of appropriate technical, economic and institutional instruments to promote smallholder dairy development.

Challenges and opportunities for small livestock holders under the new world trade regime

All the selected South Asian countries are signatories to the agreement that led to the establishment of the WTO and therefore, are obliged to follow the dictates of the new world trade regime spearheaded by the WTO. The new regime concerning dairy products became effective on 1 July 1995. Liberalisation of world trade in dairy products under the new trade regime poses new challenges and has opened up new export opportunities for the dairy industry in South Asian countries. There is need for these countries to enhance their competitive economic advantage in dairy products, in terms of both quality and cost, and to enhance their credibility in international markets. The role of governments in these countries should be to direct, co-ordinate and regulate the activities of various organisations engaged in dairy development, to establish and maintain a level playing field for all stakeholders and to create and maintain a congenial socio-economic, institutional and political environment for smallholder dairy development through appropriate policies and programmes.

The new trade regime is not expected to affect the overall world trade in milk and milk products. However, there will be some redistribution in terms of regions of origin and destination. It is expected that the decreased volume of subsidised exports of dairy products from several developed countries will be offset, to some extent, by increased export from countries like India, which do not subsidise their exports of dairy products.

In order to benefit from the new trade opportunities, India and other South Asian countries will need to set and enforce high quality standards for various dairy products through an independent non-governmental authority and to improve the basic infrastructure (particularly the ports) and the air transport system. They will also need to improve their competitive advantage in milk production by improving milk yields to reduce the per litre cost of production and by improving the quality of their products by adopting the latest processing and packaging technologies and professional management.

Compliance with phytosanitary specifications will also be necessary in order to increase the export of dairy products. A general switch to higher-value dairy products consequent upon increased access to high-priced markets in developed countries is also likely to occur (for more details see Sharma 2002).

In today's context, trade between neighbours is the harbinger of goodwill and economic uplift. In this context, the South Asian Preferential Trade Arrangement (SAPTA), which became operational in December 1995, is a welcome and significant development. It aims to facilitate trade among South Asian countries through preferential tariffs. The South Asian countries have identified a substantial number of commodities for preferential trading among themselves. Previously, they used to import/export some of these commodities indirectly from their neighbours through distant third parties. Besides the preferential tariff, the other gain to South Asian trade from SAPTA should be a drastic reduction in transportation costs. It is hoped that, following SAPTA, trade in dairy products among South Asian countries will usher in an era of prosperity in the region (Malhotra 1997).

Conclusions and their implications

The dairy sector in the South Asian countries of Bangladesh, India, Nepal, Pakistan and Sri Lanka is characterised by: small-scale, scattered and unorganised milch animal holders; low productivity; inadequate and inappropriate animal feeding and health care; lack of assured year-round remunerative producer price for milk; inadequate basic infrastructure for provision of production inputs and services; inadequate basic infrastructure for procurement, transportation, processing and marketing of milk; and lack of professional management. Other important characteristics of the dairy sector are the predominance of mixed crop-livestock farms and the fact that most of the milch animals are fed on crop by-products and residues, which have very low opportunity costs. Additionally, dairy development policies and programmes followed in these countries, including those relating to foreign trade are not congenial to the promotion of sustainable and equitable dairy development.

Low productivity of milch animals is a serious constraint to dairy development in all the countries under review. The productivity of dairy animals in the five selected countries could be increased by crossbreeding the low yielding nondescript cows with high yielding selected indigenous purebreds or suitable exotic breeds in a phased manner. The cattle breeding policy should not only focus on milk yield but should also provide for the production of good quality bullocks to meet the draft power requirement of agriculture. Upgrading of nondescript buffalo through selective breeding with high yielding purebreds, such as Murrah, Mehsani or Nili Ravi, should be given high priority in all areas where buffalo are well adapted to the agro-climatic conditions.

While fixing procurement price, producers' interests should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and provide a reasonable mark-up. Studies on cost of milk production and its financial viability should be initiated by the Departments of Animal Husbandry or the

Dairy Development Boards/Corporations in the selected countries. Such research need to be carried out in all the major agro-climatic zones and should be repeated at regular intervals of approximately three years to determine whether milk production is profitable and to furnish an objective basis for fixing producer price of milk. The studies may be entrusted to reputed universities/research organisations operating in the regions selected for the studies.

Despite all the problems it faces, the dairy sector holds high promise as a dependable source of livelihood for the vast majority of the rural poor in the South Asian countries. The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years or so in India, holds high promise for smallholder dairy development in these countries. The model needs to be replicated in all the South Asian countries with adaptations made to suit the specific conditions of the countries concerned.

Liberalisation of world trade in dairy products under the new trade regime of the WTO poses new challenges and has opened up new export opportunities for the dairy industry in South Asian countries. These countries need to enhance their competitive economic advantage in dairy products, in terms of both quality and cost, and to enhance their credibility in international markets. The role of governments in these countries should be to direct, co-ordinate and regulate the activities of various organisations engaged in dairy development, to establish and maintain a level playing field for all stakeholders and to create and maintain a congenial socio-economic, institutional and political environment for smallholder dairy development. There is need for each South Asian government to formulate and announce a comprehensive dairy development policy for their country. Such policy should be an integral part of their national development policy and due consideration should be given to its direct and indirect effects on other subsectors of the economy and vice-versa.

While exploring possibilities for the future of smallholder dairying in the South Asian Region, it is essential for us to acknowledge the variations among individuals and groups of milk producers, countries and regions and the impact of factors as diverse as dietary preferences, alternative occupations, trade regulations and subsidies. In the various production systems and less favourable climates of the South Asian countries, low production is related to the inherent poverty of individual producers and to the producer's ability to utilise by-products in the intensive manner used in more developed countries.

In the past, management has been the key factor in the success of smallholder dairying. This is evidenced by the experiences of AMUL, Operation Flood and many other successful dairy development projects. The future of smallholder dairying will also rely on the continued adaptation of management techniques to suite markets, environments and socio-economic conditions. Managing dairy plants and cattle feed factories is not the business of the government; it is better left to professional managers who are employees of the milk co-operatives and hence are accountable to their member milk producers.

Integration of dairy farming with crop production systems in South Asia is a special feature of smallholder dairying, which is not understood widely in dairy monoculture production systems. An integrated crop-dairy production system model indicates the incremental benefits in the form of draft power, meat and a range of other products provided through dairying as an adjunct to crops and productive use of crop by-products and residues, both of which have very low opportunity costs. Furthermore, milk production

is less vulnerable to weather-induced risks than crop production and hence serves as an informal means of insurance for milk producers.

References

- Bandara B.H.W.M.U.S. 2002. The current status of smallholder dairy systems in Sri Lanka. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Bhasin N.R. 1997. A grand opportunity. In: Gupta P.R. (ed), *Dairy India 1997*. 5th edition. A-25 Priyadarshini Vihar, New Delhi, India.
- Falvey L. 1999. The future for smallholder dairying. In: Falvey L. and Chantalakhana C. (eds), *Smallholder dairying in the tropics*. ILRI (International Livestock Research Institute), Nairobi, Kenya. pp. 417–432.
- FAO (Food and Agriculture Organization of the United Nations). 1998. *Production year book 1998*. FAO, Rome, Italy.
- FAO (Food and Agriculture Organization of the United Nations). 1999a. *Production year book 1999*. FAO, Rome, Italy.
- FAO (Food and Agriculture Organization of the United Nations). 1999b. *Trade yearbook 1999*. FAO, Rome, Italy.
- GoI (Government of India). 1999. *Basic animal husbandry statistics 1999*. Department of Animal Husbandry, Government of India, New Delhi, India.
- Griffin M. 1997. India: Slumbering giant of the international dairy trade. In: Gupta P.R. (ed), *Dairy India 1997*. 5th edition. A-25, Priyadarshini Vihar, New Delhi, India.
- Gupta P.R. (ed). 1997. *Dairy India 1997*. 5th edition. A-25 Priyadarshini Vihar, New Delhi, India.
- Hiremath B.N. and Sriram M.S. 1996. *Competition, financial viability and sustainability of Chitoor Union: A case study*. Institute of Rural Management, Anand, India.
- Joshi D.D. and Tarak Bahadur K.C. 2002. An overview of smallholder dairy production and marketing in Nepal. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Kumar P. 1999. *Food demand and supply projections for India*. Indian Agricultural Research Institute, New Delhi, India.
- Kurosaki T. 1995. Risk and insurance in a household economy: Role of livestock in mixed farming in Pakistan. *The Developing Economies* 33(4):464–483.
- Kurup M.P.G. 2002. Smallholder dairy production and marketing in India: Constraints and opportunities. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Malhotra R. 1997. SAARC dairy grid. In: Gupta P.R. (ed), *Dairy India 1997*. 5th edition. A-25 Priyadarshini Vihar, New Delhi, India.
- NSSO (National Sample Survey Organisation). 1998. *NSS Report of the 50th Round: 1993–94*. NSSO, New Delhi, India.

- Raja R.H. 2002. Pakistan smallholder dairy production and marketing. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDDB, Anand, India, 13–16 March 2001*. NDDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Rosenzweig M.R. and Wolpin K.I. 1993. Credit market constraints, consumption smoothing and the accumulation of durable production assets in low-income countries: Investments in bullocks in India. *Journal of Political Economy* 101(2):223–244.
- Saadullah M. 2002. Smallholder dairy production and marketing in Bangladesh. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDDB, Anand, India, 13–16 March 2001*. NDDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Sharma V.P. 2002. Implications of international trade regulations (World Trade Organization agreement on agriculture and Codex Standards) for smallholder dairy development. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDDB, Anand, India, 13–16 March 2001*. NDDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Singh K. 1999. *Rural development: Principles, policies and management*. 2nd edition. Sage Publications, New Delhi, India.
- Townsend R.M. 1994. Risk and insurance in village India. *Econometrica* 62(3):539–591.
- UNDP (United Nations Development Programme). 1999. *Human Development Report 1999*. Oxford University Press, New York, USA.
- Vyas B.M. 2002. Institutional structure to sustain smallholder dairy marketing—The AMUL model. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDDB, Anand, India, 13–16 March 2001*. NDDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- World Bank. 1998–99. *World Bank Development Report 1999*. Oxford University Press, Delhi, India.

Dairy development in Thailand and a case study on environmental impacts of peri-urban dairy colonies. Part I. Smallholder dairy development

C. Chantalakhana¹ and P. Skunmun²

1. Professor Emeritus

2. Senior Livestock Scientist

Kasetsart University, P.O. Box 1014, Kasetsart P.O., Bangkok 10903, Thailand

Introduction

In the 1940s and early 1950s, dairy farming in Thailand was considered unimportant. It was mainly in the hands of small-scale dairy cattle raisers, of Indian or Pakistan origin, who mostly lived in the suburban areas of Bangkok. At this time, most dairy products consumed by Thai people were produced from imported products, mainly powdered milk and infant milk powder; consumption of fresh whole milk was very limited. Promotion of dairy cattle rearing was confined to experimental scale and was carried out by the Department of Livestock Development and Kasetsart University; both belonged to the Ministry of Agriculture and Co-operatives (MOAC) at that time. Interest in dairy farming only became significant during the late 1950s when groups of farmers, especially those in Ratchaburi (Nong Pho), Nakhon Pathom and Ayutthaya Provinces, started to form dairy colonies. They showed that dairy farming using crossbred cattle and technologies that were relatively new at that time (such as artificial insemination (AI), forage crops, balanced rations or concentrate mixtures) could be economically viable and profitable. Furthermore, by this time milk consumption in Thailand (including the consumption of fresh milk) had started to rise at a faster rate than previously.

From 1961, the milk processing industry began to develop and expand its production of milk for drinking, using both fresh milk and milk recombined from imported ingredients. However, dairy farmers, who were mostly small-scale with few milking cows, were confronted by several serious constraints. Among those constraints were the problems of milk marketing and distribution to consumers. A further constraint was the relatively low milk yield per dairy cow in Thailand (3–5 kg/day); this poor yield was aggravated by a lack of appropriate knowledge and technology for dairy production in the humid tropics.

During the 1960s, several dairy development projects were tested in Thailand, including government projects by the Department of Livestock Development (belonging to the MOAC), as well as some projects sponsored by foreign aid, such as the Thai–Danish Dairy

Project in Muak Lek (Saraburi Province) and the Thai-German Dairy Project in Chiang Mai Province. After several years of dairy promotion in various parts of the country, many different problems and their solutions had been identified and many lessons had been learned through such experiences. The final conclusion that was eventually drawn from the various dairy development projects, which encountered different degrees of difficulties in dairy rearing in the different regions of the country, was that dairy production in Thailand was sound technically, economically and socially, especially in its contribution towards better nutrition and improved well-being of the Thai people.

In the meantime, an increasing number of Thai consumers, who were traditionally not milk drinkers, began to realise the nutritional value of milk. The increase in demand for fresh milk became quite evident in the 1970s, and the numbers of dairy farmers and dairy cows continued to grow, including those in the provinces of Ratchaburi, Nakhon Pathom, Ayutthaya, Saraburi and Chiang Mai. By this time, the government's agricultural policies stated clearly a policy on the promotion of dairy production.

In 1971, the Thai-Danish Dairy Farm, which started in 1962 with assistance from the Government of Denmark, was handed over to the MOAC to become the Dairy Promotion Organisation of Thailand (DPOT). Similarly, the Thai-German Dairy Project, which started in 1965 with assistance from West Germany, was handed over to the Department of Livestock Development (DLD) in the latter part of 1977. These two agencies, DPOT and DLD, continued to play a significant role in dairy development in Thailand, along with other agencies concerned with dairy production, training and education, processing and marketing. The infrastructure for dairy development (such as facilities for farmer training, AI centres and other technical facilities, milk collection centres, dairy processing plants, research, education and other development facilities) received increasing support from the government, and from private investors during the 1970s. However, marketing of fresh milk remained a problem to dairy farmers; while dairying was expanding to almost all regions of the country, fresh milk faced market competition from recombined milk prepared using cheap imports of skimmed powdered milk.

Dairy production in Thailand began to boom in the early 1980s, particularly following the enactment of two important legislative regulations in 1983. The Ministry of Industries introduced the skimmed milk importation regulation which requires producers of pasteurised or UHT (sterilised) milk to use a mixture of at least 1:1 raw fresh milk to recombined milk. At the same time, the Ministry of Commerce introduced the import and export products regulation, which introduced a permit system for imports of milk; this regulation has similar effects to the Ministry of Industries regulation. For example, according to the latest import and export products regulation, imports are allowed on the guarantee that the manufacturer will purchase 20 kg of fresh milk for each 1 kg of imported powdered milk.

Currently, local milk production comprises only about 20% of the total consumption; the rest has to be imported. Between 1994 and 1997, the demand for drinking milk and milk products in Thailand increased by almost 3% per year, while domestic milk production increased by almost 20% per year. Nevertheless, milk demand was larger than supply, the deficit ranged from 131 to 400 thousand tonnes of milk/year (Table 1).

Table 1. Trends of demand for drinking milk and milk products.

Year	Demand ($\times 10^3$ t)			Domestic milk		Deficit	
	Drinking milk	Infant and powdered milk	Condensed milk	Demand ($\times 10^3$ t)	Production (t)	Tonnes/year	Tonnes/day
1990	166	196	191	553	152,880	-400,120	-1096
1991	177	206	189	572	190,050	-381,950	-1046
1992	188	216	185	589	233,100	-355,900	-975
1993	197	227	182	606	276,570	-329,430	-902
1994	205	239	178	622	330,540	-219,450	-789
1995	211	251	174	636	388,080	-247,920	-679
1996	216	263	171	650	445,830	-204,170	-559
1997	220	276	167	663	631,930	-131,070	-359
Average annual change (%)							
	5.03	5.01	-1.74	2.86	19.85		

By 1999, there were almost 22.85 thousand dairy farmers across all the regions of Thailand (Table 2), as compared with only 114 farmers in 1962. About 87% of the farms had 1–10 milking cows, 12% had 11–40 milking cows and <1% had >40 milking cows. The total number of dairy cattle in Thailand in 1999 was more than 282 thousand. Data in Table 3 show the average number of cows per farm in the ten provinces with the highest numbers of dairy farms.

Table 2. The numbers of dairy farms, co-operatives, dairy cattle and milking cows, and level of milk production for 1996–99.

Year	No. of co-operatives	No. of dairy farms	No. of milking cows	No. of dairy cattle	Total milk yield (t)
1996	99	21,149	n.a.	203,736	n.a.
1997	103	21,755	n.a.	214,550	183,952
1998	111	22,843	109,242	249,712	251,538
1999	113	22,843	122,631	268,468	310,099

n.a. = data not available.

Table 3. The ten provinces of Thailand that have the highest numbers of dairy farms.

Province	Total number of dairy cattle	Milking cows	No. of cows per farm	No. of farms
1. Ratchaburi	55,186	22,465	4.5	5036
2. Saraburi	30,899	20,480	9.2	2221
3. Nakhon Ratchasima	28,737	15,955	14.4	1111
4. Lopburi	28,219	13,677	8.5	1600
5. Parachuap Khiri Khan	13,104	7196	7.4	975
6. Nakhon Pathom	11,039	5482	8.8	622
7. Chiang Mai	10,673	5935	3.4	1757
8. Phetchaburi	9812	5448	5.8	936
9. Khon Kaen	7457	2038	5.2	394
10. Sa Kaew	6081	3329	11.2	297

Traditionally, Thai people are not milk drinkers. In 1956, it was reported that per capita milk consumption (drinking milk) was as low as 0.15–20.00 cm³. (Supamala 1969). However, by 1987 per capita consumption of drinking milk in Thailand had increased to 2.32 kg/year. The increase in consumption of drinking milk, as well as other milk products such as sweetened condensed milk, has continued steadily every year. In 1994, it was estimated that Thai people consumed almost 7 kg of drinking milk/year per person. Milk consumption, especially consumption of drinking milk, is confined almost totally to urban or peri-urban populations where marketing facilities and purchasing power exist.

Production systems

Between 95% and 99% of dairy farms in Thailand can be classified as small-scale or smallholder farms under mixed crop–livestock farming systems. Some of the older dairy colonies have become peri-urban smallholder dairying systems but these still rely on the use of crop wastes and residues, such as corn stover from neighbouring farming areas, as a source of feed supply. For smallholder dairy farms in rural areas, the dairy operation is generally integrated with the production of rice, upland crops, orchard crops or various plantation crops. There is a general tendency for the number of milking cows owned by each smallholder to increase. Moreover, there is a steady shift in the role of dairying from providing a source of supplementary income to being a major or specialised enterprise in mixed farming systems.

Almost all dairy cows in Thailand are crossbreds between Holstein–Friesians (HF) and zebu breeds (such as Red Sindhi or Sahiwal). Most of these animals are F₂ or F₃ crosses, many of them produce milk yields as high as 5 thousand kg in 305 days but most of them produce around 2500–3000 kg per lactation. These crossbreds are relatively well adapted to local conditions and are well accepted by farmers. Purebred HF could be reared to increase the level of milk production, but the cost of production per kg of milk remains economically unviable. Milk yields of some highly selected F₃ or F₄ crossbreds are as high or higher than the average milk yields of some purebreds.

The use of crop residues, such as corn stover, rice straw, soybean stems or pineapple peel is very common. The use of silage or hay is less common. Silage is used only by large-scale dairy farms. For routine use as cattle feed, hay is too expensive. However, shortages of roughage feeds are serious in dry or summer seasons and farmers have to buy hay or straw, or have to increase their use of commercial mixed rations. Animal health care and AI are generally offered as dairy co-operative or government services.

Most farmers receive credit from the Bank of Agriculture and Agricultural Co-operatives (BAAC). Moreover, many of them receive loans from commercial banks, relatives or local money lenders. In general, dairy training for farmers is provided by dairy co-operatives, DPOT, DLD or the Department of Co-operatives Promotion (DCP).

Data in Table 4 show the cost of components of dairying in Thailand (Skunmun and Chantalakhana 2000). Feed costs constitute 51–67% of the costs involved in dairying (average = 58%).

Table 4. Average ($\pm$ s.d.) of cost of components of dairying in Thailand, as a percentage (%) of total cost.

Cost component	Average $\pm$ s.d.	Minimum	Maximum
Cash cost	89.81 $\pm$ 3.65	81.98	94.85
Feed	58.18 $\pm$ 5.11	51.07	67.56
– Roughage	23.45 $\pm$ 4.41	16.61	32.55
– Concentrate	34.73 $\pm$ 8.14	20.71	46.41
Labour	16.05 $\pm$ 5.00	6.41	23.12
Vaccination and medication	0.92 $\pm$ 0.49	0.23	1.88
Gasoline	1.71 $\pm$ 0.57	0.98	3.02
Electricity and water	1.56 $\pm$ 0.65	0.90	2.66
AI and semen	0.69 $\pm$ 0.37	0.22	1.28
Miscellaneous	2.98 $\pm$ 2.11	0.73	7.30
Opportunity cost for cash investment	7.72 $\pm$ 0.85	6.77	9.76
Non-cash cost	10.19 $\pm$ 3.65	5.15	18.02
Land rent	1.45 $\pm$ 1.75	0	5.18
Opportunity cost for using own land	0.85 $\pm$ 1.25	0.08	3.85
Depreciation			
– Cows	4.04 $\pm$ 1.5	1.89	6.60
– Construction	1.73 $\pm$ 1.02	0.51	3.87
– Equipment	0.65 $\pm$ 0.16	0.37	0.88
Interest on long-term loan	0.08	0	0.77
Opportunity cost for fixed assets	0.85 $\pm$ 0.30	0.43	1.49

Dairy co-operatives

As mentioned earlier, most dairy farms are small and are located in rural areas; consequently, collective services for collection, delivery and processing of milk, as well as those for AI, animal health care and concentrate feed supply, are absolutely necessary. Dairy co-operatives have been organised as part of the government's dairy promotion programme. In 1999, there were about 106 dairy co-operatives in Thailand. At this time, the oldest and largest co-operative was the Nong Pho Dairy Co-operative (NPDC) in Rachaburi Province; this was located approximately 70 km southwest of Bangkok and included more than 4 thousand dairy farmer members. Since the NPDC is quite well known and has proved to be a profitable and successful dairy enterprise, the following brief description of its operation is included in this paper.

NPDC was established by dairy farmers in the Nong Pho district in 1971. Initially, it was set up to operate a milk collection centre as a co-operative venture. Presently, this co-operative provides its members with the following services:

- Purchase and processing of raw milk and dairy products
- Marketing and distribution of milk and dairy products
- Co-operative credit and loans
- Farmer training on dairy farming and co-operative practices

- Feed mill and dairy concentrate feeds
- AI services and other technical advice and
- Dairy tools and equipment.

In 1992, there were 4358 farmer members, with similar numbers of men and women. The farmer members were organised into 32 different zones or groups according to the location of their farms. The members of each group of farmers elected (annually) a group leader or representative. Out of 32 group leaders, 15 were then elected by overall members to form the executive committee of the co-operative; their duties were to formulate policy, as well as to oversee the management of the co-operative activities. Each executive committee served a one-year term. However, if elected repeatedly, a member of the committee could serve for an indefinite period of time.

In 1992, the co-operative's milk processing plant received about 126 t/day of raw milk produced by farmer members. Farmers from the 32 groups, representing more than 90 villages, deliver the milk twice a day to the collecting centres or to the milk plant; most of the farmers were within a radius of 20 km whereas the most distant farmers were 30 km away. Payment for milk was made every ten days (on the 5th, 15th and 25th day of the month). Milk price was based on fat content as well as bacterial counts. About half of the milk was processed into pasteurised milk in plastic sachets and the rest into UHT milk in hard pack containers. The UHT milk was sold through a sales agent in Bangkok, while the pasteurised milk was distributed by the co-operative.

The co-operative's feed mill produced around 100 t of mixed feeds/day. The demand for dairy feeds continued to increase at a very fast rate. In 1992, the increase in dairy feed production was 30% as compared with the previous year. Animal feeds were sold on credit to the farmers and payment for feeds was deducted from the milk payment.

The AI service, using imported frozen semen of pedigree-quality bulls was offered to farmer members at cost price. Requests for AI were made by the farmer at the time of milk delivery to the milk collection centres. Kasetsart University Veterinary Clinic and the Department of Livestock Development provided veterinary services; the farmers had to pay only the cost of the drugs when they needed to treat sick animals.

Lessons learnt

In order to achieve success with a dairy development programme the following four categories of supportive factors are required: (a) technical inputs (b) institutional support (c) government policies; and (d) farmers' socio-economic conditions. A lack of any of these supportive factors could limit the level of achievement in any dairy development programme. Figure 1 shows various factors related to dairy production system in Thailand.

Technical inputs

A primary prerequisite in dairy production is the availability of technical inputs that consist of: (1) suitable dairy breeds for hot and humid environments; (2) availability of good quality

feeds, especially roughages and clean water; (3) good farm management and herd husbandry; and (4) appropriate control and prevention of tropical animal diseases and parasites. In general, these factors are well recognised and have been extensively documented; they will not be elaborated in detail here.

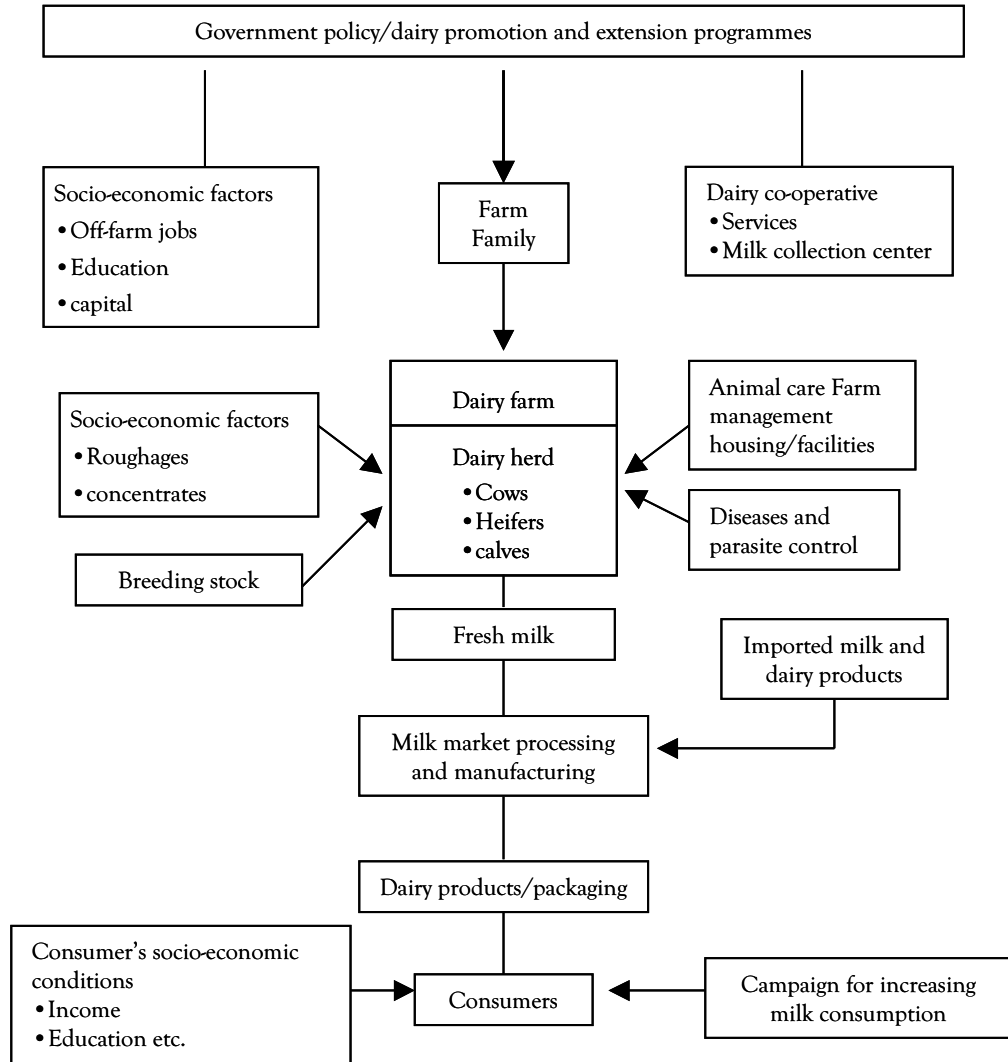


Figure 1. Factors affecting dairy production systems in Thailand.

Institutional support

Various types of institutional support are required in order to facilitate growth in dairy production. These include credit institutions, farmer training facilities, milk collection centres, processing and marketing facilities, dairy farmer co-operatives or groups, and

research and extension services. Without this support dairy development programmes can face serious constraints. As shown earlier, most dairy farmers are resource-poor smallholders who mainly depend on bank loans for farm investment. Most of these farmers have little formal education and only a limited knowledge of dairy husbandry; consequently, at least two to three months of intensive practical training is required to provide them with a reasonable background in dairy farming. Once dairy production begins, a milk collection and cooling centre is required to collect milk from the dairy farms and then to transport the milk to a milk processing plant for processing and packaging, as well as marketing of the products. Farmers constantly require dairy extension services to provide AI, as well as animal health care (such as vaccination) and other services to improve their farming efficiency. Research on various aspects of dairy production, including socio-economic and policy studies, is required in order to find solutions to various problems. Government departments and universities need to be well equipped in dairy research. There is a need for facilities capable of conducting research to identify appropriate scientific and technological interventions for the improvement of local dairy production. The lack of effective dairy extension services and inadequate research support appear to be major constraints to the efficiency of dairy production in Thailand.

Government policies

It is quite obvious that dairying cannot be expanded easily if related government policies are not supportive of dairy farming. Government policies that have been implemented and have produced major positive impacts on dairy production in Thailand include: (1) the Ministry of Commerce's (1985) regulation on dairy product manufacturing, which requires producers of recombined milk to use a ratio of fresh milk to recombined milk of 1:1 or 1:20 for skimmed powdered milk to fresh milk; (2) a milk drinking campaign by the government to increase the consumption of drinking milk from about 2 to 10–15 kg/person by the end of 2000; (3) a school milk programme launched in 1994–95 to promote milk drinking among school children living outside urban areas in order to improve children's health; and (4) diversification of rice farming to dairy farming in order to reduce paddy farming in certain areas. Furthermore, the price of milk has been regulated indirectly by some government measures; the current milk price paid to farmers is approximately 1/3 of the retail price.

Socio-economic factors

Various socio-economic factors, for instance farmer's off-farm income, availability of capital investment, milk price, price of land, farmer's level of education and training, and availability of family labour, have direct influence on dairy farmers' decisions as to whether they want to expand and improve their dairy operations. As mentioned earlier, a number of farmers initially became involved in dairy farming as a secondary career, while either the husband or wife (mostly the husband) had another form of regular employment in town. Several farmers worked as policemen, teachers or truck drivers while their wives stayed at

home and took care of their dairy farms. The price of land in most areas of Thailand has increased tremendously compared with the prices during the previous decade. Some farmers have sold part of their land for cash and forage plot area has become very limited; this has increased the farmers' problems of obtaining adequate good quality roughage for dairy cows during the summer time. The scarcity and cost of hired labour is also a problem. Moreover, most children with better education find good jobs in the city and rarely return to dairying.

Opportunities for dairy promotion and improvement

The promotion of dairy production has been quite successful, especially during the past ten years, despite many difficulties and limitations. The opportunity for expansion of dairy production in Thailand is potentially high due to the following factors.

Economic viability

The per capita consumption of liquid milk in Thailand has increased at the rate of around 20% per year. Furthermore, the amount of drinking milk consumed per person doubled between 1990 and 1994 (from 3.44 to 6.81 kg/person). However, the average annual consumption of drinking milk by Thai people is relatively low as compared with that of Singaporeans (58 kg/person) or Malaysians (46 kg/person), which indicates that a substantial increase in per capita milk consumption is possible in Thailand. In fact, the Thai government's milk drinking campaign aimed to increase per capita consumption of drinking milk to 15 kg/person by the end of 1996. In addition, there are many other indications that an increasing percentage of Thai people will become regular milk consumers, e.g. improving levels of education, higher incomes, more efficient milk marketing and an increased awareness of health issues.

Some milk manufacturers in Thailand have been exporting dairy products (such as sterilised drinking milk and condensed sweetened milk) to neighbouring countries. Hopefully, in the near future, more dairy products may be exported to such countries as a result of improving political and economic conditions.

Government policies

As mentioned previously, the Thai government has implemented various policies and administrative measures in order to promote dairy production in Thailand.

As a result of various uncertainties and a decrease in the export price of rice, the Thai government's long-term policy is to decrease the area of paddy rice production by diversification of rice farming to the production of other commodities, such as dairy

products. Hence, in some areas of Thailand, paddy fields will become forage plots for dairy farming. Such policy will enhance a rapid expansion of dairy production.

Production inputs

Feeds are one of the major inputs for dairy production that are relatively abundant in Thailand, especially concentrate feeds such as fishmeal, cereals, cassava chips, and agricultural by-products and wastes. Roughage feeds are scarce in the dry and summer seasons but in the long term, with appropriate methods of collection and preservation, this feed scarcity could be resolved easily. Many available agricultural wastes and by-products, such as sugarcane tops, straw, pineapple peel, corn stover and tree leaves are not yet fully utilised for dairy feeding. In some areas, forage crops can be grown all year round. Moreover, hay or silage making may be feasible. Nonetheless, these feed production techniques have not been used to full capacity due to certain limitations, which could be overcome by research and extension efforts. Recently, the funding of dairy research has received top priority in Thailand; hopefully, in the near future, practical dairy information will become available to dairy farmers that will enable them to improve the efficiency of their dairy operations. Currently, major research efforts aim to improve the milk yield of cows from 8–10 to 10–15 kg/day or up to 4500 kg/lactation (300 days), while reducing calving interval from 450–500 to 360–370 days.

It should be noted that in Thailand there are many areas of land that are unsuitable for crop production but can be useful for dairy farming. With the application of animal manure to improve soil fertility, as well as the use of appropriate forage systems involving leguminous plants, dairy farming could enhance the quality of the environment and ecosystems, especially by improving the quality of less-fertile soils.

For further dairy development some important strategies are required. First, in terms of policy, it is very important to establish a national body or 'Milk Board', which consists of representatives from the different sectors with an interest in dairy enterprise, to formulate and oversee national dairy policies in order to promote the national dairy industry. Second, to target major inputs to ensure the strengthening of dairy training for farmers and the provision of an effective dairy extension system. Provision of mobile extension units that give on-farm advice to farmers is one of the most effective ways to improve dairy efficiency. Third, a national programme for dairy herd improvement in Thailand (DHIT; similar to the Dairy Herd Improvement Association in the USA) must be organised for the selection and multiplication of superior quality dairy sires and cows. All dairy cows with milk yields below the national standard must be culled from dairy herds through a government-supported scheme, which provides some compensation for the dairy farmers; these culled cows could be used for beef production in other areas. Finally, there is real need for strong and continuing support for dairy research. A well-co-ordinated programme in dairy research, with highly selected topics that aim to solve the problems of real farmers or development-oriented topics, must be formulated and supported. With these strategies, a substantial expansion and improvement in dairy production is expected within the next decade.

References

- Skunmun P. and Chantalakhana C. 2000. An economic analysis of smallholder dairy farms in Thailand. *Asian-Australasian Journal of Animal Science* 13 (supplement A):50-53.
- Supamala P. 1969. Dairy production situation in Thailand. *Kasikorn Journal* 42(1):25-27. (in Thai)

Current situation and prospect for dairy production in China

J.X. Liu,¹ Y.M. Wu¹ and Z.E. Zhou²

1. College of Animal Sciences, Zhejiang University (Huajiachi Campus), Hangzhou 310029, China

2. Animal Production and Health Bureau, Zhejiang Department of Agriculture, Hangzhou 310020, China

Dairy production was not an important industry in China before 1949 when the People's Republic of China was established. In 1949 in China, there were only 0.12 million head of dairy cattle producing 0.21 million tonnes of milk for a population of 450 million. Fifty years since then, the number of dairy cattle has increased to 4.265 million head and production of dairy products has increased to 6.621 millions tonnes (National Bureau of Statistics 1999). Dairy industry has become an important business in agriculture. However, milk production/capita per year in China (6.6 kg) is far lower than the world's average (Jiang 1999). Many problems exist, which constrain further development of the dairy industry. In this paper, basic information on the dairy industry, the development course, current dairy industrial systems, contribution of smallholder producers and constraints facing the Chinese dairy industry are reviewed.

Basic information on the dairy industry in China

Number and regional distribution of dairy cattle

The total number of dairy cattle was 4.265 million heads in 1998 (National Bureau of Statistics 1999). Most of these are distributed in pasturing areas and northern China. About 70% of dairy cattle are raised in Xinjiang (0.977 million head), Inner Mongolia (0.726 million head), Helongjiang (0.685 million head) and Hebei (0.636 million head). The provinces where dairy cattle numbers exceed 0.1 million head are Shanxi (0.106 million head), Shandong (0.122 million head) and Shaanxi (0.112 million head). In order to ensure the milk supply for residents in large- and medium-sized cities, dairy production has also been developed in the suburbs of cities. The numbers of dairy cattle in Beijing, Shanghai and Tianjing are 55, 58 and 27 thousand head, respectively.

Breeds of dairy cattle

The main breed of dairy cattle is the Chinese Holstein, formerly called Chinese Black-and-White cattle. The breed was given its present name in 1992 by the Ministry of Agriculture, China. Chinese Holstein cattle originated from both exotic and indigenous sources. Exotic breeds were the offspring of dairy cattle imported from Canada, the USA,

France and northern Europe. Many of these cattle are the result of crossbreeding of local breeds with imported Holsteins. In 1972, when the breeding of the Chinese Holstein began, numbers of cows and average milk yield were 0.073 million head and 3335 kg/year per head, respectively (Li 1999). The breeding programme was finished in 1985 when the corresponding records were 0.503 million head and 4358 kg/year per head. In 1996, there were 1.055 million head of Chinese Holstein cows and milk yield was 4550 kg/year per head. Milk yields of 6000–7000 kg/year per head have been recorded in Beijing, Shanghai and Tianjing. Chinese Holsteins are widely raised in suburbs of cities and farming areas to supply pasteurised milk, milk powder and other milk products to urban citizens. The milk produced from Chinese Holstein cattle accounts for about 85.2% of total output in China.

There are other breeds of dairy cattle in northern pasturing areas. Sanhe cattle are bred in Inner Mongolia grassland areas; they have a strong resistance to cold and are well suited to grazing systems. Milk production is above 3500 kg with a milk fat content of 4.2% and a milk protein content of 3.5%. Contents of vitamins and minerals in milk are superior to those in milk from the Holstein breed. Milk from Sanhe cattle is mainly consumed by local herdsmen as pasteurised milk, milk tea and milk curd. Some is also processed into milk powder.

Xinjiang Brown cattle originated from the hybrid of Swiss Brown cattle and local Yellow cattle. They are excellent breeds of dairy cattle for the Xinjiang grassland areas. In addition, the Wenzhou buffalo, a local breed in the eastern part of southern China, is used to produce milk. In some remote regions of China, buffalo milk is also produced from crossbred animals, derived by crossing local breeds of buffalo with milk buffalo imported from India. Buffalo milk has a high milk fat content and is mainly processed into butter. Dairy goats are a subsidiary source of milk in some mountain areas of southern China.

Feeding systems and milk production

Dairy cattle in suburbs of big cities are house reared. Most of them are tied up in cattle houses but some are reared loose in barns. Milk production in these areas is quite high. On average, milk yield is around 7000 kg/year per head in Beijing, Shanghai and Tianjing (Li 1999). Some herds produce more than 8000 kg of milk/year per head.

In farming areas most dairy cattle are house reared. On average, milk yield is 5000–6000 kg/year per head in northern areas, but is only 4000–5000 kg in southern areas because of high ambient temperatures. Based on data from the Chinese Association of Dairy Cattle, smallholder dairy production accounts for 76.8% of the total dairy cattle population (Li 2000). Overall mean of milk yield (3516 kg/year per head) in China is lower than the world average.

In the present time, most smallholder dairy farms carry out a basic feeding system in which dairy cattle are offered roughages (*ad libitum*) plus silage and are supplemented with a mixture of concentrates according to the level of dairy yields. Roughages are mainly mixed-hay, harvested from local natural grasslands or ammoniated straws. Most silage is made from whole corn or corn stalk cultivated locally. The concentrates are produced locally or imported from other regions or other countries.

Dairy breeding and reproduction

Artificial insemination (AI) is widely used in reproduction of dairy cattle. There were 79 AI service stations in 1996. Of these, 42 stations (53%) had less than 10 bulls; 27 stations (34%) had between 10 and 30 bulls; and 10 stations (13%) had more than 30 bulls. In general, breeding bulls include dairy and meat types. Chinese Holstein bulls are mainly reared in three places: the Beijing AI Service Station of Dairy Breeding Centre, the Shanghai Dairy Breeding Centre and the Heilongjiang Animal Reproduction and Breeding Guide Station. Breeding bulls originated from three sources: introduction of bulls from abroad, introduction of frozen embryos from abroad and selection from local farms in China. Centres for Supervising and Inspection of Frozen Semen Quality, which are located in Beijing and Nanjing but are affiliated to the Ministry of Agriculture, are responsible for inspecting and examining frozen semen from the different AI service stations.

Technical services system for smallholder producers

Governmental stations of animal production and health are responsible for the breeding and health programmes, and extension of advanced technology to smallholder farmers. AI is used widely in dairy production. Animal production and health stations organise the introduction of frozen semen from excellent bulls in other regions and offer technical services for AI to smallholder farmers. They also provide advisory services and training programmes on feeding, management, and prevention and treatment of diseases. The concentrates required by smallholder dairy farms are mainly made and supplied by local state-owned feed plants.

In addition, there are provincial, municipal and prefectural associations for the dairy industry, which also play an important role in development of smallholder dairy production. These associations hold training courses and provide extension demonstrations to improve farmers' knowledge of dairy science and extend new technology. Even the most illiterate farmer is responsive to the new technology, provided its economic benefits are clearly demonstrated in the prevailing farm situation. Associations also arrange for farmers to attend and participate in symposia or workshops to exchange their experiences and lessons.

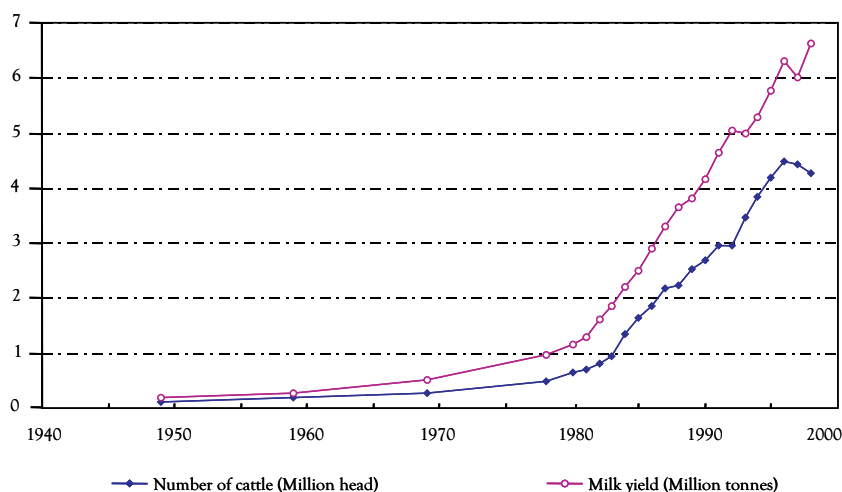
Development course

Substantial development of dairy production in China started in 1999. Depending on the economical character, the five-decade development to date may be divided into three stages: the restrained development period (1949–78), the high speed outspreading period (1979–92) and the structural adjustment period (1993–present) (Fang 1999; Tuo 1999).

Restrained development period (1949–78)

This period was characterised by insufficient investment and short supply. After proceeding for 29 years, numbers of dairy cattle only reached 0.48 million head and total milk yield

reached 0.97 millions tonnes in 1978 (Figure 1). Because of low production of milk and milk products during this period there was a shortage of supply; the products were considered as welfare products and could only be supplied in large- and medium-sized cities for the elderly, children and patients according to quota systems. Few milk products were supplied in small cities and rural areas.



Source: National Bureau of Statistics (1999).

Figure 1. Number of dairy cattle and milk yield in China.

Factors causing the short supply of milk and milk products included unsubstantial dairy funds and extreme shortages of dairy production resources (especially financial and technical resources). In addition, institutional restriction and policy mistakes resulted in low efficiency of production and lacking investment impulsion by state-owned and collective dairy enterprises.

However, some progress was made in improving the Yellow Cattle with dairy breeds. Black-and-White cattle and Sanhe dairy cattle were produced in Heilongjiang and Inner Mongolia, respectively. In this period, there was development of a dairy cattle initiated, milk powder-leading dairy processing industry.

High speed expansion period (1979–92)

This period was characterised by diversified investors and high speed development, and a mushrooming of milk production. Since 1978, China has followed an 'open-door' policy. Private sectors were permitted to develop dairy production and the simplistic publicly-owned system was at an end. Privately owned dairy cattle and goats occurred in upcountry China. During the 14 years up to 1992, annual growth rates were 14.4, 13.4 and 16.9% for the number of dairy cattle, milk yield and amount of processed milk products, respectively (Tuo 1999). Number of dairy cattle reached 2.942 million head and milk yield reached 5.031 millions tonnes in 1992 (Figure 1). Depending on the consumption levels of

milk and milk products, the Chinese dairy industry was in turn changed from being a sellers' market to a buyers' market.

The dairy industry expanded rapidly with the high-speed development of dairy production. A large number of milk processing plants were newly built or reconstructed. There were nearly 900 milk processing plants in 1990; an 80% increase compared with the number in 1980.

These achievements profited from several factors. First, the government carried out a series of policies to develop state-owned, collective and private farms, which stimulated investment enthusiasm by producers, processors and conveyancers/sellers. Secondly, science and technology contributed greatly to dairy production, resulting in modernisation of the dairy industry. Thirdly, aid projects by the World Food Programme (WFP) and European Economic Community (EEC) also contributed to the development of dairy production in China.

In this period, the economic system in China was being reformed greatly. The government took up a series of preferential policies to encourage private investors to set up and develop smallholder dairy production. These policies included: (1) providing long-term loans with low interest rates or no interest to private dairy farmers; (2) remitting taxation for dairy enterprises; and (3) supplying feed of a comparatively low price to dairy farms and enhancing progressively the purchasing price of milk from farms. At the same time, various organisations providing technical services, such as dairy breeding centres, AI stations and veterinary stations were founded in different regions of the country. They were mainly responsible for providing technical services to dairy farmers; including breeding, reproduction, health and technological training etc. The techniques of dairy breeding and AI were extensively investigated and widely applied in dairy production in this period.

Structural adjustment period (1993–present)

In 1993, milk production fell to 4.987 millions tonnes from 5.03 millions tonnes in 1992, indicating the first decrease in production (–0.25%) after a long period, starting in the late 1970s, where production had increased annually. This slight decrease in production was a signal that the dairy industry had entered into a new development period—structural adjustment. The dairy market was fully opened in this period. Numbers of dairy cattle and new processing enterprises still increased, while traditional products such as milk powder were relatively superfluous. Meanwhile, foreign dairy enterprises advanced into the Chinese market. The Chinese Government and dairy enterprises started to conduct structural adjustment of dairy production and marketing systems. These reflected the change from a planned system to a market-oriented system in the Chinese economy. There were three characteristic changes in the dairy industry in this period.

Cancellation of government subsidies

Before the early 1990s, there were double prices for almost all goods in China. The government subsidised dairy farms with concentrate feeds for animals. Farms could buy

feeds from state-owned feed plants at lower prices while they had to sell their milk to state-owned dairy processing plants at a fixed price. In addition, farms also received subsidies for their milk marketing. With entry into the adjustment period, these subsidies were gradually cancelled. Meanwhile the government strictly controlled the pricing of milk. Therefore, cost of dairy production increased in almost all farms and farmers could make little profit or reduction in deficit.

Change in structure of ownership

Dairy enterprises with joint venture and foreign capital developed quickly. In succession, multinational companies with abundant capital moved into China. Although introduction of foreign capital and technology improved the supply and management of the dairy industry enriched the dairy market in China, new problems occurred in dairy production. Some dairy enterprises were unwilling to produce milk with low profitability and purchased raw milk at relatively high price, resulting in competition for milk sources. On the other hand, some dairy enterprises, that had little capital and used outdated techniques, were bankrupted and dairy farms associated with these enterprises were phased out. As a result, there was readjustment of the distribution of milk sources.

Adjustment in the administrative system for dairy production

Subsidised policies under the planned system covered up a severe limitation for the dairy industry—production, processing and marketing of milk were independent of each other. It implied that production, supply and marketing were not synchronised, resulting in unfair distribution of profits between different sectors. This situation exerted an adverse influence on dairy production. Adjustment in the administrative system became necessary to promote dairy production. It was not a simple administrative measure, but involved all aspects of the dairy industry.

During the adjustment period, inevitably, the number of dairy cattle and milk yields fluctuated. Compared with those in 1992, dairy cattle population and milk production decreased in 1993, recovered in 1994 and increased in 1995. The fluctuation was more apparent in both eastern China and around big cities where level of consumption of pasteurised milk was high and there existed a sensitive response in the relationship between supply and demand. For example, total milk output in 1995 increased in China, but milk production decreased in 11 provinces, a >20% decrease being recorded in some provinces.

Current dairy industrial systems

From the late 1970s, throughout the high speed outspreading period and the adjustment period, a great change took place in the dairy productive structure in China. Before 1980, almost all dairy cattle were raised in the state-owned and collectively operated farms. Dairy products were processed in light industries and privately-owned plants and then marketed by state-owned commercial branches. Responsibility and obligation were clearly

demarcated between agriculture, industry and commerce, and all prices were planned, decided and managed by the government. With reform of economic ownership in rural areas, individual farmers have been able to raise dairy cattle and dairy goats since the early 1980s. Beginning with only one or a few dairy cattle per farm, farm size increased to include tens and hundreds of dairy cattle. Up until 1989, for example, the total number of dairy cows kept by smallholders in Beijing, Shanghai, Tianjing, Xi'an, Nanjing and Wuhan reached 38 thousand head, which was 21% of the total number in these six cities.

Leading enterprise

With regard to dairy industrial systems, a combination of enterprise and farmers is the main institutional structure for the dairy development programme in China (Tuo 1999). In addition to milk processing and marketing, and feed processing, the enterprises are also involved in other activities. In China they are called 'leading enterprises'. The leading enterprise may be a food processing co-operation, industrial group or a business unit, which may be state-owned, collectively owned or in private ownership. Such leading enterprises generally hold milk processing plants or facilities. There is easier access to capital for commercial enterprises, because their assets and land titles can be secured as collateral. The leading enterprises co-ordinate themselves with local administrative departments to obtain land, usually they rent the land. In addition, they serve as support organisations to help farmers with a series of services (Jia 2000). Farmers may obtain dairy cattle from the leading enterprise by lease or low-price purchase. Along with local administrative bureaus and professional associations, leading enterprises also supply farmers with technical advice on feeding, management and health, technological training etc.

There are two types of systems depending on the scale of the leading enterprise.

Giant dairy groups

With reorganisation and conformity of the dairy industry that was characterised by recombination of assets, some giant dairy groups have been formed and have become the leading enterprises regionally or nation-wide. Among them are the Shanghai Dairy Corporation (Group), the Shijiazhuang Sanlu Dairy Company, the Heilongjiang Wandashan Dairy Factory and the Inner Mongolian Yili Industrial Corporation Ltd. Due to their abundant capital, advanced technology and numerous trained personnel, these giant leading enterprises (groups) deal with their business not only inside the group, but they also invest in other industries in different regions, combine and annex other enterprises, and extend industrial chains. Their business covers almost all areas of agriculture, industry and commerce, and processing and marketing. With the formation of specialised systems of production and management within the leading enterprises, national dairy resources have been reasonably configured and assets of the dairy groups have expanded rapidly. At present, national dairy brands such as Guangmin, Sanlu, Yili, Wandashan and Sanyuan can compete with foreign brands.

Leading enterprises for smallholder producers

According to a survey carried out in over 25 provinces including Beijing, Tianjing, Heilongjiang and Henan, smallholder dairy production accounted for 76.8% of total dairy cattle (Li 2000). Milk is a perishable product. Absence of chilling facilities, high ambient temperatures and lack of hygiene are the major problems faced by smallholder producers in marketing milk. Milk production based on smallholder producers can be sustained only if facilities are provided to process and market milk. The government and/or private entrepreneurs have supported and financed the establishment of leading enterprises that collect, process and market milk as pasteurised milk, milk powder and/or fruit milk. However, the scale of these enterprises is not as large as in the giant dairy group.

Depending on the ownership of land and animals, there are several types of institutional structure for combining the efforts of enterprise and smallholder farmers in China.

Enterprises that do not hold land or farms

These enterprises have to collect milk from individual farmers and then process and market the milk. This is an original organised structure. Usually the enterprise makes contracts in advance with individual farmers; these contracts include details of the price and quality of milk. Depending on farm size, the enterprise may make contract with several individual farmers. Farm size ranges from a few to hundreds of dairy cattle. In some cases enterprises collect from specialised villages where many dairy farmers exist.

Enterprises that possess their own land or hold leases on land

These enterprises build animal houses and then lease them to farmers or loan them to farmers on an impromptu basis. Then the milk processing plant affiliated to the enterprise assures to purchase milk from the farmers at reasonable prices, which depend on the quality of the milk. Specialised villages and regions can be set up for dairy cattle keeping.

Farmers or collectives who set up a joint-stock company as a leading enterprise

The enterprise is responsible for rent of land, planning of production, and processing and marketing of milk. Farmers are producers of milk and also stockholders in the enterprise. Therefore, they can benefit from milk production as well as from profit sharing.

Enterprises that hold both their own milk-processing plant and dairy farms

Within the enterprise there are different divisions, some of which are responsible for cattle feeding, some for milk processing and marketing and some for feed processing and even

trade. Strictly, these enterprises may not be classified into the category of smallholder. However, they can be considered to be advanced smallholder dairy production systems. When the enterprise is in private ownership, the enterprise *per se* is a combination of milk processing plant and dairy farm.

Contributions of smallholder producers

Benefits to adjustment of the composition of animal production

With a huge population and limited land, shortage of feed resources has been the primary constraint to development of animal production in China. The Chinese Government has recently paid much attention to utilisation of locally available feed resources in order to develop sustainable animal production and has given top priority to adjustment of the composition of animal production (Ministry of Agriculture 2000). An important policy in 2000 was to 'stabilise swine and egg production, accelerate the development of meat-type cattle and sheep production and to give first priority to develop dairy animal and wool production'.

Development of smallholder dairy producers is in line with government policy and is beneficial to structural adjustment of animal production. Smallholder producers can in general be described as being a low input system. Almost all cattle are kept indoors and fodder is brought to them. Unlike large dairy farms, smallholder cattle owners typically feed their cows on a variety of feedstuffs, such as crop residues, hay prepared from wild weeds, alcohol by-products and brewers' by-products, as well as cabbage and beetroot. These feeds are available in varying amounts all year round. Most of them are highly fibrous, and monogastric animals such as pigs and poultry cannot utilise them. These feeds will make a major contribution to sustainable animal production systems.

Smallholders as the base of the leading enterprises that process and market milk

Combination of enterprise and farmers is a basic dairy industrial system in China. The smallholder producers form an important socio-economic group as they hold 76.8% of total dairy cattle in China. Cattle rearing in the village by smallholders is a family business and generally a part-time activity. This makes the business a flexible one in the sense that, depending on circumstances, the smallholders can add or sell one or two head of cattle quite easily. The smallholder farmers produce raw milk for leading enterprises to process and market. It is the smallholder producers that constitute the base of sustainable leading enterprises.

Improvement of rural livelihoods

Dairy production has been important in the improvement of rural livelihoods. Presently, considerable profits can be made from dairy cattle rearing. Results of our survey show that a

smallholder farmer may benefit by about US\$ 400/year from keeping and feeding a dairy cow. Attributed to dairy production, animal husbandry has been a backbone industry in many regions and has increased further the contribution of dairy production to rural livelihoods. Smallholder production not only increases the income of farmers, but also contributes to rural labour markets and the employment of farmers. Farmers may be smallholder producers and also employees in leading enterprise.

Constraints faced by the Chinese dairy industry

With the high-speed development of the dairy industry, milk production and processing capacity have increased rapidly in China. The rate of supply is gradually exceeding the actual demand for milk and milk products by Chinese citizens. Dairy products have even become overstocked and unmarketable in some regions. At the end of 1997, there was a surplus of 50 thousand tonnes of milk powder, representing 15% of total milk powder output in China (Tuo 1999). The following subsections consider the major constraints faced by the Chinese dairy industry.

Unfavourable administrative systems

Administrative departments are familiar with the planned economy system which has been in place for a long time since the founding of the People's Republic of China. Each department does things in its own way and sometimes there is a lack of close co-operation. There is little capable, centralised and high efficiency organisation to co-ordinate the dairy production, processing and marketing systems. There often appears to be extreme contradiction between the profits of producers, processors and marketers.

Although dairy associations co-ordinate to some extent the relationships between enterprises and between enterprise and farmer, they are not administrative organisations and have no power or capacity to deal effectively with the relationships. As a result, dairy production, supply and marketing are not aligned with each other and this restricts development of dairy production and decreases the efficiency of production.

Contradiction between small enterprise and large market

There are presently over 900 milk processing plants, 90% of which only have capacity to process less than 100 t of raw milk per day. They have few technical staff, inferior processing facilities and a limited variety of dairy products. Limited capital and technology prevent small enterprises from forming industrial chains from milk production to marketing. The products are, therefore, of low quality and production results in a low level of profit or even a deficit.

Furthermore, small-scale private enterprises are generally incapable of coping with spontaneous and marketing risks. They lack stability and may go out of business rapidly, leaving the dairy industry at any moment when the prices of feeds and milk fluctuate. This

lack of stability may be catastrophic for dairy industry. Proven examples of such effects are the sudden rapid decreases in dairy production and resultant fluctuations in the prices of milk and milk products, which occurred during 1988–99 and during 1993–94.

The limited variety of dairy products

Currently, there is lack of recognition that consumers often ask for ‘new’ tastes, flavours and textures, advocate nutrition and health, and favour convenience. Consequently, most dairy enterprises only produce a limited variety of milk products. The predominant product is milk powder, which account for 54% of processed milk products (Luo 1999). In some provinces, milk powder represents as much as 90% of all dairy products. Condensed milk and malt milk each account for 20% of processed milk products. Very small amounts of yoghurt, fermented milks, cheese and butter are produced, which in other countries with developed dairy industries are of similar importance to pasteurised milk

Small-scale and relative weakness of leading enterprise

Except for limited enterprises, most milk processing enterprises are of small-scale with inferior processing facilities, especially those belonging to the private sector. The dairy products are of low quality and the profits are low or non-existent. These enterprises are involved ceaselessly in irregular and invalid competition with each other. They compete for milk sources during the lean season when there is not enough milk to meet the demand, but in the flush season they demand lower prices, lower the class of milk and may even refuse to purchase milk from farmers. Thus, there is spectacular contradiction between continuity of milk production and discontinuity of milk marketing by the processing plants. This, to some extent, exerts an adverse effect on the productive enthusiasm of dairy farmers.

Once China participates in the World Trade Organization, the competition will be keener, particularly with international products. At present, 13 of the top 25 milk producing countries have exported their dairy products to China; imported dairy products amounted to 100 thousand tonnes in 1998, equivalent to 20% of total dairy product production in China (Chen 2000).

Environmental aspects

With development of dairy production, competition between humans and animals coexisting in the same places is getting severe. Space is limited and there is also environmental pollution from animal manure. There are strict regulations for land use, so farmers cannot build animal houses in their fields without permission. Our survey shows that farm size is very small, but on average farmers hold 3–5 head of dairy cattle each. While they are making great contributions to the dairy industry, smallholder producers are

incapable of dealing with animal manure, which is one of the major constraining factors for dairy production in China.

Prospect for the dairy industry in China

It is said that Chinese people seek the taste, smell and colour of foods more than the nutritional value. Diet is like a culture for Chinese people. For a long period of time, milk has been even cheaper than soft drinks, such as Coca-Cola and Sprite. However, Chinese people are paying increasing attention to their nutrition and health. Milk has been recognised to be a nourishing food. 'A cup of milk strengthens a nation' is not only a slogan, but also a real action. Since last year, the central government has been carrying out a programme for school milk in China (Ministry of Agriculture/State Development Planning Commission/Ministry of Education/Ministry of Finance/Ministry of Health/State Bureau of Quality and Technical Supervision/State Administration of Light Industry 2000). Demand for milk and milk products has increased year after year with the development of the national economy and improvement in the livelihoods of Chinese citizens. In order to meet the increasing milk demand, it is necessary to energetically develop dairy production. The following subsections consider the prospects for the dairy industry in China, based on the current situation and the projected demand for milk (Wang 1999).

Dairy processing plants become larger but fewer

There are too many milk processing plants of various sizes (approximately 1000 plants) in China. In the future, through intense competition, small-scale plants with inferior facilities will be bankrupted, while those that have abundant capital and assets with advanced technology and superior resources will increase in size and develop well. The large-scale enterprises should be able to process and market hundreds or thousands of tonnes of raw milk daily. Milk products within one city or one region may be controlled by several milk enterprises. In Hangzhou for example, there are presently only three milk-processing enterprises that dominate the production of milk processing and marketing.

Necessity for improvement of the quality of raw milk

For a long period of time milk supply was inadequate. Consequently, the Chinese dairy industry has paid great attention to the quantity of milk but less to the quality, nutritional and hygienic. It has been recognised widely that quality of raw milk is the most important factor affecting quality of commercial milk and milk products. Only good quality milk and milk products can be marketed well. Improvement of milk quality is a systematic work of course. It not only depends on feed formulation, breed of dairy cattle, environmental

sanitation and milking management, but also involves storage and transportation of milk, and education and professional moral of milk producers.

Socialised service systems

There is a need for innovative programmes that increase the resources (credit, land, feeds, research and technology) and extension-oriented support services (marketing, training, field programmes and demonstration centres) available to dairy farmers. In addition to the current systems, advisory services for finance, credit and legal aspects are needed by the farmers. Prevalence of diseases, such as tuberculosis and brucellosis, should be monitored regularly and inspections made to ensure animal health and safety for producers and consumers. Another function of the support services is to further propagandise the nutritional value of milk and to advocate milk consumption.

Modernisation of the dairy industry

The trend towards modernisation of the Chinese dairy industry seems a certainty in the new century. Through the efforts of dairy scientists, administrators and producers, the current situation will improve greatly. Extension workers and producers will require a good knowledge of advanced dairy science and technology. Dairy farms will be able to produce raw milk of high quality from improved cows. Dairy processing enterprises will have excellent facilities and will produce a variety of milk products of high quality. The milk marketing system will improve and consumers will be able to purchase pasteurised milk and milk products at their convenience. Each industry within the dairy system will need to co-ordinate well with the others. The dairy industry will then be able to achieve sustainable development.

References

- Chen X. 2000. Are we ready to join the WTO? *Shanghai Dairy* 23:(1):8–9.
- Fang Y.S. 1999. Present situation and developing trend of dairy production in China. *China Dairy Cattle* 6:5–7.
- Jia Z.G. 2000. Investment in dairy industry to found production base and speedy development of dairy production with one action. *China Dairy* 2:6–7.
- Jiang J.P. 1999. Way to speed up development of dairy production in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 408–410.
- Li Y.F. 1999. How to develop the milk production in suburb of cities? In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 445–450.
- Li Y.F. 2000. Grasping of opportunity to promote the development of dairy production in China. *China Dairy Cattle* 3:4–5.

- Luo C.X. 1999. Current situation and development prospect of dairy industry in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 421–429.
- Ministry of Agriculture. 2000. Adjustment of composition of animal agriculture: Key point in animal development in 2000. (<http://www.cav.net.cn/xmj/jyh/new032102.html>)
- Ministry of Agriculture, State Development Planning Commission, Ministry of Education, Ministry of Finance, Ministry of Health, State Bureau of Quality and Technical Supervision and State Administration of Light Industry. 2000. Circular letter relating to the implementation programme for school milk in China. (<Http://www.agri.gov.cn/news/2000/1115/homepage.htm>)
- National Bureau of Statistics. 1999. *China statistical yearbook*. China Statistics Press, Beijing, China. pp. 399–407.
- Tuo G.Z. 1999. Five-decade retrospection and vista of dairy production in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 3–13.
- Wang Y. 1999. Development prospect on dairy industry in China in 21 century. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 450–455.

The smallholder dairy production and marketing systems in Vietnam

N.Q. Suc and D.V. Binh

National Institute of Animal Husbandry, Thuy Phuong, Tu Liem, Hanoi, Vietnam

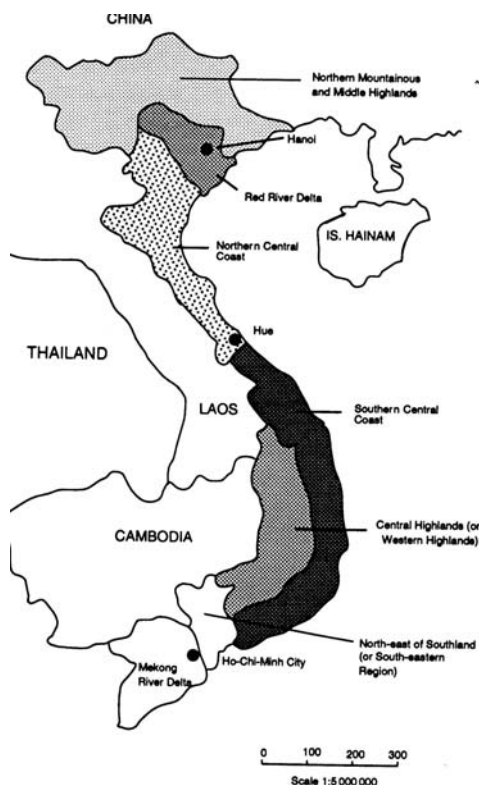
Tel. 084-4-8387236 Fax. 084-4-8389775

E-mail: tcvcn@hn.vnn.vn

Introduction

The typical character of production systems in the different agro-ecological zones of Vietnam

Vietnam is a tropical country located in South-East Asia. The total area of the country is 33 million hectares. It is divided into seven agro-ecological zones (Map 1).



Source: Binh and Suc (1995).

Map 1. The seven agro-ecological zones of Vietnam.

Northern Mountainous and Midland Region

The major features of this Region are a large land area, green hills or barren stony mountains, isolated hamlets, under-developed markets, poor living standards and a low level of education. Buffalo production is well developed; the Region's buffalo constitute 42.8% of the national buffalo herd. Pig keeping is also popular; the Region's pigs constitute 24.3% of the national pig herd. Nevertheless, productivity of the livestock enterprises is low. Transportation, communication and irrigation systems are the biggest constraints to development of this Region.

Red River Delta Region

This area has a high population density and land is scarce. Nevertheless, the Region is the second largest rice producer in the country. Cattle (especially dairy cow) production has increased with increasing demands for milk. The number of local pig breeds has fallen sharply, while the number of exotic pig herds is increasing rapidly.

Northern Central Coastal Region

This is a narrow strip, dominated by mountains in the west. In this Region, there is a tendency to promote industrial crops such as peanuts, coffee and rubber. The markets are under-developed, and dairy and beef cattle production is limited; however, buffalo production is well developed. Pig production is based on local breeds and their crosses.

Southern Central Coastal Region

In this Region, the population is concentrated within the cities. Beef cattle production is well developed; the Region's cattle constitute 27.8% of the national beef herd. Pig production in the Region is mainly from crossbreds. Goat (including dairy goat) and sheep raising is common in the dry areas. This Region is characterised by a prolonged dry season, so there are many constraints to the provision of feed for animals.

Central Highland Region

The major features of this Region are shortages of both food and labour. This Region is famous for industrial crops such as coffee and rubber. The dry season is prolonged and lack of water is the major constraint to the region. Reforestation is vitally important but difficult. Beef cattle production is well developed. Pig breeds consist of local and exotic crossed types. In the dry season, there is a major shortage of animal feed.

North-eastern Mekong Region

This is a peri-urban area and it benefits from ready access to markets. Development of cash and industrial crops is promising; these include coffee, sugar-cane and cashew nuts. Most of

the pigs, chickens and ducks are of improved breeds. Dairy cattle are having positive impacts at the household level.

Mekong Delta Region

This Region is the most important rice growing area in the country. Moreover, the majority of the national duck population (57.6% of total) is also found here. Fishing and shrimp production are also well developed.

The population of Vietnam

In 1999, the human population of Vietnam was 76.328 million. About 70% of the total labour force works in agriculture. Living standards are still very low with 11% of households considered to be very poor. Undernutrition affects approximately 36% of children. There are many jobless people in the villages and mountainous areas (Ly 1996).

Vietnam's economy

Vietnam's economy is predominantly agricultural. Rice is the main staple crop. During the past 10 years, owing to government guidelines reviewing the agricultural policy of the early 1990s, Vietnam's agricultural and rural economy has developed at a fast pace. This has helped improve the socio-economic situation and create the right conditions for deep and broad reforms in other socio-economic fields. The rural economy accounts for about 40% of GDP (gross domestic product) and about 40% of total exports. It is a source of employment and income for much of the Vietnamese population, as well as a source of supply for many industries. In 1990, agriculture provided 38.74% of GDP; however, in 1999 this contribution was reduced to 25.43% while industry's contribution increased from 22.67% to 34.49% (Vang and Thuy 1999).

Agriculture is an important part of the domestic economy of Vietnam. The cultivated area is about 11 million hectares. The agriculture is based mainly on rice production (77% of the cultivated area) supported by other crops such as maize, potatoes, sweet potatoes, cassava, groundnuts, soybeans, sugar-cane, fruit trees and other perennial commercial tree crops such as coffee, tea, rubber and coconut. According to GSOV (2000), agricultural output contributed 25.43% of GDP in 1999, of which cultivation constituted 79.4% and livestock production (mainly pigs, buffalo, cattle and poultry) constituted 18.2% (MARD 2000).

The delivery systems for livestock services

Support for breeding animal production

The government supports farmers with part of a fund for the conservation and development of animal breeds. The animal breeding centres have to provide good breeding animals to the

farms. The poor farmers have a right to buy breeding animals on credit with a low interest rate (1% per year) from a bank.

Veterinary services

In some areas, there are quite good veterinary networks with diagnostic centres and veterinary stations from which veterinarians can provide assistance to the farmers in preventative vaccination and treatment. Nevertheless, in general, veterinary services are still lacking in Vietnam, a country where tropical diseases often have serious effects. Recently, the government issued a 'veterinary code'. All institutions and economic sectors have been asked to follow this code to improve animal health care and also to protect the environment.

Artificial insemination (AI)

AI has been used in pigs and cattle for more than 30 years. The level of use of AI in the sow population of the north has only reached 30–60%, but AI is used for about 80% of dairy cows. Each province has at least one AI station, which can store and deliver viable semen to farms in the districts. Artificial inseminators can store semen for 2–4 days and then use it to supply the animal producers on the farms.

Feed resources

In recent years, there has been dramatic improvement in the area of feed production, 24.5 millions tonnes of feed being produced annually. This has greatly decreased the pressing feed deficit. Each year, 1 million tonnes of rice bran, 10–15 thousand tonnes of fish meal, 10–20 thousand tonnes of soybean and 20–25 thousand tonnes of oilseed cake are produced to provide animal feeds.

Fodder and green feed

The grasses in natural pastures have poor nutritive values. Improvement of natural pastures is expensive and has a low efficiency because of lack of water and fertiliser. Therefore, grass cultivation has been studied and developed for many years. Moreover, agricultural by-products such as maize, soybeans, rice straw and potatoes are available, and are being utilised and processed for feeding animals.

Research and extension work in animal production

To meet the Vietnamese demands of industrialisation and modernisation, animal production research has included the following activities:

- establishment of links between animal production research and marketing to assist smallholders to develop sustainable agricultural systems
- improvement of productivity of local animal breeds (dairy and meat cattle, dairy goats, pigs and poultry) by crossing with imported improved breeds

- improvement of feeding systems with the use of local resources to obtain a higher efficiency of feed conversion
- prevention and control of diseases such as foot-and-mouth disease (FMD) and leptospirosis of ruminants and pigs.

All results of research have been transferred to the farmers by training the farmers in new technologies, and by providing farmers with improved breeds and varieties of forages for use on their farms.

Dairy production in Vietnam

In Vietnam and in other countries, dairying is recognised as an instrument for social and economic development. According to the General Statistical Office of Vietnam, the cost of imported milk products has increased from US\$ 58.8 million to US\$ 70.4 million during three years of 1995–1997. It is, therefore, urgent that local milk production is developed rapidly to reduce the cost of imports. Furthermore, both creation of employment by changing the structure of the livestock sector and protection of the environment are very important. The current system of dairy production and marketing in Vietnam is illustrated in Figure 1.

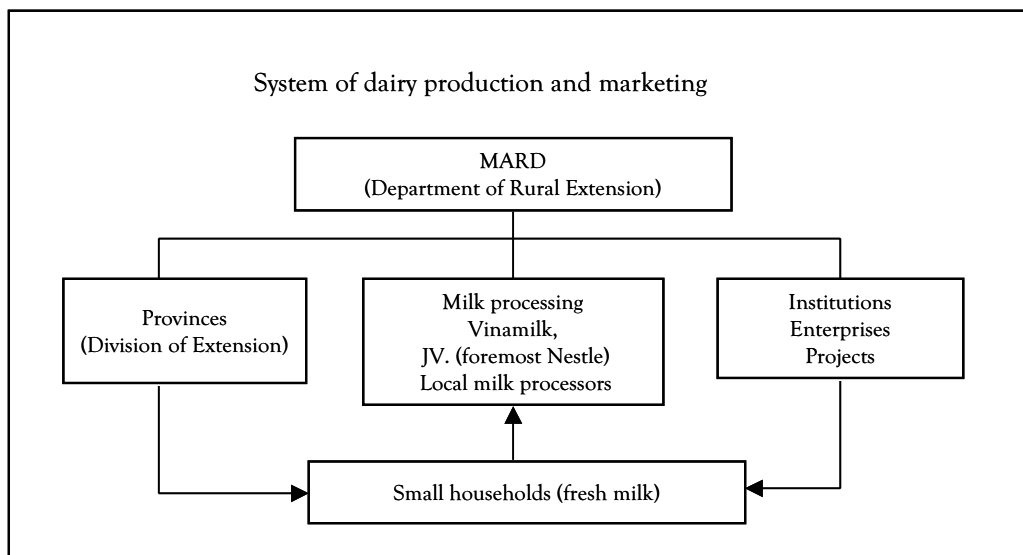


Figure 1. Dairy production system in Vietnam.

Impact on smallholder dairy production

A long time ago, dairy production from dairy cows was only carried out on state farms. Since 1985, however, with the support of the government, dairy production has been

expanded to include smallholders in the villages of Vietnam. Now, small producers, dispersed throughout the rural areas, are the main source of most of the nation's milk supply. A programme for development of dairy production has been set up to encourage dairy cattle and dairy goat production at household level. Consequently, the number of dairy cattle has increased rapidly during the last few years. At the end of 1985, Vietnam's dairy cow herd constituted 3910 head of cattle. However, in June 2000, this number had increased to 32 thousand head, out of which about 20 thousand were reproductive cows and 13 thousand were producing milk. The majority of dairy cows in Vietnam (94%) are crosses (F_1 and F_2 generations) between the Holstein-Friesian and the Sindhi breeds. The remaining 6% are pure bred Holstein-Friesian animals, which are mainly kept on breeding farms (MARD 2000).

Recent figures show that 95% of all dairy cows are raised by smallholders, the remaining 5% are raised in dairy cattle breeding farms. The breeding farm sector mainly keeps pure bred Holstein-Friesian animals in herds of 500–1400 head. The remainder of the dairy herd is kept on about 5600–5800 of the 115 thousand household farms in Vietnam. Usually, there are 3–5 dairy cows per farm, but some household farms have 20–50 dairy cows (MARD 2000).

Private management of dairy cow production in small households and application of new technologies obtained through research have combined to improve level of milk production by dairy cows in the last few years. Lactation milk yield of cows has increased from 2330 kg in 1995 to 3200 kg in the year 2000. Moreover, total milk production has increased at the rate of 33% per year, from 21 thousand tonnes in 1995 to 39.6 thousand tonnes in 1999. Meanwhile, the demand for milk has increased by 20% per year. Therefore, the requirement for milk imports is still increasing at 25% per year (GSOV 2000).

Development of dairy goat production for poor farmers

Recently, dairy goat production has caught the attention of the Government of Vietnam. The Goat and Rabbit Research Center has taken responsibility for this initiative and at present is researching and developing goat production in the country. The dual-purpose (meat and milk) goat breed, the 'Bach thao', which has a large body size and an average milk yield of 1–2 litres/day, has increasingly affected meat and milk production at the farmer level since 1993. In 1994, three breeds of dairy goat (Jumnabary, Barbari and Beetal) were imported from India with the aim of improving milk productivity of local goat breeds in Vietnam (Binh et al. 1996).

Dairy goat production is a suitable livestock enterprise for poor farmers, especially in mountainous areas, because of low investment costs for the dairy breeds, goat housing, feeding and management. Goats require only simple feeds, e.g. natural resources or agricultural by-products. Goat meat and milk have high nutritional values and are particularly useful in the diets of children and the elderly. Moreover, goat leather is a special and expensive product, which can provide a high income for producers. In Vietnam, approximately 3600 t of goat milk are produced annually. In 1997, an FAO project initiated goat milk cheese production in five provinces of Vietnam. Under this

project, the dairy goat population of Vietnam increased from 15 thousand head in 1990 to 35 thousand head in 1999.

Furthermore, the wellbeing of poor farmers has been improved by raising dairy goats that are managed using local resources. In 1994, the price of goat milk was US\$ 0.5/kg while cow milk cost US\$ 0.25/kg (Binh et al. 1996). The system for goat milk collection, processing and consumption in Vietnam has been expanded at village level.

Impact of systems of milk collection and processing on the development of dairy production

Eight big dairy companies, namely Vinamilk, Foremost, Nestlé, Bavi, Hanoi, Phu Dong, Moc Chau and Quy giao, carry out most of Vietnam's milk collection and processing. Vinamilk is the biggest company; in 2000, it collected and bought 320 thousand tonnes of fresh milk, of which about 90% of the total milk production is from Hanoi and Ho Chi Minh City and some urban provinces of Dong Nai and Long An. This company exported powder milk, dried fresh milk and a dried nutritional supplement to the value of US\$ 26.8 million in 1998 and US\$ 83 million in 2000. The Foremost Company collects and buys the majority of milk produced in the Binh Duong Province and some areas of Ho Chi Minh City (MARD 2000).

The marketing mechanism for milk is established by the extension institutions and processing companies. The milk producers make contracts, directly or indirectly, with the milk processing companies. All collected milk is transported by refrigerated lorry to the processing factories 50 km away. However, the milk from Moc Chau, 200 km from the processing factory, has to be pasteurised and kept overnight at temperatures between 0°C and 4°C. The purchase price of milk is 3500 dong/kg (US\$ 1 = 14 thousand dong in 2000), but it may depend on quality of the milk (milk fat percentage and milk density). Unmarketed fresh milk is made into yoghurt or cream by local consumers or small-scale processors. The milk processing companies have supported in the investment to farmers for buying dairy cow to develop the dairy production.

Milk is a relatively new agricultural product in Vietnam, but its production has increased from 20 thousand tonnes in 1990 to 39.6 thousand tonnes in 1999, an average growth rate of 18.9% per year. In contrast, average annual growth rates for pork, poultry meat, beef and buffalo meat, and eggs are only 7.7, 3.65, 0.2 and 6.9%, respectively. Nevertheless, total milk consumption in Vietnam is about 450–460 thousand tonnes/year, but only 7–10% of this amount is produced in the country (Vang and Thuy 1999). Per capita fresh milk production is 0.23 kg in 1995. It was increased to 0.53 kg in 2000 while per capita recent consumption is at an average of 7.9 kg per year. So, the domestic milk production forms only 6.7% of milk consumption, the other 93.3% is imported. About 70% of imported milk is in the powder form and is processed into condensed milk and yoghurt; it is sold in most towns and villages (MARD 2000).

Opportunities and constraints for the development of dairy production in Vietnam

Development of dairy production in Vietnam has many potential advantages:

- Milk consumption, particularly among people living in cities and industrial areas, is increasing rapidly. An increase in domestic production could meet some of this growing demand and reduce the level of milk imports.
- Vietnam's dairy cow and dairy goat production systems demonstrate that smallholder dairy production and marketing systems, including milk collection and processing, can create employment opportunities and improve the socio-economic conditions in rural areas.
- Rearing of dairy cows and goats at the household level can be economically efficient and can provide a high income. During the last decade, the margin between production costs and prices obtained from fresh milk has benefited farmers, mainly because of low feed costs, high prices of milk products and regular milk collection systems from their houses.
- Technologies for dairy production and milk processing are being adapted and improved to suit conditions in Vietnam. Moreover, effective production technologies are being transferred to private households for sustainable and integrated farming systems.

Nevertheless, the development of dairy cattle and goat production faces, among others, the following constraints:

- Technologies for dairy cattle and goat production, breeding management, feed processing, disease prevention, and milk collection and processing have not been introduced throughout the country.
- A deficit of protein sources in animal feeds and lack of high quality green fodder, such as legumes, affect a large part of the country and are limiting factors in dairy animal production.
- There is limited access to capital, infrastructure and facilities, which will inhibit development of dairy production.

Policies and direction for dairy production in Vietnam

During the past 10 years, the agricultural economy of Vietnam has not been affected by the region's economic crisis and has even achieved some successes. Animal production, especially milk production, has increased because of many changes in policy.

The national programme for development of dairying

This was established with a view to improving socio-economic status across the country. This programme not only increases the domestic supply of fresh milk, thereby reducing foreign currency costs of importing milk, but also creates employment and higher

incomes for farmers. Therefore, the government has prioritised the development of dairy cattle and dairy goat production based on optimised utilisation of local resources (land, labour, markets, technology, loans etc.) including the systems of milk collection, processing and marketing under the framework of private farms, co-operatives, companies and associations. Milk processing companies will be located close to the areas where dairy products are produced, helping farmers to achieve greater benefits from their animal production.

Policy for development of dairy production in household farms

Now that farming households are recognised as independent economic units with the right to use their land over long periods of time (30–50 years), they are bosses for themselves who can decide how and what to produce and where to get their inputs. Other policies on lending and provision of support to families include the use of part of the benefits from industrial production to develop the dairy production based on using two paramount resources such as available labour and land.

Foreign investment in agriculture

Up to the end of 1999, about 200 projects on agriculture and rural development, including many projects on milk production and processing, had been carried out with a total estimated funding of US\$ 1.5 billion in overseas development assistance. Moreover, a further 363 projects had been carried out with US\$ 3.766 billion in foreign direct investment. Overseas development assistance capital is very important for Vietnam's agricultural and rural development, infrastructure construction, transfer of technology and exchange of management experiences, and labour training. The state makes the most out of preferential loans and other bilateral and multilateral co-operation in technological and scientific works for the development of livestock production.

Subsides for improving dairy animal breeding

Breeding centres for dairy cattle and goats have been established by the state and private sector and will be provided with breeds that are suitable for each agro-ecological region. Many exotic breeds have been imported to improve the milk productivity of local breeds. The Ministry of Agriculture and Rural Development (MARD) provides about US\$ 1.2 million/year for the upkeep of the nucleus herd of livestock for breeding. From 1995 to 1998, the World Bank provided US\$ 10 million for a programme to improve Vietnamese cattle. The dairy and beef company under MARD has farms in Ba vi, Moc Chau and Lam Dong with a nucleus of 200–900 milking cows producing young breeding animals of good quality for state and private farms.

Rural credit

The Agriculture Development Bank of Vietnam was established in 1998, as a fully state owned bank. It has a client network of about 7000 credit co-operatives throughout the country. Between 1993 and 1998, the interest rate on rural credit was high at 2–4% per month. In 1999, however, the interest rate was reduced to 1.1% per month and an even lower rate of 0.6% per month was provided for poor farmers.

Policy for international co-operation in research and development

Policy for international co-operation in research and development of animal production, animal product processing and marketing has been attended to by the government.

Conclusions

Vietnam's recent success in increasing dairy production development is based on the application of technical progress to animal production, the mechanism of milk collection, processing and marketing, and efficient support from research and extension institutions.

The most important lesson learnt from this success is the need to set up a system of milk collection and processing in Vietnam, which supports the farmers as they develop other assets, such as dairy production in household farms.

Hopefully, dairy production in Vietnam, especially smallholder dairy production, will continue to have good opportunities for improvement and will be able to keep pace with other countries in the South. This should be possible assuming that dairy production in Vietnam receives stronger support from the government and that it has opportunities for co-operation with international organisations.

References

- Binh D.V., Suc N.Q. and Ly L.V. 1996. Research and development of the goat in Vietnam. In: Pryor W.J. (ed), Exploring approaches to research in the animal sciences in Vietnam: A workshop held in city of Hue, Vietnam, 31 July–3 August 1995. *ACIAR Proceedings* 68:60–62. ACIAR (Australian Centre of International Agricultural Research), Canberra, Australia.
- GSOV (General Statistical Office of Vietnam). 2000. *1999 Statistical Yearbook*. Statistical Publishing House, Hanoi, Vietnam. 283 pp.
- Ly L.V. 1996. A review of animal science research in Vietnam. In: Pryor W.J. (ed), Exploring approaches to research in the animal sciences in Vietnam: A workshop held in city of Hue, Vietnam, 31 July–3 August 1995. *ACIAR Proceedings* 68:15–20. ACIAR (Australian Centre of International Agricultural Research), Canberra, Australia.
- MARD (Ministry of Agriculture and Rural Development). 2000. *Project for development of dairy production in Vietnam 2000 to 2010*. MARD, Hanoi, Vietnam.

- Thuong N.V 1995. Some results of study of beef and dairy cattle in Vietnam. In: Pryor W.J. (ed), Exploring approaches to research in the animal sciences in Vietnam: A workshop held in city of Hue, Vietnam, 31 July–3 August 1995. *ACIAR Proceedings* 68:46–49. ACIAR (Australian Centre of International Agricultural Research), Canberra, Australia.
- Vang N.D and Thuy L.T. 1999. *Livestock production in Vietnam from 1990 to 1998*. Report of the workshop on the implications of the Asian economic crisis for the livestock industry, held in Bangkok, Thailand. 275 pp.

Smallholder dairy production systems in East and South-East Asia: Expanding importance, environmental impacts and opportunities for improvements

C. Devendra

International Livestock Research Institute (ILRI)
P.O. Box 30709, Nairobi, Kenya

Abstract

Smallholder dairy production systems in East and South-East Asia are discussed with reference to type of systems, characteristics, potential importance, environmental impacts and opportunities for improvement. Key features of the industry include: rapid expansion and increasing consumption of milk; a means to generate ready income; significant benefits to child nutrition; effects on poverty reduction and stability of households; strong market orientation; and promotion of linkages between rural and urban areas. Three types of dairy systems are identified and described: smallholder systems, smallholder co-operative dairy production systems and intensive dairy production systems. The first two systems are by far the most important and are associated with increasing intensification and specialisation. Dairy production mainly involves the use of Holstein-Friesian crossbred cattle. The expansion and intensification of smallholder dairy production is fuelled by an increased demand for milk, but is associated with problems of milk handling and distribution, hygiene and environmental pollution. The major constraints to production are, *inter alia*: limited choice of species; poor breeding programmes and unavailability of animals; lack of feed resources and inefficient feeding systems; poor management of animal manure; poor hygiene and human health hazards; and lack of organised marketing and market outlets. Specific areas for research and development, and opportunities for improved dairy production in the totality of production to consumption systems are identified; suggestions for performance indicators in such systems are included. A holistic focus involving interdisciplinary research and integrated natural resource management is necessary in shared partnerships between farmers and scientists to demonstrate increased productivity and sustainable dairy production systems.

Introduction

Smallholder dairy production in East and South-East Asia is a particularly important avenue of food production from cattle, buffalo and goats. Unlike South Asia where there is

a strong tradition of milk consumption, in East and South-East Asia, dairy production is expanding in importance and milk is consumed increasingly widely by the younger generation. These aspects and potential future impact are associated with a number of key features, which *inter alia* include:

- Rapid expansion, increasing consumption and strong market demand
- Recognition of the advances and impacts made in India through Operation Flood
- A means to generate ready income, build assets and socio-economic benefits
- Significant benefits to child nutrition
- Impact on poverty reduction and household stability and
- Potential for increasing the current level of production.

Among ruminant production systems, dairy production systems are by far the most dynamic. Dairying systems are influenced greatly by the reality and instant benefits of daily milk production, immediate sales to urban markets, linkages between rural and peri-urban areas, and public and private sector participation. The daily movement of one or more forms of transport to collect milk produced on the farm, delivery to milk collection centres for immediate processing, subsequent delivery to urban areas, the concurrent delivery of purchased feeds and drugs, and contact with extension personnel, clearly reflect the dynamic linkages that exist between rural and urban areas, and their development. Many of these issues are interrelated with changes in one factor invariably affecting the other; when these issues are viewed in holistic terms, the dairy sector provides major development potential.

It is not surprising therefore that all governments in the region, without exception, have given particular attention to the promotion of dairy development. China, for example, has placed major emphasis on the dairy industry while it also stabilises the production of pork and poultry (Zhang 2001). The situation in China is interesting and is reflected in the following facts:

- Decentralisation of milk production from government-controlled state farms to smallholder units since the early 1980s
- Thrice a day milking to maximise milk production and sales
- Priority to dairy development because of its impact on child nutrition and school milk programmes
- Promotion of dairy development through microcredit schemes
- Evidence of a 100% return rate to credit schemes on account of daily income generation through the sale of milk
- Together, these aspects have fuelled rapid expansion of the industry with some replacement of pig production by dairy activities.

In tandem with this development, most governments in the region have therefore made direct interventions in various forms to include policy elements and also subsidies. Additionally, the industry as a whole has strong production and post-production components, and also involves widespread participation of the private sector. In view of the rapid expansion and variable levels of development in East and South-East Asia, the opportunities for improved dairying and development of more sustainable production systems are considerable. Major challenges exist therefore in examining and improving the prevailing dairy production systems, current levels of production and post-production systems. The task is compelling at a time when

available supplies of milk are unable to meet either the current or the projected future demand for milk, bringing into question the efficiency of individual animal production systems in Asia (Devendra 2001).

This paper provides an overview of the types and characteristics of smallholder dairy production systems in East and South-East Asia, and current supplies and projected demand for milk. It discusses policy and institutional issues, marketing, environmental impacts, and constraints and opportunities, and alludes to major research and development issues that will need to be addressed to sustain and expand smallholder dairying in the future.

Current production and projected consumption

It is important to keep in perspective the current production levels and projected future consumption patterns. Table 1 illustrates the levels of milk production and consumption during 1992–94. These data suggest that per capita milk production was inadequate to meet per capita milk consumption in China and South-East Asia, whereas in other East Asian countries, milk production was surplus to per capita consumption. In South-East Asia, per capita milk consumption was substantially higher than production in 1993. The annual growth rate of production was negative in China and relatively small (1–2%) in South-East Asia.

Table 1. *Milk production and consumption, 1992–94.*

Region	Productivity (kg)	Annual growth rate of production* (%)	Per capita production** (kg)	Per capita consumption** (kg)
China	1530	–1.6	6	7
Other East Asia ⁺	1983	5.1	30	16
South-East Asia	628	1.2	3	11
India	973	2.4	66	58
Other South Asia	538	5.1	62	58

* For 1982–94.

** For 1993.

⁺ Includes Hong Kong, Macau, Mongolia, North and South Korea.

Source: adapted from Delgado et al. (1999).

Table 2 presents data relating to projected milk production and consumption up to the year 2020; data were adapted from Delgado et al. (1999). Both annual growth rates of production and consumption are projected to increase in the future. More importantly, a comparison of per capita production and per capita consumption levels, as well as total production and consumption in China, other East Asian countries and South-East Asia, indicated that only in the latter subregion would supplies be unable to meet consumption requirements. The percentage increase in per capita consumption of milk between 1993 and 2020 indicates increases of 71.4, 25.0 and 45.5% in China, other East Asian countries and South-East Asia, respectively. Data in Table 2 also indicate the level of adequacy in the three subregions. Although by 2020, self-sufficiency will be achieved with surpluses in China and other East Asian countries, the pathway to achieve this will call for significant

Table 2. Projected milk production and consumption, 1993–2020.

Region	Annual growth of total production (%)	Annual growth of total consumption (%)	Per capita production in 2020 (kg)	Per capita consumption in 2020 (kg)	Level of sufficiency	Increase in per capita consumption by 2020 over the level in 1993 (%)
China	3.2	2.8	13	12	Adequate	71.4
Other East Asia ⁺	3.9	1.7	29	20	Adequate	25.0
South-East Asia	2.9	2.7	5	16	Inadequate	45.5
India	1.6	4.3	135	125	Adequate	115.5
Other South Asia	3.1	3.4	92	82	Adequate	41.4

⁺ Includes Hong Kong, Macau, Mongolia, North and South Korea.

Source: adapted from Delgado et al. (1999).

expansion and improved efficiency of production, and in particular, improvements to all the factors affecting production. Conversely, South-East Asia will not be self-sufficient in milk production and will continue to be reliant on imports of milk at high cost. For comparative reasons, in both Tables 1 and 2, data are included to show the trends in India and other South Asian countries.

The data in Tables 1 and 2 indicate that in both China and South-East Asia, major opportunities exist to address improved dairy production, not only in terms of increasing individual animal performance in efficient production systems, but also by improving other factors such as post-production systems and marketing, which are associated with organised dairy production.

Implications of increased demand

The projected need for more foods of animal origin in Asia has a number of demand-driven consequences, which also need to be addressed. These include *inter alia*:

- Stress on the management of natural resources
- Emphasis on increased productivity per animal
- Improved efficiency in feed resource use
- Intensification of animal production systems
- Increased concentration of animals in smallholder areas
- Increased disease risks, pollution and human health issues and
- Urbanisation associated with increased consumption of meat and milk.

Types and characteristics of smallholder dairy production systems

Three types of smallholder dairy production systems exist:

Smallholder systems

Ownership of between 2 and 15 animals characterises this system, in which milk production is a major component of farm income. Either buffalo or cattle are kept in essentially mixed systems where annual cropping is common; in addition, pigs and chicken are also reared. Good market opportunities are important determinants and this system tends to be found mainly in peri-urban areas. Milk production contributes about 35–65% of total farm income in several countries in Asia. Occasionally, dairy goats are also used in these systems. The dairy animals are either tethered or stall-fed. Some of the milk produced is used for home consumption, but most is sold directly by farmers or through middlemen who transport the milk to urban areas or processing units. Most of the systems are of a subsistence nature. The resource-poor situations of the smallholders have prevented intensification and specialisation, mainly because of a lack of access to services and resources. On the other hand, where land is not limiting, and access to credit, resources and market opportunities exist, smallholders have tended to expand their herds and have increased milk production. Some farmers process condensed milk: 2.2 litres of fresh milk and 450 g of white sugar are used to produce 1 kg of condensed milk which is then sold to coffee shops and factories. In Vietnam, income from the sale of condensed milk is higher than that from selling fresh milk (Cuong et al. 1992). An important feature in this category is informal milk marketing.

One important characteristic of these smallholder dairy production systems is their rapid expansion in smallholder areas, driven essentially by the urban demand and the opportunities to generate income. Consequently, there has been increased smallholder participation in this enterprise and, with it, expansion in the geographical areas that constitute smallholder limits. Good examples of this are Bangkok and Khon Kaen in Thailand, Ho Chi Min City in South Vietnam and Beijing in China. With Ho Chi Min City, for example, smallholder dairying operations involved a radius of about 60 km around the city in the mid-1980s, but have now expanded to over twice this radius.

Smallholder co-operative dairy production systems

These systems are more advanced and mature, in comparison with the first category of systems. They are formed from a natural aggregation and concentration of smallholder dairy units. Their formation is due to government and/or private sector intervention driven by an apparent necessity and varies from country to country. In India, for example, formation of these co-operatives occurred because of both types of intervention; in contrast, in the countries of South-East Asia, co-operatives are the result of direct government intervention. Due to differences in the types of intervention, the size of co-operatives varies and larger co-operatives are emerging, involving anything from 40–250 smallholders. This kind of commercial smallholder dairying is growing rapidly around major cities. The co-operatives are focal points, which provide services to farmers as well as promoting the organised collection, handling and sale of milk to consumers. Co-operatives enable the smallholders to improve their competitive edge in open-market

economies. Good examples of this system are found in several areas, especially in proximity to major cities, as found in Thailand, the Philippines, Vietnam and China. In the Philippines, for example, specific government intervention includes the promotion of dairy co-operatives for groups of farmers producing milk from swamp × Murrah cross-breds and also from Holstein–Friesian cattle crossbreds.

Two examples of this category are instructive. The first is in the Nang Pho Dairy Co-operative, Ratchaburi Province, about 100 km south of Bangkok in Thailand. A survey of 43 farms indicated that 95% of them were <0.32 ha in area (Skunmun et al. 1999). A more recent survey of 10 farms in the same area gave a range of 0.02–0.48 ha. Most farms had between 0.32–1.12 ha of additional land, mainly rented or owned to grow fodder. The majority of cattle sheds were attached to the house or were between two and five metres from the house. The net cash return (as a percentage of total income) was 68.9% and the average cost of milk production was US\$ 0.22/kg (Skunmun and Chantalakhana 2000). The authors suggested that attention to the following areas could further reduce the cost of production: feeds, reduction of the number of herd replacements and maintenance of production records. It is interesting to note that from dairy operations alone, only three farms made profits, emphasising the importance of crop–animal systems and also the scale of operations.

Another example, on a much larger scale, is the Landhi Cattle Colony in Karachi, Pakistan, which has about 220 thousand animals in a 5-km radius. About 95% of these animals are buffalo and 5% are cattle of which half are crossbreds. It began originally as a mechanism to concentrate animals outside the city limits, but has grown into a large and complex enterprise within the city. Pregnant animals are purchased from rural areas and exclusively stall-fed on cereal straws, green fodders and concentrates. Female calves produced are sold, except for a small number that are kept as replacements for breeding. Male calves are fattened for four months and slaughtered. At the end of their lactation, the original females are also slaughtered. Indiscriminate growth of the colony, without regulatory and policy interventions, has resulted in a serious situation, which is made more complex by very poor hygiene, health hazards such as contaminated ground water, ever increasing quantities of unused manure and other impacts on the environment.

Intensive dairy production systems

The third category of smallholder dairying is intensive production systems. The expansion of smallholder dairy production, increasing experience and open-market opportunities have led to the development of more intensive and specialised production systems. This trend is reflected in Table 3, which shows that small and marginal farms, and medium and large farms contributed 42 and 35% of the volume of total milk produced.

These relatively large, intensive and increasingly specialised systems are characterised by the following features:

- Relatively large numbers of animals, about 60–250/per farm, involving both buffalo and cattle

Table 3. Distribution of dairy animals and milk production among landless, small/marginal and medium/large-scale producers in India.

Type of farmers	% of farmers	% of dairy animals	% of milk production
Landless	26	22	23
Small and marginal	49	42	42
Medium and large	25	36	35

Source: Jong (1996).

- Application of improved stall-feeding systems using purchased chopped straws, green fodder and concentrates at high cost
- Use of capital intensive infrastructure e.g. dairy equipment and other inputs and
- Existence of well-organised marketing systems and access to markets.

Within smallholder dairy systems, however, intensive dairy production units are least in number and are usually in the hands of more knowledgeable dairy farmers, who also have access to credit facilities and services.

Considered together, the three types of smallholder dairy production systems have the following features:

- They occur commonly in peri-urban areas and are distinctly market-oriented.
- They are a component of integrated crop-animal production systems.
- Purebred Holstein-Friesian cattle, their various crossbreds including Holstein-Sahiwal crossbreds are used widely. In the Philippines and the south-western parts of China, in the Guangxi and Yunnan Provinces, swamp $\times$ river buffalo crossbreds are also used for milk production.
- The level of exotic blood is highly variable and ranges from about 25 to 75% on farm. Crossbreeding programmes have generally not been successful, including the production and use of stable crossbreds.
- Short-term productivity gains from use of crossbreds are considered to be more important, as they bring immediate benefits, than the rational use of indigenous breeds and maximisation of their production through selection.
- The choice of buffalo and cattle for milk production is dependent on location, as well as availability of animals.
- Dairy goats are used marginally for milk production, especially in China but also in Vietnam and Indonesia, where they supply precious animal proteins for household nutrition.
- There seems to be little or no data comparing the efficiencies of milk production between indigenous buffalo and cattle, cattle crossbreds and goats in smallholder systems.
- In socio-economic terms, dairying provides an attractive means to generate daily income. This has important implications on human nutrition, participation of women, household stability, repayment of loans and self-reliance.
- Expanded and demand-driven dairy production has led to intensification and specialisation of smallholder production systems, with emerging problems relating to milk handling, hygiene and environmental pollution, and to human health hazards.
- Intensification has limited the ability of smallholders to compete with larger enterprises because of smallholders inadequate access to subsidies, which benefit

larger farmers. Removal of these subsidies provides better opportunities for the smallholders; and

- Women and children are heavily involved in the milking and management of dairy animals.

Constraints to production

There are several constraints to production, which include *inter alia*:

1. Choice of species and breeds within species, and availability of animals for dairying. The latter accentuates dependence on the importation of animals and germplasm
2. Poor breeding programmes and lack of availability of stable crossbreds
3. Lack of feed resources and inefficient feeding systems with associated high costs of milk production
4. Limited management of animal manure and urine
5. Poor hygiene and human health hazards
6. Lack of organised marketing and market outlets.

It is not intended to discuss these constraints to production in detail, given the focus on these issues in the country case studies, but it is relevant to highlight some of the more important issues because it is necessary to overcome emerging problems.

Choice and availability of animals

Buffalo and cattle are used for dairying with complementary advantages, but a more serious problem is the availability of animals. Often good quality Holstein–Friesian crossbreds are not available or their cost prohibits use by small farmers, unless the animals are made available by government schemes. Several countries in the region have therefore embarked on massive importations of germplasm in the form of live animals, and frozen semen and ova from various industrialised countries. Nevertheless, sustainable breeding programmes are necessary to ensure the continuing availability of dairy animals. Many of the larger farms attempt to produce their own crossbreds mainly through artificial insemination (AI), but not without problems associated with the application and associated costs.

Feed resources and improved feeding systems

Feeding and nutrition have repeatedly been highlighted as the major constraints in animal production systems globally (ILRI 1995) and subregionally in South-East Asia (Devendra et al. 1997). Improved animal nutrition in dairy production is therefore a major consideration.

Of the non-genetic factors affecting production, this is especially important since cost of feeding accounts for about 40–60% of the total cost of milk production in intensive systems. In smallholder systems, inadequate land and size of operation are further constraints on production. In the cooler temperate Beijing area of China, dairy production has expanded significantly through the integration of triticale into the cropping system, as a

replacement for barley during the winter–spring period. This has involved a shift from rice cropping alone to rice–triticale double cropping, resulting in higher grain and forage yields, increased silage production, improved composition of milk from dairy cows, increased economic benefits from grain–forage cropping systems compared with grain–grain cropping, and dairy production (Wang et al. 1993).

It is important, therefore, that improved feeding systems and improved efficiency of feed use are viewed clearly in a farming systems perspective. In this context, the following prerequisites are considered important:

- Knowledge of availability of all feeds (forages, crop residues, agro-industrial by-products and non-conventional feed resources) throughout the year
- Synchronisation of feed availability to requirement by animal species
- Assessment of the extent of feed surpluses and deficits
- Development of strategies to cope with the shortfalls
- Increased feed production (e.g. production of multipurpose tree legumes and development of food–feed systems)
- Justification for purchased concentrates
- Priorities for use of crop residues
- Development of feed conservation measures and,
- Strategic supplementation for milk production, especially during critical dry seasons.

In many situations, long dry periods of between four and seven months, such as in the eastern islands of Indonesia, north-east Thailand, central Vietnam, many parts of China and countries in South Asia, result in inadequate availability of feeds. Furthermore, feeds that are available at this time are of poor quality, which further exacerbates animal productivity. In such environments, it is therefore essential that all avenues for feed production be considered with the main objective being to ensure the maximum possible availability of animal feeds. In this context, the development of a food–feed system is an important strategy. The system is one that maintains, if not increases the yield of the food crop, sustains soil fertility and provides dietary nutrients for the animals. The subject, together with various case studies, has recently been reviewed (Devendra et al. 2001).

These prerequisites need to be considered in holistic terms to promote efficiency in feed resource use and, associated with this, increased productivity of the animals. In the absence of such a holistic focus, research and development efforts concerning feed resource use will continue to be of a ‘piecemeal’ approach, mainly component technology interventions with variable success rates.

Improved animal health care

Improved animal health care is also essential as it imposes a serious source of loss. Diseases often rank, with the availability of feed resources and nutrition, as the major constraints to production. A variety of diseases (e.g. mastitis and brucellosis) affect the calf and milking cow. Losses due to disease are variable across countries and are dictated largely by the level of management, knowledge base, access to drugs and services, and the efficiency of extension

services. Losses are naturally greater in the high number of newer farms and much less in the more established farms where efficient preventive health care and treatment can overcome the disease problems.

In many parts of South-East Asia, proliferation of new dairy farms is challenged by disease problems, often through poor hygiene as a source of loss. Government and private sector interventions have been concerned largely with reducing the losses through provision of appropriate medication. In peri-urban areas, an emerging problem that will need increasing attention is the hazard to human health associated with intensive and stall-fed dairy production.

Management of animal manure

Animal manure produced on farm, represents a major health hazard. The problem increases with increasing herd size and intensification, and is associated with a number of issues including: quantity and quality of manure and urine produced; inadequate removal, frequency of removal and storage in proximity to where the excreta is produced; labour availability; methods used for manual disposal; value and use of dung; and linkages to rural areas. In most situations, the systems for manure management and use are very haphazard and present serious problems to both animals and humans. The human health hazards in intensive smallholder systems are much more serious than initially realised, because of inadequate supervisory and sanitary measures, without which the situation can worsen. This was highlighted in an investigation on the effects of dairy wastes on water and soil resources in smallholder dairy systems in Thailand (Chantalakhana et al. 1998). Results showed that:

- Waste water from older established dairy barns and crowded farms constituted a great risk to the environment because of the high COD (chemical oxygen demand), BOD (biological oxygen demand) and presence of coliform organisms
- Both wastewater and leaching, from piled up manure and manure drying on bare surfaces were implicated in ground water contamination
- Waste water from dairy farms, well water and public waterways in the locality all provided evidence of a cumulative problem associated with a lack of effective waste management practices, therefore constituting critical sites for monitoring and
- Monitoring of wastewater could be based on relatively simple tests that correlate broadly with more sophisticated chemical and biological tests.

Organised marketing and market outlets

The high demand for milk and milk products necessitates an organised link with production. Availabilities of a market drive, organised marketing and access to market outlets are therefore important prerequisites for the distribution and sale of milk produced. In the absence of these, prospects for promotion of efficient milk production will always be vulnerable and a risk.

Environmental impacts

One important consequence of expanding dairy production, intensification and specialisation of traditional systems is the need for efficient manure and urine waste disposal systems. Large concentrations of animals, poor infrastructure, the movement of animals, poor husbandry and unhygienic milk handling systems are sources of major disease outbreaks and threats to human health. In general, efficient waste disposal systems are not in place and are often non-existent; in consequence, dairy wastes present a major health hazard for humans. The situation becomes more serious in peri-urban areas and is compounded by poor infrastructure, and lack of regulations, monitoring and enforcement. Zoonotic diseases such as tuberculosis and brucellosis can be passed to humans. Depending on the proximity of the dairy wastes to cities, these and other diseases may spread to human populations. Additionally, concentrations of animals and their wastes produce various gases (carbon dioxide, methane and nitrous oxide), which have detrimental affects on the atmosphere and global warming.

Nevertheless, the presence of efficient collection and disposal systems for manure and urine can promote their beneficial use. When returned to the field to fertilise crops and fodder, dairy wastes can contribute to the increased availability of feeds for dairy animals. Such nutrient transactions also promote linkages between rural and peri-urban areas.

Opportunities for improvement

Feed resources and improved feeding systems

Improved feeding systems that ensure optimum performance, and efficient and low cost milk production need to consider the following issues:

- Feed availability and feeding systems
- Seasonality of production
- Basal roughage resources
- Strategic and effective use of supplements
- Access to low cost and potentially important feeds and
- Extent of use of feed resources from the farm.

Associated with the above, it is pertinent to note four important points that are relevant to feeds and feeding:

- Ruminant production systems are unlikely to change in the foreseeable future. Proposed new systems and returns from them would therefore have to be demonstrably superior and supported by massive inputs of capital and other resources (Mahadevan and Devendra 1986; Devendra 1989). However, there will be increasing and predictable intensification and a shift within systems. This situation is increasingly likely with decreasing availability of arable land. The principal aim should therefore be to address improved feeding and nutrition, in which the objective is maximum use of the available

feed resources, notably crop residues and low quality roughage, and various leguminous forages as supplements;

- During the recent Asian economic crisis, the smallholder dairy farms that collapsed were those which depended on the use of imported feeds, notably maize and supplements
- Good profits from dairy production systems accrue from systems that use the maximum possible amount of indigenous materials, especially feeds. An approach that promotes and maximises such use and self-reliance is therefore essential and
- The quality and quantity of manure and urine produced depend on the type and quantity of feeds used. Improvement in intake, digestibility and output of manure can be ensured by feeding good quality green forages and crop residues, as well as by strategic use of protein supplements.

Year-round feeding systems

A parallel strategy concerning opportunities to increase feed availability is the objective of developing sustainable year-round feeding systems. In this quest, maximising feed production is essential. The following approaches are feasible:

1. Intercropping with cereal crops
2. Relay cropping
3. Food-feed cropping systems
4. Intensive use of available crop residues
5. Forage production on rice bunds
6. Alley cropping and
7. Three-strata forage systems in dry land areas.

Priorities for the use of crop residues

Given the range of crop residues available, priorities for their use are essential in prevailing animal production systems. These priorities will depend on the quantities available, relative nutritive values, the potential value to individual ruminants species, the state of knowledge regarding their use to enhance animal production, and the potential for technology transfer and application. Table 4 summarises the three categories of crop residues, their nutrient potential and the animal species that make the best use of them. These aspects have been reviewed elsewhere (Devendra 1997 and 2000).

Management of animal manure and nutrient recycling

Crop production in developing countries depends largely on the use of organic manure from animals. Inorganic fertilisers are often too expensive or unavailable to farmers who wish to use them; this emphasises clearly the importance of animals, the value of crop-animal integration and interactions, and the contribution of animal manure to sustainable

Table 4. Factors affecting crop residue use by animals in Asia.

Type of residue	Nutrient potential	Species (product/service)*
Good quality (e.g. oilseed cakes and meals, cassava leaves)	High-protein, high-energy supplement, minerals	Pigs, chicken, ducks, ruminants (meat, milk)
Medium quality (e.g. coconut cake, palm kernel, sweet potato vines)	Medium-protein	Pigs, chicken, ruminants (meat, milk)
Low quality (e.g. cereal straws, palm press fibre, stovers)	Low-protein, very fibrous, bulky	Ruminants (meat, draft), camels, donkeys, horses (draft)

* Ruminants refer to buffalo, cattle, goats and sheep.

Source: Devendra (1987).

agriculture. Organic materials have been used, widely and beneficially, to improve soil fertility and crop yields. In north-east Thailand, for example, where 80% of the soils are of the sandy type, animal dung continues to be very valuable for crop production (Supapoj et al. 1998). The use of animal dung in crop cultivation serves directly to supply the soil with nitrogen, phosphorous and potassium. The dung improves the physical, chemical and biological properties of soil, including improvements in soil structure and nutrient availability, and infiltration and water retention capacity, and stimulation of nitrogen fixing soil bacteria (Turner 1995). Additionally, humus in the dung improves soil pH value and therefore, phosphorous release. For reasons of cost, farmers often use a combination of inorganic fertilisers and organic materials to improve soil organic matter and soil fertility.

A considerable quantity of under-utilised and inefficiently used animal manure and urine is available in smallholder dairy units; improvement of its use to increase agricultural productivity represents a major challenge.

Opportunities for research and development

The improvement of smallholder and market-oriented smallholder dairy production in smallholder and rain-fed mixed farming systems offers considerable research and development opportunities. Many of the improvements in dairy production through crossbreeding and through various interventions in animal nutrition and health have been supply-driven, without farmer participation and conducted on experimental stations. Component technologies that have been validated on farm have seldom been adopted. A lack of farming systems perspective has meant that important interactions between animal nutrition, genotype and disease, and between animal and crop production, have not been considered together. Moreover, socio-economic and policy factors that influence the dynamics of the systems have not been addressed.

Specific areas

Some specific areas, which merit research and development attention, include *inter alia*:

- Recognition that dairy activities involve the totality of production-to-consumption systems
- Better understanding of the socio-economic factors influencing the dynamics of the systems

- The effects of specific improvements and components of the systems with maximum potential for intervention
- Synchronisation of feed availability and quality with the physiological and productive needs of different species (buffalo, cattle) and genotypes (unimproved, improved) of dairy animals throughout the year
- Genotype $\times$ nutrition $\times$ disease interactions and the effects of animal health interventions;
- The effects of improved nutrient flows and recycling on crop yield and crop residue quality in mixed farming systems and
- Development of strategies for more efficient feeding of animals and nutrient recycling through the introduction of legumes into cropping patterns.

Addressing these and other issues calls for a more holistic focus involving interdisciplinary approaches, which together can affect potential improvements in a cost-effective manner.

Expanding dairy production into rain-fed areas and promotion of rural development

Dairy production, more than any other animal production system, has demonstrated spectacular growth in the linkages between rural and urban areas. The daily production, processing and consumption of milk have promoted these linkages in many countries through a network of interrelated activities. Transport and transport costs act as a constant link between rural and urban areas and integrate both these areas. The daily shipment of milk, purchased feeds and supplements, semen for AI and drugs are examples that are concerned with this process. These movements and activities increase with decreasing proximity to markets in urban areas. Rural development is encouraged further by the presence of co-operatives that provide necessary services and ensure returns to farmers.

An additional potential opportunity for further expansion concerns the use of rain-fed areas. Currently, smallholder dairy production is mainly found in the irrigated areas where land is already overused; however, potential opportunities exist for expansion of smallholder operations, especially in rain-fed lowland areas where soil moisture and crop production are relatively high. Justification for this approach, driven by the need for more food of animal origin, is associated with the following considerations in Asia:

- Available rain-fed area account for about 82% of the land area in Asia. They are found mainly in the arid/semi-arid zones but also in the subhumid zones (TAC 1992 and 1994)
- The rain-fed areas, in the lowlands and uplands, contain 51–55% of the total population of cattle and small ruminants in Asia
- Within the 86% of the total human population of Asia living in these areas, poverty and the ‘poorest of the poor’ are found
- Natural resource degradation is intense and
- Major challenges exist for integrated natural resource management, poverty alleviation and improved food security.

Importantly, such expansion and the associated need for more productive animals, feed production and nutrient transfer, and their collective use in smallholder dairy systems provide major opportunities to link rural and smallholder areas, which in particular will benefit resource-poor farmers. Integrated management of natural resources will be prominent and could address FAO's concept of area-wide integration, in which markets can be linked to nutrient surplus and nutrient deficit areas. However, appropriate policies and infrastructure may be needed to ensure the efficiency of this process. The promotion of linkages between rural and smallholder areas in the use of production inputs, intensification, nutrient flows and marketing of produce needs to be pursued to ensure that the activities are compatible with reduced pollution, and minimal disease risks and human health issues.

An example of how a feed in rural areas can be processed and fed to animals, and the manure produced can be processed for crop cultivation, thus linking rural and smallholder areas, concerns a plant in Jakenan, Solo in Indonesia. Rice straw is bought from farmers at 30 thousand rupiahs (Rp) per truck (US\$ 1 = Rp 9511, March 2001), subjected to microbial treatment and then fed to animals at the rate of about 3.5 kg of straw plus 3 kg of groundnut straw/head per day in stall-feeding systems. The production system is in stages, from calves to adults. The animals used are Holstein-Friesian crossbreeds, which show body weight gains of 0.7–0.8 kg (live weight) per day, and dairy cattle. The former produce about 15–25 kg of dung/head per day; about a thousand kg of processed manure (PM) is produced each month. The dung produced is removed from the barns every fortnight. The wet dung is dried at 60°C, stored and bagged. This process destroys all the residual toxins, weed seeds, and micro-organisms and renders a high quality product. This is sold at 300 Rp/bag. About 250 t of PM is sold every month. The chemical composition of PM is 80% organic matter; 1.5% total N; 1.6% P₂O₅; 1.8% K₂O; >2.8% CaO; and >0.5% Mg. The product has a pH value of 5.5–7.5.

The PM has been applied not only to rice but also to vegetables, sugarcane, tobacco and potatoes. The advantages indicated include:

- Reduced cost of crop production by about 10%
- Increased rice yields by about 51% (equivalent to 2.8 t/ha). On farmers fields, the increased yields have been about 2.2 t/ha
- Similar increased yields recorded for tobacco and vegetables.

Furthermore, attempts have been made to mix the PM with poultry manure in a 3:1 ratio and to use PM in integrated systems involving dairy-fish operations. In these integrated systems, the returns as a percentage of total income are 40% from PM, 30% from dairying, 20% from sale of calves and 10% from sale of fish. This scheme is impressive and has been expanded and linked to involve several parts of Central, East and West Java, Sulawesi and Riau, in which farmers have benefited significantly in terms of increased income from the use of PM.

Sustainability

In general, smallholder systems are constrained by numerous problems including access to services, credit and resources, so much so that strategies to cope with these problems, such as

diversification of resource use, represent the major objectives in subsistence systems. Over time, however, specialisation, intensification and increased income enable expansion of smallholder operations, especially among the more innovative and progressive farmers. Whether or not the systems are sustainable will depend largely on a holistic view of the enterprise, the efficiency of natural resource management, strategic use of production resources and appropriate technology that addresses the totality of production-to-consumption systems, which is highly relevant to market-oriented smallholder dairy production. It is essential that such strategies also consider long-term environmental consequences. Defined in this way, sustainable smallholder dairy production systems are those that can demonstrate:

- Efficiency in the management of natural resources and beneficial effects through crop-animal interactions (e.g. nutrient recycling)
- No evidence of resource degradation (e.g. maintenance of soil fertility)
- Promotion of maximum use of indigenous materials and a high degree of self-reliance
- Maximisation of the use of available labour and creation of employment opportunities and
- Improved livelihoods for the rural poor.

Performance indicators

The multidisciplinary approaches, coupled with integrated natural resource management need to be identified to ensure sustainable agriculture and environmental protection. This is a complex and by no means easy task, but research and development programmes need to be sensitive to these aspects in their intent and scope, to be coupled to methodologies for efficient use of resources, to comprise appropriate technology interventions and to increase dairy production. Finally, it is important to stress in the search for the realisation of these objectives, that the research and development activities are a shared partnership between farmers and scientists in which the farmers are the target beneficiaries; the ultimate benefits need to be translated into improved livelihoods for these resource-poor farmers.

Performance indicators, hand in hand with economic analysis, largely reflect the success of the programme. Table 5 presents suggestions of some performance indicators appropriate to developing country situations, with no claims to being exhaustive. Possible performance indicators are summarised in three categories. The efficiency and management of integrated natural resources will largely determine animal performance and productivity, profitability and impact on household stability, improved livelihoods and rural development. Thus, for example, excessive use of purchased feeds and concentrates will result in high feed cost as percentage of the total production cost, implying in practice that maximum use needs to be made of all available feed ingredients as well as home mixing of these to produce desirable low cost, but effective concentrates. Likewise, improved nutrient balance and soil fertility will stimulate crop yields with increased production of feeds for animals.

Table 5. Some performance indicators are appropriate to developing country situations.

Type	Indicator
1. Natural resources	• Increased soil fertility • Reduced soil erosion • Feed cost as percentage of total costs • Production per unit of water • Nutrient balance • Positive crop–animal interactions • Level of pollution • Sustainability
2. Profitability	• Returns as a percentage of total cost of production • Return on assets • Change in net worth • Cash surplus
3. Households	• Number of children going to school • Malnutrition/human health • Extent of off-farm work • Stability of co-operation/revolving funds

Conclusions

Smallholder dairy production systems are expanding avenues of food production from animals in developing countries. The potential to sustain this expansion is enormous, but necessitates addressing several major constraints and issues that affect the totality of production to consumption systems, as well as the environment. The considerable research and development opportunities that exist provide major challenges for demonstration of: increased productivity from dairy cattle; efficient management of natural resources; improved livelihoods for poor farmers; and the development of sustainable production systems that are consistent with environmental integrity.

References

- Chantalakhana C., Korpraditsakul R., Skunmun P. and Poondusit T. 1998. Environmental conditions and resource management in smallholder dairy farm in Thailand. II. Effects of dairy wastes on water and soil. *Asian–Australasian Journal of Animal Science* 12:220–225.
- Cuong L.X., Le V.L. and Huynh D. 1992. Feeding systems and potential for improving dairy cattle in Vietnam. *Proceedings of the 6th Asian–Australasian Animal Science Congress* 11:259–270.
- Delgado C., Rosegrant M., Steinfeld H., Ehui S. and Courbois C. 1999. *Livestock to 2020: The next food revolution*. Food, Agriculture, and the Environment Discussion Paper 28. IFPRI (International Food Policy Research Institute), Washington, DC, USA; FAO (Food and Agricultural Organization of the United Nations), Rome, Italy; and ILRI (International Livestock Research Institute), Nairobi, Kenya. 72 pp.
- Devendra C. 1987. Expanding the use of crop residues and agro-industrial by-products in Asia and the Pacific. *Proceedings of the feed resources in Asia and the Pacific Asian Productivity Organisation*, Tokyo, Japan. pp. 106–141.

- Devendra C. 1989. Ruminant production systems in developing countries: Resource utilisation. In: *Feeding strategies for improved productivity of ruminant livestock in developing countries*. IAEA (International Atomic Energy Agency), Vienna, Austria. pp. 5–30.
- Devendra C. 1997. Crop residues for feeding animals in Asia: Technology assessment and adoption. In: Renard C. (ed), *Crop residues in sustainable crop/livestock farming systems*. CAB (Commonwealth Agricultural Bureau) International, Wallingford, UK. pp. 241–268.
- Devendra C. 2000. Strategies for improved feed utilisation and ruminant production systems in the Asian region. *Asian–Australasian Journal of Animal Science* 13 (Supplement July 2000, B):51–58.
- Devendra C. 2001. Productivity enhancement and animal production systems in Asia. *Proceedings of the Asian Agriculture Congress held at Manila, Philippines* (In press).
- Devendra C., Sevilla C. and Pezo D. 2001. Food–feed systems in Asia. *Asian–Australasian Journal of Animal Science* 14:1003–1113.
- Devendra C., Thomas D., Jabbar M.A. and Kudo H. 1997. *Improvement of livestock production in rain-fed agro-ecological zones of South-East Asia*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 107 pp.
- ILRI (International Livestock Research Institute). 1995. Global agenda for livestock research. In: Gardiner P.R. and Devendra C. (eds), *Proceedings of a consultation*. ILRI, Nairobi, Kenya. 118 pp.
- de Jong R. 1996. *Dairy stock development and milk production with smallholders*. PhD thesis, Wageningen Agricultural University, Wageningen, The Netherlands. 308 pp.
- Mahadevan P. and Devendra C. 1986. Present and projected ruminant production systems of South-East Asia and the South Pacific. Forages in South-East Asia and the Pacific. *ACIAR Proceedings* 12:1–6. ACIAR (Australian Center for International Agricultural Research), Canberra, Australia.
- Mathur B.N. 2000. Problems and challenges confronting the dairy industry in India. *Asian–Australasian Journal of Animal Science* 13(Supplement July 2000, A):447–452.
- Skunmun P. and Chantalakhana C. 2000. An economic analysis of smallholder dairy farms in Thailand. *Asian–Australasian Journal of Animal Science* 13 (Supplement July, 2000 A):50–53.
- Skunmun P., Boonsom S., Kaewjuwan S. and Chantalakhana C. 1999. Environmental conditions and resource management in smallholder dairy farms in Thailand: Production systems and management of resources. *Asian–Australasian Journal of Animal Science* 12:215–219.
- Supapoj N., Nablang K. and Konboon Y. 1999. Using organic material to improve lowland rice. In: Ladha J.K., Wade L., Doberman A., Reichart W., Kirk G.J.D. and Piggin C. (eds), *Rainfed lowland rice: Advances in nutrient management research*. IRRI (International Rice Research Institute), Los Banos, Philippines. pp. 161–168.
- TAC (Technical Advisory Committee). 1992. *Review of CGIAR priorities and strategies. Part I*. TAC Secretariat, FAO (Food and Agricultural Organization of the United Nations), Rome, Italy. 250 pp.
- TAC (Technical Advisory Committee). 1994. *Review of CGIAR priorities and strategies. Part II*. TAC Secretariat, FAO (Food and Agricultural Organization of the United Nations), Rome, Italy. 229 pp.
- Turner M. 1995. The sustainability of rangeland to cropland nutrient transfer in semi-arid West Africa: Ecological and social dimensions neglected in the debate. In: Powell J.M., Fernandez-Rivera S., Williams T.O. and Renard C. (eds), *Livestock and sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa. Volume II. Technical Papers. Proceedings of an international conference held in Addis Ababa, Ethiopia, 22–26 November 1993*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 435–452.

- Wang Z., Guo Y.X., Xu Y.C., Wang L.C., Wang P.G. and Tan Y.F. 1993. Study on the integrated rice-silage triticale farming system. In: Guo Y.X. (ed), *Rice-based crop production structure in China*. Chinese Academy of Agricultural Sciences, Beijing, China. pp. 302-316.
- Zhang C.G. 2001. Dairy industrial policy in China. (Mimeo). Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences, Beijing, China. 10 pp.

Smallholder dairy production and marketing in Kenya

H.G. Muriuki

Ministry of Agriculture and Rural Development
P.O. Box 30028, Nairobi, Kenya

Summary

Kenya has a population of about 29 million people, a land area of about 571 thousand square kilometers and a varied climate stretching from humid in the coastal areas to cool temperate in the interior highlands. Its land productivity potential also varies from high potential, constituting less than 20% of the total land area, to very low potential in dry areas in the north-eastern parts of the country.

Agriculture is the backbone of Kenya's economy, contributing over 25% of the gross domestic product (GDP); it is the lifeline of about 80% of the country's poor and contributes 70% of the national employment.

Kenya has a unique smallholder dairy system, which is the most developed in sub-Saharan Africa with an estimated dairy herd of 3 million head. Most of the dairy cattle are crosses of Friesian-Holstein, Ayrshire, other dairy breeds and local zebus. The smallholder dairy farms are concentrated in the crop-dairy systems of the high productivity potential areas of the country, produce about 60% of total milk production and contribute over 80% of the marketed output.

Dairy marketing in Kenya is mainly of liquid milk where over 80% is sold raw with the participation of itinerant milk traders (hawkers) who control about 28% of marketed milk (Staal et al. 1999), despite a policy that discourages them.

Dairy is important in the livelihoods of many farm households in rural Kenya and in terms of generating incomes and employment, including off-farm employment.

The presence of a large population of dairy cattle, a large and growing human population who include milk as part of their diets and a supportive environment are indications of the opportunities that exist for smallholder dairying in Kenya.

Investment in the national rural infrastructure such as rural access roads, water supply and electricity and economic improvement in the country will allow for increased milk supply and consumption, and will contribute to increased employment.

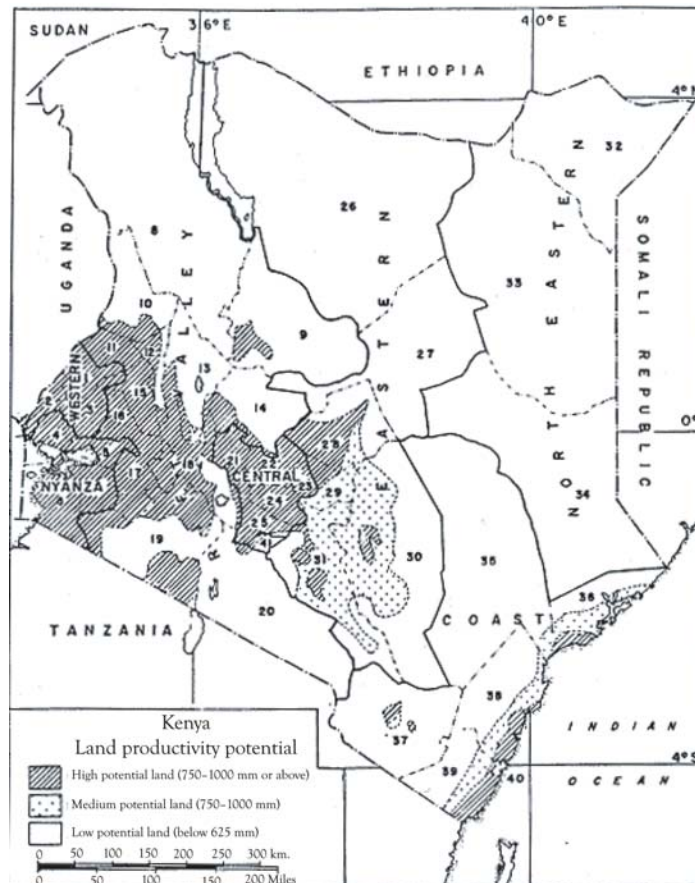
Introduction

Kenya has a total area of 582,646 km², of which 11,230 km² is under water (CBS 1999), and a human population of 28.7 million (CBS 2001). Its climate varies from warm and humid

in the coastal areas to cool temperate in the highlands. The annual rainfall ranges from less than 200 to over 2000 mm in some parts of the highlands.

According to land productivity potential, the country can broadly be divided into three regions (Figure 1):

- High potential areas with an annual rainfall of more than 750 mm, spreading from central Kenya through to the central Rift Valley to western Kenya and the coastal strip.
- Medium potential areas with an annual rainfall of more than 625 mm but less than 750 mm, located in parts of central-eastern Kenya and neighbouring the high potential coastal strip.
- Low potential areas with an annual rainfall of less than 625 mm, stretching from north and north-eastern Kenya to the southern parts bordering Tanzania.



Source: Ominde (1988).

Figure 1. Kenya's land productivity potential.

Kenya's economy is based largely on agriculture, which contributes over 25% of the GDP. Agriculture also provides raw materials for agro-industries; accounting for about 70% of all industries. Over 80% of the country's population rely on agriculture for employment and general livelihood. The contribution of livestock to the economy is most appreciated in the

drier parts of the country. According to Gem Argwings Kodhek (Tegemeo Institute of Agricultural Policy and Development, personal communication), dairy is the second largest contributor to the agricultural GDP, second only to beef.

Dairy production

The dairy industry is the most developed of the livestock subsectors and is comparatively well developed relative to the dairy industries of other countries in sub-Saharan Africa. The industry, like other agricultural subsectors, is dominated by small-scale farmers.

Milk is produced primarily from cattle (the main source of marketed milk in Kenya), camels and goats, which contribute 84, 12 and 4%, respectively (Table 1).

Table 1. *Estimated population of milk animal species/breeds and percentage contribution to annual milk production (1997).*

Species	Breed type	Estimated number ($\times 10^3$)	Milk production (% contribution)
Cattle	Improved dairy type	3203	59.8
	Zebu	9545	24.6
Camels	<i>Camelus dromedarius</i>	800	11.5
Goats	Indigenous (East African)	10,500	4.0
	Improved dairy type	34	0.1

Source: MoARD unpublished (Kenya Dairy Development Policy Proposal for 2000).

The major types of cattle kept for milk production are the improved exotic breeds and their crosses (collectively called 'dairy cattle') and the indigenous (zebu) cattle, which provide milk for communities in the drier parts of the country. The Sahiwal, though a zebu, is usually grouped together with the exotic cattle because it is regarded as an improved dual-purpose breed. The improved dairy cattle contribute about 60% and the zebu cattle about 25% of the total national milk output (Table 1). Market-oriented dairy farming in Kenya, where exotic cattle are dominant, is concentrated in the crop-dairy systems of the high potential areas where feed supply and disease control are much better than in the arid and semi-arid lands (ASALs) of the country. Zebu cattle, which constitute about 70% of the total population of cattle in Kenya, are, however, widely distributed and are found in all agro-ecological zones of the country due to their adaptation to highly diverse environments. About 70% of the herd is found in the ASALs of the country.

The dairy herd is mainly composed of purebred Friesian-Holstein, Ayrshire, Guernsey, Jersey and their crosses. The crosses constitute over 50% of the total herd while the Friesian-Holstein and Ayrshire dominate the pure breeds.

Dairy production systems in Kenya can largely be classified as large- or small-scale. Small-scale producers (the smallholders) dominate dairy production owning over 80% of the 3 million dairy cattle, producing 56% of the total milk production and contributing 80% of the marketed milk (Peeler and Omore 1997). In a recent study by the Smallholder Dairy (Research and Development (R&D)) Project (SDP) (Staal et al. 1999), covering the

majority of the milk producing regions in the country, most of those surveyed were smallholders and 73% of these had dairy cattle. These findings confirmed the importance of dairy in Kenya's agricultural sector and the country's economy. The study also confirmed that dairy production is conducted on small farms with crossbred cow herds, which range in size from one to three head, and that production is based on close integration of livestock and crops. Dairying is a multi-purpose cattle system providing milk, manure and a capital asset to the farmer.

Smallholder dairying in Kenya

As mentioned earlier, dairy production in Kenya is predominantly run by smallholders. Nevertheless, market-oriented dairy farming in Kenya, based on exotic cattle, started almost a century ago when European settlers introduced dairy cattle breeds and other exotic forms of agriculture from their native countries. Several factors, which include the presence of significant dairy cattle populations, the importance of milk in the diets of most Kenyan communities, a suitable climate for dairy cattle and a conducive policy and institutional environment, have been contributing factors to the success of dairy production by smallholders (Conelly 1998; Thorpe et al. 2000). The success is also attributable to the fact that milk serves as a cash crop providing a continuous stream of cash throughout the year for households growing other cash crops whose income is realised only once or twice a year.

Improved dairy cattle production by indigenous Kenyans was not carried out until after 1954 when the Swynnerton Plan of 1954 allowed them to engage in commercial agriculture (Conelly 1998). By 1963, when Kenya attained independence, the dairy herd had expanded to about 400 thousand exotic cattle largely in the hands of the settlers.

After independence, there was a rapid transfer of dairy cattle from the settler farms to the smallholders resulting in a decline in the cattle population on large-scale farms to 250 thousand head by 1965. To encourage dairy production by smallholders, the government effected a number of changes in the provision of livestock production and marketing services, resulting in highly subsidised services. In 1971, the government abolished the contract and quota system of dairy marketing to Kenya Co-operative Creameries (KCC) to allow for the inclusion of smallholder producers.

The continued provision of highly subsidised livestock and other services by the government proved unsustainable due to budgetary and other constraints. By the late 1980s, the quality of livestock services provided by the government had declined, prompting it to adopt structural adjustment and economic restructuring which, among other changes, included liberalisation of the dairy industry with a view to increasing the role of the private sector (Omore et al. 1999). In the period preceding the 1980s, parastatal and other quasi-government institutions such as KCC and Kenya Farmers Association played major roles in marketing and delivery of agricultural commodities, services and inputs. With their collapse, there is increased reliance on the private sector, including community-based organisations (CBOs), for delivery of livestock and other agricultural services formerly in the government domain.

Development of smallholder dairy production systems in the Kenya highlands has been marked by declining farm size, upgrading to dairy breeds and an increasing reliance on purchased feeds, both concentrates and forage (Staal et al. 1997). In areas such as Kiambu District, purchased fodder has become very important in dairying. The area planted with fodder for sale is equal to the area planted with maize, the staple food crop.

Dairy production by smallholders is a multi-purpose cattle system producing milk and manure, and serving as a capital asset. It is characterised by small crop-livestock farms, each comprising a few acres. The dairy cattle are mostly adult cows. As mentioned earlier, an important feature of the smallholder system is that milk is a cash crop for households who generally grow other cash crops and use manure to fertilise food and cash crops. Cash crops in these farms may include coffee, tea, market vegetables, pyrethrum and, in some cases, cut flowers. The main food crop is maize, but others include beans, sweet potatoes, potatoes, vegetables (such as kale) and in a few cases, wheat. The major cattle feeds are natural grass and planted fodder, mainly Napier grass. Other feeds, which depend on area and availability, include maize crop residues, compounded feeds, milling by-products and weeds. Where farms are small, cattle are confined and fed through a cut-and-carry system in which feed materials are brought to the animals (Baltenweck et al. 1998; Staal et al. 1999). The importance of manure in dairy adoption has largely been overlooked. Studies by the Smallholder Dairy Project, Lekasi et al. (1998) have shown that nutrient cycling through dairy animals and use of manure is a key driving force to dairy adoption and to sustaining smallholdings. In some cases dairy cattle have been kept mainly to supply manure for coffee plants and food crops.

Cattle breeding in the smallholder sector depends on the availability and cost of artificial insemination (AI) services and/or bull service. Use of AI was very popular when it was provided almost free-of-charge by the government but use of bulls has been increasing since the collapse of the government AI services, following their liberalisation. There has been increased reliance on the private sector, including CBOs, to provide AI and other livestock services in place of the collapsed government services; however, as yet they have not been able to fill the gap. Either because of this or other circumstances, calving intervals are long, with an official national estimate of 450 days and recent studies indicating an average of 590 days in Kiambu (Staal et al 1998a). There have been discussions, at the policy level, on how the change from a government controlled to a liberalised economy, including dairy subsector, should have been managed to avoid disruptions of service provision to the farmers. Nevertheless, no 'concrete' plans have been put in place to address the issues discussed.

Milk production in the smallholder sector is constrained by a number of factors; the major ones being the level of dairy cattle feeding, animal genetics and disease challenges. Disease challenge has become more important where dairy production practices have spread into less productive areas because of the need for more agricultural land. In these areas, grazing systems dominate and disease risks are high. Disease challenge, especially of tick-borne diseases e.g. East Coast fever (ECF), is equally important in the high potential areas as a result of the collapsed government services and failure of the private sector to fill the gap. Other important factors that influence dairy development, besides animal management related issues, include poor and inadequate infrastructure.

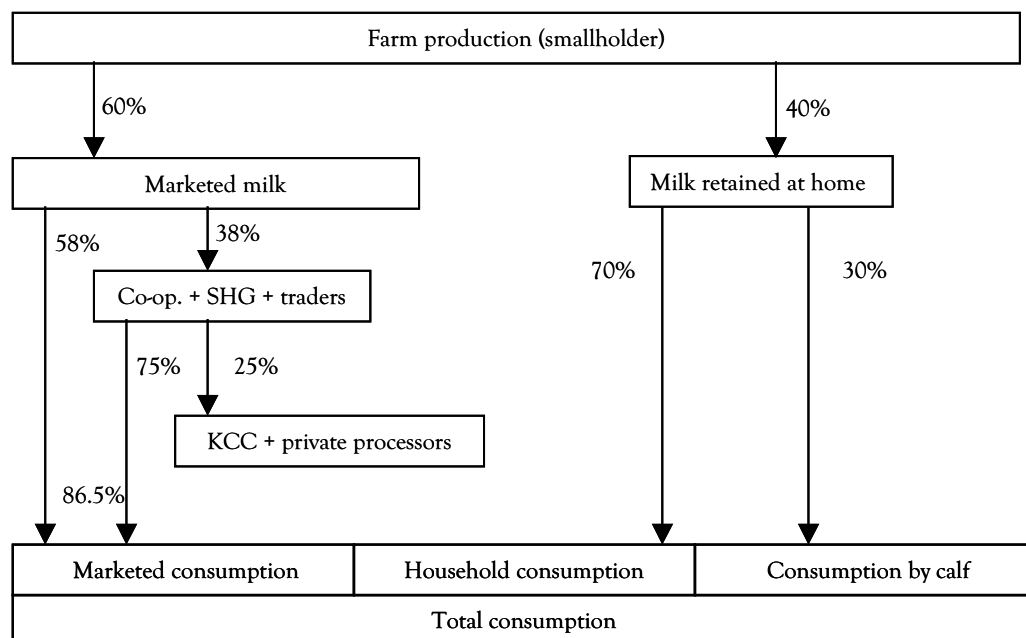
Milk marketing and marketing channels

As mentioned earlier, milk production in Kenya is based on several different species of livestock but for marketed milk, the most important species is cattle.

It is estimated that of the 2.4 million tonnes of milk produced annually from all species, cattle produce about 2 million tonnes, of which 1.6 million tonnes is from the dairy herd and mainly from the smallholders.

On-farm consumption (non-marketed milk) accounts for about 40% of milk and the remaining 60% is marketed through various channels (Figure 2). Less than 15% of marketed milk flows through milk processors (Thorpe et al. 2000), who include Brookside, Spin Knit, Premier, KCC and other smaller private processors. The balance of marketed milk is sold as raw milk. Non-processed milk marketing channels include: direct milk sales to consumers by farm households (58%); and milk collected by dairy co-operative societies, self help groups and individual milk traders who also sell either directly to consumers or to processors.

Differences in milk marketing channels exist between and within the country's various regions. Until recently, marketing through KCC dominated in areas with high production and low consumer concentration or few alternative market outlets. Nairobi city and its environs, which is the largest single market in the country, accounts for over 60% of the



Note: Percentages indicate the proportions from the source; SHG = self help groups; KCC = Kenya Co-operative Creameries.

Source: Modified from Omore et al. (1999).

Figure 2. Milk marketing channels.

formally marketed milk whilst Coast Province and parts of Western Province are among the milk deficit areas in the country.

Women and school age children contribute greatly to labour for dairy activities, especially to milk production and marketing, which involve waking up very early in the morning to feed and milk cows, and to take the milk to market. This labour input has been viewed negatively, raising concern relating to gender imbalances in labour distribution at the farm level.

Supply and demand situation

Kenya has largely been self sufficient in milk and milk products, except in years of extreme bad weather. Very little however is known about the real demand for milk and milk products. Consumption in the country is mainly in the form of liquid milk.

Available statistics show that milk production in Kenya nearly doubled from about 1.3 million tonnes in 1981 to about 2.5 million tonnes in 1990, but has since stagnated (MoARD unpublished—Dairy Development Policy Proposal). This reduction in milk production is, however, difficult to explain given the fact that there has not been any observed major milk shortfall in the country. Consequently, recent statistics may underestimate milk production. This possibility is made more likely by the results of recent studies by the Smallholder Dairy Project (Ouma et al. 2000), which showed underestimation in one of the districts in Central Kenya.

On the other hand, milk demand is expected to continue to increase due to growth of the human population for which the highest rate of growth is expected in the urban centres.

It has been estimated that annual consumption of milk and dairy products in developing countries will be more than double between 1993 and 2020, from approximately 168 to 391 million tonnes (Thorpe et al. 2000). Population growth, urbanisation and increased purchasing power are expected to drive this increase in consumption. Estimated growth in the consumption of milk and dairy products in developing countries is 3.3%. This compares with the 2.6% annual growth reported by Leaver et al. (1998) for developing countries in the short term. In Kenya, the 3.3% projected annual growth in consumption seems to be in line with the country's 3% per year population growth and the continued urbanisation. It is, however, doubtful whether this growth will be achieved in the near future, especially the proportion of growth in consumption expected from increased purchasing power, since the economic trend in the country indicates otherwise.

The Kenya Dairy Master Plan report (MoLD 1991) estimated that per capita consumption of marketed milk was 125 kg/year in the urban areas and 19 kg/year in the rural areas. Milk producing rural areas, however, were reported to have a higher per capita consumption. Preliminary results of a study carried out in Nairobi and Nakuru by the Smallholder Dairy Project indicate higher levels of consumption and a reversal of the urban-rural levels of consumption, with Nakuru rural areas having higher levels of consumption per capita than both Nakuru and Nairobi urban centres (Ouma et al. 2000).

The Dairy Master Plan (MoLD 1991) predicted a national milk surplus (i.e. higher marketed supply than consumption) by the year 2000. Nevertheless, using KCC data for

intake and sales, another study (Muriuki 1991) predicted a possible shortfall in marketed milk by the same year. The main reason for the predicted shortfall was the observation of a continued rise in demand for marketed milk as human population continued to grow, especially in the urban centres, while the observed growth in milk production was slow. Another factor that could increase demand for milk is growth in personal incomes. However, per capita income in Kenya has been declining; thus, no increase in milk demand is expected from this source.

On the supply side, most of the increase in marketed milk has been based on continued increase in size of the dairy cattle population. This population has, however, stagnated over the last decade. The milk yield per cow has been very low, with an annual yield of 1300 kg/cow. Lactation averages are also low for the officially recorded herds, comprised of the national dairy cow elite mainly owned by large-scale farmers. Available information from the Dairy Recording Services of Kenya (formerly the Kenya Milk Records) for the year 2000 show an average lactation (305 days) yield of 4477 kg for the Friesian–Holstein, which was the highest for all the dairy breeds recorded (Esther Gicharu, Dairy Recording System of Kenya, personal communication).

Considering the above scenario, indications are that both demand and supply have the potential to increase. On the demand side, per capita income especially for the urban population will be critical, while on the supply side, many factors will be in play: feeds and feeding, market infrastructure, relative milk price, production systems etc.

Given the current economic situation, where real income levels seem to be declining and going by the past trends, supply and demand balance is not expected to change significantly. Even with the prevailing economic conditions, Kenya is self-sufficient in milk and milk products; this situation is likely to persist for some time to come unless the economic and market situations change. Nonetheless, if any change does occur the situation is more likely to move towards shortfalls in milk production than production of a surplus.

Dairy as a source of livelihood

In Kenya, there are about 625 thousand smallholder dairy farmers (Peeler and Omore 1997) whose main source of income is dairying. About 40% of the milk produced is retained at home for household consumption and for calf feeding. This confirms the importance of dairy both as a source of income for rural household and as a source of household nutrition. Per capita milk consumption for households producing milk on the farm is higher than the national rural average (MoLD 1991) emphasising the importance of milk in the diets of the Kenyan rural community who constitute three quarters of the poor people in the country.

The ability of dairy enterprises to earn regular income and to contribute to the household diet on a daily basis throughout the year is an advantage over other farm enterprises. This is a pointer as to why dairy is favoured as a cash crop for most farm households in the high potential areas of Kenya, even where other cash crops do equally well.

Dairy production also creates employment for the rural communities at the farm level and off-farm employment to informal milk traders, co-operatives and others dealing with milk marketing. Recent studies indicated that labour for dairy production activities was

provided mainly by the family but 60% of household were found to hire labour, with 20% retaining permanent labour throughout the year (Staal et al. 1998b).

At a Land O'Lakes Regional Round Table meeting held in Malawi in March 2000 (Staal et al. 2000) indicated that for every 100 litres of milk/day, the processing sector employs 0.2 to 0.4 persons; milk bars employ 1.2 to 2 persons and itinerant traders (hawkers) employ 3 persons. These figures have been contested by the milk processors who want to believe that the processing subsector has a higher 'multiplier' effect than the informal sector. Nevertheless, the ability to create employment is very important in a country where level of unemployment is very high and the economic situation is poor.

It has been noted that adult women in Kenya are more involved in intensified dairying than adult men (Tangka et al. 1999). Women contribute more labour in activities such as collecting and processing of feed, feeding, milking, marketing of milk, cleaning of sheds and fetching of water for animals. Although women carry out most of the work in dairying activities, they also appreciate that they are better off due to income increases and stability (Mullins et al. 1996).

Access to income by women, not only from dairy enterprises but also from other agricultural enterprises such as tea and coffee, is of concern at policy level. Men have been accused of receiving the cash payment from farm earnings and misappropriating it on personal enjoyment. Dairy income, however, is controlled primarily by women and very little of this income shifts into the control of men. For example, Tangka et al. (1999) found that women had some control over dairy income in 76% of surveyed households.

Participation of itinerant milk traders (hawkers) has generated much controversy in Kenya, mainly because of perceived health risks to the consumer. What is not in dispute, however, is that the informal market, which handles the bulk of marketed milk (Thorpe et al. 2000), pays higher farm gate prices, offers lower consumer prices and generates employment for rural people. It is also reported that milk traders earn higher daily wages than the general average for their category of workers. Other benefits from dairying include animal manure, which is used on the farm or sold for cash. Manure is important in sustaining smallholdings and accounts for the apparent profitability of dairying, even where dairying appears to be a loss making enterprise.

National effort towards development of smallholder dairying

The adoption of dairy production by the smallholder in Kenya owes much to the government's policy and effort, which have deliberately developed the sector. This was more pronounced soon after independence. The donors have also contributed through specific programmes and projects. The United Nations Children's Fund (UNICEF), the Food and Agriculture Organization of the United Nations (FAO) and the Danish International Development Agency (DANIDA) have made major efforts to develop the dairy industry, especially the processing subsector. KCC developed most of its infrastructure through the interventions of these donors, especially DANIDA. Other notable programmes include the National Dairy Development Project (NDDP) and the Rural Dairy Development Project (RDDP) sponsored by the Dutch and Finnish

Governments, respectively. The NDDP's major activities were towards improved production while the RDDP focused on marketing.

Current efforts include the SDP, funded mainly by the Department for International Development (DfID) and the Kenya Government, who contribute in kind, and the Livestock Development Project (LDP), which is sponsored by the Finnish Government. The SDP's goal is to contribute to sustainable improvements in the livelihoods of poor people in Kenya and their purpose is to improve access by smallholder dairy farmers to technologies, advice and information. The project is an integrated research and development programme implemented through collaboration between the Ministry of Agriculture and Rural Development (MoARD), the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI). With declining farm sizes due to pressure on land from the expanding population and access to formerly public-delivered research and development services, a major issue is how to make the smallholder farmer more productive within the existing economic situation. SDP has plans to address these issues by testing and validating service delivery mechanisms through farmers' organisations. One concept that was tested recently is the delivery of dairy feed to society members through credit arrangements with their co-operative society's processing plant, where the payment system is based on deductions from payouts. Other areas that the project is considering for testing include delivery of extension services through milk processors and other market agents, and through contract arrangements. To make impact in these areas, the project is refocusing its purpose and putting more emphasis on influencing policy and institution reforms through informed ideas.

The LDP's overall objective is to improve the standard of living for the rural population within the programme area, the western Kenya region, through increased milk production and consumption. A major feature of the LDP is its holistic approach combining efforts to increase milk production and improve the efficiency of the milk system.

The above are just some of the projects targeting dairy improvement. There are also other efforts through non-governmental organisations and other community specific projects.

Environmental impact of dairy production

Environmental problems arise from: natural calamities such as drought and floods; human, livestock, crop and forest diseases; soil erosion, degradation, infertility and desertification; and human activities which exacerbate natural problems or create new man-made problems, such as pollution, encroachment into other land uses leading to deforestation and negative impacts on wildlife and on pastoralists (MoARD 1995).

Population increases in Kenya, which are currently estimated at 3% per year, have created pressure on land, forest and water resources.

According to an FAO report on the Dairy Development Project (FAO 1993), the possible negative environmental impacts of promoting dairy development in Kenya are overgrazing of natural pastures, and pollution by cooling and processing plants. The Dairy Master Plan (MoLD 1991) had raised the issue of overgrazing but little attention was given to this issue. The major concern arose from the fact that as the pressure on land increases,

there could be further subdivision of the already small parcels of land in the highly populated areas. This is particularly worrying as each new household is likely to own cows regardless of the size of its parcel of land. One 'school of thought' was that if dairy production continued to rely on natural grazing, an increase in the Kenyan dairy population would lead to overgrazing since the dairy population had already reached its threshold by 1990. The FAO report (FAO 1993), however, observed that in the context of Kenya, development of dairying would not entail overgrazing because the additional feed would not be obtained from the areas which are already over-exploited; instead, farmers would tend to rely more on grown fodder and increased use of concentrates.

Other concerns relating to environmental degradation are consequent to the movement of communities from high potential areas to marginal lands, as a result of pressure on land without consideration to the land's carrying capacity. The immigrants tend to move with their practices including the keeping of dairy cattle. The result is usually overgrazing and other forms of land abuse, such as deforestation and other demands, e.g. for fuelwood. The spread of farming practices, such as dairy production, to less productive areas of the country where less land use intensification has occurred and where grazing systems dominate, makes disease challenges and land degradation risks more important because of their influence on adoption and performance of dairy production.

While one cannot rule out possibilities of pollution from milk cooling and processing plants, the problem may not be significant. A possible source of pollution is the packaging materials used for milk, which tend to be abandoned as rubbish. Pollution from cattle waste is unlikely until there is more commercial intensification; currently, demand for manure is higher than supply. Under the current situation, manure is an integral part of the smallholder crop-dairy system and is a driving force to dairy adoption in some parts of the country. Manure is a medium for nutrient cycling through the animal and sustains smallholder systems.

While there has been concern over possible environmental degradation by livestock, no major study has been carried out to establish the situation and possible impact of current production and processing practices. Other possible sources of environmental problems include the use of cattle dips, poor choice of location for cattle dips and uncontrolled use of prescription drugs. The collapse of the government veterinary services, as a result of structural adjustments and economic reforms may exacerbate these problems, as there has been an emergence of alternative service providers who are only semi-qualified and are likely to misuse drugs.

Some current common practices of smallholders, such as the planting of fodder species, e.g. Napier grass, are environmental friendly and help to protect the soil from erosion etc.

Smallholder production opportunities and constraints

In the past, adoption of dairy farming in Kenya has been favoured by several factors including: the presence of smallholder communities who kept cattle and who included milk as an important part of their diets; the presence of a significant dairy cattle population; a subtropical geography suitable for dairy cattle farming; and a conducive policy and

institutional environment provided by successive governments (Thorpe et al. 2000). This combination of factors has led to a unique smallholder dairy industry in Kenya.

Furthermore, opportunities for smallholder dairy production in Kenya are enhanced by the fact that the country has the genetic base and holds 85% of the dairy cattle population of eastern Africa (Thorpe et al. 2000); a well developed milk processing sector putting it ahead of its neighbours; and the recent re-launching of the East African Community that has resulted in formation of a common market for a combined population of about 81 million people (Daily Nation, 16 January 2001).

The contribution of dairying to the sustainability of smallholder crop–dairy systems through its roles in nutrient cycling, regular cash generation ability, employment creation and provision of farm household nutrition makes it an easy choice as a vehicle to address rural poverty.

Development of smallholder dairying is, however, constrained by many factors including: feed scarcities, disease challenges, the poor state of infrastructure such as rural access roads, and water and electricity supplies, limited access to suitable credit and the general poor national economic performance. Other problems include slow legal and policy reforms and poor access to production and marketing services including those for agricultural inputs.

Infrastructure such as rural access roads, and water and rural electricity supplies have a major influence on milk marketing efficiency and are perhaps the most limiting factors to the development of the smallholder dairy.

Conclusions

Smallholder dairying dominates both milk production and marketing in Kenya. The history of the dairy industry in Kenya spans almost a century, but not until the 1960s did the smallholder get into commercial dairy production. Dairying is a source of income not only to the estimated 625 thousand smallholder households, but also to a larger number of individuals employed in milk marketing. Moreover, it plays a crucial role in sustaining smallholder crop–dairy systems through nutrient cycling within the system.

The current milk production level of 4–5 litres/cow per day can be improved. This will, however, only occur if there is investment in market infrastructure and a general improvement in the economy.

Dairy is an important factor in the effort to reduce poverty in the rural areas of Kenya. Most smallholders start very poor and struggle to acquire their first cow as a means to get out of poverty and to sustain their household; therefore, owning a cow is a means of survival.

Dairy also creates employment opportunities through both the informal and formal market channels. From information obtained through the SDP, it appears that the informal sector is the more efficient in terms of prices, net incomes and employment creation. It has been argued that the road to dairy development cannot be through the informal sector, but the reality as seen in many developing countries is that the sale of raw milk, which drives the informal sector, is going to continue for a long time to come.

References

- Baltenweck I., Staal S.J., Owango M., Muriuki H., Lukuyu B., Gichungu G., Kenyanjui M., Njubi D., Tanner J. and Thorpe W. 1998. *Intensification of dairying in the greater Nairobi milk-shed: Spatial and household analysis*. Smallholder Dairy (Research & Development) Project. MoA/KARI/ILRI Collaborative Research Report. ILRI (International Livestock Research Institute), Nairobi, Kenya.
- CBS (Central Bureau of Statistics). 1999. *Statistical abstract 1999*. CBS, Office of the President and Ministry of Planning and National Development, Nairobi, Kenya.
- CBS (Central Bureau of Statistics). 2001. *1999 Population and housing census*. Volume I. CBS, Office of the President and Ministry of Planning and National Development, Nairobi, Kenya.
- Conelly W.T. 1998. Colonial era livestock development policy: Introduction of improved dairy cattle in high-potential farming areas of Kenya. *World Development* 26:1733–1748.
- FAO (Food and Agriculture Organization of the United Nations). 1993. *Kenya Dairy Development Project preparation report*. Report 34/93 CP-KEN 33. FAO, Rome, Italy.
- Leaver J.D., Santos F. J. and Anderson S. 1998. Meeting consumer demands for milk and identifying research priorities. In: Gill M., Smith T., Pollott G.E., Owen E. and Lawrence T.L.J. (eds), *Proceedings of a symposium organised by the British Society of Animal Science held at Nairobi, Kenya, 27–30 January 1998*. BSAS Occasional Publication 21. BSAS (British Society for Animal Science), Edinburgh, UK. pp. 43–51.
- Lekasi J.K., Tanner J.C., Kimani S.K. and Harris P.J.C. 1998. *Manure management in the Kenya highlands: Practices and potential*. The Henry Doubleday Research Association, Brainsdale, Victoria, Australia. 35 pp.
- MoARD (Ministry of Agriculture and Rural Development). 1995. *Agricultural sector review*. ASIP Secretariat, Kilimo House, Nairobi, Kenya.
- MoARD (Ministry of Agriculture and Rural Development). Kenya Dairy Development Policy proposal 2000. Unpublished.
- MoLD (Ministry of Livestock Development). 1991. Kenya Dairy Master Plan. Report prepared for the Ministry by the Danish International Development Agency, August 1991. MoLD, Nairobi, Kenya.
- Mullins G., Wahome L., Tsangari P. and Maarse L. 1996. Impact of intensive dairy production on smallholder farm women in Coastal Kenya. *Human Ecology* 24:231–253.
- Muriuki H.G. 1991. Liquid milk supply and demand in the formal (KCC) market in Kenya: A government price fixed market. MSc thesis, University of Illinois at Urbana-Champaign, USA.
- Ominde S.H. 1988. Kenya's population growth and development to the year 2000.
- Omoro A., Muriuki H., Kenyanjui M., Owango M. and Staal S.J. 1999. *The Kenya dairy subsector: A rapid appraisal*. Smallholder Dairy (Research and Development) Project Report. Nairobi, Kenya. 51 pp.
- Ouma E., Staal S.J., Omoro A., Wanjohi P., Njoroge L. and Njubi D. 2000. *Consumption patterns of dairy products in Kenya*. MoA/KARI/ILRI Collaborative Research Report, Smallholder Dairy (Research & Development) Project, Nairobi, Kenya.
- Peeler E.J. and Omoro A. 1997. *Manual of livestock production systems in Kenya*. 2nd edition. KARI (Kenya Agricultural Research Institute), Nairobi, Kenya. 138 pp.
- Staal S. and Muriuki H. 2000. Policies and the informal sector in the dairy industry. Paper orally presented at a Land O'Lake Round Table Meeting in Malawi. (unpublished).
- Staal S., Delgado C. and Nicholson C. 1997. Smallholder dairying under transactions costs in East Africa. *World Development* 25:779–794.

- Staal S., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M. 1998a. *Characterisation of dairy systems supplying the Nairobi milk market: A pilot survey in Kiambu District for the identification of target groups of producers*. Smallholder Dairy (R&D) Project. KARI/MoA/ILRI Collaborative Dairy Research Programme, ILRI, Nairobi, Kenya. pp. 85.
- Staal S., Owango M., Muriuki H., Lukuyu B., Musembi F., Bwana O., Muriuki K., Gichungu G., Omore A., Kenyanjui M., Njubi D., Baltenweck I. and Thorpe W. 1998b. *Dairy systems characterisation of the Nairobi milk shed: Application of spatial and household analysis*. MoA/KARI/ILRI Collaborative Research Report. Smallholder Dairy (Research and Development) Project, Nairobi, Kenya.
- Staal S.J., Kruska R., Balteweck I., Kenyanjui M., Wokabi A., Njubi D., Thornton P. and Thorpe W. 1999. Combined household and GIS analysis of smallholder production systems: An application to intensifying smallholder dairy systems in Central Kenya. Paper presented at the third international symposium on Systems Approaches for Agricultural Development (SAAD-III) held at Lima, Peru, 8–10 November 1999, National Agrarian University, La Molina, Lima, Peru.
- Tangka F., Ouma E.A., Staal S.J. and Shapiro B. 1999. Women and the sustainable development of market-oriented dairying: Evidence from the highlands of East Africa. Paper presented at the International Sustainable Development Research Conference held at University of Leeds, Leeds, UK, 25–26 March 1999.
- Thorpe W., Muriuki H.G., Omore A., Owango M.O. and Staal S. 2000. Dairy development in Kenya: The past, the present and the future. Paper presented at the annual symposium of the Animal Production Society of Kenya, Nairobi, Kenya, 22–23 March 2000.

An overview of dairy development in Tanzania

L.R. Kurwijila

Department of Animal Science and Production, Sokoine University of Agriculture
P.O. Box 3004, Morogoro, Tanzania

Introduction

Tanzania, with an estimated human population of 29 million, is endowed with 88.6 million hectares of land suitable for agriculture, of which only 6% is currently cropped (MoAC/ SUA/ILRI 1998). About 60 million hectares of rangelands are ideal for livestock but only 40% of these lands can be used for livestock production due to tsetse infestation of the remaining rangelands. The carrying capacity of the rangelands has been estimated at 20 million animal units but in 1996 there were only 16 million animal units (MoAC 1997).

Tanzania has an estimated 3.87 million agricultural households, of which 17% are female headed. Most households (average size = five persons) are dependent on growing crops only, while 4 out of 10 also keep livestock. Only 0.4% of rural households are solely dependent on keeping livestock. Most households keep small herds of livestock (average number being 14). Of the 21 million agricultural household members, approximately 8.7 million (≥ 10 years old) work full time on the farm.

Although Tanzania ranks third in Africa after Ethiopia and Sudan in size of cattle population, productivity is relatively low. Livestock production as a whole contributes 18% of the total gross domestic product (GDP) and 30% of agricultural GDP. The dairy industry contributes 30% of the livestock GDP, beef contributes 40% and other livestock contribute 30% (MoAC 1997). A recent rapid appraisal study (MoAC/SUA/ILRI 1998) gave an updated assessment of the performance of the Tanzanian dairy industry. The population of livestock in Tanzania in 1995 was estimated at 15.6 million cattle (in about 1.114 million households), 10.7 million goats (in about 1.26 million households), 3.5 million sheep (in about 520 thousand households), 435 thousand pigs and 26 million poultry. Seven regions (Kigoma, Morogoro, Pwani/Dar, Lindi/Mtwara and Ruvuma) have insignificant cattle populations (< 5 animals/km²) mostly due to tsetse infestation. Exotic dairy cattle and their crosses numbered about 246 thousand head, which includes estimates for Dar es Salaam but excludes dairy cattle kept in other urban centres.

Milk production has not kept pace with population growth, especially the urban population (Sumberg 1997). Total milk production from indigenous cattle and improved cattle is estimated at 643 thousand tonnes (79%) and 171 thousand tonnes (21%), respectively. Large-scale farms produce only about 30 million litres out of the 171 million

litres produced by improved dairy cattle; smallholder cattle produce the rest. Most smallholder production is concentrated in the regions of Arusha and Kilimanjaro where approximately 66% of dairy cattle are located. Per capita milk availability varies widely geographically depending on local cattle populations and seasonally due to feed availability. The overall per capita milk availability is low (20–22 kg/annum) compared with Kenya (80 kg/annum), the average for Africa (35 kg/annum) and the world average (105 kg/annum). Constraints to increased dairy production have been cited in the Agricultural and Livestock Policy Document to be: i) poor nutrition; ii) diseases and parasites; iii) weak extension services; iv) inadequate supply of dairy stocks; v) inadequate research; vi) non-availability of credit services; vii) disorganised milk marketing; and (vii) poor processing facilities.

Against this background of opportunities and constraints, the Agriculture and Livestock Policy sets a target of increasing the per capita supply of milk to 26 kg/annum by the year 2000 implying a dairy herd increase to about 500 thousand head by the same year. To overcome the identified constraints and make use of available opportunities (suitable land, climate, a large cattle population, growing demand for milk and milk products etc.), the dairy industry needs to develop appropriate policies and development strategies within the framework of the macro-economic and the Agricultural and Livestock Policy environment prevailing in Tanzania. Over the years, the overall objectives of Tanzania's dairy development policy have been attainment of national self-sufficiency in milk and dairy products and contribution to poverty alleviation.

The purpose of this paper is to give an update of the dairy industry in Tanzania including milk production systems, the efficiency and economics of milk production, impact of smallholder production on poverty alleviation, nutrition, the environment, dairy consumption and marketing. The paper concludes by looking at future prospects and constraints.

Milk production and marketing systems in Tanzania

Dairy production systems

A rapid appraisal study identified five dairy production systems that have evolved in Tanzania over time (MoAC/SUA/ILRI 1998). These are:

- i) Smallholder dairy farming, integrated with perennial crops like banana and coffee, found in the northern regions (Kilimanjaro/Arusha), Kagera Region in the north-west and the southern highlands of Tanzania.
- ii) Smallholder dairy farming integrated with annual crops like maize and cereals found in the central part of Tanzania.
- iii) Specialised medium-scale dairy farms found near big urban centres such as Dar es Salaam, Tanga, Mwanza and Musoma. On these farms with 10 to 50 cows, milk production is the main economic activity. There is little crop cultivation and a limited level of mechanisation.

- iv) Peri-urban dairy is found in the coastal belt, mainly near Dar es Salaam, Tanga, Morogoro and other urban centres where many civil servants and businessmen have taken up dairying as a means of generating additional income.
- v) The traditional, semi-sedentary system, which accounts for 75% of total milk production. However, this sector is relatively forgotten in dairy development policies, which generally aim at the crossbred cattle dairy farming. 'Because of its size, this sub-sector represents the biggest potential for increasing milk production in Tanzania, yet very little effort has been directed at improving milk offtake from this sub sector' (Kurwijila 1996; Kurwijila et al. 1997). The Austroproject Association is one of the exceptions, being an organisation that supports this group of mainly Maasai herders, in collecting and marketing their milk.
- vi) Parastatal large-scale dairy farms. The government through the dairy farming company (DAFCO), operated at least 7 dairy farms with a total of over 3000 dairy cattle. In spite of having the best dairy animals in the country, the performance of the DAFCO farms did not measure up to expectations due to a number of management problems. Milk production declined from 7.5 litres/cow per day in 1982 to 6.7 litres/cow per day in 1994 (Keregero 1988; Mtumwa and Mwashia 1995). Most of these farms have been privatised or are in the process of being privatised.

Animal health services delivery systems

Until recently, the delivery of animal health services was embedded in the agriculture extension system with the government paying for cost of extension personnel, transport and some drugs, especially those used for tick control. Following market liberalisation in the mid-1980s, the veterinary service has been increasingly run by the private sector. The government still pays the salaries of extension veterinary staff, and meets the costs of disease surveillance and vaccinations against epidemic and transboundary diseases such as CBPP (contagious bovine pleuropneumonia) and rinderpest. Due to the poor infrastructure of the animal health delivery system, especially in rural areas, the use of para-veterinary staff is encouraged.

Related to this is delivery of artificial insemination (AI) and breeding services. The government runs a national AI centre at Usaa River in Arusha but the service has not been very efficient with ≤ 5000 inseminations being recorded per year. Fully privatised veterinary and AI services are still confined to very few urban and peri-urban centres where farmers are accessible and able to pay for the services. Government policy is to move towards a private sector serviced and government regulated animal health delivery system within the next 10–15 years.

Efficiency and economics of milk production

The competitiveness of any dairy industry depends on the efficiency with which milk is produced. This may be measured in biological terms such as calving intervals, feed

conversion efficiency and milk production/cow per day, which translate into cost of production per litre. Smallholder production reveals a similar trend to that shown by data from the Tanga Smallholder Dairy Development Programme (Msanga et al. 2001; Table 1). The general decline in performance of both first lactation heifers and multiparous cows is a reflection of reduction in use of several essential inputs (feeding, veterinary services etc.) and extension services as the number of farmers and cows increases in the dairy development programme.

Table 1. *Milk production trend under Tanga Smallholder Development Programme (1990–95).*

Year	Number of cows	LS mean* first lactation yield (SE)	LS means repeated lactation yield (SE)
1990	99	2084 (79)	1993 (132.1)
1991	167	1996 (63.5)	1881 (93.1)
1992	248	1904 (56.2)	1952 (80.8)
1993	74	1668 (87.0)	2178 (115.3)
1994	120	1358 (71.4)	1774 (106.1)

* LS means = least squares means; SE = standard error.
Adapted from Msanga et al. (2001).

The cost of production varies depending on the production system. It is reported to be lower in the rural based traditional system, where milk fetches as little as 80 Tanzanian shillings (TSh) per litre (US\$ 1 = TSh 900, November 2001), than in urban and peri-urban areas where milk production costs have been estimated to be in the range of TSh 165–200/litre (de Wolf 1999). In the southern highlands, smallholder dairy farmers are reportedly producing milk at TSh 60–80/litre (Mugittu 1999). The value of dairying extends beyond milk sales. Manure and heifers are particularly important outputs of the enterprise, especially in the zero grazing systems of the Kagera and Kilimanjaro coffee/banana economy where manure is ranked second after milk (Silas et al. 1998).

Milk production, supply and demand

Improvements in milk supply in Tanzania have largely been due to increases in cattle numbers rather than increases in productivity. The number of indigenous cattle increased by 20% between 1984 and 1997. The number of crossbred dairy cattle increased from 142 thousand to 250 thousand over the same period (an increase of 6% per annum). Although the improved dairy herd has grown at a rate of 6%, this has not had a big impact on per capita consumption because the dairy herd is still a very small proportion of the total herd. The relative growth rate in urban and peri-urban areas during the same period is reported to have been much higher. In Dar es Salaam, for example, the number of dairy cattle increased from about 2 thousand in 1984 to over 20 thousand by 1995. The spatial distribution of milk supply is skewed in favour of regions with high zebu and/or dairy cattle populations, such as Kilimanjaro, Arusha, Dar es Salaam/Coast, Mara, Mwanza, Kagera, Singida and the

major urban centres. This is associated with much higher levels of per capita milk consumption in urban centres (30 litre/annum) than in rural areas (15–20 litres/annum).

It was estimated that by 1998 the traditional livestock sector was producing about 438 million litres of milk per year, while the commercial sector produced 250 million litres of milk. Though the offtake from the dairy herd contributes only about 20% of total milk production, it is estimated that it contributes 95% of the marketed milk. Over the last two decades, total milk production has increased at the relatively low rate of about 2.8% per annum, i.e. the same rate as population growth. Therefore, despite the large number of cattle in Tanzania, production of milk and milk products has not satisfied the demand, particularly in the urban market (Table 2).

Table 2. *Milk production and consumption trends in Tanzania 1970–98.*

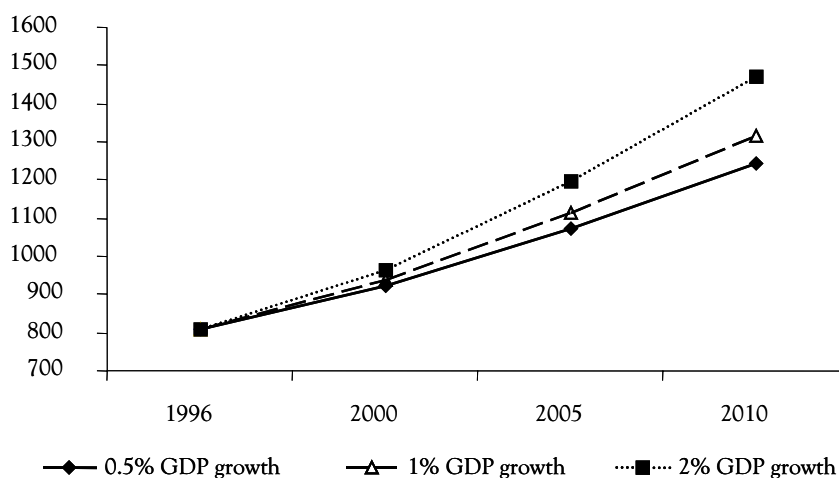
Year	Population ($\times 10^6$)	Milk production ($\times 10^6$ kg)	Per capita consumption (kg)
1970	13.3	302	22.9
1980	17.5	391	22.1
1985	21.7	436	20.1
1990	25.9	500	19.3
1995	28.1	585	21.0
1997	30.2	675	22.4
1998	31.1	687	22.1

Source: MALDC (1997–98 to 1998–99).

Tanzania's per capita milk supply of 22 litres/annum is one of the lowest in sub-Saharan Africa. This is partly due to the predominance of the low milk producing zebu cattle (with yields of about 200 kg/annum) and a relatively small improved dairy herd producing below potential (with yields of about 1800 litres/cow per annum versus potential yields of 2500 litres/cow per annum), lack of milk marketing infrastructure, low purchasing power and the cultural food consumption habits of consumers.

According to the MoAC/SUA/ILRI (1998) study estimates, milk demand projections to the year 2010 (based on current consumption levels, urbanisation levels of 5% per annum, a population growth of 2.3% per annum, an overall income elasticity for dairy products of 0.8 and a modest real GDP growth of 1% per annum) indicate that demand could increase by 60% to 1.5 billion litres of milk annually (see Figure 1) or a per capita consumption of 44 and 30 litres/annum, respectively, in urban and rural areas.

Milk production (under the following assumptions: no change in current cattle herd productivity and structure; an increase in zebu cattle population of 1.7% per annum and a dairy herd expansion of 4.6% per annum) would increase by 43% to 1.33 billion litres/annum resulting in a shortfall of some 170 million litres/annum (466 thousand litres/day). Milk production would have to increase at the rate of 3% per annum to keep pace with demand. Should the economic performance of the economy improve by 2% GDP or more, the gap between supply and demand will be even greater, signifying an opportunity for smallholder dairy producers to use dairying as an attractive avenue for poverty alleviation. Policy guidelines are required to enable farmers to fully exploit this potential opportunity.

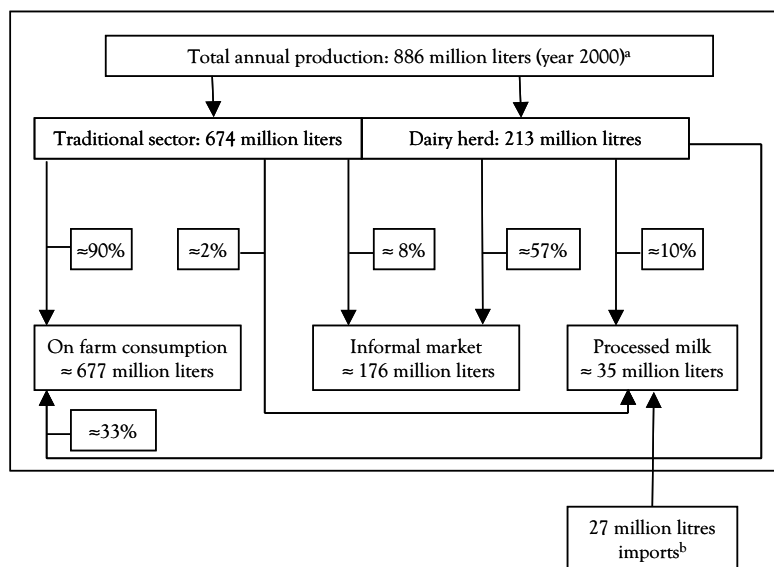


Source: MoAC/SUA/ILRI (1998).

Figure 1. Milk demand projections for Tanzania to the year 2010.

Milk collection, processing and marketing

Figure 2 illustrates the flow of milk in the Tanzanian market.



Sources: (a) MoAC/SUA/IRLI (1998); (b) Verwer (1999).

Figure 2. The flow of milk in the Tanzanian market.

History of organised milk marketing and processing

Most of the milk produced in the country is consumed at the farm level or sold to neighbours. The government's policy is, however, to attempt to channel surplus milk to

dairy plants for commercial processing, with a view to supplying urban markets with hygienic milk and milk products.

In the past, rural milk collection was organised by the processing plants. A network of collection routes, on the village feeder roads, was established by each plant. On these routes, collection centres equipped with cooling facilities were provided and operated by Tanzania Dairies Limited (TDL). In addition, a number of producers delivered their milk directly to the processing plants, earning a collection fee.

At this time, seven processing plants owned by TDL were processing milk. However, the ability of TDL to collect and process raw milk was very low and with ageing of plant machinery and milk collection infrastructure, the capacity to collect and process raw milk declined drastically over time. The effectiveness of milk collection depended on the availability of adequate transport, road conditions and the operation of milk cooling centres. Due to the ageing of machinery, poor maintenance, frequent breakdown of vehicles and unattractive official producer prices, less milk was collected by the plants leading to low capacity utilisation of the established dairy plants.

The share of local fresh milk processed by TDL reached its highest level in 1979, 14.3 million litres (35.64%) out of a total of 40.1 million litres processed (Lohay 1988). TDL relied heavily on the recombining of World Food Programme (WFP) milk powder and butter oil.

Current milk marketing and processing

The marketing policy has undergone significant changes as part of the overall process of structural adjustment. The marketing of milk and milk products in the formal sector was previously done by TDL, but most of the milk produced was sold directly to consumers. After liberalisation and privatisation of TDL, the private sector has been investing in collection, processing and marketing. This has resulted in improved availability of milk in urban centres and better prices for the producers, although consumer prices remain high.

Some parastatal organisations and private companies have established other small processing units. This has improved the total processing capacity from 290 thousand litres/day under TDL to the current level of 401 thousand litres/day (Table 3). However, the total daily intake is only about 80 to 90 thousand litres/day. During the dry season, milk intake from local sources decreases by as much as 30%. Some processors in Dar es Salaam use imported milk powder to fill the gap.

In spite of these positive developments, the marketing of milk is still dominated by informal milk marketing. It has been reported that less than 10% of milk produced in the country is marketed as processed milk and milk products. The market is highly fragmented. High milk producing areas are situated far away from milk centres in the major urban centres. The range of dairy products on the market is still very limited. Over 90% of the milk marketed informally is sold as raw milk by informal market intermediaries with all the attendant health risks (MoAC/SUA/ILRI 1998). In some towns like Mwanza, Tabora and Shinyanga, itinerant milk vendors supply nearly all the fresh milk consumed (Sumberg 1996; Stewart 2000; SUA/ILRI 2000).

Table 3. Milk processing plants in existence after privatisation in 1995.

S. No.	Lo- cation	Plant name	Year estab- lished	TDL Plants before liberal- isation ($\times 10^3$ liters/day)	Private dairy plants after liberalisation ($\times 10^3$ liters/day)	Highest level of milk processed/day (year)	Status
1	DSM	Royal Dairy	1968	90	90	3836 (1994)	Privatised, operating
		Natures Choice	1994	0	4.5		Second hand, private, closed
		Azam	1993	0	3		Private, operating
		Tommy Dairy	1998	0	15		New, private, operating
		REKI Enterprises	1997	0	6		New, private, operating
2	Tanga	Ex-TDL plant	1980	30	30	2240 (1985)	Not yet privatised, closed
		Tanga Fresh	1998	0	10	n.a.	New, private, operating
		Tanga Dairy Co-operative Union (TDCU)	1993	0	10	n.a.	New, private, operating (milk chilling only)
3	Arusha	(Ex-TDL) Arusha Dairy Company	1969	60	60	10,137 (1979)	Privatised, operating
		Arusha Dairy Company	1995	0	60	n.a.	Privatised, operating
4	Mara	(Ex-TDL) Musoma Dairy	1970	45	45	15,391 (1977)	Privatised, operating (UHT)
		(Ex-TDL) Utegi Plant	1970	45	45	10,000 (1977)	Not yet privatised, closed
		Baraki Sisters	1995	0	3	n.a.	Private, operating
		New Mara Milk	1998	0	6	n.a.	New, operating
5	Mwanza	Victoria Dairy	2000	0	10	n.a.	New, operating
		Lake Side	1970		5	n.a.	Private, closed
6	Kagera	9 Mini-dairies (100–500 litres/day)	1994	0	1.8	n.a.	KALIDEP, semi-private, operating
7	Moro- goro	University plant (SSA)	1976	0	3	700 (1976)	Public, operating
8	Tabora	Ex-TDL plant	1945	5	5	1475 (1984)	Privatised, closed
9	Coast	Mojata	1995	0	6	n.a.	New, private, operating
10	Iringa	ASAS	2000	0	5	3000 (2001)	New, private, operating
		NJOLIFA/ CEFA	1997	0	10	n.a.	Not operating
11	Mbeya	Ex-TDL	1979	16	16	3542 (1986)	Closed
12	Moro- goro	Melela bustani farm	1995	0	0.5	n.a.	Operating
Total installed capacity				291	401.8		

n.a. = data not available.

Updated from Kurwijila et al. (1997).

Milk imports

During the 1970s and 1980s Tanzania enjoyed food commodity aid from the WFP, the EU and other bilateral sources. The largest amount of recombined milk received in a year was about 35 million litres of liquid milk equivalent (LME) in 1983 (Lohay 1988) which declined to about 7 million litres LME in 1993. The WFP/EU dairy commodity aid stopped in 1995. Since then milk imports have declined somewhat. In 1999, the Netherlands Economic Institute (NEI) estimated that 5 million litres LME of recombined milk were imported into Tanzania (NEI 1999). A recent detailed study of the Tanzania Revenue Authority's data on dairy imports into Tanzania has shown that total milk imports between 1995 and 1998 amounted to 109.6 million litres LME, equivalent to 27.4 million litres LME per annum (Verwer 1999). This figure is similar to the TDL total import of 27.9 million litres in 1985. It appears therefore that in response to the market forces prevailing in Tanzania, other importers have moved in to fill the gap left by WFP/EU commodity aid. Currently imports come in through non-governmental organisations (NGOs) and religious organisations, and in the form of emergency relief aid from the EU's European Commission Humanitarian Office (Verwer 1999).

The official government policy is to allow milk imports as long as proper taxes are paid. Recent outcries from the private milk-processing sector have forced the government to review this policy with a view to reviewing tax regimes vis-à-vis subsidised milk imports to protect the local industry against dumping.

Conclusions

- The dairy industry in Tanzania has come a long way. From the state-owned farms and processing plants of the 1970s and 1980s, the private sector including smallholder farmers is playing an increasingly important role in milk production, processing and marketing.
- Traditional dairy cattle still contribute a significant amount (over 75 of the estimated 886 million litres of milk produced and consumed).
- The contribution of the smallholder production is presently about 30% and is increasing, but accounts for over 85% of marketed milk.
- Total processing capacity is about 400 thousand litres/day, about 67% of the capacity required to supply Tanzania with about 500 thousand litres of milk/day in the 236 million litre/annum milk market. Current actual processing throughput is only about 80–90 thousand litres/day; this is achieved by about a dozen small-scale to medium-scale dairy processing plants.
- The per capita consumption remains low at about 22 litres/annum, but demand is conservatively estimated to grow to 1.33 billion litres, leaving a supply gap of about 170 million litres/annum (466 thousand litres/day) by the year 2010. Imports are currently estimated at 27 million litres LME/annum (74 thousand litres/day) and are projected to increase.

- The prognosis for the future of the dairy industry in Tanzania is good given the way dairying is spreading rapidly to non-traditional dairying areas in response to the economic opportunities it provides to milk producers and the growing domestic market demand.

References

- Keregero M.M. 1988. The role of the livestock sector in preventive nutrition programmes. *Proceedings of the Tanzania Society of Animal Production* 15:280–296.
- Kurwijila L.R. 1996. Challenges and coping strategies for the Tanzania dairy industry to satisfy the future demand for milk and milk products by the growing human population. *Proceedings of the Tanzania Society of Animal Production* 23:1–22.
- Kurwijila L.R., Jorgensen P. and Mdoe N.S.Y. 1997. *Market oriented dairying: The case of Tanzania. Paper presented at the FAO workshop held at Anand, India, 1–3 December 1997.* FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. pp. 86–102.
- Lohay A.B. 1988. Contribution of the milk processing industry towards the national nutritional demand in Tanzania. *Proceedings of the Tanzania Society of Animal Production* 15:243–279.
- MoAC (Ministry of Agriculture and Co-operatives). 1997. *The agricultural policy of Tanzania.* Government Printer, Dar es Salaam, Tanzania.
- MoAC (Ministry of Agriculture and Co-operatives)/SUA (Sokoine University of Agriculture)/ILRI (International Livestock Research Institute). 1998. *Rapid appraisal of the Tanzania dairy subsector: Executive summary.* Volume 1. ILRI, Nairobi, Kenya.
- MALDC (Ministry of Agriculture, Livestock Development and Co-operatives). Budget speech, 1997/98 to 1998/99.
- Msanga Y.N., Brayant M.J. and Katule A.M. 2001. Effect of environmental factors on lactation performance of crossbred dairy cattle on smallholder farms in northern Tanzania. *Tanzania Journal of Agricultural Science* 3. (in press).
- Mtumwa A. and Mwashia P.S. 1995. The strategy for sustainable dairy development in Tanzania. *Proceedings of the Tanzania Society of Animal Production* 22:1–13.
- Mugittu F.V. 1999. A survey of cost of smallholder milk production in the southern highlands of Tanzania. Southern Highlands Dairy Development Programme, Tanzania. Unpublished report.
- NEI (Netherlands Economic Institute). 1999. Livestock sector review. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. Mission Report. NEI, Rotterdam, The Netherlands.
- Silas O., Masuruli B. and Stanslaus D. 1998. Privatisation of the dairy sector services: Its effect to the smallholder farmers in Kagera and the role of KALIDEP project. In: de Wolff et al. (eds), *Proceedings of the 2nd National Dairy Development Conference held at Arusha, Tanzania 5–7 August 1998.* Ministry of Agriculture and Co-operatives. pp. 18–29.
- Stewart P. 2000. Project proposal towards the revival of the Tabora Dairy. Unpublished.
- SUA (Sokoine University of Agriculture)/ILRI (International Livestock Research Institute). 2000. A PRA report on milk marketing study in Greater Dar es Salaam and Mwanza milk market. Unpublished report.
- Sumberg J. 1996. Livestock production in peri-urban areas of Africa: An analysis of Dar es Salaam, Mwanza and Shinyanga in Tanzania. Unpublished research report submitted to the ODA Livestock Systems Research Programme. Overseas Development Group, University of East Anglia, Norwich, UK.

- Sumberg J.E. 1997. Policy, milk and the Dar es Salaam peri-urban zone: A new future or an old development theme? *Land Policy* 14(4):277-293.
- Verwer S. 1999. Exporting milk to Tanzania and Jamaica. PhD thesis, University of Wageningen, Wageningen, The Netherlands.
- de Wolf J. 1999. Economics of dairy farming in Dar es Salaam. *Proceedings of the Tanzania Society of Animal Production* 26:29-37.

Smallholder dairy production and marketing in eastern and southern Africa: Regional synthesis

H.G. Muriuki¹ and W. Thorpe²

1. Ministry of Agriculture and Rural Development, P.O. Box 30028, Nairobi, Kenya

2. International Livestock Research Institute, P.O. Box 30709, Nairobi, Kenya

Introduction

The production of milk for the market (dairy production) in eastern and southern Africa (E&SA) has some common characteristics. In all countries except South Africa and Zimbabwe, it is dominated by smallholders. With the exception of Sudan and Somalia, where camels make a major contribution, cattle are by far the largest source of marketed milk (Table 1). Milk is produced in three systems: by pastoralist herds; by herds kept by agro-pastoralists; and by crop-livestock farmers (Walshe et al. 1991). The demand for milk by the producer household and its neighbours, the potential to produce a surplus over these requirements and the accessibility of 'external' markets, particularly urban centres, determine the level of milk off-take and therefore the importance of marketed milk production in each of these systems (de Leeuw et al. 1999). Consequently, in E&SA the importance or otherwise of smallholder dairy systems reflects the proximity to major markets, the dietary and cattle (or camel) keeping habits of the local population and the milk production potential of the farming system.

While in the arid, semi-arid and highland zones of E&SA there is a long tradition of cattle (or camel) keeping and milk consumption, cattle production in the more humid zones has been constrained by tick-borne diseases and trypanosomosis, resulting in the predominance of sheep and goats and minimal milk production and consumption (de Leeuw et al. 1999; Kurwijila 2002a). As a result, smallholder dairy systems in E&SA tend to be concentrated in the (subhumid) highlands, the wetter semi-arid and drier subhumid areas, and near to or within urban consumption centres (Walshe et al. 1991). Less proximate production occurs only in those regions with concentrations of traditional consumers and/or with an efficient market infrastructure (Kurwijila 2002a; Muriuki 2002; Omiti 2002; Tsehay 2002).

The majority of the rural systems producing marketed milk in E&SA are integrated crop-dairy systems, which benefit from the positive synergies between the dairy enterprise, staple food crops (generally maize) and any cash cropping (Kurwijila 2002a; Muriuki 2002; Staal 2002). On the other hand, the potential for marketed milk production from pastoralist and agro-pastoralist systems generally depends on the cost of collection and transport of milk that is surplus to producer household needs, which is largely determined

Table 1. *Total milk availability for sub-Saharan Africa (SSA) and in selected countries of eastern and southern Africa, 1985 and 1998.*

SSA and selected countries of eastern and southern Africa	Percentage of total milk availability										
	Total milk availability ($\times 10^3$ t)			Cows' milk		Buffalo milk		Milk of other species		Net imports	
	1985	1998	Change	1985	1998	1985	1998	1985	1998	1985	1998
Total SSA	13,728	17,432	2704	57	63.5	0	0	26.9	26.5	16.1	9.9
Ethiopia	1125	1170	45	60.7	80.1	0	0	19.6	19	19.7	0.9
Kenya	1656	2421	765	89.6	94	0	0	7.6	5.9	2.8	0.1
Madagascar	484	536	52	94.7	97	0	0	0	0	5.3	3
Somalia	2412	2263	-149	19.5	24.9	0	0	77.1	74.6	3.4	0.5
Sudan	2637	4557	1920	63.9	64.1	0	0	31.8	35.3	4.3	0.6
Tanzania, United Republic of	530	724	194	81.1	85.4	0	0	12.8	13	6.1	1.5
Uganda	377	485	108	94	98	0	0	0	0	6	2
Zimbabwe	530	552	22	98.1	105.1	0	0	0	0	1.9	-5.1

Source: Tambi et al. (2001).

by the distance to a consumption centre (Omiti and Staal 1996; Omiti 2002). If there is demand for an easily transported dairy product such as butter, which dominates the Ethiopian dairy market (Tsehay 2002), these costs will be lower than for liquid milk. Conversely, where demand for fresh liquid milk and production is close to a concentration of consumers, pastoralists and agro-pastoralists are able to compete with peri- and intra-urban dairy producers, as shown by Maasai herders in Tanzania supplying the major market of Dar es Salaam (Kurwijila 2002a).

It is these characteristics of smallholder dairying which explain the large variation in dairy consumption, production and marketing amongst and within the countries of E&SA, and which determine the technical, policy and institutional challenges affecting smallholder dairy development.

Milk availability and consumption

Tambi et al. (2001) have reported a comprehensive analysis of the patterns of change from 1985 to 1998 in dairy consumption and production in developing countries, including results for individual countries in E&SA. The measure of milk consumption used in their study is a simplification of the system used by the Food and Agriculture Organization of the United Nations (FAO) in its 'food balance sheets'. It uses 'domestic supply' without adjustments for changes in stocks and is referred to as 'milk availability', calculated as domestic production plus net imports. In the absence of documented studies on actual consumption in the majority of countries in E&SA, the estimates of Tambi et al. (2001) give a reasonable comparative picture of the regional variation in dairy consumption.

The analyses show that in 1998, developing countries had over 228 million tonnes of milk available for consumption and other uses. Of this total, India alone had 31% and sub-Saharan Africa (SSA) only 8%. Whilst camels' milk was not important in west, central and southern Africa, it was in eastern Africa (Table 1). Nevertheless, cows' milk dominates marketed milk production throughout the region. In SSA, net imports accounted for only 10% in 1998, down from 16% in 1985. These imports were mainly serving consumers in West and Central Africa. In E&SA, net imports formed a very small proportion of available milk (Table 1) indicating the high degree of self-sufficiency in production of milk and dairy products in the region, which is an oft-stated national policy (e.g. in Ethiopia, Tsehay 2002; and Tanzania, Kurwijila 2002b).

Between 1985 and 1998, of all developing country regions except West Asia and North Africa (WANA), SSA had the smallest percentage increase in total milk availability (27%). Kenya and Sudan accounted for over 70% of the change (Table 1). The insecurity and political instability in many eastern and southern African countries, e.g. Angola and Somalia, contributed to the region's relatively poor performance, which in turn affected availability per capita.

What is more, from 1985 to 1998, milk availability in SSA grew less rapidly than the human population, such that by 1998 SSA experienced a decrease of approximately 4 kg in milk availability per capita (Table 2). While cows' milk production per capita decreased in several countries in E&SA, it increased for the region as a whole because Sudan and

Kenya—the region’s largest milk producers—reported significant increases in cows’ milk production. Although net imports and production from other species declined in Kenya, the increase in cows’ milk production more than compensated for the decline. As a result, there was an overall increase in total milk availability per capita, which was reported as 85 kg in 1998 (Table 2). This value was approximately four times higher than the availability in Ethiopia and Tanzania, and approximately double that of Zimbabwe (countries including large areas with endemic trypanosomosis and tick-borne diseases), but much lower than for Sudan and Somalia, countries with many pastoral people.

Neighbouring countries, such as Ethiopia, Somalia, Tanzania and Uganda, exhibited different patterns of change of milk availability (Table 2). In Ethiopia (including Eritrea), per capita availability decreased between 1985 and 1998 by 21% from the already low level of 26 kg. This was due to decreases per capita in net imports and in milk production from ‘other species’. Somalia, Tanzania and Uganda each experienced a decline in domestic production and net imports. In southern Africa, Zimbabwe exhibited a similar pattern of change to those of the eastern African countries. Between 1985 and 1998, availability per capita decreased by 14 kg, mainly because of declining production of cows’ milk and a reduction in net imports (Table 2). These changes reflect the rapid growth of the country’s human population, the decline of the dairy herd in the large-scale commercial sector and the slow development of smallholder dairying (Smith et al. 1998).

Kurwijila (2002a) reports that dairy consumption has risen faster in urban and peri-urban areas of Tanzania than in rural areas because of the growth in peri-urban and intra-urban dairy herds and the increased availability of milk and dairy products for urban consumers. In Dar es Salaam, for example, the dairy cattle herd increased from about 2 thousand in 1984 to over 20 thousand head by 1995. Consequently, the per capita consumption is much higher in urban centres (40 litres/annum) than in rural areas (15–20 litres/annum) (Kurwijila 2002a). On the other hand, Muriuki (2002) cites recent results for the central region of Kenya, where smallholder dairy production is a major part of the farming system. These data show that dairy consumption is higher in rural producer areas than in the major urban centres of Nakuru and Nairobi where, unlike in Dar es Salaam, urban dairy production is not common.

These results suggest the need in the E&SA region for more detailed studies of dairy consumption levels and their patterns, and for a better understanding of the factors affecting these levels and their likely trends over the next 10–20 years. Only with use of reliable estimates of current and projected demand will producers, processors, market agents, and the technicians and policy makers who serve them, be able to support the development of smallholder dairy through efficiently meeting consumers’ needs.

Dairy production systems

As for milk availability, Tambi et al. (2001) have estimated the changes in milk production from 1985 to 1998 in developing countries. For E&SA, the results relate to cattle, the dominant dairy species in most countries in the region (Tables 3 and 4). In addition, the authors ‘decomposed’ the changes in milk production due to changes in total herd size

Table 2. *Per capita milk availability (kg) for sub-Saharan Africa (SSA) and in selected countries of eastern and southern Africa, 1985 and 1998.*

SSA and selected countries of eastern and southern Africa	Total milk availability (kg)		Cows' milk (kg)		Buffalo milk (kg)		Milk of other species (kg)		Net imports (kg)	
	1985	1998	1985	1998	1985	1998	1985	1998	1985	1998
Total SSA	59.5	55.4	33.9	35.2	0	0	16	14.7	9.6	5.5
Ethiopia	25.6	20.1	15.6	16.1	0	0	5	3.8	5	0.2
Kenya	83.3	85.1	74.7	80.1	0	0	6.3	5	2.4	0.1
Madagascar	47.8	36.7	45.3	35.6	0	0	0	0	2.6	1.1
Somalia	367.2	256	71.7	63.7	0	0	283.2	191	12.3	1.3
Sudan	122.9	164.4	78.5	105.3	0	0	39.1	58.1	5.2	1
Tanzania, United Republic of	24.3	23	19.7	19.7	0	0	3.1	3	1.5	0.4
Uganda	25.6	24.2	24.1	23.8	0	0	0	0	1.5	0.5
Zimbabwe	63.1	49.2	62	51.7	0	0	0	0	1.2	-2.5

Source: Tambi et al. (2001).

Table 3. *Cattle numbers and milking cows in sub-Saharan Africa (SSA) and in selected countries in eastern and southern Africa, 1985 and 1998.*

SSA and selected countries in eastern and southern Africa	Total cattle ($\times 10^3$)		Change	Milking cows ($\times 10^3$)		Change	Milking cows (%)		Change
	1985	1998	1985-98	1985	1998	1985-98	1985	1998	1985-98
Total SSA	154,630	192,586	37,957	24,310	31,967	7656	15.7	16.6	0.9
Ethiopia	28,000	34,514	6514	3567	4507	940	13	13	0
Kenya	12,727	13,418	691	3209	4494	1284	25	33	8
Madagascar	10,255	10,331	76	1735	1870	135	17	18	1
Somalia	4454	5433	980	1158	1413	255	26	26	0
Sudan	20,536	33,119	12,583	3510	6083	2573	17	18	1
Tanzania, United Republic of	12,593	14,163	1570	2680	3267	586	21	23	2
Uganda	5064	5438	374	1013	1358	345	20	25	5
Zimbabwe	5582	5429	-154	1170	1317	147	21	24	3

Source: Tambi et al. (2001).

Table 4. Cow's milk production and yield per cow in sub-Saharan Africa (SSA) and in selected countries in eastern and southern Africa, 1985 and 1998.

	Total cows' milk ($\times 10^3$ t)		Change	Annual growth (%)	Yield (kg/cow)		Change
	1985	1998	1985–1998	1985–98	1985	1998	1985–1998
Total SSA	7827	11,040	3214	3.2	322	345	23
Ethiopia	683	941	258	3	192	209	17
Kenya	1484	2277	793	4.1	462	507	44
Madagascar	458	520	62	1	264	278	14
Somalia	471	563	93	1.5	407	399	–8
Sudan	1685	2920	1235	5.6	480	480	0
Tanzania, United Republic of	430	618	188	3.4	160	189	29
Uganda	355	475	121	2.6	350	350	0
Zimbabwe	520	580	60	1	444	441	–4

Source: Tambi et al. (2001).

(herd effect), the proportion of animals milked (milking effect) and the productivity per animal (productivity effect) (Table 5). The analyses showed that SSA had the lowest milk production per cow of all regions of the developing world. Similarly, between 1985 and 1998, SSA had the smallest increases in the proportion of animals milked and their productivity.

Most cows' milk production in SSA was concentrated in eastern Africa; Sudan, Kenya, Ethiopia, Somalia and Tanzania were the top five countries producing about two-thirds of the total cows' milk in the continent (Table 4). For the period 1985 to 1998, these eastern African countries demonstrated different patterns of change in cows' milk production, in part because unlike the cattle population in Kenya, the large cattle populations of Sudan, Ethiopia and Eritrea had relatively limited numbers of exotic dairy cattle and their crosses (Table 6; Tsehay 2002). Partially as a consequence, milk yields increased by only 17 kg/animal per year in Ethiopia and Eritrea (Table 5); this small increase accounted for one-quarter of the total increase in milk production. An increase in the size of the cattle herd by 6.5 million head also contributed significantly to the increase in milk production. In Sudan, milk yield per milking cow stagnated, whilst the high growth in the cattle herd accounted for >80% of the increase in milk production (Table 5). A similar pattern was noted in Uganda, where milk yield was static with the increase in milk production coming mostly from expansion of the herd and the proportion of animals milked.

In Kenya, where 60% of milk comes from dairy cattle (Muriuki 2002), milk yields/cow were more than double those in Ethiopia (Table 4), but they grew only marginally faster (about 44 kg/animal) than in Tanzania. An increase in the proportion of milking animals from 25 to 33% of the herd contributed >60% of Kenya's 800 thousand tonnes increase in milk production. The increase in productivity contributed about one-fifth of the increase in milk production (Table 5). By contrast, in Somalia increases in cattle numbers were responsible for the entire increase in milk production, while in Zimbabwe a change in the herd structure towards increased milking was responsible for the entire increase in milk production between 1985 and 1998 (Table 5).

Relative to all other countries in E&SA, Kenya has a very large herd of exotic breed dairy cattle and their crosses. The Kenyan dairy herd probably accounts for over 75% of all specialised dairy cattle in E&SA (Table 6). These dairy cattle, the descendents of the cattle from European settler farms established almost a century ago (Conelly 1998), are predominantly owned by smallholders (Muriuki 2002). Several major factors have contributed to the widespread adoption of dairying by smallholders in Kenya (Muriuki 2002; Omiti 2002) including: the importance of milk in the diets of most Kenyan communities; a favourable production environment (mid to high altitudes with bimodal rainfall); the presence of the original settler dairy cattle population; and policy and institutional environments (through to the early 1990s) conducive to large- and small-scale dairying. As for Kenya, in Tanzania the exotic breed-based dairy cattle population produces the majority of the country's marketed milk (Table 6; Kurwijila 2002a). It is significant that, in common with the systems in Kenya, approximately 65% of Tanzania's dairy cattle are located in the bimodal rainfall northern highlands in smallholder crop-dairy systems that support high human population densities (Omore and Staal 1998). It is these areas of good potential for biomass production, combined with ready markets for milk, which have significant potential for smallholder dairy development in E&SA.

Table 5. Sources of change in cows' milk production in sub-Saharan Africa (SSA) and in selected countries in eastern and southern Africa, 1985–98.

	Sources of change ($\times 10^3$ litres)					Change in per capita production (kg)	Sources of change (% of total)			
	Herd effect	Milking effect	Productivity effects	Interaction effects	Total change		Herd effect	Milking effect	Productivity effects	Interaction effects
Total SSA	1921	437	569	286	3214	0.4	60	14	18	9
Ethiopia	159	17	62	20	258	0.5	62	7	24	8
Kenya	81	487	142	83	793	5.4	10	61	18	10
Madagascar	3	32	24	2	62	-9.7	6	52	39	3
Somalia	104	0	-9	-2	93	-8.0	112	0	-10	-2
Sudan	1032	126	0	77	1235	26.8	84	10	0	6
Tanzania, United Republic of	54	36	77	21	188	-0.1	28	19	41	11
Uganda	26	88	0	7	121	-0.3	22	73	0	5
Zimbabwe	-14	82	-5	-3	60	-10.2	-24	136	-8	-5

Source: Tambi et al. (2001).

Table 6. Dairying in eastern and southern Africa: Cattle, milk production and per capita milk availability.

Parameter		Kenya	Tanzania	Uganda	Ethiopia	Malawi	Zambia	Zimbabwe
Cattle ($\times 10^3$ head)	Zebu	10,400	13,900	5400	34,500	732	2275	4400
	Dairy	3045	250	150	120	12	23	150
Percentage dairy cattle		23	2	3	<1	2	1	3
Annual milk production ($\times 10^3$ litres)		3075	814	485	1170	33	59	570
Annual per capita milk availability (litres) LME*		85	23	24	20	4	8	49

* LME = liquid milk equivalent.

Sources: Omiti and Staal (1996); Omore and Staal (1998); Mpofu (1999); Tambi et al. (2001); Tsehay (2002).

By contrast, in Malawi, South Africa and Zimbabwe, the mid altitude, mono-modal rainfall agro-ecologies of southern Africa (with their lower potential for biomass production), the risk for cattle diseases and, until recent years, the policy and institutional environments have inhibited adoption of dairy production by smallholders. Consequently, their dairy cattle populations are small relative to their total cattle populations (Table 6; Smith et al. 1998; Mpofu 1999). Furthermore, as yet, market mechanisms are not in place to extract milk from traditional systems, which, in any case, are largely in agro-ecologies adverse to producing milk in excess of the needs of the producer households and their neighbours.

Most countries in E&SA have, therefore, not benefited in the way that Kenya has and to lesser extents Tanzania and Uganda have from smallholder dairy development. As Muriuki (2002) reports, dairying in Kenya has become a very significant source of income to the estimated 625 thousand smallholder producer households and to those employed in the marketing of milk, in total some 25% of all households. In addition, dairying plays a crucial role in sustaining smallholder crop-dairy systems through nutrient cycling within the systems (Kurwijila 2002a; Muriuki 2002; Staal 2002) which, along with the adoption of planted forage and agro-forestry technologies, has played a crucial role in the development of crop-dairy systems that sustain increasingly high human population densities, even in some semi-arid areas (Tiffen et al. 1994).

In the face of sub-division of family farms as land passes from generation to generation, adopting dairying and owning a dairy cow (most households own only one or two) is, therefore, a means of survival for many smallholder families in Kenya (Muriuki 2002). It is also a potential means of accumulating some capital. Incremental daily inputs of labour, land, feed and other inputs over time are accumulated and compounded in the form of an additional cow or heifer, or a saleable male (Staal 2002). These animals may be sold when needed to meet lump-sum expenditures, such as school fees or medical bills, or to invest in upgrading farm facilities. As such in E&SA and particularly in Kenya, smallholder dairy represents an important tool in reducing poverty in rural and peri-urban areas. Whereas, at times it is argued that those already owning dairy cattle are not poor, most smallholders practising dairying were poor and struggled to acquire their first cow. Dairying was a means to escape poverty and to sustain their families, with particular benefits accruing to women and children (Kurwijila 2002a and b; Muriuki 2002; Omiti 2002; Tsehaye 2002; Staal 2002; Tangka et al. 1999).

Throughout E&SA, returns to dairying vary considerably because producer prices for milk vary between surplus and deficit and between urban and rural areas, and because costs of production vary depending on the production system and whether outputs other than milk are valued products (Kurwijila 2002a). For example, in northern Tanzania, manure and heifers are particularly important outputs in the coffee/banana $\times$ zero-grazed dairy-based economies where manure is ranked second in value after milk (Rugambwa et al. 1995). However, Kurwijila (2002a) concludes that the cost of producing milk in Tanzania is seemingly higher than in neighbouring Kenya and Uganda, where farmers accept lower prices for both milk and heifers.

In Kenya, the costs of and returns to production have been estimated recently for two contrasting sites (Staal 2002). The first was an area of relatively extensive crop-dairy production in Nakuru, Rift Valley, where farmers keep three to five crossbred dairy cattle

and rely mostly on grazing. The second was in Kiambu in the intensive central highlands, where land sizes are smaller (an average of two acres), so farmers keep two to three high-grade dairy cattle. Because the land is not able to provide adequate animal nutrition, farmers purchase some fodder and concentrate feeds. Profits to dairy production were US\$ 0.02 and 0.04/litre for the extensive and intensive sites, respectively. These were returns after normal wage costs (currently, rural wages are approximately US\$ 25/month) had been deducted for the family labour. They suggest that smallholder dairying can compete well against alternative enterprises available to the farmers. Staal (2002) suggests that these two sites are representative of the important dairy production areas of highland eastern Africa and that the results imply good opportunities for smallholder dairy producers in the region.

In summary, there is much variation in the level of adoption of market milk production (dairy production) by smallholders in E&SA. Particularly Kenya, and to some extent Tanzania and Uganda, have significant dairy subsectors based on smallholders, the outputs of which are reflected in high per capita availabilities of milk (Tables 2 and 6). By contrast, the high per capita availability of milk in Zimbabwe (Table 6) and South Africa reflect their continuing dependence on large-scale production units. Factors explaining this marked variation and underpinning the high adoption of smallholder dairying in East Africa include: the importance of milk in the diets of rural communities and urban consumers; a favourable production environment (mid to high altitudes with bimodal rainfall); the availability of the original settler dairy cattle populations; and policy and institutional environments (through to the late 1980s/early 1990s) conducive to smallholder dairying.

Constraints to increased productivity in current systems include: inadequate year-round feeding; losses from cattle diseases, particularly tick-borne diseases; and poor access to input and output market services. In much of E&SA, the lack of adequate feed (particularly in the mono-modal rainfall areas) and disease challenge, interacting with a lack of veterinary services, inhibit the adoption of dairying by smallholders. Because of the resultant low milk production densities (litres/km²), these constraints impose a very high cost on attempts to introduce milk collection schemes and related output market services. Until these interacting inhibitory factors are addressed, increased milk production in the region (and in West and Central Africa) is likely to continue to result from expansion of the indigenous cattle population and some increase in the proportion milked, with relatively little coming from increases in productivity (which are usually associated with the use of exotic dairy breeds and their crosses).

Milk marketing systems

In most of E&SA, milk production and marketing systems are those described by Tsehay (2002) for Ethiopia: an urban system; a peri-urban milk system; and a rural system. While in Ethiopia, butter is the predominant traded product (Tsehay 2002), generally consumers in E&SA demand fresh liquid milk and its marketing is dominated by traditional (the so called 'informal') markets, with only small proportions of total production being marketed through a cold-chain, pasteurised process (the so called 'formal' market). For example, in Ethiopia the proportion of total marketed milk sold formally is very small (Tsehay 2002);

in Tanzania and Uganda it is estimated at <5% (Omiti and Staal 1996; Kurwijila 2002a) and in Kenya it is about 15% (Omore et al. 1999). Approximately 30–35% of production is consumed on farm (by the family and calves), with the balance (generally four to six litres) marketed.

In the dominant traditional (or ‘informal’) markets, the milk may pass straight from the producer to a domestic or institutional consumer, or it may pass through two or more market agents before reaching the consumer (Staal et al. 1997; Omiti 2002). Tsehay (2002) and Kurwijila (2002a and b) have noted the importance of intra-urban dairy production in Ethiopia and Tanzania, which, as for peri-urban systems, shortens the market chain for the fresh milk that is preferred by the majority of consumers. As the majority of those consumers have no access to refrigeration, invariably, the custom is to boil the milk to extend its shelf life (Walshe et al. 1991; Omiti and Staal 1996; Kurwijila 2002a; Muriuki 2002; Redda 2002).

As Omiti (2002) has discussed for Kenya, the macro-economic reforms implemented or being implemented in E&SA, have increased the competition for marketing functions (such as collection, transportation, processing and distribution/retailing) and have resulted in increased income and employment opportunities, especially for small-scale milk traders (Omiti and Muma 2000). Many sell <120 litres of milk per day, but this business activity enables them to earn a daily income equal to approximately twice the national average (Omore et al. 1999; Staal 2002), which represents a significant contribution to poverty reduction. Similar estimates are available for Tanzania (Kurwijila 2002b) and Uganda (Omiti and Staal 1996), and presumably are estimable for southern African countries like Malawi and Zimbabwe, where there are some indications that enforcement of regulations banning the informal marketing of milk is being relaxed. In the face of these strong informal markets, many governments are having to address how best to ensure fair competition between the ‘formal’ and ‘informal’ markets to the benefit of producers and consumers, most of whom are in low-income households (Muriuki 2002; Omiti 2002).

Input services

In the same way that policy and institutional reforms are being implemented to support competitive milk marketing, public institutions and the private sector in many E&SA countries are trying to develop innovative and progressive institutional mechanisms for input services. These include efforts to encourage the formation of rural savings and credit co-operative organisations. As Omiti (2002) points out, where cash is a serious constraint to dairy development for subsistence-oriented farmers, designing appropriate institutional mechanisms of availing credit is a prime concern.

Other input markets serving smallholder dairying are also major concerns. The 1980s and 1990s have seen most E&SA countries experience the collapse of some and the decline of the remainder of government input services (veterinary, artificial insemination (AI) and extension advisory services) for smallholders, with an increased reliance for service delivery on the private sector, including community-based organisations (CBOs) and co-operatives

(Owango et al. 1998). Clinical and preventive veterinary services have been a prime target for privatisation (Tambi et al. 1997 and 1999).

Nahdy (2002) articulates eloquently these issues as faced by Uganda and describes its government's radical plans for restructuring research and extension services, and their decentralised funding and management by local communities. Complementary to and underpinning this will have to be a mindset shift by technicians and their managers to participatory approaches for research and extension services for smallholders, such as the steps reported by Mwangi and Wambugu (2002) for improving the availability of feed resources in Central Kenya. Their efforts are building upon the experiences gained in Coastal Kenya, where gender-sensitive, client-oriented research and extension support was developed for smallholder dairy producers and the early adopters of dairy production (Maarse et al. 1998).

As Kurwijila (2002b) states, with the current move to privatise most government services, the challenging question is how to internalise costs such as those for research and extension services, training, the control of epidemic diseases and the delivery of AI services which have elements of public goods; the cost of these services may well be beyond the reach of smallholder farmers, at least in the short term. The Ugandan example (Nahdy 2002) is one approach, which includes the implicit gradual scaling down of donor/government subsidies (Kurwijila 2002b; Omiti 2002). Certainly, the priority for the shift from public to private delivery of input services is a managed transition (Kurwijila 2002b; Muriuki 2002), not the often observed sudden withdrawal of operating funds to government agencies to the detriment of the livelihoods of many rural households.

Policy and institutional issues

Although it has been shown that in E&SA smallholders are competitive in dairy production, it is probable that policy interventions will be required to sustain their viability, especially to support the more widespread adoption of dairying by smallholders within the region (Omiti 2002; Staal 2002). This is because the small scale of milk production and marketed output implicit to smallholder systems can often result in low bargaining power and limited ability to capture economies of scale in marketing. As was described in the section on milk marketing systems, farmers use a variety of strategies to overcome this. The first approach is generally to sell their milk directly through the informal market to consumers, thereby achieving higher prices and reducing transactions costs (Staal 2002). The use of milk traders to bulk milk, and perform distribution and marketing services is also common. Dairy farmer co-operatives and other farmer groups, if efficiently managed, can improve the market position of smallholder farmers through collective actions (Owango et al. 1998; Kurwijila 2002b; Muriuki 2002; Omiti 2002; Tsehay 2002). Policies that support these activities, and do not interfere with individual market activities of farmers and traders, are likely to sustain competitiveness of producers and contribute effectively to improved rural and peri-urban livelihoods.

Kurwijila (2002b) has also stressed the need for improvements in processing, quality assurance and efficiency if the smallholder dairy subsector in Tanzania and elsewhere is to

survive in an increasingly liberalised global market. He argues that this will require self regulation rather than control from the government, which, by implication, means that the industry will have to organise itself to better face the challenges of today and tomorrow. Currently, there is movement in E&SA towards stakeholder-managed national dairy boards with efforts to ensure the effective representation of and voice for the smallholders and their market agents who dominate dairy production and marketing.

Likewise, the continued privatisation of input services will function for those services and regions where smallholders can afford the costs of targeted quality services (Tambi et al. 1999; Kurwijila 2002b), but for other services and in more marginal areas, public support may continue to be needed (Tambi et al. 1997; Omiti 2002; Staal 2002). These input services include research and extension, as discussed by Nahdy (2002) and others. Last, but by no means least, is the urgent need in the E&SA region for more investment in national infrastructure such as rural access roads, water supplies and electricity distribution (Muriuki 2002). Such investment would ensure that these essential public services are available to support the smallholder production and marketing of perishable products like milk.

Conclusions and challenges

Delgado et al. (1999) presented a convincing case for continued demand-driven dairy development to 2020 through which smallholders, including those in E&SA, if given adequate technological, policy and institutional support, will benefit by meeting the projected large increases in milk consumption. The projected estimates of increased demand for milk are based upon the expected growth of the human population, its urbanisation and its increased purchasing power (Delgado et al. 1999). In E&SA, as elsewhere, the 'white revolution' as some have called it, is therefore linked to overall economic performance (especially the creation of urban jobs). Current political and economic uncertainties in E&SA, the importance to dairy development of government reform processes, including the need for urgent public investment in infrastructure (especially roads and water supplies), allied to the unfolding tragedy of AIDS and its effects on communities and their productivity, suggest that some re-examination of the projections for E&SA may be required. A re-examination would serve to guide and stimulate more-focused national and regional programme support for smallholder dairy development.

An important part of that re-evaluation should be *ex-post* impact assessment studies of dairy development in the region, including evaluation of the returns to the many major project investments during the last 40 years (e.g. in Tanzania; Kurwijila 2002b). Many useful lessons can be learnt from the successes and the more numerous failures of past efforts.

These analyses should be guided by the broad conclusion from this synthesis (and the earlier study by Walshe et al. 1991) that the factors explaining the marked variation in adoption of smallholder dairying in E&SA are: whether or not milk is important in the diets of rural communities and for urban consumers; whether there is a favourable agro-ecological environment for producing milk in excess of the needs of the producers' households and their neighbours; whether urban consumer centres are accessible by smallholder producers; whether there are sources of dairy genotypes; and whether policy

and institutional environments are conducive to smallholder dairying. Without good access to efficient output and input markets (including research and extension services), favourable production environments will not be enough to stimulate smallholder production in the areas of E&SA where, as yet, dairy development has been slow.

Therefore, the major challenges to be faced in E&SA are the need for:

- Better information on the demand for milk and dairy products and the determinants of that demand
- An understanding of the lessons learnt from the wide variation in dairy development in the region and identification of the determinants of that variation
- Communication of those lessons to policy makers and development planners backed by estimates of the aggregate value to society of dairy development, especially smallholder dairy development and
- Stimulation of a change of mindset amongst many advisers and technicians from a supply-driven to a demand-driven development process.

References

- Conelly W.T. 1998. Colonial era livestock development policy: Introduction of improved dairy cattle in high-potential farming areas of Kenya. *World Development* 26:1733–1748.
- Delgado C., Rosegrant M., Steinfeld H., Ehui S. and Courbois C. 1999. *Livestock to 2020: The next food revolution*. Food, Agriculture and the Environment. Discussion Paper 28. IFPRI (International Food Policy Research Institute), Washington, DC, USA; FAO (Food and Agriculture Organization of the United Nations), Rome, Italy; and ILRI (International Livestock Research Institute), Nairobi, Kenya. 72 pp.
- Kurwijila L.R. 2002a. Dairy development in Tanzania: Country paper. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Kurwijila L.R. 2002b. An overview of dairy policies in Tanzania. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- de Leeuw P.N., Omore A., Staal S. and Thorpe W. 1999. Dairy production systems in the tropics. In: Falvey L. and Chantalakhana C. (eds), *Smallholder dairying in the tropics*. ILRI (International Livestock Research Institute), Nairobi, Kenya. pp. 19–37.
- Maarse L., Wenholt W. and Chibudu A. 1998. *Making change strategies work: Gender sensitive, client oriented livestock extension in Coast Province, Kenya*. Royal Tropical Institute, Amsterdam, Netherlands. 114 pp.
- Mpofu N. 1999. *Sourcing of dairy cattle by smallholder farmers in southern Africa*. Market-oriented Smallholder Dairy Project Working Document 6. ILRI (International Livestock Research Institute), Nairobi, Kenya. 15 pp.
- Muriuki H.G. 2002. Smallholder dairy production and marketing in Kenya. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints*.

- Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.* NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Mwangi D.M. and Wambugu C. 2002. Forage legume technologies: Participatory experiences with farmers and community based organisations in central Kenya. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.* NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Nahdy S.M. 2002. Decentralisation of services in Uganda: The formation of national agricultural advisory services. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.* NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Omiti J.M. 2002. Impacts of liberalisation in Kenya's dairy sector. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.* NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Omiti J. and Muma M. 2000. *Policy and institutional strategies to commercialise the dairy sector in Kenya.* Occasional Paper 6/2000. IPAR (Institute of Policy Analysis and Research), Nairobi, Kenya.
- Omiti J. and Staal S. (eds). 1996. *The Ugandan dairy subsector: A rapid appraisal.* ILRI/NARO/MAAIF Research Report. ILRI (International Livestock Research Institute)/NARO (National Agricultural Research Organization of Uganda)/MAAIF (Ministry of Agriculture, Animal Industry and Fisheries of Uganda), Kampala, Uganda. 137 pp.
- Omoro A. and Staal S. (eds). 1998. *The Tanzania dairy subsector: A rapid appraisal. Volume 3—Main Report.* ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Omoro A., Muriuki H., Kenyanjui M., Owango M. and Staal S. 1999. *The Kenya dairy subsector: A rapid appraisal.* Smallholder Dairy (Research & Development) Project Report. Ministry of Agriculture/Kenya Agricultural Research Institute/International Livestock Research Institute, Nairobi, Kenya. 51 pp.
- Owango M.O., Staal S.J., Kenyanjui M., Lukuyu B., Njubi D. and Thorpe W. 1998. Dairy co-operatives and policy reform in Kenya: Effects of livestock service and milk market liberalisation. *Food Policy* 23:173–185.
- Rugambwa V.K., de Wolf J., Stanslaus D. and Litalala E.M. 1995. Credit facilities and heifer supply within the Kagera Livestock Development Programme, Tanzania. In: *Proceedings of the FAO (Food and Agriculture Organization of the United Nations) workshop on market orientation of small-scale milk producers and their organisations held at Morogoro, Tanzania, 20–24 March 1995.* pp. 66–76.
- Smith T., Titterton M. and Dube D. 1998. Dairy production systems in Zimbabwe. Paper presented at the BSAS (British Society of Animal Science) conference on food, lands and livelihoods held at Nairobi, Kenya, 27–30 January 1998.
- Staal S.J. 2002. Smallholder dairy competitiveness. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.* NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Staal S., Delgado C. and Nicholson C. 1997. Smallholder dairying under transactions costs in East Africa. *World Development* 25:779–794.

- Tambi E., Mukhebi A.W., Maina O.W. and Solomon H.M. 1997. *Privatisation of animal health services in Kenya: An evaluation of the Kenya Veterinary Association Privatisation Scheme (KVAPS)*. OAU (Organization of African Unity)/IBAR (Inter-African Bureau for Animal Resources)/PARC (Pan-African Rinderpest Campaign)/ILRI (International Livestock Research Institute) Report. ILRI, Nairobi, Kenya. 84 pp.
- Tambi N.E., Mukhebi W.A., Maina W.O. and Solomon H.M. 1999. Probit analysis of livestock producers' demand for private veterinary services in the high potential agricultural areas of Kenya. *Agricultural Systems* 59:163–176.
- Tambi E., Nicholson C., Staal S. and Thorpe W. 2001. Patterns of change in dairy production and consumption in developing countries from 1985 to 1998. *Market-oriented Smallholder Dairy Research Working Document 7*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 65 pp. (In press).
- Tangka F., Ouma E.A., Staal S.J. and Shapiro B. 1999. Women and the sustainable development of market-oriented dairying: Evidence from the highlands of East Africa. Paper presented at the international sustainable development research conference held at the University of Leeds, UK, 25–26 March 1999.
- Tiffen M., Mortimore M. and Gichuki F. 1994. *More people, less erosion: Environmental recovery in Kenya*. ACTS Press, Nairobi, Kenya.
- Tsehay Redda. 2002. Small-scale milk marketing and processing in Ethiopia. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Walshe M.J., Grindle J., Nell A. and Bachmann M. 1991. *Dairy development in sub-Saharan Africa: A study of issues and options*. World Bank Technical Paper 135. Africa Technical Department Series. The World Bank, Washington, DC, USA. 97 pp.

Smallholder dairy production and marketing constraints in Nigeria

M.L. Yahuza

Project Manager, National Livestock Project Division (NLPD), Federal Department of Livestock and Pest Control Services, 9 Yakubu Gowon Way, PMB 2222, Kaduna, Nigeria

Summary

Livestock production contributes about 12.7% of the agricultural GDP (gross domestic product) in Nigeria. Pastoral communities produce the bulk of milk consumed in the rural and urban areas of Nigeria.

The gap between supply and demand for dairy products is widening as a result of increases in population and urbanisation. Imports that used to bridge part of the gap have been declining as a result of devaluation of the Nigerian naira, (₦), (US\$ 1 = ₦ 113.5 in November 2001) and reductions in the importation of milk powder and butter oil. Consequently local collection, processing and marketing of milk is becoming increasingly competitive. The World Bank and the National Livestock Project Division (NLPD) seized the opportunity provided by this development to initiate a pilot dairy co-operation programme in Kaduna State.

The programme has progressed well and has been accepted by pastoralists. Over 36 associations have been formed of which 18 (with 1820 members) have been registered as co-operative societies. A number of associations are supplying milk to the scheme. An apex organisation, the Kaduna Federation of Milk Producers' Co-operative Association Limited, which trades under the name MILCOPAL, has been established.

MILCOPAL is responsible for the procurement, transportation, processing and marketing of milk on behalf of all the registered co-operative societies. The board of the federation, made up of all the chairpersons of the various societies including the Managing Director of the federation, is responsible for fixing the price of milk.

The programme has made a profound impact on the lives of the participating pastoralists. It has also established that small quantities of milk produced by smallholders can be collected, processed and supplied to urban areas. However, there are still some problems regarding seasonal fluctuations in production and consumption. Furthermore, a large volume of milk has to be collected from various routes to make the operation viable. A lot still needs to be done to ensure the sustainability and replication of the programme in other areas of the country.

Introduction

Livestock play a very important role in Nigerian agriculture contributing about 12.7% of the agricultural GDP (CBN 1999). The livestock population comprises about 14 million cattle, 34 million goats, 22 million sheep and about 100 million poultry (RIM 1990). Other livestock species of economic importance are donkeys, pigs and camels. The livestock subsector is dominated by traditional systems of production, processing and marketing. Transhumance pastoralists in the drier north of the country rear a very high proportion of the cattle herd and many sheep and goats.

Accurate statistics on livestock production and marketing are not available and therefore, detailed projections of the supply and demand of the livestock subsector cannot be realistically made. It is clear, however, that over the last decade the supply of meat, milk and eggs has failed to keep pace with the increasing population. Somehow, the price elasticity of dairy products has not effectively affected demand.

The supply of animal products has been declining over the past two decades, while demand has been increasing, as a result of increases in population and urbanisation. Consequently, Nigeria has remained a net importer of livestock and livestock products. Restrictions placed on imports of animal products and foodstuffs in the 1980s coupled with the introduction of the Structural Adjustment Programme (SAP), which saw a massive devaluation of the Nigerian currency, initially reduced the importation of meat and dairy products. However, during the period 1995 to 1999, expenditure on the importation of food and live animals has tended to increase (Table 1).

Table 1. *Importation of food and live animals (Nigerian naira (₦) $\times 10^6$.*

Item	1995	1996	1997	1998	1999
Food and live animals	88,349.9	75,954.6	100,640.3	102,165.1	103,489.9

Source: CBN (1999).

Recent statistics on the importation of dairy products in Nigeria are not easy to come by. However, devaluation of the local currency has significantly reduced the importation of milk powder and butter oil on which the local dairy plants depended. The large number of closed dairy plants throughout the country provides evidence of this problem (CBN 1999).

Dairy development in Nigeria

The various activities of the Nigerian dairy industry (viz. milk production, importation, processing, marketing and consumption) have been going on in the country for over 60 years. These activities are, however, unorganised except for the relatively few processing firms that produce and market reconstituted milk products from imported powdered milk. Despite the unorganised nature of the industry, the dairy industry represents an important component of the agricultural sector of the economy with great economic, nutritional and social implications (Olaloku 1976).

The industry provides a means of livelihood for a significant proportion of rural pastoral families in the subhumid and semi-arid ecological zones of Nigeria. According to FAO (1988), an estimated 183 thousand rural households derived some income from the dairy industry in 1986. The industry, through commercial dairy processing plants and marketing segments, provides employment and value. Currently, however, very few of the 63 known processing plants are operating. Those that are still functioning operate at less than 20% of capacity. At present, the market has been taken over by 'cottage' outfits that process and market yoghurt in urban areas. Most of these use milk powder to produce yoghurt.

Improvement of the living standard of Nigerians has been the major focus of various national development plans (first in 1962/68 and the fourth in 1981/85). Consequently, the dairy industry, through which better nutrition can be provided to the citizens, was given adequate attention in these development plans. In some selected areas, the government established dairy farms with local and imported breeds of cattle. In addition, milk collection centres including mobile collection points were established.

Milk collection schemes

These began in the late 1920s when the Veterinary Department set up units in northern Nigeria to which pastoral women brought fresh milk for cream separation and processing into clarified butter fat (CBF). The women were paid only for the cream while the skim milk was returned to them. The various governments of the then northern region encouraged the establishment of milk collection and cooling units. The CBF scheme was set up to encourage the pastoralists to keep their cattle in one place throughout the year, offering them 'an immediate market for all the milk they could produce' (National Archives 1934-48).

The collection scheme was primarily set up to export CBF to England, where the fat was used to make expensive brands of toilet soap (National Archives 1934-48). Other private enterprises, including the United Africa Company, entered the export business, offering higher prices than the government to encourage middlemen to collect more CBF from the pastoralists; this increased CBF exports from 10 t in 1933 to 2400 t in 1939 (Walker 1981).

The delivery of milk for cream separation demonstrated the possibilities of whole milk collection. Therefore, the then Veterinary Department set up a milk processing plant at Vom (Jos-Plateau) in 1939, originally to produce butter and later to produce cheese (Walker 1981). Some milk came from the Vom dairy herd kept by the department, but mostly it came from Fulani women through a network of collection centres. A similar scheme was launched at Kano in 1940.

Growth of the dairy industry in Nigeria could be attributed to wartime (World War II) restrictions on dairy produce imports and a ban on CBF exports. For these reasons, the annual output of the Vom Dairy for 1949-50 was 123.8 thousand kg of butter, 50.8 thousand kg of CBF and 36.7 thousand kg of cheddar-type cheese to suit the taste of expatriate customers (Buchanan and Pugh 1955).

With the lifting of restrictions, after World War II, the government effort did not have any lasting effect. The dairy plant at Vom eventually closed in 1954, due to the availability of imported butter of higher quality in urban markets. According to Walker (1981), the

indigenous products were of low quality and they were difficult to sell in competition with imported products which were only slightly more expensive.

The West African Milk Company is now renting the site of the farm and has stocked it with Friesian × White Fulani crosses. A small processing plant has also been established at the site. Milk from the animals is being used to produce pasteurised fresh milk, yoghurt, butter and cheese. Performance data are not available and therefore the economical viability of producing milk from Friesian × White Fulani crosses is not known; however, several problems exist with this production system. First, even though these crossbreds have far higher milk yields than indigenous cattle, they are very expensive to maintain because of their high susceptibility to diseases. Second, the market for products produced by the company is located far away from the production plant.

Establishment of dairy farms and processing plants

Before independence in 1960, dairying in Nigeria was influenced by the colonial experience, which placed complete reliance on large government farms to meet the growing demands of the cities. After the colonial period, and as part of the government's strategy to encourage dairy industrial development, the federal, regional and/or state governments established several dairy-processing plants throughout the country. Among these were Madara Limited in Jos, Plateau State, and Agege Dairy Farm near Lagos. The first herd of indigenous cattle was upgraded with imported *Bos taurus* cattle, which by 1975 produced nearly 200 thousand litres of milk/year from 69 milking cows. Other government dairy farms were established at Ibadan, Kaduna, Maiduguri, Minna, Ilorin and Kano.

Perhaps, the major achievement of these interventions has been the creation of awareness of the need for dairy development as part of the overall efforts to improve on the performance of the livestock subsector. One of the direct results of this awareness has been the establishment of milk processing plants by both the private and public sectors, as a means of catalysing domestic production. However, the availability of cheap imported milk powder in particular and other dairy products in general has created a disincentive for the development of a domestic dairy industry, particularly as the processing plants have completely neglected the appropriate pricing and milk collection aspects (NLDP 1992).

Since the introduction of the Structural Adjustment Programme in 1986, the processing plants have been operating at less than 20% of full capacity because the price of imported milk powder and butter oil has become prohibitive.

Milk production from traditional herds

The livestock resource survey carried out by the Federal Department of Livestock and Pest Control Services in 1990 puts the cattle population of Nigeria at 13.9 million (RIM 1990). Of these, 13.5 million (96%) are in the hands of the pastoral Fulani. This pastoral herd is the most important source of domestic milk in Nigeria. Only a few imported cattle breeds such as Friesians and Brown Swiss, and their crosses are being kept in experimental milk production farms owned by government agencies. A few privately owned commercially oriented dairy farms,

owned by companies and individuals, are known to exist. These farms, which constitute the organised dairy farms, produce an insignificant proportion of the domestic milk supply.

Four major production systems can be identified in the country. They include pastoral systems, usually carried out by the Fulani who control at least 95% of the cattle population. The Fulani are mostly semi-settled, moving to locations where seasonal water supplies make pasture available during the dry season. However, some Fulani are nomadic and are constantly on the move in search of water and pasture. They keep large herds and depend on milk and dairy products for sustenance. Some settled Fulanis also exist.

A study by ILCA (1976) showed that White Fulani or Bunaji cattle, under the traditional system of production, have calving intervals of 22 to 24 months or more. Age at first calving ranges from 48 to 50 months and milk production (i.e. milk drawn excluding that consumed by the calf) is 306 kg over a lactation period of 441 days (253 kg/year). Moreover, calf mortality can be as high as 28%.

Since the majority of the national herd is in the hands of the pastoralists, the ILCA (1976) study, which was conducted with herds in the traditional system, seems to illustrate the present productivity of the national herd. On the basis of cattle population figures for 1990 and an estimated growth rate of 4%, the total cattle population is expected to reach 21.5 million by the end of this year. Based on the productivity of the cattle population under the traditional system of production, it is therefore estimated that domestic milk production in 2001 will reach 515.3 thousand tonnes. Data presented in Table 2 show the predicted size of the cattle population and the magnitude of milk production for the period between 2001 and 2005.

Table 2. *Estimated cattle population and milk production.*

Year	Cattle population	Milking cows (head)	Milk production (t)
2001	21,470,800	3,435,328	515,291
2002	22,329,632	3,572,741	535,911
2003	23,222,817	3,715,650	557,347
2004	24,151,729	3,864,276	579,641
2005	25,117,798	4,018,847	606,827

Source: Livestock Subsector Review Report No.102/92CP-NIR 49 SR/5/8/92.

In addition to the supply of milk from the national herd, an insignificant quantity of milk is supplied by the commercial dairy farms. Several processed dairy products are imported into Nigeria. These include evaporated milk, powdered milk, butter, cheese and cream. Condensed milk and dry powdered milk have dominated the Nigerian milk import trade for a long time.

Milk products

Traditional milk products

The wives of pastoralists usually process fresh milk into various traditional milk products. These include *nono* (sour milk), *kindirmo* (sour yoghurt), *maishanu* (local butter), *cuku* (Fulani

cheese) and *wara* (Yoruba cheese). These products are usually hawked around the local area by women or are sold in specific locations, such as the livestock markets in certain towns.

Due to the short shelf life and the fact that hawking is carried out on foot, these products are usually only available within walking distance of Fulani settlements. For the same reasons, these products are also more readily available in the northern states of the country.

Reconstituted dairy products

A number of dairy-processing plants exist in different parts of the country. Most are urban-based and are, particularly the government owned ones, supposed to collect milk from their catchment areas in order to stimulate local production. This aspect has, however, been abandoned and the processing plants rely mostly on combining and reconstituting imported milk powder. The various products from these processing plants include ice cream, chocolate milk, yoghurt, cheese and long life milk. The last census undertaken for these plants (NLPD 1992) put the number of these plants at 63. Most have, however, closed down and those that are still operating do so at less than 20% of their full capacity. Reasons for closure include, among others, shortages of raw materials (particularly imported powdered milk) and breakdown of machinery and equipment as a result of lack of spare parts etc.

Markets for dairy products

Marketing of milk and milk products involves a large number of individuals, including the pastoralists, processors, milk product distributors and retailers. The marketing systems follow the production pattern, which distinguishes between traditional producers, who operate mainly in the rural or semi-urban markets, and the reconstituted milk product producers and milk product importers who operate in the urban markets.

Traditional markets

The traditional marketing system, which involves local dairy products such as *madara* (fresh milk), *nono* (sour milk), *kindirmo* (yoghurt), *maishanu* (local butter) and *wara*, *wagashi* and *chuku* (cheese), is dominated by Fulani women and girls who are directly engaged in the collection, processing and sale of the dairy products. The milk produced by the cows is for both household consumption and direct sales to local consumers as fresh milk, clarified fat (ghee) or other forms of traditional dairy products.

These milk products are carried on the women's heads, in calabashes and gourds, as they walk to sale points such as rural markets, roadside settlements and semi-urban areas.

Urban markets

The urban milk and milk product markets are the concern of the distributors, wholesalers, depots, bicycle boys, retailers and other market outlets. The milk products include

evaporated milk, powdered milk, baby formula, packaged liquid milk, yoghurt, butter, ice cream and cheese.

Demand and supply of dairy products

In 1990, Nigeria had an estimated human population of 86 million based on the figures released by the National Population Commission. With a yearly growth rate of 2.5%, the population is expected to reach 112.75 million by the year 2001. Based on the 1990 figures, Nigeria imported about 512.3 thousand tonnes of liquid milk equivalent. With an estimated 278.9 thousand tonnes of local production in the market, the total milk supply in 1990 was about 791.3 thousand tonnes, giving a per capita consumption of 9.17 kg/year.

Assuming that there has been no change in per capita consumption since 1990, the demand for milk and milk products will be over one million tonnes in 2005 (Table 3).

Table 3. *Estimated human population, and annual demand for and supply of milk from the national herd, 2000 to 2005.*

Year	Human population ($\times 10^6$)	Demand (t)	Supply (t)
2000	110	990,000	495,479
2001	112.75	1,014,750	515,291
2002	115.56	1,040,004	535,911
2003	118.45	1,066,050	557,347
2004	121.42	1,092,780	579,641
2005	124.45	1,120,005	606,827

Source: Livestock Subsector Review Report No: 102/92 CP-NIR 49 SR 5/8/92.

As prices, income and education are major factors dictating the demand for milk and milk products in Nigeria, demand will likely increase and more pressure will be brought to bear on the system and the government to satisfy the increase in demand. However, it is unlikely that the nation will continue to have foreign exchange to expend on imports of dairy products. The structural adjustment programme will continue to curtail most forms of importation including the import of dairy products. This point underscores the necessity and urgency for developing local dairy resources so that most of the population can have access to milk and milk products.

Smallholder dairy co-operatives: NLPD's experiences

Background

The NLPD, a division of the Federal Department of Livestock and Pest Control Services, was established in 1974. It was given the sole responsibility for the implementation of the first World Bank-assisted Livestock Project. The division, whose headquarters is in Kaduna, has offices in all the 36 states of the federation. Four zonal offices co-ordinate project

activities in states within the zone. When the Second Livestock Development Project (SLDP) was approved, as a follow-up of the completed First Livestock Development Project, the NLPD was again given the responsibility for implementing the project nation-wide. The SLDP became effective in April 1987 and was closed in June 1995.

During a mid-term review of the SLDP, a pilot dairy development programme was added to the SLDP in order to seize the opportunity provided by the devaluation of the naira, which made local milk collection, processing and marketing competitive. Kaduna State was chosen as the area in which the pilot programme was to be implemented. Producers were organised into groups and the small quantities of milk produced by pastoral families were collected, processed and marketed on their behalf. The profit was returned to the producers for use in other community development endeavours.

Kaduna State lies within the subhumid agro-ecological zone of north central Nigeria; this zone has an annual rainfall ranging from 600 to 1000 mm. The area is suitable for the production of crops such as sorghum, yam and maize. The state also provides a dry season sanctuary for cattle because of its relatively high rainfall, which supports the growth of pasture.

The cattle population of the state is estimated at 1.007 million head. More than 90% of these are owned and managed by traditional, semi-settled pastoralists (RIM 1992). The cattle, mostly Bunaji, are managed and milked by the men; however, the women, who usually use the proceeds for the financing of household expenditures, carry out the processing and marketing of milk and dairy products (Waters-Bayer 1985).

Supply of and demand for dairy products in Kaduna State

Daily milk offtake per lactating cow averages 0.74 litres/day, ranging from 0.36 litres in the dry season to 1.27 litres in the wet season (World Bank 1993). Thus, in 1990, total milk offtake in the state was estimated to be between 20 and 25 thousand litres. Nevertheless, milk offtake has the potential to increase to between 75 and 95 thousand litres if milking is carried out twice a day, and nutrition and market channels are improved.

In 1991, a total of 275 thousand tonnes of dairy products was imported into Nigeria; the national average per capita consumption for the population being estimated at 3.1 kg. The average annual imported quantity sold in Kaduna State (population = 3.9 million in 1991) was estimated at approximately 2.0 kg of liquid milk equivalent per capita. When the total annual imported quantity of around 8 thousand tonnes is added to the 21 to 27.4 thousand tonnes (low and high estimates) sold from domestic production, the total average per capita consumption is estimated to be 7.3–10 kg/year.

Organisation and management of milk co-operatives

Dairy was not included in the SLDP because during the design and appraisal phases, economic conditions favoured importation of highly subsidised raw materials (mainly milk powder and butter oil) rather than reliance on local sources of raw milk. A seven-fold devaluation of the naira, coupled with the doubling of powdered milk prices in the

international market shifted the comparative advantage to local production. The pilot dairy scheme was therefore incorporated into the redesigned project to encourage small-scale dairy production. The strategy was to establish a vertically integrated 'farmer organisation' based dairy industry, with self-sufficiency in dairy products as the underlying objective.

A small-scale dairy development unit was established in the NLPD and given responsibility for the implementation of the programme. A spearhead team was established and sent to the NDDDB in India for a short training in 'farmer organisation and development'. On the return of the team, a mobilisation drive was initiated. The mobilisation was started at Kachia grazing reserve where pastoralists have been settled and provided with infrastructure under the SLDP. The first Village Milk Co-operation Association was established at Kachia grazing reserve in 1991. Today there are 36 identified associations with 1820 members spread across Kaduna State, of these associations 20 have been registered as co-operative societies. Each society has an elected chairman and an appointed secretary. The secretaries act both as administrators of the societies and as record keepers for the milk supplied by members of the societies. The secretaries are paid from the commission that the federation pays to each society (on a per litre basis) for the quantity of milk supplied.

As the number of members of the association increased and the volume of milk also enlarged, it was felt necessary to establish an apex organisation that would be solely responsible for the procurement, transportation, processing and marketing of milk supplied by the associations. Thus, the Kaduna Federation of Milk Producers' Co-operative Association Ltd. was born. The federation which now trades under the name of MILCOPAL not only provides the services mentioned above to all its member societies, but also supplies supplementary feeds and animal health care at full cost to the various associations. Conversely, the Dairy Development Unit under the NLPD is responsible for sourcing improved dairy technologies from research institutes and extending them to the members of the various societies.

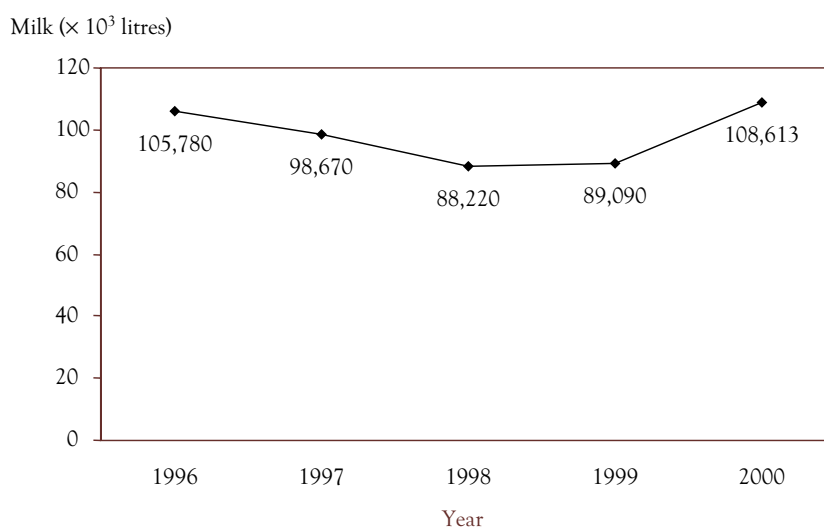
Prior to the closure of the SLDP and in view of the potential shown by the programme, the World Bank decided that a grant could be given to MILCOPAL to purchase controlling shares in the Kaduna Dairy Processing Plant. Previously, this processing plant was used by the federation, but owned solely by the Kaduna State Government. Consent was obtained from the State Government, and the World Bank released the grant and the shares were purchased accordingly. Today, the federation holds 55% of shares in the plant while the Kaduna State Government owns 45%.

The NLPD, through the World Bank project, provided the vehicles for procurement and marketing of milk. It also provided the initial seed capital for milk procurement and operation. The management of MILCOPAL was also provided from the staff of the NLPD. With the exception of veterinary drugs, all development activities of the federation are funded by the NLPD, while commercial operation (e.g. milk procurement, transportation, processing and marketing including operating staff salaries) is funded directly by MILCOPAL.

A total of 490.3 thousand litres of raw milk was procured from its member societies over the last five years. This volume could have been greater if it was not for the transhumance

practised by the pastoralists that drastically reduced the quantity supplied in the dry season. Some collection routes had to be abandoned because they were unviable.

However, there are indications that milk collection will increase as dry season milk supplies are slowly increasing consequent to increases in the purchase of supplementary feeds and a tendency among pastoralists towards sedentarisation (Figure 1).



Source: World Bank (1993).

Figure 1. Annual milk procurement.

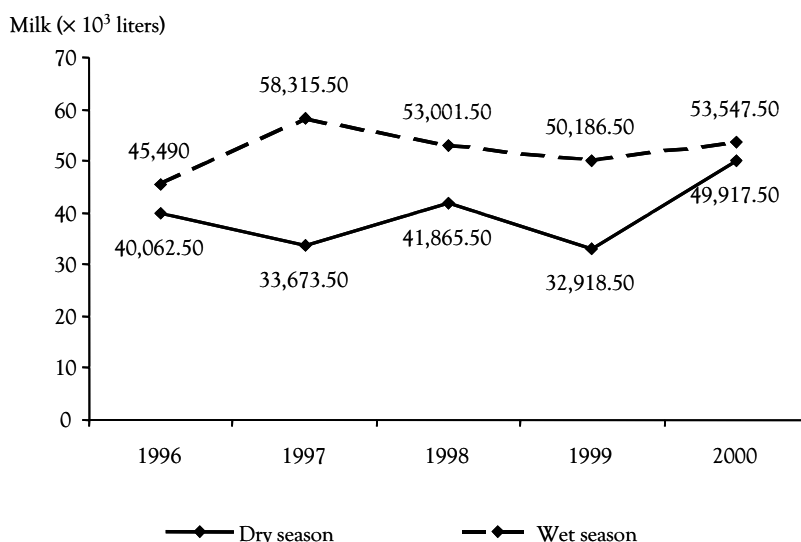
Marketing of dairy products

Seasonal variation in the supply and marketing of milk and other dairy products poses a serious challenge to MILCOPAL. In the rainy season when feeds and water are available, productivity of the animals increases substantially and more milk is available to be supplied by the various societies. Unfortunately, as indicated in Figure 2, demand for milk and other dairy products is lowest during the rainy season.

During the rainy season, MILCOPAL has to produce butter from the excess milk. In addition, more effort has to be put into marketing to enable the federation to dispose of all the milk products; this extra work is very costly to the organisation. However, there have been recent improvements in the previously unpromising market for butter.

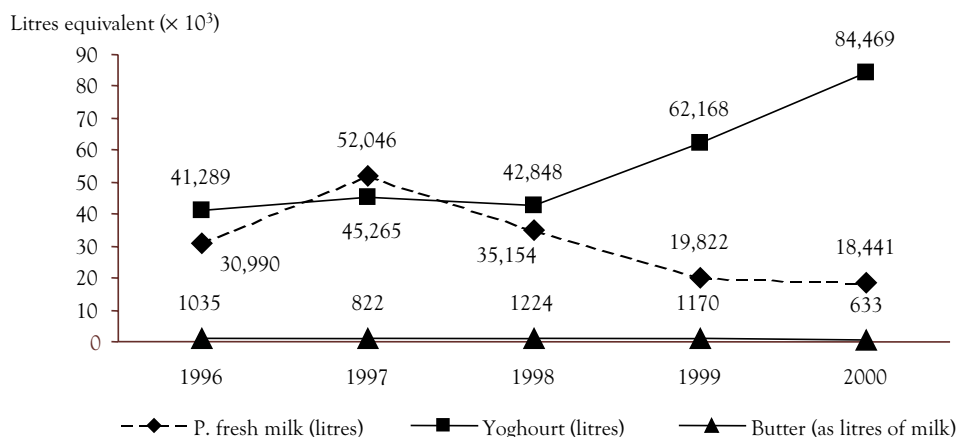
During the dry season, when production is low as a result of low availability of forage resources, demand for milk products is highest. Sometime the federation has to supplement milk supply with powdered milk in order to retain its customers. The customers do not seem to be able to differentiate between products made from natural cow milk and those made from milk powder, as their loyalty does not seem to alter.

Of the three products produced and marketed by MILCOPAL, viz. yoghurt, fresh milk and butter, yoghurt seems to be the most popular (Figure 3).



Source: World Bank (1993).

Figure 2. Dry and wet season supply of milk by the various co-operative societies.



P. fresh milk = pasteurised fresh milk.

Source: MILCOPAL Annual Marketing Report.

Figure 3. Consumer preferences for dairy products in Kaduna State.

Fresh milk, which costs the federation less to process and is probably more profitable, appears to be unpopular with Nigerian consumers as it accounts for only 30% of total products sold. Therefore, the future of the dairy industry in Nigeria and perhaps that of the operations of the federation will depend more on the production of yoghurt and other sour milk products, which seem to be very popular with Nigerian consumers, than on sales of fresh milk. Packaging will, however, pose a very serious challenge. Currently, the federation

resorts to serving out large shapeless quantities in order to keep production cost low and maintain affordable prices.

Cost/benefit analysis of the operation of the farmer organisation

As stated above, the development costs of the federation are being shouldered by the NLPD. These include, among others, the payment of salaries for the seconded staff, the costs of provision of animal health care (excluding the cost of the drugs), and the sourcing and dispersal of dairy technologies. In addition, the initial seed capital was provided as a grant to the federation. It is doubtful that the federation's commercial operations would have survived this long without continuous injections of funds, in the form of grants from the NLPD. (Annex I).

The most important lesson learnt from the operation of MILCOPAL is that smallholder agro-pastoralists in Nigeria can supply milk to urban centres. It is evident, however, that dairy development requires considerable amounts of skilled manpower for milk handling, processing and marketing, for organising farmer associations and for training farmers how to manage these associations. This skilled input has been required even though the volume of milk (490,373 litres in 5 years) collected and marketed has been lower than that expected. A valuable lesson learnt from the pilot scheme is that trained and experienced manpower would be very useful in expanding the programme in Kaduna State and the nation in general.

The pilot Dairy Co-operative Development Programme has had a profound impact on the socio-economic status of the participating pastoralists, especially the women. Women have benefited most, because collection of milk from their doorsteps has relieved them of the enormous burden of hawking their milk to markets far away from their places of abode. The programme has also provided the pastoral families with a regular income. A few of the societies have used their commission to carry out some community development programmes. For example culverts have been constructed across roads to facilitate collection of milk in the rainy season.

References

- Buchanan K.M. and Pugh J.C. 1955. *Land and people in Nigeria: The human geography of Nigeria and its environment*. University of London Press, London, UK.
- CBN (Central Bank of Nigeria). 1999. *Annual report 1999*. CBN, Lagos, Nigeria.
- FAO (Food and Agriculture Organization of the United Nations). 1988. *Agricultural development in Nigeria 1965–80*. FAO, Rome, Italy.
- ILCA (International Livestock Centre for Africa). 1976. *Livestock production in the sub-humid zone of West Africa*. System Study 2. ILCA, Addis Ababa, Ethiopia.
- Livestock subsector review. Report 102/92 CPNIR 49 SR/5/8/92.
- MILCOPAL Kaduna Federation of Milk Producers' Co-operative Association Ltd. Annual marketing report.

- National Archives. 1934–48. *Archives, A. 1934–1948. Ghee (butter) industry (clarified butter fat or 'CBF'), Zaria Province ACC. 1697.* National Archives, Kaduna, Nigeria.
- NLPD (National Livestock Project Division). 1992. *National dairy survey.* NLPD, Kaduna, Nigeria.
- Olaloku E. 1976. Milk production in West Africa: Objectives and research approaches. *Journal of the Association for the Advancement of Agriculture in Africa* 3:5–13.
- RIM (Resource Inventory and Mangement). 1990. *Livestock resource survey 1990.*
- Walker D.A.W. 1981. *Livestock development in Nigeria 1914–79. A brief historical review.* Working Document 1. NLPD (National Livestock Project Division), Kaduna, Nigeria.
- Waters-Bayer A. 1985. *Dairying by settled Fulani agropastoralists in central Nigeria. The role of women and implications for dairy development.* ODI Pastoral Development Network Paper 20c. ODI (Overseas Development Institute), London, UK. 24 pp.
- World Bank. 1992. *Feasibility study of the rehabilitation and operation of the Kaduna dairy plant.* The World Bank, Washington, DC, USA.
- World Bank. 1993. *Feasibility study on the viability of the Kaduna Federation of Milk Producers' Co-operative Association Ltd.*

Annex I. Commercial operations of MILCOPAL*

Profit and loss	1995	1996	1997	1998	1999	2000
Turnover	4,593,544	5,754,828	4,494,644	4,432,094	5,362,190	8,018,542
Less: cost of sales	4,135,411	5,369,266	4,218,618	5,157,461	4,438,138	4,093,963
Gross profit	458,143	385,562	276,026	(725,367)	924,052	3,924,579
Other income	633	12,313	73,768	103,306	317,240	3200
	458,776	397,875	349,794	(622,061)	1,241,292	3,927,779
Less: administration/ general expenses	2,575,763	3,164,583	3,215,087	3,221,344	5,835,645	3,495,316
Net loss/profit for the year	(2,116,987)	(2,766,708)	(2,865,293)	(3,843,405)	(4,594,353)	(432,463)

* MILCOPAL = Milk Producers' Co-operative Association Ltd.

Smallholder dairy production and marketing in Ghana

E.O. Otchere and S.A. Okantah

Animal Research Institute, Council for Scientific and Industrial Research
P.O. Box AH 20, Achimota, Ghana

Introduction

Ghana has about 1.25 million cattle. The West African Shorthorn (WASH) is the most populous breed, constituting about 60% of the cattle population. Ghanaian WASH cattle have not been consciously and generally selected for high milk production. In the early 1930s, the Veterinary Services Department of the then Gold Coast (now Ghana) imported White Fulani (WF; zebu) bulls from northern Nigeria to cross with the indigenous WASH to improve on its body size and level of milk production. The stabilised WF × WASH genotype is called the Sanga; it has features intermediate between the taurine WASH and the WF (zebu).

Rege et al. (1994) indicated that the numbers of Sanga are increasing at the expense of the WASH in Ghana. The biggest threat to the WASH now is from the numerically superior but ill-adapted zebu found in the West African sub-region, which, as a result of cross-breeding, is eroding the WASH genes.

Table 1 shows the changes in human and cattle populations, and number of cattle per 100 people. Almost all milk produced in Ghana is from cattle. There is a consistent decline in the number of cattle per 100 persons, indicating that human population growth outstrips growth of the cattle resource base. This scenario will have serious implications on local milk production and on milk and dairy product imports.

Table 1. *Human population, cattle population and number of cattle per 100 persons in Ghana (1984–96).*

Year	Humans (× 10 ⁶)	Cattle head (× 10 ⁶)	Cattle per 100 persons
1984	12.3	1.08	8.8
1986	13.04	1.13	8.7
1988	13.74	1.14	8.3
1990	14.47	1.14	7.9
1992	15.24	1.16	7.6
1994	16.02	1.22	7.6
1996	18.0	1.25	6.9

Institutional issues

Animal agricultural development is presently handled by the Ministry of Food and Agriculture (MoFA) through the Animal Production Department (APD), Veterinary Services Department (VSD) and the Livestock Planning and Information Unit (LPIU). The activities of the APD and VSD include:

- breed improvement
- forage and pasture development
- stock water development
- disease control
- vaccination
- tsetse and trypanosomosis control, vaccine production and laboratory services among others.

The LPIU facilitates the task of decision making by providing information on the livestock industry in an easily accessible and comprehensible format. The LPIU also monitors and evaluates the impact of new activities initiated by the APD and VSD.

The country operates a unified agricultural extension system (UAES) administered by the Department of Agricultural Extension Services (DAES) of the MoFA. The APD, VSD and national agricultural research system (NARS) provide subject matter specialists to train frontline extension staff to disseminate, on a wide scale, technologies that are beneficial and economically important for livestock production.

The Animal Research Institute of the Council for Scientific and Industrial Research (CSIR), under the Ministry of Environment, Science and Technology, provides major animal agricultural research support to the MoFA. Additional research support is given by the Animal Science Departments of the University of Ghana, Kwame Nkrumah University of Science and Technology, the University of Cape Coast and the University for Development Studies. The universities are under the Ministry of Education.

Production systems

Cattle production is mostly sedentary and agropastoral with limited transhumance. In recent times, large nomadic herds have invaded Ghana from Burkina Faso and Niger. Such nomadic herds had been forced out of Ghana because of the tendency of such herds to destroy crops. In Ghana, a mutually beneficial solution for farmers and nomads needs to be identified. This should be possible since the size of Ghana's national cattle herd is rather low.

In the northern savannah, cattle herd sizes are generally small, usually between 10 and 50 head. Ownership patterns are complex and the herd may belong to one owner, one family or one village.

In the southern savannah, herds are generally larger in size, frequently between 50 and 200 head. In many cases, however, these herds are the property of absentee owners and are cared for by hired Fulani herdsmen. The absentee cattle owners may be businessmen, civil servants or farmers. Normally, the herdsmen's only remuneration is the right to milk sold

from the herd. In some cases, however, the Fulani may also be given the third calf from any cow (Hill 1964).

This arrangement has implications for technology adoption. Recent studies by the Animal Research Institute have shown that strategic supplementation of cow feeds increases milk yields, improves calf growth and decreases calving intervals (Obese et al. 1999; Okantah et al. 2000a, b). However, it has not been possible for this strategy to be adopted because neither the herdsman who gets more milk nor the owner who gets more calves is prepared to pay for the supplements.

Diseases and cattle production

Diseases constitute a major constraint in cattle production. The major diseases that kill cattle are rinderpest, contagious bovine pleuropneumonia (CBPP), anthrax and blackleg. Routine vaccinations have allowed greater control of these diseases. Moreover, the VSD has established a system of surveillance through routine sero-monitoring for rinderpest, brucellosis and CBPP. This has facilitated early disease detection and control.

Other important diseases are trypanosomosis and dermatophilosis. The indigenous WASH has a low milk yield but is tolerant to trypanosomosis and dermatophilosis. In contrast, the Sanga produces more milk but does not have the same degree of tolerance to trypanosomosis and dermatophilosis. Imported exotic dairy breeds (e.g. Holstein-Friesian and Jersey) or their crosses have not survived under Ghanaian conditions, notably because of the scourge of dermatophilosis (Koney 1996) and poor environmental adaptation. Exotic cattle introduced to the country were found to require high levels of nutrition and management in the humid Ashanti region (Alhassan and Owusu 1980; Gyawu et al. 1988) and were adversely affected by heat stress on the Accra Plains (Okantah et al. 1993).

Tuberculosis and brucellosis in cattle are also important because of their public health significance. Only a few limited surveys have been carried out on the prevalence of bovine brucellosis in Ghana. Oppong (1966) reported a prevalence rate of 23.4% on the Accra Plains. In southern Ghana, a prevalence rate of 55.3% has been reported more recently (VSD 1997). Available information on bovine tuberculosis in Ghana is scarce (Bonsu et al. 2000). Table 2 shows data indicating prevalence of infection of tuberculosis in some areas of southern Ghana.

Table 2. *Prevalence of bovine tuberculosis in southern Ghana.*

Location	Prevalence (%)	Source
Accra Plains	7.0	VSD 1997
Katamanso	2.6	ARI 1997
Nungua	1.0	Bonsu 1998
Aveyime	4.0	Bonsu 1998
Dangbe-West	13.8	Bonsu 1998
Volta region	1.0	VSD 1997
Pokoase	19.0	ARI 1997

Source: KNUST and ARI (no date).

Available data indicate that the diseases affect cattle production in general and milk production in particular. Of greater importance is the need to take cognisance of the existence of public health risks in the consumption of raw milk.

Protein malnutrition in Ghana

Malnutrition is not new in Ghana if we note the length of time the term *kwashiorkor*, a Ga word, has been in use in medical literature. Protein malnutrition is still with us. At present, food of animal origin constitutes only 5% of the average Ghanaian's diet. The rest is made up of starchy staples such as cereals, roots and tubers (Levin 1997). In Ghana, about 30% of children under 5 years of age are underweight. Incidence of malnutrition in the northern regions of Ghana is very high among children aged between 12 and 23 months. Nearly 70% of children in this age group are less than 80% of the standard weight for age, indicating that children in this age group do not receive enough foods of adequate quality to support normal growth. Indications are that urban malnutrition is increasingly a problem and needs to be given serious attention (Levin 1997).

Contribution of milk to human nutrition in Ghana

The contribution of cow milk to human nutrition is a function of the level of consumption in different dietary situations. In Ghana, its significance lies in its contribution of those nutrients, which are deficient in traditional staples such as cereals, roots and tubers.

Some adult Ghanaians, however, are intolerant to milk because of their inability to digest lactose (milk sugar); these individuals lack the enzyme to enable them digest milk sugar. One wonders, therefore, if milk could have any role to play in the alleviation of protein malnutrition in Ghana. According to Olaloku (1974) extensive studies, in India for example, show that lactose or milk intolerance is not a reliable guide for deciding whether milk should be used to improve the diets of malnourished populations. Such studies have shown that even in milk intolerant individuals, protein-calorie malnutrition responds readily to milk administration, thus demonstrating satisfactory absorption of some milk proteins in the small intestines. Moreover, processing of milk into fermented products provides alternate safe forms of milk suitable for inclusion in the diets of lactose tolerant and intolerant individuals.

General herd management and milk production by smallholder herds

General routine herd management and milking have been described (Otchere 1966; Okantah 1992; Okantah et al. 1995). Milk is extracted, particularly by smallholder herders, for home consumption and for sale. Milking is often once a day and invariably in the

morning. The presence of the calf is always necessary to induce milk let-down (Otchere 1966; Okantah et al. 1995).

Otchere (1966) reported a milk yield of 738 ml/cow per day over a 240-day period for Sangas maintained on free-range native pasture and corralled at night, with no supplemental feeding. The mean butterfat content for a total of 349 samples from once-a-day milking was 4.48%. Okantah (1992) reported mean daily partial milk yields of 0.9 and 0.7 kg for the wet and dry season, respectively, on the Accra Plains. In the northern Guinea savannah in northern Ghana, Karbo et al. (1998a) reported similar observations. Cumulatively these data indicate that indigenous cattle kept by smallholders are generally low milk producers. It should, however, be pointed out that the milk yield figures above did not represent the genetic potential of the animals used in the studies because: (a) the amounts did not include milk consumed by calves; (b) the cattle had not been selected for high milk yield; and (c) the environment had not been improved enough to really enable the animals to demonstrate their full genetic make-up for high milk yield.

It has been demonstrated that large quantities of milk are available from several thousands of low-yielding cattle in the smallholder system (Okantah 1992). Consequently, the Ministry of Food and Agriculture initiated a pilot milk collection project on the Accra Plains. This exercise has been extended to Sekyedumasi and peri-urban Kumasi in the Ashanti Region. In 1998, the pilot milk collection project collected 85,587 litres of milk from smallholder farmers in peri-urban Accra (LPIU 1999).

Demand for dairy products in Ghana

Milk production in Ghana is low and as such there is low per capita milk consumption. Currently, local annual milk production is conservatively estimated at 36.5 thousand tonnes. Most of it is from smallholder agropastoral producers. There is a big shortfall between domestic milk production and consumption. The deficit is made up through imports of milk and milk products. Table 3 shows the volume of dairy product imports from 1995 to 1999. The fluctuations in imports are due to variation in the availability of foreign exchange for importation. With a removal of dairy subsidies in European nations, the cost of imports of dairy products would constitute a heavy drain on the meagre foreign exchange resources of the nation. The current economic environment, under which the local currency (the cedi) has eroded in value, should be a positive incentive for increased local milk production. It may even make it possible for local production to compete favourably with imported products.

Table 3. Imports of dairy products into Ghana.

Year	Quantity ($\times 10^3$ t)
1995	10,469.7
1996	5649.6
1997	6140.7
1998	10,101.0
1999	7470.4

Source: LPIU various occasional papers.

Economics of smallholder systems and benefits to producers

Karbo et al. (1998b) reported that smallholder milk producers in peri-urban Tamale in northern Ghana (northern Guinea savannah) generated substantial daily income throughout the year from the sale of milk. A study was conducted in the transition zone to evaluate the potential contribution of milk sales to farmers' income as compared with the income from crop production. The analysis revealed that the potential income contribution from milk sales was the same as that from crop production (Nsiah-Ababio 1998). A comparison of the two systems is somewhat difficult because milk production depended on access to free communal grazing land. In a survey conducted in the Techiman District of Brong Ahafo Region, it was observed that producing 'wagashi' (cottage cheese) from fresh milk added a value of 54% to milk compared with sales of the fresh product (SFSP-GTZ-MoFA 1998).

Small milk collection projects have been initiated and studies on the economic feasibility of such small-scale milk collection centres have been undertaken. A comparison of capital expenditure, operational costs and revenue has demonstrated that such centres are viable (Adu 1997).

Clearly, smallholder milk producers enjoy economic benefits especially when small cash incomes are available throughout the year. Smallholder systems also offer employment to both producers and processors. In addition, it can be inferred that milk consumption by smallholders' families improves their nutritional status.

Marketing and processing of milk and milk products

Karbo et al. (1998a) in a survey carried out in peri-urban Tamale in the northern region of Ghana reported no problems with marketing fresh milk. Respondents complained of not having enough milk for sale. The lack of marketing problems with milk and milk product sales could imply the viability of a peri-urban dairy project. Consumers, however, complained about the unhygienic conditions under which milk was collected and processed at the rural level. Milk processing in this survey was reported to be the domain of women. The main processed product was a soft cheese called *wagashi*. Sales of *wagashi* in urban Tamale were not high probably because of the very elementary level of processing and presentation.

Similar observations to those above have been reported in studies of smallholders in the Ashanti region (KNUST and ARI, no date). Women process unsold milk from smallholder herds into *wagashi*.

In the Ashanti region, however, the Beef and Dairy Research Station of the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, produces pasteurised milk, yoghurt and occasionally cheese and butter. These are marketed on the university campus. Furthermore, a pilot milk collection centre in Sekyedumasi procured

fresh milk from Fulani herdsmen and processed it into sweetened milk and yoghurt for sale in nearby Ejura or far away Kumasi.

Another survey on processing and marketing of milk among peri-urban agropastoralists on the Accra Plains in Ghana revealed an association between the sale of processed milk and distance from consuming metropolitan centres (Okantah et al. 1999). In districts close to urban centres less milk was processed, with most milk being sold fresh. On the other hand, in districts further removed from urban centres, 66.7–76.2% of farmers processed milk into cheese, obviously to increase its shelf life. Similarly consumption of processed milk by farmers was associated with the proximity or distance of districts to urban centres, though in all districts fresh milk was readily consumed.

Milk marketing and processing in southern Ghana is similar to that described above. Marketing opportunities are, however, better because of the high population of Accra and its environs. The Amrahia Dairy Farm of the Animal Production Directorate (APD) of the Ministry of Food and Agriculture (MoFA) operates a milk collection scheme in southern Ghana. The farm produces and pasteurises its own milk and also produces some yoghurt. The farm serves as an outlet for milk produced by smallholders. The policy now is to get the private sector to take over the milk collection scheme.

Other quasi-governmental institutions, which produce and process small quantities of milk, are the Animal Research Institute and the University of Ghana Agricultural Research Station, Legon.

There are two multinational dairy enterprises in Accra, namely Fan Milk Limited and Nestle, Ghana Limited. They use imported milk powder and butter oil for reconstitution. These enterprises have shown keen interest and willingness to purchase local fresh milk for processing.

In 1990, the total production of reconstituted milk and ice cream by Fan Milk and Nestle was 2.08 and 0.998 million litres, respectively, but by 1996 the production of these products had increased to 27.6 and 3.582 million litres. From the level of imports of milk and milk products into Ghana, there are clearly good prospects for processing fresh milk produced locally by smallholders.

There is, however, a strong distrust of outsiders (researchers etc.) by traditional smallholder livestock producers. Consequently, the social goals of livestock producers and their attitudes towards new technologies, labour investment as well as willingness to change traditional practices are not well understood by researchers and policy makers.

In Ghana, there appears to be a lack of accurate data for effective economic analysis of livestock projects compared with crop production projects. As such, in the formulation of integrated agricultural projects the livestock subsector is often the weakest link because of the lack of sufficient accurate data.

Detailed feasibility studies have been made for specific livestock ventures in Ghana and as commercial ventures, they have seemed to be profitable. Nevertheless, most commercial livestock ventures (ranches and milk processing plants) have closed down after a few years of operation because they have proved unprofitable. On the other hand and rather surprisingly, the traditional sector has survived the odds, even though they have been described as non-productive.

Policy

A Ghanaian National Livestock Breeding Policy workshop was held in 1992 and, by 1995 both Livestock Breeding Policy and Animal Breeding Plans had been formulated (Okantah and Boa-Amponsem 1992; Ahunu et al. 1995). The major recommendations were to:

- select and develop the indigenous WASH as a beef animal
- develop the Sanga as a dual-purpose cattle
- develop exotic (dairy) and Sanga crossbred cattle for milk and meat production.

In view of the zoonotic threats from consumption of milk produced in the traditional sector, a policy needs to be formulated on boiling milk produced by the smallholders. Policy on acculturation of milk consumption among children in primary and secondary schools is also necessary so that lactose intolerance is not a problem when they become adults.

Concluding remarks

The dairy industry in Ghana is in its infancy. The domination of smallholder milk producers will persist for a considerable length of time. The Animal Research Institute recognises the great potential that smallholder cattle producers have to move the country forward towards self-sufficiency in milk production. The institute's short- to medium-term strategy, therefore, is to focus research efforts on developing appropriate technologies for development and extension agencies to use to facilitate modern dairy production in Ghana.

References

- Adu S. 1997. An economic feasibility of establishment of a small-scale milk collection centre in cattle rearing communities in Ghana. BSc dissertation, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Ahunu B.K., Boa-Amponsem K., Okantah S.A., Aboagye G.S. and Boadu M.K. 1995. Animal breeding plans for the Republic of Ghana. A report submitted to the Ministry of Food and Agriculture. Ministry of Food and Agriculture, Accra, Ghana.
- Alhassan W.S. and Owusu Y. 1980. Lactation responses to concentrate feeding in the humid tropics. *Tropical Animal Health and Production* 12:171–176.
- ARI (Animal Research Institute). 1997. Annual Report of Animal Research Institute, CSIR 1997. ARI, Council for Scientific and Industrial Research, Achimota, Ghana.
- Bonsu O.A. 1998. *The prevalence of tuberculosis in cattle in the Dangbe-West District—Public health implication*. MSc thesis, School of Public Health, University of Ghana, Legon, Ghana. 40 pp.
- Bonsu O.A., Laing E. and Akanmori B.D. 2000. Prevalence of tuberculosis in cattle in the Dangbe-West district of Ghana, public health implications. *Acta Tropica* 76:9–14.
- Gyawu P., Asare K. and Karikari P.K. 1988. The performance of imported Holstein–Friesian cattle and their progeny in the humid tropics. *Bulletin of Animal Health and Production in Africa* 36:362–366.

- Hill P. 1964. A socio-economic report on cattle ownership and Fulani herdsmen in the Ashaiman/Dodowa District of the Accra Plains. Institute of African Studies, University of Ghana, Ghana. (mimeo).
- Karbo N., Bruce J. and Okantah S.A. 1998a. A survey on peri-urban dairy in northern Ghana. Paper presented at the 1st Biennial National Agricultural Research Project (NARP) conference held at Accra, Ghana, 16–20 November 1998.
- Karbo N., Bruce J. and Okantah S.A. 1998b. Evaluating the yield potential of peri-urban dairy in northern Ghana. Paper presented at the 1st Biennial National Agricultural Research Project (NARP) conference held at Accra, Ghana, 16–20 November 1998.
- KNUST (Kwame Nkrumah University of Science and Technology) and ARI (Agricultural Research Institute). (No date). Literature review. SUA/KNUST/ARI/NRI/ILRI milk marketing, processing and public health project. 32 pp.
- Koney E.B.M. 1996. Dermatophilosis in Ghana: Effect on livestock industry. *Tropical Animal Health and Production* 28:35–85.
- Levin C. 1997. Ghana's agricultural sector and prospects for the future. Lecture presented at the Institute of Economic Affairs, Accra, Ghana, 29 May 1997.
- LPIU (Livestock Planning and Information Unit). 1999. *1998 Annual Progress Report*. National Livestock Services Project. Ghana Ministry of Food and Agriculture, Accra, Ghana.
- Nsiah-Ababio R. 1998. Potential contribution of milk sales to farmers' income. BSc dissertation, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Obese F.Y., Okantah S.A. and Oddoye E.O.K. 1999. Post-partum reproductive performance of sanga cattle in smallholder peri-urban dairy herds in the Accra Plains of Ghana. *Tropical Animal Health and Production* 31:181–190.
- Okantah S.A. 1992. Partial milking of cattle in smallholder herds on the Accra Plains: Some factors affecting daily partial milk yield and milk composition. *Animal Production* 54:15–21.
- Okantah S.A. and Boa-Amponsem K. 1992. Livestock development in Ghana: A proposal on breeding aspects revisited. Paper presented at a Ministry of Food and Agriculture workshop on formulating a National Breeding Policy for Ghana 25th GASA symposium.
- Okantah S.A., Aggrey S.A. and Amoako K.J. 1993. The effect of diurnal changes in ambient temperature on heat tolerance in some cattle breeds and crosses. *Bulletin of Animal Health and Production in Africa* 41:33–38.
- Okantah S.A., Gyawu P., Asante Y., Oddoye E.O.K., Obese F.Y., Abdulai M. and Mumuni A. 1995. Characterization of peri-urban dairy production in Ghana. Paper presented at IDRC/CARNET peri-urban dairy project post-survey workshop held at Accra, Ghana, 29 May to 2 June 1995.
- Okantah S.A., Oddoye E.O.K., Obese F.Y., Gyawu P. and Asante Y. 1999. A survey of processing and marketing characteristics of peri-urban agropastoral dairying in Ghana. *Ghana Journal of Agricultural Science*. (In press).
- Okantah S.A., Obese F.Y. and Oddoye E.O.K. 2000a. Effect of farm (herd) and season of calving on reproductive performance of sanga cows in smallholder peri-urban dairy farms in the Accra Plains. *Ghana Journal of Agricultural Science* 33. (In press).
- Okantah S.A., Obese F.Y. and Oddoye E.O.K. 2000b. Effect of farm and season on the growth performance, body condition score and milk yield of sanga cattle in smallholder peri-urban farms in the Accra Plains of Ghana. *Ghana Journal of Agricultural Science* 33. (In press).
- Olaloku E.A. 1974. Problems and possibilities of milk production. In: Loosli J.K., Oyenuga V.A. and Babatunde G.M. (eds), *Animal production in the tropics*. Heieman Educational Books (Nigeria) Ltd., Ibadan, Nigeria. pp. 43–65.

- Oppong E.N.W. 1966. Bovine brucellosis in southern Ghana. *Bulletin of Epizootic Diseases in Africa*. 14:397-403.
- Otchere E.O. 1966. *Preliminary observations on milk production among the Fulanis on the Accra Plains*. BSc dissertation, Faculty of Agriculture, University of Ghana, Legon, Ghana. 28 pp.
- Rege J.E.O., Aboagye G.S. and Tawa C.L. 1994. Shorthorn cattle of West and Central Africa. I. Origin, distribution, classification and population statistics. *World Animal Review* 78(1):2-13.
- SFSP-GTZ-MoFA (Ministry of Food and Agriculture). 1998. Survey of milk production in the Techiman District of Brong Ahafo region. Paper presented at the SFSP-GTZ-MoFA workshop in co-operation with the Dairy Science Unit, Animal Science Department, Kwame Nkrumah University of Science and Technology, Kumasi held at Sunyani, Ghana, October 1998.
- VSD (Veterinary Services Department). 1997. *Annual report of the Veterinary Services Department, Ghana*. Ministry of Food and Agriculture, Accra, Ghana. 17 pp.

Theme 1: Country papers and regional overviews

Plenary discussion

After the presentation of the regional overview papers, participants raised issues that affect the opportunities for smallholder dairy development. Other concerns related to the perceptions of policy makers and of development agencies to dairy as a contributor to the sustainable improvement of rural and peri-urban livelihoods.

These issues and concerns were:

1. The presentations did not emphasise several issues that affect smallholders in the developing world:
 - the role, relevance and importance of smallholders to agriculture and their contribution to national economies
 - there are major constraints to smallholder production including:
 - the absence of, or the difficulty of accessing, credit facilities
 - livestock diseases (such as foot-and-mouth), especially those affecting trade
 - the overwhelming presence of government in service delivery resulting in inefficient services (such as the delivery of artificial insemination)
 - recurring deficits of feeds and fodder
 - the threats to these constraints represent for smallholder livelihoods and
 - the risk aversion strategies practised by smallholders.
2. Low productivity of dairy systems is common to countries of the South. How can this be improved in a sustainable manner (considering resources and constraints) through consensus between farmers and policy makers?
3. Milk is not the only product a smallholder dairy producer gets from his/her buffalo, camels, cattle, sheep and goats.
4. There is no common definition of a smallholder:
 - they can be defined by farming system
 - the number of cows should be considered (rather than just land area), otherwise landless dairy producers will be excluded
 - other descriptors may be important: individual; illiterate; subsistence; poor;
 - the definitions must take into account country differences.
5. The availability of credit may not be an issue in some countries, but the type of credit (its suitability for smallholders) might be.
6. The North is pushing for free trade but subsidising its producers. Until subsidies are removed, competitiveness cannot be estimated realistically.

7. National policies in some countries are in conflict with smallholders' interests. For example, in many countries, especially in South Asia and South-East Asia, national policies tend to support imports of dairy products, but not local production.
8. National and smallholder agenda should not be separate and need to be considered together in the context of the World Trade Organization (WTO) agreements.

These and the related issues raised during the plenary discussions following the presentations in themes 2 and 3 were subsequently discussed in small groups of workshop participants.

The outcomes for theme 1 are given below.

Group discussion

In common with the other theme groups, the group discussion of theme 1 was structured around a set of questions. These addressed issues affecting the adoption and productivity of smallholder dairying at the farm and national levels.

The questions discussed by the group were:

1. Are the production objectives of smallholder dairy farmers driven by minimising risks and the use of external inputs? If so, how will that influence approaches to increasing productivity (or should it be reducing risks)?
2. What factors are driving the intensification of smallholder agriculture? How can dairying contribute and what will determine its success?
3. Is disease risk a major biological factor limiting the adoption and productivity of smallholder dairy in our regions? If so, how can current research programmes draw more effectively upon the expertise in the South to address smallholders' needs for improved disease control practices?
4. When and where will productivity rather than herd increases be important to dairy development and why, and what differences in research and development (R&D) approaches will be required?

The group's responses were described as follows.

How does risk aversion influence approaches to increasing productivity?

Farmers tend to avoid adopting (new) productivity-enhancing technology unless there are mechanisms to accommodate risks and uncertainties in input and output markets. We need to devise approaches with farmers who are considering adopting new technologies by taking into account farmers' perceptions, and the risk-bearing and risk-avoidance mechanisms that exist in society.

Socio-economic factors must be considered in all these approaches. Farmers' participation in the selection of technologies is important for successful adoption.

Type of risk	Approach
Technical risks (yield, variability, mortality)	• Appropriate breed selection • Feed availability • Veterinary services
Market risk	• Cooperative approach (fair prices, supply of inputs, collective bargaining power)
Financial risk	• Type of credits (in-kind, low interest, SACCOS) • Group lending, micro-credit—Grameen Bank approach
Management risks	• Training in specific skills • Demonstration • Extension services

How can dairying contribute to the intensification of smallholder agriculture?

- Contribution of livestock/dairy to national GDP needs to be assessed.
- Contribution of livestock/dairy to household income, employment, food security to be assessed/defined.
- Understanding crop/livestock integration/interaction in systems across the countries of the South and identifying livestock-friendly cropping systems.

Consider contributions in terms of:

- Draft power
- Manure and fibre
- Household liquidity
- Asset build-up
- Maximising efficiency of nutrient flows within the dairy farm
 - Minimising use of external input (fertilisers, feeds/fodders).
 - Support to other farm activities (economic integration), e.g. manure for horticultural crops.

How can research expertise on livestock diseases in the South contribute to improved disease control practices for smallholders?

Observation: Livestock disease is a major risk faced by smallholders

- Results on disease control to be shared among countries in the South (e.g. *Theileria* vaccine, improved FMD vaccine etc.).
- Consider the influence of genotype × nutrition × disease interactions—for specific locations, countries, livestock species — and exchange the information.
- Importance of recognising genetic resistance to disease and its utilisation and preservation through crossbreeding and selection. Sharing of such information is important.
- Identify diseases common in the South that cause heavy economic losses, e.g. mastitis, brucellosis, and FMD, and exchange the information.

- Alternative animal health care delivery systems wherever co-operative systems do not exist (informal farmers' groups, user groups, any other village forum, use of village-based animal health workers or para-vets where vets do not exist).
- Co-operation on the creation of disease-free zones across borders is crucial for the control of contagious diseases.

When and where will increases in herd size or productivity be important?

- Depends on type of farming system and location of the country.
- No uniform approach is desirable or possible.
- It should take into account social and economic factors appropriate for the country to the farming system in question.
- Factors like availability of agricultural land, crop residues, employment implications etc. are the usual determinants of herd size or the productivity debate.
- Short-cut methods to genetic improvement through selection, e.g. use of open nucleus breeding as against progeny testing programmes, which require a lot of resources.
- Additional inputs have to be considered before deciding on intensification or extensive (large herd size) production systems: cost of labour, land, feed resources and genotype of the animal.

After the plenary presentation of the outcomes of the group discussion, these additional points were stressed:

- Intensification of dairying (and its reverse) depends on the price and availability of labour and not of land.
- Herd size will generally match the availability of agricultural by-products.
- Need to understand farmers' preferences and perceptions before proceeding in terms of risk management.

Conclusions

The presentations, the supporting country and regional papers and their discussion highlighted the complexity of smallholder dairy systems in countries of the South and the multiple and interacting factors affecting their contributions to the livelihoods of dairy producers and traders and influencing the satisfaction of consumers of milk and dairy products. Yet, at the same time, it was clear that many of the issues related to smallholder dairy production and marketing systems are shared by many of the countries in the South and that there were many promising opportunities for effective collaboration to address issues of common interest.

Theme 2: Implications of international trade regulations for smallholder dairy production and marketing

Implications of international trade regulations (World Trade Organization agreement on agriculture and Codex Standards) for smallholder dairy development

V.P. Sharma

Indian Institute of Management, Ahmedabad 380 015, India

Introduction

The past few decades have seen much progress towards trade liberalisation around the world. However, trade liberalisation in the agricultural sector has been more difficult as many governments continue to implement restrictive trade policies. In the 1990s, the Uruguay Round of the General Agreement on Trade and Tariffs (GATT) made some progress towards liberalising the world agricultural markets. One of the agricultural sectors most affected by trade restrictions has been the dairy sector. For example, for several decades, the European Union (EU), Japan, Canada and the United States of America all have had extensive tariffs and quotas related to dairy trade. As reported by the Organization for Economic Co-operation and Development (OECD 1999a), the 1996–98 average measure of member countries' producer support estimates (PSEs) for dairy is highest for all the commodities reported in absolute terms (US\$ 49 billion) and second only to rice as a percentage of gross value of production (52%). Among the consumer support estimates, the OECD ranks milk first again in absolute terms (US\$ 37 billion) and third as percentage of consumer expenditures (47%). According to the OECD (1999b), the EU was the largest exporter of cheese and second in butter exports only to New Zealand during 1993–97. These export levels occurred because of the large export subsidies. The 1996–97 World Trade Organization (WTO) notification data reveal that 82% of the EU cheese exports, 100% of butter and 99% of skim milk powder (SMP) were subsidised. By 2000, when the Uruguay Round Agreement on Agriculture (URAA) provisions are fully implemented for developed countries, it is estimated that almost 60% of world dairy trade will still be exported with subsidies (US Dairy Export Council 1998). The volume of EU exports subsidised as a percentage of total—i.e. both subsidised and unsubsidised—exports averaged more than 80% for coarse grains, rice, butter, SMP, cheese and other milk products (USDA, ERS 1999). Market access provisions allow for tariff rate quotas (TRQs) with prohibitively high rates of over-quota duty (as high as 300%). Thus, even after full implementation, world dairy markets will continue to be characterised by highly subsidised exports, limited market

access and heavy government interventions. This raises questions about the effects of trade liberalisation on the world dairy markets.

The objective of this case study is to investigate how trade liberalisation is likely to affect the welfare of small-scale producers and consumers and dairy prices in various developing countries with special focus on India. The following section reviews trade policies of the dairy sector and explores the possibility and likely effects of various policy changes under the WTO for the dairy sector. The Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) Agreements are presented next, focusing on those provisions that are relevant for the dairy sector. Global competitiveness of the Indian dairy industry is analysed briefly. Finally, conclusions and policy implications of the study are presented in the last section.

Trade policy and the WTO

Government policies typically generate various trade distortions that imply departure from competitive market equilibrium. They include import policies and domestic agricultural policies, as well as export policies.

Import policies

Import policies consist of tariff and non-tariff barriers, usually designed to discourage imports. These include import quotas, minimum import prices, discretionary import licensing etc. While tariff barriers have an indirect impact on import volumes (through their price effects), most non-tariff barriers restrict trade by affecting import volumes directly.

In the URAA, countries agreed to open markets by prohibiting non-tariff barriers, converting non-tariff barriers to tariffs and reducing tariffs over a period of 6 years by a simple unweighted average of 36% with a minimum rate of reduction of 15% for each tariff line for developed countries. For developing countries, the reduction is 24% on average and a minimum of 10% per tariff line over 10 years. Countries were obligated to provide a minimum level of import opportunities for products that were previously protected by non-tariff barriers (3–5% for developed, 1–4% for developing and current access maintained by all countries), by establishing tariff rate quotas (TRQs). This import system established a quota and a two-tiered tariff regime for affected commodities. A lower tariff applies to imports within the quota, while a higher tariff applies to imports exceeding the quota. Overall, 36 countries, including 14 OECD members, scheduled more than 1300 TRQs, of which 183 are for dairy products.

Several concerns associated with the TRQ regime have arisen during the implementation of URAA. These are important for world dairy markets and bear implications for upcoming negotiations. The average fill rate for notified dairy products in OECD countries in 1997 was 62%, which is similar to the level of the previous 2 years. However, relying on the fill rate as an indicator of market access has limitations. First, notification is not uniform across countries. Some countries notify imports up to the TRQ level only, while others report all imports. Conversely, some countries report the volume

under the licenses issued, rather than actual imports. Another problem with the average fill rate is that it gives equal weight to all TRQs, irrespective of trade volume. For example, Japan has two scheduled SMP categories, with fill rates of 56 and 46%, resulting in an average fill rate of 50% for SMP. Yet with corresponding TRQs of about 7 thousand and 86 thousand tonnes, the average fill rate as conventionally calculated overestimates market access in this case. The broad product classification for TRQs allowed under the URAA has prevented opening up minimum access in some subproducts within this broad product category. Some countries calculated the quota at a broad level of product aggregation, such as dairy products, and then allocated the total TRQ rather arbitrarily among subproducts, minimising trade in import-sensitive commodities. In the process, the countries chose those types of products where additional imports would hurt less. These were sometimes those products produced at low levels in the country, or product categories for which the countries had preferential import conditions. For instance, Japan's schedule of 12 dairy TRQs consists of 95 tariff lines. The 8 dairy TRQs in the US schedule contain 96 lines, while Canada's 11 TRQs have 32 lines and the EU's 12 dairy TRQs have 57 lines. The countries calculated the quota quantity required under the minimum access commitments for the whole aggregate of dairy products and then allocated this quantity to individual types of dairy products in a more disaggregated level.

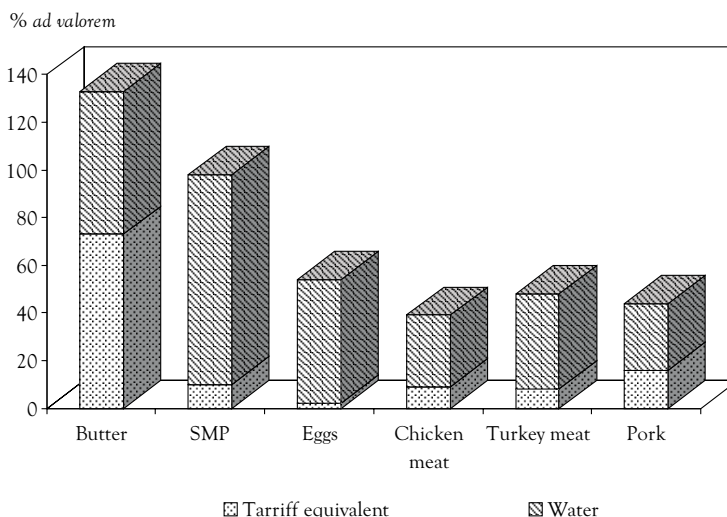
Dairy markets in many developed countries are highly protected. For example, US dairy markets are protected by Section 22 of the Agricultural Adjustment Act of 1933, as amended, which prevents dairy imports from interfering with the USDA's dairy price support programme. The Section 22 import quotas have contributed to keeping US dairy product prices substantially above world prices. For example, during 1992 and 1993, US prices for SMP, cheese and butter were on average 50, 51 and 21% higher, respectively, than world prices for these products (Dobson and Cropp 1995). The relationship was similar during the post-WTO period, when SMP, cheese and butter prices were significantly higher than world prices (Sharma and Sharma 2000).

The requirement for developed countries to reduce tariffs by 36% by the end of the implementation period is unlikely to have major impact on protection levels. This is for two major reasons. First, the base period, 1986–88, was a period of very low world market prices for a number of important agricultural commodities compared with longer run averages and relative to more recent prices. This indicates that when tariff equivalents in the base period were calculated, they were automatically high compared with a more representative period. Second, as the calculation of tariff equivalents for existing non-tariff barriers was left to the countries concerned, most countries were guilty of 'dirty tariffication', that is the newly calculated base-level tariffs provided even higher protection than the non-tariff barriers they replaced in the base period. According to an estimate presented by Hathaway and Ingco (1995), some EU tariffs and the US tariffs contain considerable 'dirt' and this 'dirty tariffication' appears to have occurred in the sensitive commodities such as dairy and fishery products. The extent of 'dirt' in tariffication varied widely among countries and commodities—the magnitude appears to be largest in the EU and European Free Trade Association (EFTA) (Ingco 1995).

Looking at individual import markets and products within the dairy sector, it appears that in the developed countries the bound tariffs are normally over 100% and as high as

370% for yoghurt in Japan and 300% for butter in Canada. In contrast, the tariffs are as low as zero and do not exceed 65% in developing countries (Sharma 2000). Therefore, while supposedly opening up barriers, tariffication in effect increased the protection of the EU and US markets by significant amounts.

To determine whether tariff reductions under the URAA will lead to increased market access and generate pressure for policy changes in the developed countries, it is necessary to examine the extent to which there is 'water' in the tariffs for agricultural products. A 'watery' tariff is one that is greater than needed to bridge the gap between the domestic and world market price. This is important because lowering the tariff will not increase market access until the tariff equals the percentage gap between domestic and world price. A comparison of EU tariff equivalents with applied tariffs during 1995–97 (Figure 1) reveals a substantial margin of 'water' in the EU's tariffs for dairy and meat products. Between 1995 and 1997, the EU's tariffs were very 'watery' for SMP and butter. For SMP, this stems from a small price gap (tariff equivalent) and high tariffs, whereas for butter, although the price gap was large, the applied tariffs were in excess of 130% between 1995 and 1997.



Source: USDA, ERS (1999).

Figure 1. 'Water' in the EU tariffs for selected commodities, 1995–97.

In many developed countries, tariffs have not been set in *ad valorem* terms but as specific tariffs, which has important implications for the transmission of world price changes to the domestic market. The specific tariff, in addition to protecting the level of domestic price (as an *ad valorem* tariff does), also reduces the degree of transmission of changes in the world market to the domestic market. The level of protection of non-*ad valorem* varies inversely with import price—a decline in import price yields an increase in the level of protection and vice versa. Given that non-*ad valorem* tariffs tend to be less transparent than *ad valorem* tariffs, it is not surprising that countries would apply this form of tariff to their most highly protected products.

Under the URAA, countries had a great deal of flexibility in deciding how much each agricultural tariff would be cut, so average reductions vary by country. The required unweighted average of 36% tariff reductions with the only constraint being a 15% cut on each tariff, left countries with much freedom to decide how to allocate their tariff reductions. Countries tended to reduce low tariffs by significant amounts, while reducing only slightly the existing high tariffs if the product was of trade importance. The smallest cuts tended to be made on over-quota tariffs of products protected by TRQs. Included in this category for Canada are dairy and poultry products; for Japan, grain and dairy products; and for the US, sugar, peanuts and dairy products. Not only were these tariffs reduced by significantly smaller amounts than other tariffs but also they tended to be higher to begin with. This practice allowed countries to reduce tariffs on commodities that did not compete with domestic production, while keeping high tariffs on products more sensitive to competition.

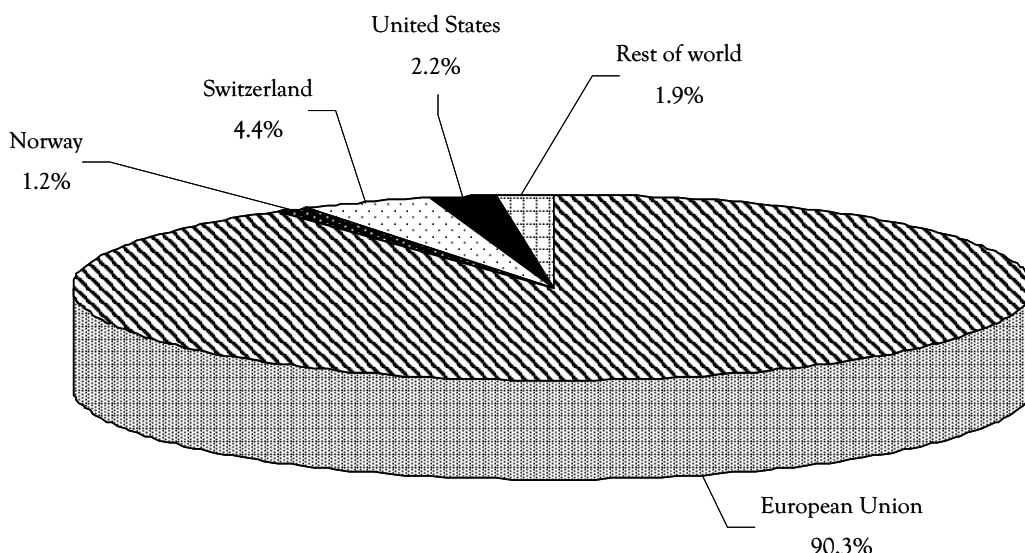
An important set of issues in implementing the market access provisions under the URAA relates to special safeguard provision (SSG), which may be used for products which have undergone tariffication (Article 5 of the URAA). This provision comes in two forms: a 'price triggered' and a 'quantity triggered' provision. In the quantity triggered form of SSG, an additional duty can be imposed if imports exceed their average 'during the preceding three years for which data are available' by no more than 5%. Under the price triggered form of the SSG, an additional duty can be imposed if the c.i.f. (cost, insurance and freight) import price of the shipment concerned falls below 90% of the 1986–88 average reference price ('trigger price'). The more the c.i.f. price falls below that trigger price, the higher the additional duty can be in accordance with a precise schedule included in the URAA. Sometimes even quantity and/or trigger prices were manipulated so that countries could more easily use SSG provisions. However, presently access to the SSG provisions is not universal and only 38 members have reserved the right in their schedule to apply the SSG. According to an estimate by Konandreas (1999), during the 1995–98 period there have been 200 instances when the SSG has been used (72 price triggered and 128 quantity triggered). Out of these, 35 were dairy products (15 price triggered and 20 quantity triggered), which amounts to about 18% of the total cases. Thus the use of SSG is higher in dairy than in other products.

Export policies

Export policies include both export restrictions and export promotion instruments. While most export policies were associated with food aid in earlier years, export promotion policies (mainly export subsidies) have become dominant features of the current world situation. These policies directly or indirectly influence world markets. Typically the prices in the world markets become more volatile under these policies. For instance, the EU uses world markets as a means of surplus disposal policies. Without price support and surplus disposal policies, both the EU markets and the world markets would absorb a supply shock. But with these policies, the shock is entirely absorbed by world markets. Thus dairy export policy in the EU and the US increases fluctuations of world markets.

In the URAA, the countries have agreed to limit both subsidised export volumes and subsidy expenditures (by 21% in volume terms and 36% in monetary terms for developed countries and developing countries were to reduce their subsidised volumes by 14% and their outlay by 24%). For dairy products, export subsidy limits were agreed for four product aggregates: butter, cheese, SMP and 'other dairy products'. Within each aggregate, countries are free to allocate export subsidies to the most sensitive products.

The EU is one of the largest exporters in several dairy product markets. In fact, the EU was the largest user of export subsidies accounting for about 90% of total export subsidies during 1998–99 (Figure 2). In the case of dairy products, the US and the EU are the major subsidising countries. According to Gulati and Narayanan (2000), dairy products account for about one-third of the US\$ 7 billion export subsidies on all agricultural products. Moreover, on a per tonne basis, the subsidised exports of butter and butter oil by the EU, carried a subsidy of US\$ 2169, on average for 1995–98. The export subsidy on milk powders was US\$ 796/tonne and for cheese US\$ 1018/tonne during the same period.



Source: USDA, FAS (2000).

Figure 2. Share of different countries in export subsidies in 1998–99.

Although there have been a number of dairy policy changes to meet URAA commitments, there have also been a number of trade problems that have arisen since 1995. Very few countries have changed their policies substantially to conform to their export subsidy commitments. Some of the issues that have arisen in the area of export subsidy and need to be addressed in the next round of negotiations are discussed below.

One of the disputes following the Uruguay Round concerned the 'carry-over' provisions committed to, as part of the URAA. In 1996, the EU, South Africa and Poland exceeded their volume commitments. The EU and Poland claimed the right to carry over 'unused' portions of their 1995 commitments to make up for the 1996 overruns. In response, other

countries argued that flexibility in provisions in the agreement were meant only to allow a country to pay back when it exceeded its limits, not as an opportunity for countries to 'bank' unused subsidies.

Countries can also easily modify the form of their support, as there is sufficient room for shifting subsidy from one component to others. Countries can substitute their export subsidies to output-related deficiency payments, which are allowed in the blue box.¹ For example, the US in its 1996 Farm Act has re-targeted funds previously dedicated to export subsidies to market promotions. It has now expanded its Export Credit Guarantee Programmes, where commercial credit is extended to finance agricultural export sales to low or middle-income countries. These programmes are covered under the green box² policies and are allowable without limits under the URAA. Similarly, the EU and Canada instituted export-marketing policies that allow them to circumvent their subsidy commitments.

As with other provisions, export commitments are expressed in terms of aggregate within certain product groupings. Countries are able to maintain barriers by concentrating their export subsidies on those few key products most important to the economy. For example, the EU is most reliant on subsidies for dairy products, bovine meats, poultry and fresh fruits and vegetables. The US and New Zealand had challenged Canada's milk pricing policy through the WTO Dispute Settlement mechanism. The allegation was that export subsidies are generated when milk for use in export products were sold in Canada at lower prices than would be obtained if the dairy products were sold on the domestic market. The WTO panel ruled in March 1999 that Canada was effectively subsidising the export of milk products through its use of 'special milk class' pricing, whereby certain dairy exports are undertaken with milk priced lower than is available for otherwise similar domestic milk products.

The base period (1986–90) from which reductions in export subsidies were negotiated, were periods of historically high levels of subsidies in most of the countries. A number of countries have also taken advantage of what is known as the 'front-loading' option, where they could use the 1991–92 period as the starting point for the export subsidy reduction rather than 1986–90. The amounts of subsidised exports, which can be exported by both the US and the EU during the implementation period are significantly increased if the 1991–92 base is used for commodities and this flexibility in starting point has reduced the impact of export subsidy reductions.

The above results indicate clearly that so far very few countries have changed their policies substantially to conform to their export subsidy commitments. The EU and the US, by far the largest exporters of subsidised commodities, continue to rely on subsidies to bridge the gap between high domestic support prices and lower world prices. High base

-
1. The blue box has resulted from the Blair House agreement between the USA and the EU, and was agreed to accommodate EU compensation payments and US deficiency payments. The direct payments legitimate under the blue box come in several forms: payments made on fixed areas and yields, payments made on 85% or less of the base level of production, livestock payments made on a fixed number of head (in beef sector, compensatory payments are made on the basis of a maximum stocking rate per hectare).
 2. Green box policies need to meet a number of criteria, specified in Annex 2 of the Agreement on Agriculture. Green box policies include expenditure on government service programmes like research, pest and disease control, training services, extension and advisory services, marketing and promotion services, infrastructure and environmental services, public stockholding for food security purposes, domestic food aid, natural disasters etc.

levels, from which cuts were required, have permitted most countries to accommodate required reductions under their current policies. The countries appear to have implemented policies that allow them to circumvent those commitments and undermine the substantial export subsidy disciplines of URAA.

Domestic policies

Domestic agricultural policies can have a sizeable effect on agricultural trade. These policies include subsidising production or consumption, production control, price support and price discrimination schemes. Production, consumption and storage subsidies are commonly used instruments in dairy policies around the world. For example, the EU has production subsidies for casein (to absorb surplus SMP) and storage subsidies for butter. The EU also subsidises dairy consumption in SMP for animal feeding. A production subsidy shifts the supply curve down, while a consumption subsidy shifts demand upwards. This influences both prices and quantities in the country affected, as well as world markets if the country is involved in international trade.

Some limitations on domestic support were thought to be essential for the successful achievement of WTO's trade goals aimed at establishment of 'a fair and market oriented agricultural trading system... and correcting and preventing restrictions and distortions in world agricultural markets'. The provisions in the URAA put controls over many trade-distorting domestic policies used to support farm prices and incomes (trade-distorting domestic support measures to be reduced by 20% by developed and 13.3% by developing countries). Other domestic policies were exempt from any controls.

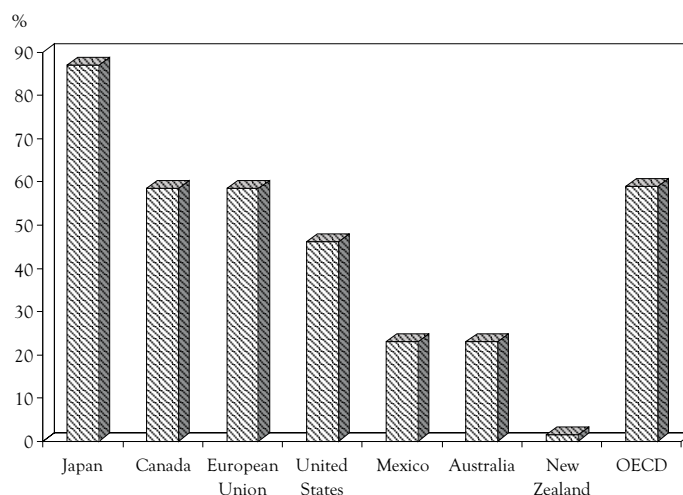
The URAA classifies supports into several categories—those that are acceptable because they are minimally trade distorting and those that are not acceptable as they are obviously trade distorting; those that have ceiling levels and those which do not have ceiling levels. In the final agreement, domestic policies deemed to have the largest effect on production and trade, (amber box policies) are to be disciplined by requiring limitations or gradual reductions in related support levels. Policies presumed to have the least effect (no more than 'minimal trade-distorting effects') on production and trade (green box policies) are exempt from any disciplines.

Domestic support is disciplined through the use of an Aggregate Measure of Support (AMS)³ calculated for each product but committed for reduction in terms of total for all commodities. Due to broad aggregation of commitments under the Uruguay Round, this is an area where there has been limited substantive gain over the past five years. Some of the issues that have arisen in the domestic support area are discussed below.

Generally the interventions in developed countries have taken the form of policies to support the incomes of the producers and shield them from impact of price variability in international markets. The incidence of these protective policies has been highest in

3. AMS is an index, which measures the supports considered to production and trade distorting under the WTO. Three elements are included in the AMS calculations: (i) market price support (to be calculated on the basis of the gap between the world market price and the domestic administered price multiplied by the quantity of production eligible to receive that administered price); (ii) non-exempt direct payments; and (iii) other subsidies not exempted from reduction commitment.

developed countries including the EU, Japan, the US and Switzerland. In the case of milk, Japan, the EU, Canada and the US have a very high level of protection, while Australia and New Zealand have relatively low protection (Figure 3). The 1996–98 OECD average milk nominal assistance coefficients (NAC) were 2.08 for producers and 1.92 for consumers, so the gross value of farm receipts and the value of consumer expenditure were each about twice what the same quantities would have been worth at world prices. The PSEs for dairy were 58% in 1998 (marginally lower than 59% in 1986–88) compared with 37% for all commodities (down from 41% in 1986–88).



Source: OECD (1998).

Figure 3. Producer subsidy equivalents (PSEs) for milk in selected OECD countries, 1995–97.

The domestic support provision seems to legitimise the types of subsidies provided by developed countries, while placing ceilings and reduction commitments on those subsidies developing countries tend to provide. Furthermore, the developed countries have an added advantage as they have traditionally provided high subsidies and are only called upon to reduce them. Developing countries, however, have not traditionally provided subsidies (or only in minimal amounts) and are not permitted to introduce or increase their subsidies. Under the domestic support provisions of the URAA, governments can continue assisting their agricultural sectors and rural economies through those programmes presumed to have the smallest effects on production and trade—the ‘green box’ policies. These include domestic food aid, certain types of income support, research, inspection, natural disaster relief and other programmes like crop insurance, environmental programmes and rural assistance.

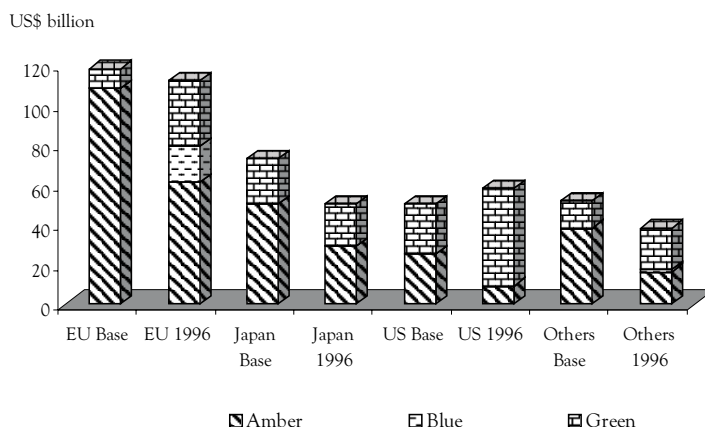
In the original WTO agreement, 26 countries made commitments to reduce domestic support. The EU, Japan and the US are by far the largest providers of amber support in absolute terms, accounting for about 90% of total AMS for the 24 countries that had reported an AMS as of June 1998. An analysis of these notifications shows that all countries

reporting their 1995 support levels are meeting their commitments to reduce trade- and production-distorting subsidies from the 1986–88 base level agreed to in the URAA. Most countries reduced this support by more than the required amount.

How did compliance move so rapidly?

Although some of the decline in AMS has occurred simply because the domestic support levels in the base period 1986–88 were high, some has also been the result of policy changes undertaken by some countries since 1986–88. There is now less reliance on price support and more reliance on direct payments and green box policies. The EU's reform of its Common Agricultural Policy (CAP) from 1992 to 1995, for example, reduced support prices and increased producer payments that are linked to production-limiting programmes. Japan has reduced administered prices or held them constant since 1986–88. Moreover, the US has undertaken important reforms under both the 1990 and the 1996 Farm Acts that reduced amounts of direct payments included as part of the AMS and increased the amounts of direct payments counted as part of green box policies.

While the support from policies believed to have the greatest effects on production and trade (amber box) has declined in many countries, support from green box policies has increased by 57% from 1986–88 to 1996 (Figure 4). Most of this increase was concentrated in the US, the EU and Japan. Most of the US\$ 130 billion expenditures on green box policies in 1996 went for domestic food aid, infrastructure services, investment aids for disadvantaged producers and other general government service programmes.



Source: USDA, ERS (1998).

Figure 4. Comparisons of domestic support levels in selected countries.

The URAA stipulates that direct payments under production limiting programmes (blue box policies) are excluded from current AMS calculations, although they were included in the calculations for the base AMS. This essentially makes a mockery of the AMS

reduction commitments by the developed countries. Similarly, the exemption of the EU's area compensation and headage payments from their current AMS calculation has a significant effect on current AMS. Therefore, most of the developed countries needed no real change or reduction in their domestic support subsidies to fulfil their AMS reduction commitments.

By stipulating that the AMS reductions are not product specific, but sector wide, measured in terms of total AMS, countries have been able to shift support among different products. In the case of the EU, this has involved changing the composition of assistance to less sensitive products like cereals and oilseeds while assistance is maintained or increased for some other commodities like dairy products, sugar and beef in fulfilling AMS commitment.

Experience so far shows that AMS has not been binding for any country and most of the developed countries have already achieved all the required reductions in domestic support in one way or another. Hence, their domestic support commitments will not act as a direct constraint on agricultural policies for the immediate future.

Impact of the URAA on international prices of dairy products

It was expected that lower exports of subsidised dairy products by the EU and USA would increase world market prices. Estimates of the impact of the WTO Agreement on world prices for dairy products ranged from a 4% increase in butter to an increase of about 20% for cheese (Andrews et al. 1994). However, the world prices of major dairy products in general showed a gradual decline (ranging from a decrease of 3.89% for cheese to about 11% in case of SMP) in the post-WTO period (Sharma and Sharma 2000).

For SMP, prices declined from US\$ 2150/t (FOB New Zealand = the mid-point of export price reported by the New Zealand Dairy Board) in July 1995 to a low of around US\$ 1225/t in June–July 1999. The SMP prices recovered during the last half of 1999, rose from around US\$ 1225/t to over US\$ 1475/t FOB New Zealand in the span of 6 months (June–December 1999) (FAO 2000). The increase in import demand was the main driving force for moving prices up. However, SMP market prices in USA and the EU were about one-and-a-half times higher than the world market prices, which shows the presence of high export subsidies. In case of whole milk powder (WMP), the international market prices continued to decline in the post-WTO period. The WMP prices declined from about US\$ 2250/t in the first half of 1995 to as low as US\$ 1425/t in May–October 1999. However, WMP prices also increased towards the end of 1999, rising about 5% to US\$ 1500/t in December 1999. International prices appear to be following a slowly upward trend, but remain well below the pre-WTO period of around US\$ 2100/t level. Demand for WMP, like SMP, appears to have strengthened this year following the economic recovery in Asia.

Butter prices, which had maintained their level better than other dairy products in 1998, fell sharply in the last half of 1999 reaching a level of US\$ 1225/t. Much of the down

turn has occurred recently, as demand from Russia (the main market for butter, which traditionally imports most of its butter requirements between December and February) has failed to materialise. World butter prices declined from US\$ 2000/t FOB New Zealand in January 1996 to a level of about US\$ 1225/t during August–December 1999. This year, Russian imports are expected to again decline and for this reason, any recovery in butter prices in the near future is doubtful. The world cheddar cheese prices also showed a declining trend in the post-WTO period. The EU has become the price setter for international trade in dairy products. One reason for this was the devaluation of the Euro against the US dollar. In addition, the EU has been aggressive in raising export subsidies on milk products to enhance competitiveness. The US also pays heavy export subsidies for different milk products under the Dairy Export Incentive Programme (DEIP); these subsidies distort and depress international prices.

Sanitary and technical regulations

Sanitary and technical regulations and the administrative procedures such as inspection, certification and product requirements raise important trade issues. Surveys by the European Commission's Trade Directorate and the Office of the US Trade Representative show that numerous domestic regulations impede imports, including those in the dairy sector, in almost all countries (OECD 1999c). Regulatory issues are likely to become increasingly important as tariffs on dairy products fall. This section provides information on the international arrangements dealing with non-tariff issues, focusing on those relevant for the dairy sector.

A major accomplishment of the Uruguay Round has been the introduction of new rules for solving disputes, through the WTO's Dispute Settlement Body. The WTO now tackles non-tariff barriers through the Sanitary and Phytosanitary (SPS) agreement and a strengthened Technical Barriers to Trade (TBT) agreement. It gives more importance to international bodies, such as the Codex Alimentarius—an international code of standards for human health protection and fair practices under the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO)—the Office International des Epizooties (animal health) and organisations operating in the framework of International Plant Protection Convention. Dispute settlement involves well-defined procedures of notifications, the calling of a panel when necessary and possibly of an appellate body. However, debates and decisions within the Codex Alimentarius, for example, have become more controversial.

The Sanitary and Phytosanitary (SPS) Agreement

The more specific SPS agreement was crafted to authorise only those domestic measures based on an objective risk analysis and to reject those that constituted a 'disguised trade restriction'. The SPS agreement covers health risks (food safety) arising from additives, contaminants, toxins and pathogens contained in food products. The agreement recognises

the right of governments to restrict trade to protect human, animal or plant health, but such measures must be transparent and consistent. There must be equal treatment for all nations and between imports and domestic products. A central role is given to the principle of equivalence. That is, a WTO member shall accept other countries' SPS measures as equivalent, even if they differ from its own, provided that the foreign measures achieve the importing members an appropriate level of protection. Members' measures that are based on international standards are deemed to be in accordance with the SPS agreement. Members may introduce or maintain SPS measures that result in a higher level of protection than that achieved by the relevant international standards if there is a scientific justification, or if it is a consequence of a level of SPS protection deemed appropriate by the member based on an appropriate assessment of risks.

The WTO panels and appellate body rulings have repeatedly emphasised the need to assess risks as stated in the SPS agreement (Article 5.1) and to conform to the need to provide scientific evidence (Article 2.2). The SPS agreement states that countries are entitled to determine the level of precaution they deem appropriate and that 'in cases where relevant scientific evidence is insufficient, a member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information' (Article 5.7). As a general rule, the precautionary principle can not be invoked unless proper risk analysis is first carried out. However, uncertainties persist about the nature and extent of the potential risks that may be taken into consideration and on the interpretation of how long a 'temporary' measure can last.

The Technical Barriers to Trade (TBT) Agreement

The TBT agreement defines rules to assess the justification for domestic measures affecting trade. The 1979 agreement was revised substantially during the Uruguay Round negotiations. It states that a technical regulation (compulsory) or a standard (normally implemented on a voluntary basis), as well as the enforcement procedures must be justified by a 'legitimate objective' such as national security, safety for consumers or the environment, animal and plant health, or fairness of trade. The agreement also seeks to ensure that national measures are transparent and minimise restrictions on trade. Compliance with relevant international standards is encouraged. The TBT agreement covers all measures not covered by the SPS agreement. In terms of dairy products, the TBT agreement covers packaging, composition and labelling as well as quality requirements, i.e. production and processing methods as well as final product characteristics and nutritional aspects.

However, the quickening pace of technological development and innovation in the dairy sector makes it increasingly profitable to harmonise product definitions, packaging and labelling requirements. WTO panel decisions have established the general principle that international rules do not permit WTO members to restrict the imports of products on the basis of how they are produced. The TBT agreement limits the scope of this principle by accounting for processes and production methods, but the degree in which measures referring to processes and production methods can be legitimate remains under debate.

National measures based on processes and production methods are more likely to be admitted if the production method clearly affects the quality of the product. Scientific considerations about nutritional and sanitary quality of new dairy products are therefore likely to play an increased role in trade.

Competitiveness of the Indian dairy industry

To anticipate what might happen to Indian dairy product trade flows in the case of reduced protection for the world dairy industry arising from the WTO, we must know how cost competitive this industry is, in addition to knowing policy details and negotiating arguments. The key question is: under more liberal trade, would India increase its imports or exports?

This is an important and contentious issue, which can have a significant impact on the welfare of millions of dairy farmers and the processing industry in India and abroad. This section seeks to answer this question, by estimating different indicators of global competitiveness and the impact of various factors on competitiveness of the Indian dairy industry. Competitiveness is a complex term and can be defined in several ways ranging from the domestic resource cost ratio concept to the competitive advantage concept encompassing segmented markets, differentiated products, economies of scale and so on. The nominal protection coefficient (NPC) is the most popular measure of global competitiveness (Corden 1971; Balassa and Schydrowsky 1972; Gulati et al. 1990), which is quite simple and easy to understand. The NPC of a commodity measures the ratio of domestic prices relative to world prices. If the NPC is greater (less) than one then the commodity under consideration is protected (taxed), compared with the situation that would have prevailed under free trade. The NPC of different commodities are calculated under two alternative hypotheses: (i) the importable hypothesis, when the foreign product is an actual or potential substitute for the domestic commodity in the domestic market, and (ii) the exportable hypothesis, where the domestic product is or potentially could be exported to compete in foreign export markets. For the present study, NPCs were computed under the importable hypothesis because India is not a major exporter of dairy products, but will have to face the competition of highly subsidised imports.

The estimates of NPC based on mid-point of export price (FOB) reported by the New Zealand Dairy Board (US\$/tonne) under the importable hypothesis are presented in Table 1. The value of NPC for SMP was below unity in all the years except 1999, which reflected marginal competitiveness during the period 1995 to 1998. In contrast, the values of NPC for WMP and butter were above unity in all the years, which indicated either high domestic prices or low international prices, hence non-competitiveness. However, these indices were not steady from year to year—mainly due to variation in the world price of dairy products, which is most volatile. During the period (1995–99) there was a downward trend in the world prices of most dairy products due to large subsidies given by the EU and the US, while there was no significant increase in the domestic prices. On average, the NPC of SMP was lower than the NPCs for WMP and butter. These results of nominal protection indicators

suggest that perhaps WMP and butter have not been efficient import substitutes, when compared with world market prices.

Table 1. Nominal protection coefficients (NPCs) for skim milk powder (SMP) , whole milk powder (WMP) and butter under the importable hypothesis, 1995–99.

Year	SMP		WMP		Butter	
	Range	Average	Range	Average	Range	Average
1995	0.814–0.927	0.853 (0.601)	1.000–1.252	1.092 (0.660)	0.971–1.288	1.074 (0.509)
1996	0.785–0.933	0.854 (0.633)	0.985–1.150	1.076 (0.677)	0.926–1.252	1.065 (0.495)
1997	0.829–0.961	0.904 (0.650)	1.095–1.235	1.163 (0.709)	1.066–1.347	1.245 (0.549)
1998	0.873–1.075	0.975 (0.640)	1.013–1.123	1.076 (0.648)	0.943–1.040	1.006 (0.514)
1999	0.979–1.163	1.086 (0.674)	1.117–1.263	1.221 (0.682)	1.046–1.338	1.250 (na)

Note: NPCs were calculated based on mid-point of export price (FOB) ranges reported by the New Zealand Dairy Board (US\$/tonne) plus the export subsidy given by the EU on dairy products; na = data not available.

However, the high values of NPC are mainly due to large export subsidies on dairy products by most of the developed countries and significant decline in the world market prices of dairy products in the post-1995 period. For example, the average export price (FOB) of SMP was about US\$ 1444/t in 1999 and the EU and US paid about US\$ 867 and US\$ 950/t, respectively, as subsidy on SMP exports, which represented more than 60% of the world prices (Sharma 2000). There was some decline in the export subsidy to comply with commitments made under WTO but the proportion of export subsidy as percentage of world market prices showed an upward trend. A similar trend was also observed for WMP and butter.

The NPCs calculated at distortion free world market prices are well below unity for all the products in all the years. The reduction in the value of NPC was most pronounced in the case of butter, followed by WMP and lowest in the case of SMP. This is mainly due to large subsidies on fat-based products, which have low demand in developed countries because of these countries food habits, but are dumped in the developing countries with the help of large export subsidies. These results indicate clearly that the Indian dairy industry is highly import competitive, if developed countries remove the export subsidies.

The raw milk cost is the largest single cost item in the dairy product chain, so the question of milk product competitiveness is reduced to whether milk cost at the farm level is competitive. Raw milk costs have a significant impact on the competitiveness of the dairy sector; an increase in domestic price reduces the competitiveness of the dairy industry while a fall in domestic price increases its competitiveness. Other important factors that have significant influence on competitiveness of the dairy industry are exchange rate and world price of dairy products. Increases in exchange rates and international prices of dairy

products increase the competitiveness of the industry quite significantly by reducing the values of NPCs in all cases. In contrast, reductions in global market price and exchange rate reduce the competitive strength of the industry. Since the international prices and exchange rates are highly volatile and are outside the direct influence of government and industry, the only way to increase the competitiveness of the Indian dairy sector is by reducing the cost of raw milk. The raw milk cost can be reduced either by raising the milk yield or by reducing the cost of milk production. Since, reduction in cost is not possible, the option available to reduce cost of production per unit of milk and thus keep domestic prices low, is to increase the yield level of dairy animals. The average milk yield per animal in India is one of the lowest in the world. Therefore, in order to remain competitive in the international market, there is a need to enhance productivity of milch animals and to introduce measures to improve sanitary standards with legal back-up in the milk production and processing sectors in the global free trade regime.

The above results indicate clearly that Indian dairy industry is highly competitive, if all export subsidies given by developed countries in general and the EU and US in particular, are eliminated in line with the current WTO rules for industrial products.

Conclusions and policy implications

Agriculture was a centre piece of the Uruguay Round of trade negotiations that created the WTO. This paper analyses the implications of the WTO agreement on agriculture, and the SPS and TBT agreements for smallholder dairy production and marketing. The experience of the first five years of implementation of the WTO agreements suggests a mixed picture, both in terms of implementation of its various provisions and its impacts. Many distortions in agricultural markets still remain and not all the expected benefits have materialised. Based on our findings and review of policies and market realities, we find the following weaknesses in the Uruguay Round agreements of relevance to agricultural trade in general and the dairy sector in particular:

- In the URAA, member countries agreed to convert all non-tariff barriers to tariffs and to reduce them. However, experience shows that these new disciplines provided for flexibility in implementation and many developed countries have found ways to limit impacts on their domestic agricultural sectors. Moreover, universal tariffication did not result in low and stable tariffs for dairy products. The formulae used in the Uruguay Round allowed some countries to inflate the tariff equivalents of previously non-tariff measures for particular products and to minimise the rate of reduction in tariffs for sensitive products. In some cases, countries used relatively large cuts on low tariffs and small cuts on high tariffs to meet the overall 36% average reduction requirement.
- Some countries have access to the provision of special safeguards, which allow them to increase tariffs above the ceiling levels in order to protect their domestic market from a surge of imports or very low world prices. In general, only developed countries have access to the SSG provision.
- Experience with regard to domestic support shows that restraints on internal support measures do not limit spending and have not been binding for any country. Moreover,

the level of support offered to domestic industries in the US and the EU has not been influenced by these commitments. Despite the fact that the US is meeting its AMS commitments, the US has notified the expenditures under green box policies that were almost twice as much as they were during the base period, 1986–88. There is an apparent shift from amber to green box programmes. The same situation occurred in the EU.

- Export subsidies have a major detrimental effect on the world market prices, which affect the income and returns of farmers and industry in the importing and non-subsidising export countries. The dairy sector is again a major offender as regards export subsidies. There is a high concentration of subsidies to a few countries and a few commodities. Only 25 of the 134 WTO members have a right to subsidise exports and the bulk of export subsidies is accounted for by two to three countries. The two biggest players on the international scene in the dairy sector, the US and the EU, together accounted for more than 90% of all subsidised dairy exports in 1995.
- Some implementation problems associated with export subsidy commitments have also emerged. Recent decisions to carry-forward and rollover unused export entitlements, aggregation of commodities in certain product groups and Canada's special class pricing systems have had a damaging impact on world markets.
- Some of the countries have also misused the provisions of the SPS and TBT agreements without sound scientific basis.

The results of competitiveness analysis reveal that protection to SMP was lower than WMP and butter in all the years. The estimates of NPC at distortion free world market prices (if all export subsidies are abolished) show that all the dairy products considered in the analysis are efficient import substitutes. The major reasons for the high level of protection afforded to major dairy products in India were that: (i) the international prices for most dairy products declined significantly in the post-WTO period, and (ii) export subsidies on these products increased substantially. International price of dairy products and exchange rate are the two important international level parameters that have a major influence on the competitiveness of this industry, but the industry and even the country have no control over these parameters. Domestic market price is another significant determinant of competitiveness of the industry and this is the only factor that is within the control of industry and the nation.

The findings of this study have important implications for policy making in the dairy sector. It is clear that the Indian dairy industry has achieved remarkable progress during the last two-and-a-half decades. However, the situation is changing very fast and the Indian dairy sector is moving towards an open economy environment of liberalisation due to commitments made to the WTO, as well as domestic economic reforms. These changes have significant implications for the Indian dairy industry and can threaten the success of the 'white revolution' in achieving self-sufficiency in milk production. With the opening up of the Indian dairy industry and the moving of most dairy products to Open General License (OGL) coupled with low import tariffs, imports of milk powders have increased substantially from 282 t in 1995–96 to about 18 thousand tonnes in 1999–2000. This inflow of cheap imports will lower domestic product prices but will have a negative impact on the incomes of the millions of rural producers and processors. Moreover, the world dairy prices are highly distorted with heavy export subsidies and domestic support, which depress

the domestic prices and create unhealthy and unfair competition for the domestic industry. India was the only country, which had committed a zero per cent bound rate of duty for milk powders and 40% for butter and butter oil compared with 100–150% for milk and cream, which are practically not traded in the world market. Recently, India renegotiated the zero bound tariffs of milk powders with the US, Australia and the EU under Article XXVIII of GATT, which is consistent with the TRQ provisions of WTO, but it took almost 6 months to notify these tariffs. Such delays can have significant adverse impacts on the dairy sector.

Export subsidies have adverse impacts on world market prices. There is general consensus around the world that export subsidies are the most trade distortive measures and can no longer be justified. Hence, in the next round of negotiations the government must focus on securing significant reductions in export subsidies, resulting in their eventual elimination and prohibition in the dairy sector. Moreover, they must focus on restriction of the carry forward and rollover export provisions.

Since the access to the provision of SSG is not universal, the Indian dairy industry would expect to see either the removal of 'special safeguard duty' provisions of the URAA or the making of them available to all member countries. The Indian dairy industry is also concerned to ensure that SPS and TBT measures continue to be based on the application of sound scientific principles and do not become *de facto* barriers to trade. India should press for abrogation of Articles 3.2 and 5.7 of the SPS agreement, which have proven to be controversial. India should take a lead in bringing together all developing countries and should negotiate/participate actively in WTO negotiations to protect smallholder producers' interests from unfair and distorted trade competition in an open economy environment.

The government should evolve a mechanism to monitor international prices and other developments in the world market and take corrective actions, such as anti-dumping duties and suitable tariff rates, to protect the dairy industry from unfair competition. The Indian dairy industry and particularly organisations/institutions like the National Dairy Development Board (NDDB), should take a lead role in monitoring trends in the global market (especially related to domestic support and export subsidy levels, and international prices) and provide the relevant information to help the government during the negotiation process.

The major policy implication of this study is that the Indian dairy industry is highly competitive but must be protected from distorted and unfair trade competition in a liberalising economic environment.

References

- Andrews N., Roberts I. and Hester S. 1994. The Uruguay Round outcome: Implications for agricultural and resource commodities. In: *Outlook 94. Proceedings of the national agricultural and resource conference held at Canberra, Australia, 1–3 February 1994. Volume 1. World commodity markets trade*. ABARE, Canberra, Australia. pp. 171–179.
- Balassa B. and Schydrowsky D.M. 1972. Domestic resource costs and effective protection once again. *Journal of Political Economy* 80:63–69.
- Corden W.M. 1971. *The theory of protection*. Oxford University Press, London, UK.

- Dobson W.D. and Cropp R.A. 1995. *Economic impacts of the GATT agreement on the US dairy industry*. Department of Agricultural Economics, Marketing and Policy Briefing Paper Series 50. University of Wisconsin–Madison, Madison, Wisconsin, USA.
- FAO (Food and Agriculture Organization of the United Nations). 2000. *Commodity and market review 1999–2000*. Commodities and Trade Division, FAO, Rome, Italy.
- Gulati A. and Narayanan S. 2000. Cork the genie back into the bottle. *Economic Times*. 17th August 2000.
- Gulati A., Hansen J. and Pursell G. 1990. *Effective incentives and India's agriculture: Cotton, groundnuts, wheat and rice*. Policy, Planning and Research Working Paper 332. The World Bank, Washington, DC, USA.
- Hathaway D.E. and Ingco M.D. 1995. Agricultural trade liberalization and the Uruguay Round. In: Martin W. and Winters L.A. (eds), *The Uruguay Round and developing economies*. World Bank Discussion Paper 307. The World Bank, Washington, DC, USA.
- Ingco M.D. 1995. *Agricultural trade liberalization in the Uruguay Round: One step forward, one step back?* Policy Research Working Paper 1500. The World Bank, Washington, DC, USA.
- Konandreas P. 1999. Next round of negotiations in agriculture with special reference to dairy sector. Paper presented at the international symposium on international prospects for dairying in the next WTO negotiating round held at Buenos Aires, Argentina, June 3–4 1999.
- OECD (Organization for Economic Co-operation and Development). 1998. *Policies in OECD countries: Measurement of support and background information*. OECD, Paris, France.
- OECD (Organization for Economic Co-operation and Development). 1999a. *Agricultural policies in OECD countries: Monitoring and evaluation 1999*. OECD, Paris, France.
- OECD (Organization for Economic Co-operation and Development). 1999b. *Agricultural outlook: 1994–2004*. OECD, Paris, France.
- OECD (Organization for Economic Co-operation and Development). 1999c. *Food safety and quality issues: Trade considerations*. Consultants' report by J.C. Bureau, E. Gozlan and S. Marette, revised by W. Jones. OECD, Paris, France.
- Sharma V.P. 2000. Assessing the effects of the WTO agreement on Indian dairy industry: What can we learn from past five years? *Indian Dairyman* 52(11):7–26.
- Sharma V.P. and Sharma P. 2000. *Performance and competitiveness of Indian dairy industry*. Report submitted to the Ministry of Agriculture, Centre for Management in Agriculture (CMA). Indian Institute of Management (IIM), Ahmedabad, India.
- United States Dairy Export Council. 1998. Dairy export subsidies and the WTO Canada case. *World Dairy and Outlook* 3(4):3–4.
- USDA, ERS (United States Department of Agriculture, Economic Research Service). 1998. *Agriculture in Uruguay Round: Analyses of government support*. Staff Report AGES880802, December 1988. ERS, USDA, Washington, DC, USA.
- USDA, ERS (United States Department of Agriculture, Economic Research Service). 1999. *Implementation of Uruguay Round tariff reduction, agricultural outlook November 1999*. ERS, USDA, Washington, DC, USA.
- USDA, FAS (United States Department of Agriculture, Foreign Agricultural Service). 2000. *Export subsidies disadvantage US agricultural exports*. FAS, USDA, Washington, DC, USA.

The competitiveness of smallholder dairy production: Evidence from sub-Saharan Africa, Asia and Latin America

S.J. Staal

International Livestock Research Institute, P.O. Box 30709, Nairobi, Kenya.
Tel. 254-2-630743; E-mail: s.staal@cgiar.org

Introduction

Where crop production is feasible, livestock production is an essential component of farming systems. It provides food, traction, manure and fibre, and performs other social and economic functions. There is growing recognition, however, of the contribution of livestock production to income generation for smallholder farmers through the production of higher-valued products compared with most crops. One of the key income-generating livestock activities available to resource-poor and even landless households is market-oriented milk production. Not only does this generate income on a steady daily basis, but it has also been shown to contribute to capital accumulation of resource-poor households, enabling them to invest in education or other productive activities and assets. Further, that income is often partially accrued by the women of the household, subsequently yielding positive effects on child welfare and nutrition.

This paper presents several sets of evidence regarding the level of competitiveness of smallholder dairy production. Smallholder dairy production refers to market-oriented milk production by resource poor households, which may or may not have land holdings located in urban, peri-urban or rural areas. Although there are differences across countries and systems, the size of herds may range from a single cow to 15 or more in higher-income countries.

The paper begins by examining projections for strong growth in dairy demand globally and particularly in developing countries. Subsequently, two types of competitiveness are examined: competitiveness in local domestic markets and competitiveness internationally. First, local competitiveness is addressed through a set of case studies from sites in countries in Asia, sub-Saharan Africa (SSA) and Latin America. Secondly, detailed budget case studies are presented from two countries. International competitiveness is then examined using the same range of case studies. National-level data on milk imports are presented to illustrate a key underlying driving factor to continued smallholder viability, that of the nature of demand. Finally, some policy issues are highlighted that continue to influence smallholder dairy producer competitiveness.

The continuing livestock revolution

Clear evidence is now available that smallholder livestock producers in developing countries are being presented with growing market opportunities. A recent study by Delgado et al. (1999) updated in Delgado et al. (2001) examined the trends for livestock demand and production to 2020, with a focus on developing countries. Based on a global food model, they predicted where and to what degree demand for livestock products will grow and simultaneously predicted where the increased production needed to meet that demand will occur.¹

The projected changes are dramatic, particularly because of increases in per capita income in Asia and elsewhere in developing countries. Furthermore, because of growing human populations and urbanisation, consumption of animal products will increase significantly in all developing countries by 2020. In developing countries, consumption of meat and milk is predicted to grow by up to 50% in the period from 1983 to 2020, to approximately 44 and 87 kg/capita per annum, respectively (Delgado et al. 1999). In Table 1, projected growth in meat and milk consumption is shown for the period from 1997 to 2020. Much of the growth in meat consumption will occur in pork and poultry, although, in addition, beef consumption per capita is expected to grow by more than 30%. In simple monetary value terms, these dramatic changes in overall livestock production, which are already well on their way, will be larger than the Green Revolution of the 1960s and 70s.

Table 1. Projected growth in total milk and meat consumption for selected regions, 1997 to 2020.

Region	Meat		Growth rate	Milk		Growth rate
	1997	2020		1997	2020	
	$\times 10^6$ t/year		%/year	$\times 10^6$ t/year		%/year
China	53	104	3.0	10	23	3.5
India	4	9	3.5	60	132	3.2
Latin America	35	45	2.4	54	82	1.8
Sub-Saharan Africa	6	11	3.2	17	35	3.3
Developing countries	111	213	2.9	194	372	2.7
Developed countries	98	114	0.7	251	276	0.4
World	208	303	1.8	445	654	1.7
	kg/capita		%/year	kg/capita		%/year
China	43	71	2.8	8	16	4.3
India	4	7	3.3	62	104	3.0
Latin America	54	69	1.2	112	127	0.6
Sub-Saharan Africa	10	12	0.9	30	37	1.0
Developing countries	25	35	1.7	43	61	1.8
Developed countries	75	84	0.5	194	203	0.2
World	36	44	1.0	77	87	0.6

Source: adapted from Delgado et al. (2001)

1. The IMPACT model is a global food model of 22 commodities including seven livestock commodities, covering 36 separate regions/countries, and with annual iterations to 2020. It incorporates expected growth in population and income, and changes in productivity (Delgado et al. 2001).

Although milk consumption growth is not as dramatic when viewed in overall global terms (an expected annual growth rate of 1.8% to 2020), growth of milk consumption in developing countries will be much more significant. From 1997 to 2020, milk consumption in developing countries is expected to grow from 194 to 372 million tonnes (t)/year, a 92% increase, at an average annual growth rate of 2.7%, compared with 0.7% in developed countries. China is projected to experience the highest rate of growth in milk consumption at 3.5%, followed closely by sub-Saharan Africa (SSA) and India at 3.3 and 3.2%, respectively (Table 1); however, these increases are from relatively low initial levels. In per capita terms, the growth rates are lower, illustrating the effect of population growth on demand, but also underlining the importance of changes in consumption due to income level and urbanisation. In sharp contrast, consumption in developed countries is expected to remain almost constant. This phenomenon is thus centred almost entirely in the developing world.

From the point of view of smallholder producers, however, the following important questions remain: where will the increased milk production needed to meet this demand take place and will smallholder livestock producers be able to participate in this market opportunity?

In answer, increased production is expected to occur generally in the same areas where increased demand is expressed. Increased importation from more distant parts of the globe is not expected. This simply follows the current pattern, where a relatively small proportion of production is traded globally: $\leq 10\%$ of volume of global livestock production is traded internationally (FAOSTAT). In spite of the public attention sometimes given to livestock and dairy product trade issues, livestock products are not easily traded. Dairy products require extensive transformation or high cost to preserve and transport them, after which they may not compete well in quality against local fresh products. Thus, the IMPACT model predicts that countries that are deficit in livestock products will generally import feed rather than meat and milk, leading to rapid increases in feed grain imports in some areas. The implication for imports of milk by developing countries is similar. Although imports will increase as consumption of dairy products increase, as a proportion of total consumption they are expected to remain constant or decrease. Delgado et al. (2001) project a 69% increase in milk imports² to developing countries, from 20 to 34 million tonnes/year during the period 1997 to 2020. As a proportion of developing country production, however, the level of imports will decrease from 10 to 9%. This process is well established. For the developing world as a whole, however, net milk imports per capita decreased from 5.3 kg in 1985 to 4.7 kg in 1998 (Nicholson et al. 2001). Consequently, the proportion of milk produced in developing countries will increase. By 2020, developing countries will produce just over 50% of all milk globally, an increase from 38% in 1997. Smallholders, who currently produce most of the world's milk, may be well placed to capture the opportunities presented by the Livestock Revolution.

2. 'Milk imports' are measured in liquid milk equivalent units (LME) and include all dairy products.

Local competitiveness of smallholder dairy production

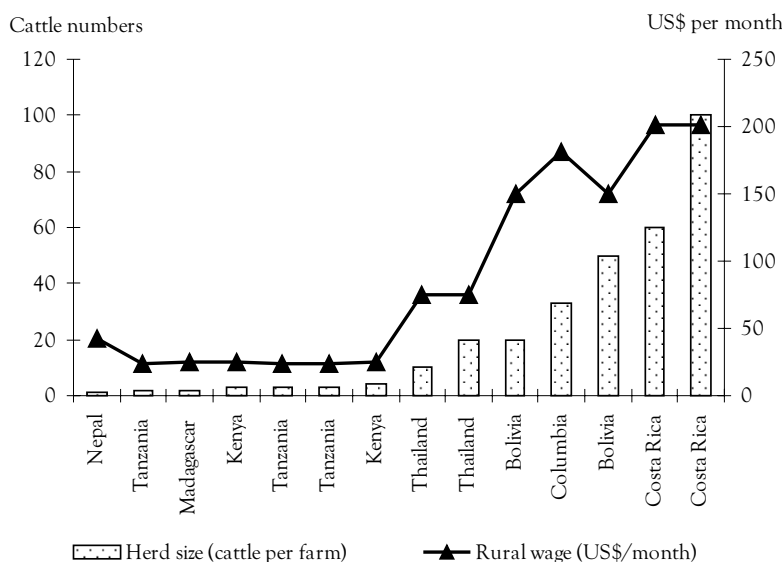
Sources of competitiveness locally

Critical to understanding the competitiveness of smallholder dairy production is the appreciation that it is generally a labour-intensive activity, relying on the use of family and hired labour instead of mechanisation. Thus, cows are usually milked by hand, fodder is cultivated and gathered manually and milk may be carried by foot or bicycle to sales points. Clearly, such a system of production relies on the lack of better alternative employment opportunities and on the absence of more valuable agricultural enterprises. This means that other crops and livestock production that are practical and marketable locally do not offer significantly better returns, but also that industrial development has not succeeded in providing adequate numbers of better-paying jobs. In such circumstances, the opportunity costs of farmer labour are low, which is generally reflected in low observed casual wage rates in rural areas.

The competitiveness of smallholder dairy production is thus partially dependent on low opportunity costs for labour. This may be the primary determinant of smallholder competitiveness locally, within a given economic region or nation, where wages are generally homogenous. Figure 1 provides some examples of this effect. Using recent case studies from SSA, Asia and Latin America, variation in observed rural wages with typical herd size from the same farming system is examined.³ The consistent pattern is an increase in herd size with an increase in rural wage rates. The logic behind this is clear. As wages increase, including the alternative employment opportunities for family members, farmers attempt to substitute other inputs for the relative costly labour component. Portable milking machines may be introduced and hand tractor carts may be used to carry feed and fodder. Land may also be substituted for labour as the latter becomes relatively more costly, in which case farmers shift to a greater reliance on grazing rather than on intensive fodder production. For these capital inputs to be cost effective, they typically require greater volumes of production, since they offer economies of scale. Herd sizes thus increase, and the structure of competitive production shifts away from smallholders, towards what may be described as medium-sized commercial production. To ensure returns from the increased capital investment, production may also become more specialised, with fewer of the crop–livestock interactions that typically occur on a mixed crop–dairy farm. Within a given economic environment, where wages and employment opportunities are low and generally similar, evidence suggests that smaller dairy production units are more competitive and successful than larger ones.

Another aspect of smallholder dairy success, that is sometimes overlooked, is the value that smallholders capture from non-dairy product outputs of the dairy enterprise, such as manure and savings. Particularly in high potential agricultural areas where population

3. Unpublished results from case studies carried out in November to December 2000 by the International Livestock Research Institute (ILRI) and collaborators under the project on Transregional Analysis of Crop–Livestock Systems.



Source: ILRI collaborative project on Transregional Analysis of Crop-Livestock Systems.

Figure 1. Variation in observed rural wage rates with dairy herd sizes from sites in sub-Saharan Africa (SSA), Asia and Latin America, 2000.

densities are high, such as East Africa or Bangladesh, the primary constraints to livelihoods may be the dual threats of small land sizes and poor soil fertility. The soil fertility constraint may result from the need for near-continual cropping in order to provide adequate subsistence. Manure becomes a key ingredient in the provision of the required nutrients and soil organic matter. The introduction of off-farm fodder and concentrate feeds simply increases the quantity of nutrients made available through manure. Under such conditions of chronic nutrient deficiency, the value of manure to a mixed dairy-crop farmer may be very high. In Kenya, researchers found that the value of manure produced in a small dairy farm may be $\leq 30\%$ of the value of milk produced, based on the observed market values for both (Lekasi et al. 1998). This value is captured on farm through the increased value of crop production, simply by applying the manure to crops on farm. Large dairy producers have greater difficulty capturing this value, since they may practice specialised dairy production without crops and the quantities of manure they produce may be so great that the issue becomes one of disposal rather than use. They consequently lose the additional returns to dairy production that efficient manure use may offer.

Finally, dairy cattle, like other cattle, may present important savings and capital accumulation mechanisms for resource-poor farmers. Incremental daily inputs of labour, land, feed and other inputs over time are accumulated and compounded in the form of a valuable cow or heifer or even a fattened bull calf or castrate. These animals may be sold when cash is needed to meet lump-sum expenditure needs, such as to pay school fees or to invest in upgrading farm facilities. The value of these savings is additional to other returns to smallholder dairy production for farmers with very restricted access to formal capital sources. Again, large-scale producers have greater difficulty in capturing this value; given

their greater access to other investment opportunities, investment in cattle incurs opportunity costs instead of positive returns to the family utility for savings.

It is important to note that manure and savings benefits are eroded, or disappear when wages increase. High labour costs lower the value of manure, which as a bulky form of nutrients require considerable handling compared with more concentrated inorganic fertiliser. Under higher wage conditions, the cost of labour required to raise animals begins to outweigh the value of the accumulated capital. Therefore, evidence suggests clearly and consistently that where labour opportunities are low, where soil nutrients and land are scarce, smallholder mixed dairy producers successfully out-compete larger more specialised producers locally.⁴

Case studies in profitability: Kenya and Thailand

While the above analysis provides evidence of smallholder competitiveness in dairy production, a more basic indicator is simple profitability. For any enterprise to be competitive in its market environment, it should exhibit at least 'normal' profits. Normal profits are those that offer the same return to investment (such as of land, labour and capital) that would be available from alternative enterprises locally. In the case of labour, for example, a normal profit would approximate the wages available to the entrepreneur elsewhere in the market. Any enterprise that exhibits above-normal profits may be regarded as rewarding investment at a better level than most local enterprises and so can be considered competitive.

Two case studies are used here to examine the competitiveness of smallholder dairy production in this manner. The first comes from Kenya, where research was conducted between 1997 and 1999 on 43 smallholder dairy farms in several contrasting sites (SDP 1999). The second is a study of 44 smallholder dairy farms in Thailand, conducted in 1998–99 (Hall et al. 2000). The case studies represent different ends of the spectrum in terms of labour opportunity costs in dairy production. While rural wages in Kenya are approximately US\$ 25/month, in Thailand they are approximately US\$ 75–90/month.

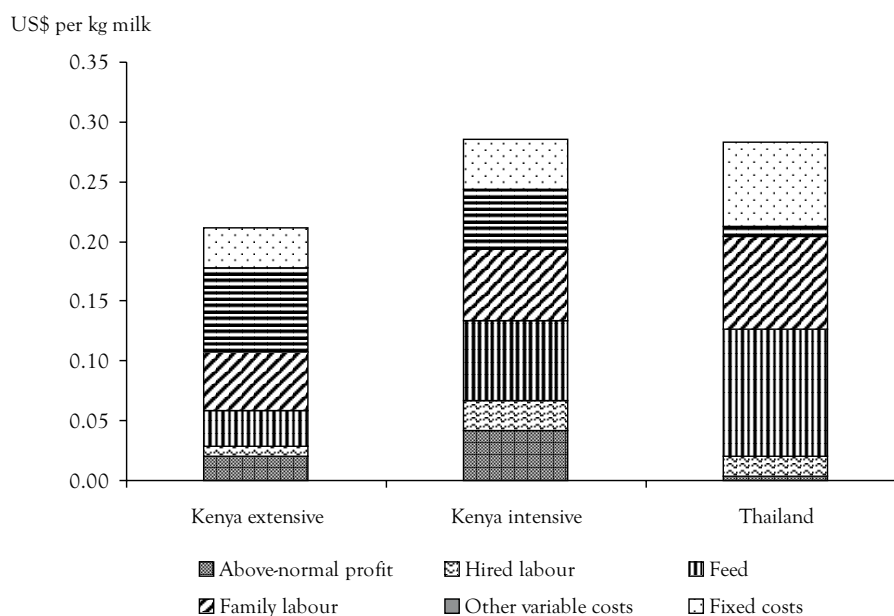
In Kenya, results from two contrasting sites are presented. The first site is an area of relatively extensive crop–dairy production in Nakuru, Rift Valley, where farmers keep three to five crossbred dairy cattle, including two or three cows, on about five acres of land, and are reliant mostly on grazing. The second Kenyan site is in the intensive central highlands of Kiambu, where land holdings are small and so farmers keep only two to three high-grade dairy cattle, including one or two cows, on an average of two acres of land (SDP 1999). Because the area of land held cannot provide adequate animal nutrition, farmers purchase fodder and concentrate feeds.

In Kenya, cattle keeping, milk production and milk consumption are strongly rooted in tradition, so that even the raising of crossbred animals builds directly on age-old habits.

4. In the urban environments of many developing countries, large-scale dairy production units dependent on purchased feeds may be very successful because higher milk prices are available close to cities through informal raw milk markets. The discussion here refers instead to the larger environment of rural land-based dairy and crop production.

Kenya is also largely self-sufficient in dairy products, with imports representing <1% of imports. In Thailand, the case study comes from the central province site of Ratchaburi, where farmers keep around 20 grade dairy cattle, including 10–12 cows, on some five acres of land (Hall, personal communication, 2000).⁵ The Thai farmers also rely heavily on concentrate feeding. In contrast to Kenya, Thailand has much less tradition of milk production and consumption. Imports constitute some 65% of domestic dairy demand. In both country studies, complete cost, labour and revenue data were gathered over a period of a complete year, so as to capture seasonal variation and to avoid relying on farmer recall, thereby increasing the accuracy of the budget measurements.

A summary of the results of the dairy production budgets for the three sites is shown in Figure 2, expressed uniformly in terms of US\$/litre of milk produced. Basic cost categories are compared and above-normal profits shown. The results show that both of the Kenyan sites exhibit above-normal profits for dairy production, US\$ 0.02 and 0.04 per litre for the extensive and intensive sites, respectively. These are returns after normal wage costs have been deducted for the family labour used in dairy production. The results suggest that smallholder dairying on these farms can compete well against alternative enterprises available to the farmers and is likely to offer higher returns. It should be noted that these two sites are considered representative of important production areas of highland East Africa; thus, these results imply good opportunities for smallholder dairy producers in the region broadly.



Source: SDP Kenya 1999 and Hall et al. 2000.

Figure 2. Comparison of costs and returns to smallholder dairy producers in Kenya and Thailand, per kg milk.

5. These farms are generally larger than typical farms in the area as they were selected from a sample of co-operative members. Other farms are comprised typically of some seven cows on two acres of land (Hall, personal communication, 2000).

In Thailand, the farms and herds are somewhat larger, but they represent smallholders in the context of their more commercialised farming environment. The results from these farms show no above-normal profits (Figure 2). Overall, returns to dairy production are estimated to be zero at -US\$ 0.002/litre, which represents a return that is approximately equal to a normal profit.⁶ Again, this return is the amount after the costs of family labour have been valued (at the local market wage) and deducted. The results suggest that dairy production offers about the same return to labour as that available from alternative enterprises and general employment in the area; these factors are implicitly valued in the wage rates and land rental rates used in the cost calculations. While this result does not indicate the same degree of competitiveness as that seen in Kenya, it nevertheless suggests that for some farmers, depending on personal preferences, dairy production will yield a viable enterprise and livelihood compared with local alternatives. The same study found that for farms that increased the level of inputs in disease control and genetic improvement, returns were increased and above-normal profits were reported (Hall et al. 2000). Possibly reflective of these results is the fact that the number of milk cows in Thailand doubled between 1992 and 1999 (TOAE 2000). It should be remembered that this increase in cow numbers is in the context of a domestic dairy market that has previously relied heavily on imports to meet most of its demand.

Case studies from different settings suggest that smallholder dairy production can compete successfully against alternative local activities. It should be noted that in these case studies it was not possible to value the contribution of manure, which if positive, can be regarded as a profit above that shown. Comparisons of scale and wage opportunities indicate that where employment opportunities are low, smallholders will retain an edge. Further, the Kenya and Thailand cases indicate that normal- or above-normal profits are available from smallholder dairy production. The Thailand case suggests that smallholders can compete even in the context of a mainly import market. In the next section, international competitiveness is examined more closely.

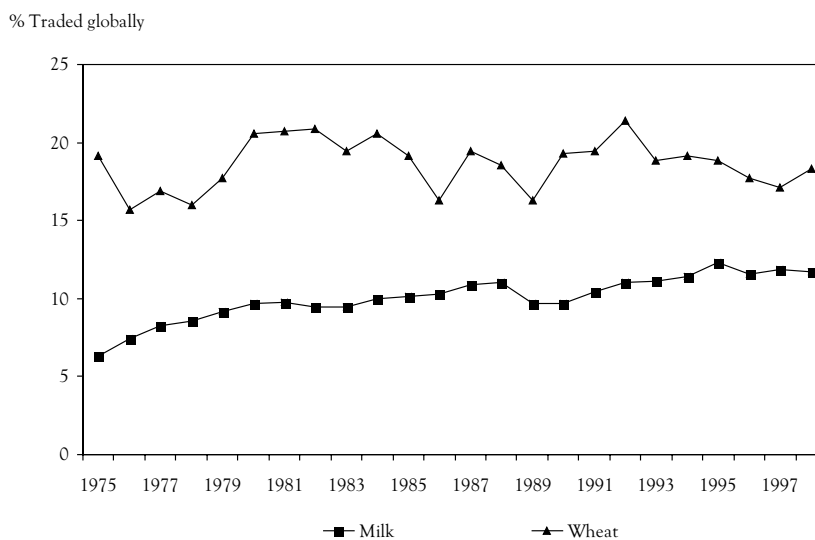
Smallholder competitiveness internationally

While the above analysis showed evidence that smallholders can compete locally, a frequently raised issue is whether farmers in developing countries can compete internationally. This debate may be highlighted as World Trade Organization agreements gradually reduce the level of border tariffs, potentially opening new markets for dairy trade, at least in those countries that have traditionally maintained high trade barriers.

How large is the dairy trade?

A starting point for examining the international competitiveness of dairy production may be to identify the scale of the issue. Figure 3 compares the proportion of global production that was traded internationally during 1975–98 for two major food commodities—milk and

6. Estimated from the results of Hall et al. (2000).



Source: FAOSTAT.

Figure 3. Percentage of world milk and wheat production that was traded, by volume, 1975–98.

wheat.⁷ In the case of wheat, the proportion has varied from about 15 to 22% of total world production. For dairy products, the proportion traded is less and has remained at just over 10% since the mid 80s, although it appears to have been lower previously. Although these results are not conclusive, they seem to suggest that dairy trade faces some of the same obstacles faced by other livestock products, for which an even smaller proportion is traded. As mentioned in the first section of this paper, these obstacles are related to the need to transform and preserve livestock products before they can be traded. It should be noted, however, that <1% of rice production is traded internationally, in spite of the relative ease of bulking and transport. This low level of trade may be related to the subsistence nature of a large proportion of rice production. In contrast, much of wheat production is highly commercialised. Aside from the regulatory environment and strategic domestic considerations, the volume of trade relative to production may thus be influenced by some combination of these factors, structure of production and physical characteristics of the product.

Competitiveness measured through import parity

A common approach, to evaluating the extent to which local producers can compete against imported products, is to calculate import parity prices of products.⁸ This is one part of the domestic resource cost approach to measuring comparative advantage (Chenery 1961). Import parity price in the case of milk is calculated by starting with the world price for whole

7. Milk here is milk equivalents, representing all types of dairy products traded.

8. Export-parity prices are generally used in situations where a country is a net exporter.

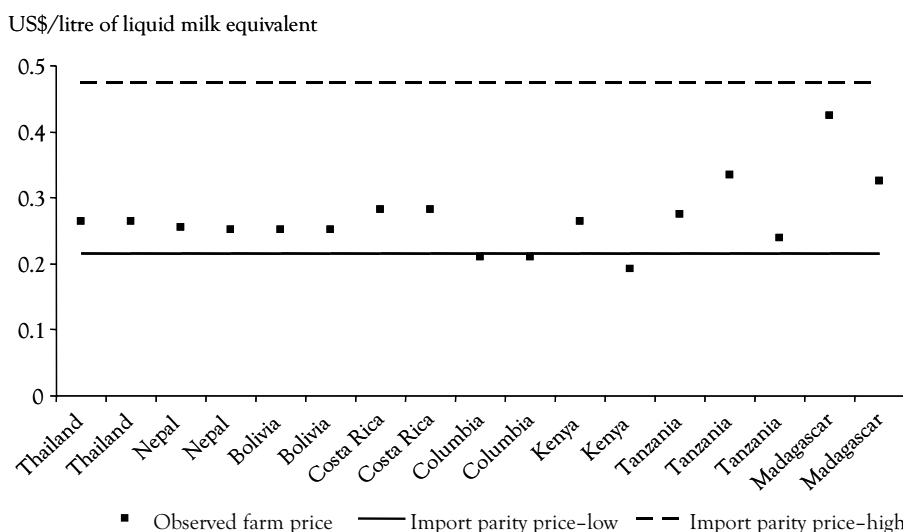
milk powder (WMP), and adding to it the costs of transport to the local market and the costs of transformation into liquid milk. To compare with farm-gate prices, the cost of local milk collection is deducted from the reconstituted liquid milk cost. This then represents the import parity price of milk at the farm gate, directly comparable to the prices received by farmers. If the import parity price is lower than the farm price, local producers have difficulty competing because consumers are likely to prefer the lower cost import. If the import parity price is higher than the farm price, local producers may be competitive, as their milk is cheaper than imports. These price comparisons ignore differences in quality, which should be kept in mind.

Approximate import parity prices were calculated for selected case study countries.⁹ Because detailed transport and processing costs were not available for each country, two different margins were applied to the world milk prices based on transport and processing in Kenya (Staal 1995) and Thailand (Hall 2000) in order to attain a range of potential import parity outcomes. Therefore, these estimates provide only rough indications of the potential comparisons of import parity prices over time with current farm prices. Import parity prices were estimated for WMP prices of US\$ 1500–2500/t, the general range of world market price for that commodity in recent years. In late February 2001, the world market price was about US\$ 2050/t (USDA 2001). Figure 4 compares the import parity estimates with recently observed farm gate prices for the case study countries. Generally, the results show that observed farm gate prices are scattered across the potential range of import parity prices (Figure 4) shown in units of US\$/litre of liquid milk equivalent. The graph reinforces the recognition that local competitiveness will vary considerably and will depend not just on fluctuations in world milk powder prices, but also heavily on local costs of transport, handling and processing. Observed prices in some of the country cases are in the lower range of import parity prices suggesting that many smallholder producers can compete effectively against the threat of imported dairy products. Naturally, this will vary from country to country, depending partly on import tariff regimes and transport costs to international markets. Nevertheless, this type of analysis is based heavily on the assumption that imported and domestic fresh dairy products are perfect substitutes. As shown in the next section, international competitiveness may be based largely on the nature of domestic demand for milk and dairy products, and in the minds of traditional milk consumers, the substitutability of imported and fresh products may be limited.

Traditions of dairy consumption and imports—The fresh milk premium

Milk and dairy product consumption is not a traditional habit in all cultures of the world. Regions where milk is not traditionally consumed beyond infancy include large parts of South-East and East Asia, and those parts of SSA where trypanosomiasis has precluded cattle keeping, such as coastal West Africa and much of Central Africa. Nevertheless, in

9. ILRI collaborative project on Transregional Analysis of Crop–Livestock Systems (unpublished observations).



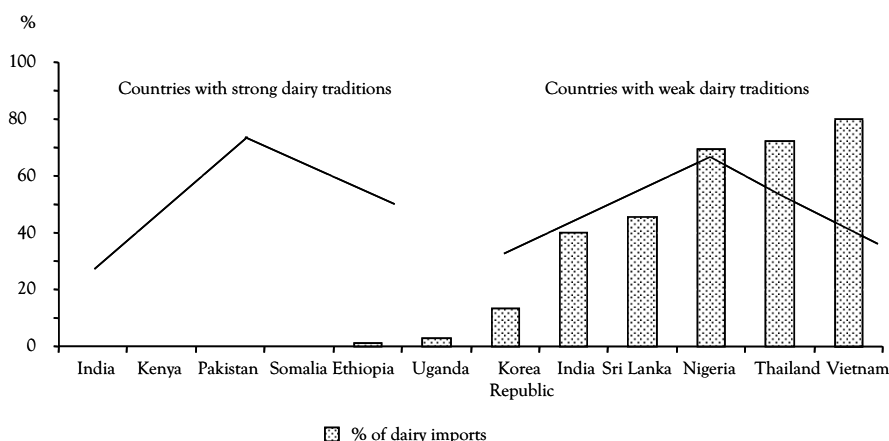
Sources: Observed prices from unpublished data gathered by ILRI and collaborators under the project on Transregional Analysis of Crop-Livestock Systems. Import parity prices based on current and historical ranges of whole milk powder (WMP) prices over the last 10 years, from FAOSTATadd and USDA (2001) data. Processing and handling margins are based on Staal (1995) and Hall (2000).

Figure 4. Comparison of observed farm-gate milk prices with current and historical range of approximate import parity prices for selected countries.

these countries, demand for dairy products has grown. Much of this growth in demand can be linked to the influence of habits introduced from other industrialised nations. In West and Central Africa, consumers have developed a taste for sweetened condensed milk and yoghurt. In parts of Asia, consumers now use milk powder, and buy ice cream and other sweet dairy products. The key point here is that these relatively newly introduced dairy products are by physicochemical nature either easily imported directly or easily made from imported milk powder. These products often require relatively little fresh milk. These consumer choices contrast with those of consumers in regions where milk is consumed traditionally, such as South Asia and East Africa. In these regions, much of the demand is for fresh liquid milk, such as in Kenya where some 80% of milk is consumed in tea. Consumers in such countries often regard reconstituted milk (prepared from milk powder) as an inferior product compared with fresh milk. Because fresh liquid milk, other than high-cost UHT milk, is practically impossible to trade internationally in any quantity due to its limited shelf life, domestic producers in these countries nearly always have an advantage; this might be termed the fresh milk premium.

In terms of proportion of dairy demand that is satisfied by import, the impact of this factor is dramatic. Figure 5 compares the proportion of dairy imports for two sets of countries, those with and without a strong tradition of dairy product consumption. Countries with dairy traditions include India, Pakistan and several East African countries. Those without include Nigeria (the coastal areas), Sri Lanka,¹⁰ and south-eastern and East

10. Sri Lanka offers an interesting case, in which the Tamil community has strong dairy traditions and consumes fresh milk, while the Sinhalese community does not have dairy traditions and so mainly purchases milk powder (Ibrahim et al. 1999).



Source: Nicholson et al. (2001), using FAO data.

Figure 5. Percentage of domestic milk availability that is imported, countries with strong dairy traditions and countries with weak dairy traditions.

Asian nations. Those without dairy traditions import up to 80% of their domestic production, as in the case of Vietnam. Those with strong dairy traditions import a fractional amount, generally <1% but up to 2% in the case of Uganda.

Clearly, an important factor here is the fact that countries that are traditional consumers of milk are also traditional producers. Typically, milk production is well integrated into local agricultural systems; thus, these countries have the capacity to supply their own markets. The starting advantage in the traditionally consuming and non-consuming countries is generally oppositely placed. In traditional dairy countries, imports generally have difficulty competing with strongly demanded fresh milk, even if imports offer lower prices. Contrastingly, in non-traditional dairy countries, local milk producers may have difficulty competing with low cost imported products that meet consumers' preferences.

It is interesting to note, however, that in Thailand, a country where large-scale dairy product consumption has been learned relatively recently and where imports continue to supply about 65% of the market, the number of dairy cattle approximately doubled between 1990 and 1999, from about 75 thousand to 140 thousand (TOAE 2000). This suggests that as non-traditional consumers move beyond consumption of milk powder and yoghurt, and develop an interest in fresh liquid milk, that the fresh milk premium may begin to occur even where imports have traditionally dominated. Future domestic producer competitiveness, including smallholder competitiveness, may grow as demand for liquid milk grows.

Policies to enhance smallholder dairy competitiveness

In spite of the above evidence suggesting that in many areas smallholders remain competitive in dairy production, policy interventions can continue to provide additional support to their viability. The small scale of milk production and marketed output implicit to smallholder systems can often result in low bargaining power and limited ability to capture economies of scale in marketing. Farmers use a variety of strategies to

overcome this. The first strategy is generally to sell direct through the informal market to consumers, hotels etc. thereby obtaining higher prices for their milk and reducing transactions costs (Staal et al. 1997). Use of milk traders to bulk milk, and perform distribution and marketing services is also common. Finally, dairy farmer co-operatives and other farmer groups can improve the market position of small farmers through collective actions. Policies that support these activities and do not interfere with individual market activities of farmers and traders are likely to sustain competitiveness of producers.

Smallholders may also have poor access to livestock services and credit compared with larger-scale producers. These services may include veterinary services and artificial insemination, and credit for feeds and replacement cattle. Formal services typically favour larger producers, who may be more willing to pay the full costs of such services. Formal public services continue to be constrained by access to adequate resources; continued privatisation is needed for those services and regions where smallholders can afford the costs of targeted quality services (Ahuja et al. 2000). In areas that are more marginal and for other services, public support may continue to be needed.

Finally, other policies may exist that favour more capital-intensive dairy production. These may include the requirement of collateral for credit, which excludes smallholders, and differential access to development project or programme resources.

Lessons learned and conclusions

Global trends in livestock demand and production point clearly to strong growth potential, especially in developing countries. Growth in milk demand will play an important role in this and will present new opportunities for smallholder producers in countries where the growth is expected to be greatest.

This paper presents evidence suggesting that smallholder dairy producers remain competitive in many areas. Local competitiveness is supported by several key factors, including low opportunity costs of labour and the ability of small mixed farms to capture more efficiently the value of nutrient cycling. It should be noted that it is not a policy or development objective to maintain low opportunity costs in support of smallholder dairying. Certainly the goal is the opposite, higher wages and better employment opportunities. The key point here is that where wages and opportunities remain low for whatever reason, smallholder dairy production will provide a viable activity and one which is unlikely to be threatened significantly by large-scale production, unlike perhaps the case of poultry production.

Evidence is also presented to suggest that in some cases, countries with mainly smallholder dairy production can compete internationally. This may depend on future trends in world milk prices. Nevertheless, the pattern of dairy imports globally suggests strongly that the fresh milk premium will continue to support local producers, especially in countries where milk is consumed traditionally, but potentially to an increasing extent in countries where milk consumption habits are growing.

Acknowledgments

Contributions towards data sources and analyses came from members of the project on Transregional Analysis of Crop Livestock Systems, particularly Isabelle Baltenweck, M.N.M Ibrahim, Federico Hollman, Mario Herrero, the Smallholder Dairy Project (Kenya), Liston Njoroge and Robert Ouma. I am grateful to David Hall for access to his data and analysis from Thailand and to Simeon Ehui for comments. Financial support for gathering case study information was provided by the Systemwide Livestock Programme of CGIAR. Responsibility for the accuracy of the data presented and for the views expressed is reserved exclusively by the author.

References

- Ahuja V., George P.S., Ray S., McConnell K.E., Kurup M.P.G., Ghandhi V., Umali-Deininger D. and de Haan C. 2000. *Agricultural services and the poor: Case of livestock health and breeding services in India*. Indian Institute of Management, Ahmedabad, India; the World Bank, Washington, DC, USA; and the Swiss Agency for Development and Co-operation, Bern, Switzerland.
- Chenery H.B. 1961. Comparative advantage and development policy. *American Economic Review* 51(1):18–51.
- Delgado C., Rosegrant M., Steinfeld H., Ehui S. and Courbois C. 1999. *Livestock to 2020: The next food revolution*. Food, Agriculture and the Environment Discussion Paper 28. IFPRI (International Food Policy Research Institute), Washington, DC, USA; FAO (Food Agriculture Organization of the United Nations), Rome, Italy; and ILRI (International Livestock Research Institute), Nairobi, Kenya. 72 pp.
- Delgado C., Rosegrant M. and Meijer S. 2001. Livestock to 2020: The revolution continues. Paper presented at the annual meeting of the International Agricultural Trade Research Consortium, Auckland, New Zealand, 18–19 January 2001.
- FAOSTAT. FAO on-line database. <http://apps.fao.org>
- Hall D.C. 2000. *Three essays in animal health economics*. PhD dissertation, Texas A&M University, College Station, Texas, USA.
- Hall D.C., Ehui S. and Shapiro B. 2000. *Economic impact and sustainability of animal health programs on dairy farms in central Thailand*. Working paper. Department of Agricultural Economics, Texas A&M University, Texas, USA; and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Ibrahim M., Staal S.J., Thorpe W., Tanner J. (eds). 1999. *Appraisal of the Sri Lanka dairy sub-sector. Volume 1. Synthesis of main results. Volume 2. Main report*. Ministry of Livestock Development & Estate Infrastructure, University of Peradeniya, Sri Lanka; and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Lekasi J.K., Tanner J.C., Kimani S.K. and Harris P.J.C. 1998. *Manure management in the Kenya highlands: Practices and potential*. Natural Resources Systems Programme, Department of International Development (DFID), UK; and the Henry Doubleday Research Association. Emmerson Press, Kenilworth, UK. 35 pp.
- Nicholson C., Tambi E., Staal S.J. and Thorpe W. 2001. *Patterns of change in dairy production and consumption in developing countries from 1985 to 1998*. MOSD Working Paper 7. ILRI (International Livestock Research Institute), Nairobi, Kenya.

- SDP (Smallholder Dairy Project). 1999. Smallholder Dairy Project. Unpublished survey data. Joint project of the Ministry of Agriculture and Rural Development, Kenya Agricultural Research Institute (KARI) and International Livestock Research Institute (ILRI), Nairobi, Kenya.
- Staal S.J. 1995. *Peri-urban dairying and public policy in Ethiopia and Kenya: A comparative economic and institutional analysis*. Florida University Graduate School, Florida, USA. 275 pp.
- Staal S.J., Delgado C. and Nicholson C. 1997. Smallholder dairying under transaction costs in East Africa. *World Development* 25(5):779–794.
- TOAE (Thai Office of Agricultural Economics). 2000. *Agricultural economic indicators of Thailand, 2000*. Government of Thailand Press, Bangkok, Thailand.
- USDA (United States Department of Agriculture). 2001. <http://www.ams.usda.gov/dairy/mnsc/inter.htm>.

Theme 2: Implications of international trade regulations for smallholder dairy production and marketing

Plenary discussion

Following the presentation of the international trade and smallholder competitiveness papers, participants raised issues and concerns regarding the impact of trade regulations on smallholder dairy development and, related to that, the probable drivers of domestic dairy production, especially consumption patterns of dairy products.

The issues and concerns were:

1. The negotiation skills and strategies of the South are not as well developed as those of the North. This leads to unfair international agreements. There is the need to strengthen the South's capacity for negotiation.
2. The relationship (or lack thereof) between smallholders and the World Trade Organization (WTO) should not be ignored. If the price of imported milk is low, it may replace domestic milk demand/consumption and therefore endanger milk production and family livelihoods because of the multiple roles of dairy.
3. While raising domestic production through increasing yields and reducing costs was seen as important, there were different views on the impact of imports on domestic production.
4. Some participants felt that where the demand for fresh milk is strong, i.e. where there is a tradition for consumption of milk and dairy products, imports of cheap powder will not threaten local markets.
5. Others said that traditional preferences for fresh milk can change, and imports reduce the demand for fresh milk, which reduces the price of domestically produced milk, making smallholders suffer.
6. This was reinforced by the comment that where there are smallholders, there is poverty and, regardless of traditional consumption patterns, poor people will buy the cheaper product.
7. It was emphasised that for many smallholders, dairy is only one component of the farming system and it should not be dealt with in isolation. Nor can it be the only route to poverty alleviation.
8. In the same context, it was noted that an important role of dairying in smallholder farming systems was to provide alternate sources of income for families when crops fail (risk spreading).

These and the related issues from the plenary discussion of the presentations in themes 1 and 3 were subsequently discussed in small groups of workshop participants.

The outcomes for theme 2 are given below.

Group discussion

As for the other themes, the group discussion of theme 2 was structured around a set of questions. The questions addressed the determinants of dairy demand and the linkages, real or perceived, between international trade in dairy products and the competitiveness of smallholder dairy.

The questions discussed by the group were:

1. What are the determinants of the competitiveness of smallholder dairy?
2. Are the effects on smallholder producers of international trade regulations (relating to dairy products) well understood and reliably estimated? If not, what will be the factors that will have to be considered in estimating the effects?
3. Do we have reliable estimates of dairy demand by region/country/area and the structure of that demand? How will variation in those estimates and in the structure of demand (including substitutability) affect smallholder dairy development policies and programmes?
4. Are there issues related to international trade regulations of importance to smallholder dairying and how can developing countries best address those issues?

The group responses were given below.

What are the determinants of the competitiveness of smallholder dairy?

Issues to be understood: the significant determinants of international competitiveness are:

- Costs of production
- Efficiency of processing plants
- Quality of products
- Exchange rates
- Current international prices and subsidies
- Consumer preferences
- Importance of informal vs. formal markets.

Are the effects on smallholder producers of international trade regulations (relating to dairy products) well understood and reliably estimated? If not, what will be the factors that will have to be considered in estimating the effects?

- It appears that not all countries have fully understood the implications of international trade agreements, despite signing these agreements. Asymmetry in knowledge on international trade regulations exists among South countries.
- Countries need to be sensitised on the basic structure of the WTO and its basic components, namely the various agreements such as the Agreement on Agriculture and Sanitary and Phyto-sanitary (SPS) measures.

- Imports of subsidised dairy products (subsidies in a variety of forms such as domestic support, export subsidies etc.) will adversely affect local prices, and thereby incomes and employment generated by smallholder dairy production that is common among countries of the South. Even in countries that do not have access to subsidised products, depressed international prices due to such subsidies may depress local income.
- There is also a need to consider differences in some countries like Vietnam. Import taxes have a possible negative impact on local consumption.
- There is also a need to consider the effects of other non-tariff trade barriers such as technical standards and phyto-sanitary measures, and their significant potential to adversely affect trade from countries of the South. Conflicting provisions in SPS agreement of WTO allows certain countries to fix standards that are higher than required to satisfy standards set by international bodies such as Codex Alimentarius Commission, OIE etc.

Relative importance of different markets:

- Potential to export (degree of self sufficiency)
- Relative importance of processed products
- Consumption patterns
- Local price structures

Do we have reliable estimates of dairy demand by region/country/area and the structure of that demand? How will variation in those estimates and in the structure of demand (including substitutability) affect smallholder dairy development policies and programmes?

- Not all countries have reliable data collection structures in place, but India does.
- There are reliable estimates from formal markets but not from informal markets.
- There is a need to unify methods relating to data collection, analytical methods and application across countries.

Are there issues related to international trade regulations of importance to smallholder dairying and how can developing countries best address those issues?

- There is a need for a working group to be set up to study the implication of WTO rules for local dairy industry.
 - There is a need for a provision in the rules that allows for an importing country to impose duty relative to subsidies.
 - Duties should be harmonised and be universal.
- In their plenary presentation, the group emphasised these key issues:
- Distortions exist in the current policy environment governing international trade in dairy products.

- The need to review export subsidies and subsidies in general including domestic support.
- The need to review non-tariff trade barriers.
- Each country needs to review its import duties in relation to its needs to protect sufficiently its domestic industry.
- Recommendations from this conference should reach policy makers in countries of the South.
- ILRI, or another international organisation, should undertake comparative studies on these issues and take into consideration the points raised in this conference.

After these group outcomes were presented in a plenary session, discussion highlighted the following:

- There was consensus in the group about the unfairness of international competition.
- The spirit of WTO is that every human can take advantage of cheaper goods.
- Trade has to be fair. No country should subsidise goods and people should be able to choose what they buy.
- South politicians signed agreements without realising the implications of doing so. There is the need for an extension to the WTO deadlines to allow countries in the South to deliberate again.

Conclusions

The presentations, the supporting papers and their discussion highlighted the sensitivity of international trade issues and the urgency for a better understanding in countries of the South of WTO regulations and their implications for domestic competitiveness and dairy development. The strengthening of capacities in the South for effective negotiation related to international trade regulations was also required. Steps towards achieving those objectives are presented in the workshop recommendations.

**Theme 3: National dairy policies
(including policies related to
research, extension, development
and training) for smallholder
production and marketing**

National policies supporting smallholder dairy production and marketing: India case study

S. Parthasarathy¹

Assistant Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

India currently holds a leadership position in the dairy world, with a production level of 78 million tonnes of milk and annual growth rate of a little over 4%. This is an appropriate time to review successive policy interventions of the government over the years, assess their impacts, both if only to draw lessons for policy makers within India and for those in the developing world to understand and possibly replicate the Indian model.

The story has to start with the historical context of dairying in India. Over centuries, dairying in India meant keeping a head or two of cattle in the house. The choice of livestock made a clean distinction between the uses of the cow and the buffalo; one was draft animal and the other was kept for milk. Indian livestock farming for centuries was caught in the vicious loop of large numbers, shortage of feed and fodder, low productivity, and recurring epidemics. Obviously before modern era of dairy development began, there was no system at the village level for handling surpluses nor was there a mechanism for collection, transportation, process and distribution. Surpluses could only be converted to ghee or milk sweets.

Policy interventions during the colonial rule underscored the need to supply milk to armed forces and city dwellers through the military farms. A regulatory colonial regime established milk colonies (Mumbai, Kolkatta, Chennai), laid down quality standards for ghee and butter, and ensured control over the movement of milk and milk products. A post of milk commissioner was also created, a legacy that has outlasted all its critics, and survives in a liberalised era (recalling) essentially as a monument of colonial arrangements supporting an alien philosophy, and an anachronistic co-operative law.

One of the first policy initiatives immediately after independence was the recommendation from the milk sub-committee of the policy committee on agriculture (1950), which resulted in city milk scheme being set up in Delhi, which grew eventually to cover nearly 100 towns and cities by 1960. These were essentially demand-driven, urban (consumer) oriented initiatives run by governments, and could not compete with milk vendors, as there was no supporting strategy to cover the milk producers in rural areas with required price and other incentives in an integrated fashion. An incentive-less pricing system benefiting only urban consumers with cheaply priced milk in fact resulted in what

1. The views expressed in this paper are the author's own deriving from his previous experience in this sector and do not reflect the views of the organisation in which he is currently working.

one may call an anti-dairy cycle whose ill effects were compounded by cheap imports to reconstitute as milk and maintain urban supplies.

It would be worthwhile to look briefly at the overall situation in this sector in the country during the early fifties. Dairies were then located in urban areas, owned by governments and without an efficient procurement system, and many potential rural milk sheds were largely untapped. Since the city dairies were unable to obtain sufficient milk through middlemen, milk powder was imported for reconstitution. Private milk supplies were erratic, usually adulterated and over priced. In most villages one middleman had the procurement monopoly and producers were forced to sell their milk at prices fixed by him. Seasonal fluctuations in production often had the producer at a double disadvantage—low prices in winter due to flush production and no stocks in summer due to sustained demand. The low prices paid to milk producers ensured that they did not invest in the expansion of their production, which thus stagnated.

Throughout the 50s and 60s dairy development and animal husbandry remained depressed, as the procurement prices were artificially kept low. This killed whatever incentive the producer had to produce more. In fact, through the initial five year plans up to the time the National Dairy Development Board (NDDB) was set up in 1965, the small rural milk producer was at a discount; the importance of forging a viable marketing link between the milk producer and consumers did not get woven into any policy effort, let alone being recognised as the critical step in any viable system. Amul (Anand Milk Union) was the only exception.

Amidst all these developments an event took place in 1946 in the remote district of Kheda in today's Gujarat. Led by Tribhuvan Das Patel and deriving inspiration from that charismatic leader, Sardar Vallabhai Patel, a group of poor milk producers started a movement to protest against the milk monopolist of the day, Polson Dairy, who had been awarded the sole rights to supply milk to Bombay milk scheme. The movement tasted success when its protagonists won the right to form a dairy co-operative and to supply milk to the Bombay milk scheme. Operations were started with a modest 5-can procurement of 247 litres of milk from two village societies. Eventually this would blossom into the legendary Amul of today. The tiny seeds of a life-sustaining principle of producers' co-operative was sown, which would eventually lead the way and place the small producer right at the heart of all dairy development activities in the future.

A major step forward, which would have far reaching implications for the future came in 1965 with the setting up of NDDB to oversee dairy development in the country. The background to the formation of NDDB has been narrated often but is well worth recapitulation. It so happened that in 1964 Lal Bahadur Shastri, the then Prime Minister of India, visited Anand to inaugurate a cattle feed factory put up by Amul. He was so impressed by what he saw on this visit that he wrote to all state governments and ministers personally commending the programme for setting up co-operative dairies based on the Anand pattern in other states. The following year the NDDB came into being, registered under the Societies Registration Act and Public Trusts Act, as an expert technical body to guide and co-ordinate the accelerated development of the dairy industry in India and to provide the necessary technical, managerial and consultancy services. NDDB was expressly asked by the

Prime Minister to attempt to replicate the Anand pattern milk co-operatives movement throughout the country.

During the interregnum between the third and fourth plans (1966–69) the government of India, with the help and advice of the NDDB, made major policy changes in dairy development. Milk production in rural milk sheds through milk producers' co-operatives and movement of processed milk to urban demand centres became the corner stone of government policy for dairy development. This single policy initiative of the government would give a boost to dairy development and initiate the process of establishing the much needed linkages between the producer and the consumer through a pricing, procurement and marketing system, that would result in a White Revolution. The policy package included measures, which enabled the NDDB to regulate and streamline the chaotic dairy set up that existed in the country at that point of time.

- the NDDB itself was structured as a fully autonomous technical body under the aegis of the Ministry of Agriculture and as the adviser to the ministry for all matters related to dairy development in the country
- the NDDB was made the canalising agency of the government for the import and export of all milk products and was authorised to regulate the rampant milk solids imports, all in order to save domestic dairy production from smothering discrimination by the private and government dairy plants
- to fulfil its role as a single window consultancy body for dairy development, the NDDB equipped itself with skills and infrastructure for assisting the fledgling Indian dairy industry on all aspects of dairying, from farm production to processing, value addition, marketing and turn key execution of major engineering and construction projects and
- cross breeding of the indigenous cattle with exotic breeds became official policy for milk production enhancement and gained economic relevance as the co-operative network under operation flood moved in to provide market stimulus and price support.

Many other policy linkages connected with breeding (frozen semen production stations), cattle feed (large feed compounding mills), disease control (foot-and-mouth disease (FMD) vaccine production plant), veterinary services and manufacture of dairy and feed milling equipment, would be woven into the implementation processes through the Operation Flood Programme as elements of an integrated strategy that are now taken for granted in any dairy development process that is required to succeed. To balance the seasonal and regional production imbalances, to ensure balanced supply of milk and milk products to all regions of the country, the NDDB structured dynamic regional and national milk grids, linking all major milk sheds and co-operative milk unions. And to ensure continuing supply of managerial skills for the growing dairy industry, the NDDB promoted the Institute of Rural Management in Anand (IRMA).

Operation Flood

Operation Flood was the project conceived and proposed by the NDDB to restructure the milk markets in India and to make the market the engine for milk production growth. Phase I of the project was agreed upon between the Government of India and the World Food

Programme (WFP) in March 1970. Operation Flood involved an imaginative but pragmatic use of the funds generated by monetising the WFP gifts of milk powder (126 thousand tonnes) and butter oil (42 thousand tonnes). The commodities were sold to the metropolitan dairies at market prices (and so not adversely affecting indigenous milk production), to help them capture a commanding share of the city's milk market. The funds thus generated were used to finance expansion of the metro dairies, build rural feeder/balancing dairy plants and to replicate the Amul model co-operative milk producers' unions in the hinterland milk sheds, through a judicious mix of loans and grants.

The overall goal of Operation Flood I was to lay the foundation of a modern dairy industry in India which would adequately meet the country's needs for milk and milk products, and which would be capable of viable, self-sustaining growth. This was sought to be done through the establishment of producer controlled dairy co-operatives in the major milk sheds, modelled on Amul, which would evolve into viable business enterprises. In effect, this would enable millions of small producers to market their daily surplus production, through their co-operatives, and gain direct access to far-flung urban demand centres, eliminating all middlemen.

Specifically, Operation Flood's main marketing objective was to enable the metro dairies to capture commanding shares of the liquid milk markets in Mumbai, Kolkatta, Delhi, and Chennai. These four cities represented India's largest metropolitan demand centres. During the 1950s and 1960s city milk supplies were seriously threatened by seasonal declines in production, often compounded by adverse climatic conditions. Operation Flood arranged expansion of the metro dairies, increasing their outputs, enabling them to capture the commanding shares of their respective milk markets, to become the price and quality leaders in the market. They were to be sufficiently large to oblige traditional milk traders to compete with the modern dairies in terms of quality, thereby limiting their freedom to dilute milk, and in terms of price, preventing thereby the manipulation of milk prices with adverse effects for producers.

NDDB, in implementing Operation Flood, started to change the existing situation by organising co-operatives, initiating discussions with state governments, and by creating a management structure which combined competence in rural development, animal husbandry, dairy engineering, marketing and manpower development. The campaign to establish co-operatives immediately met with strong and sustained opposition from those whose interests was challenged including middlemen and contractors. NDDB often found it difficult to persuade state governments to support the formation of the Anand Pattern milk co-operatives in their states, because of the fundamental change of approach to dairy development involved. NDDB's approach threatened the prevailing vested interests and the bureaucracy's traditional fear of change. It was the ever watchful and dynamic leadership of Dr Kurien that saw the NDDB through the shoals of bureaucratic opposition and other no-changers, to a position of dominance in this sector. There were however some helpful bureaucratic developments. The attention given to dairy development was increased by the creation of the post of a Joint Secretary within the Ministry of Agriculture, who was responsible for the administration of the ministry's dairy wing and dairy development in general. By and large, they lent NDDB policy support and implementation assistance over the years.

The World Food Programme assistance to India's dairy development programmes known as Operation Flood I, was replaced by food aid direct from the European Community and a World Bank/IDA loan under Operation Flood II, and Operation Flood III. The objectives and methods were the same as Operation Flood I. By the time the third phase of Operation Flood ended in 1996 the three phases of the programme had some significant achievements to their credit. Individual targets for each phase of the programme were consistently and substantially exceeded. Here is a summary of the gains out of an integrated policy of dairy development that underlay the Operation Flood and how they resulted in benefits to the smallholders:

- the enormous urban market stimulus led to sustained production increase raising per capita availability of milk to nearly 210 grams per day
- dependence on commercial imports of milk powder ended with positive impacts on indigenous producers
- modernisation and expansion of the dairy industry and its infrastructure activated a national milk grid, which was a strong counterweight or deterrent to the market forces governing milk
- marketing mechanism of milk expanded to about 800 urban centres, providing assured outlets for rural producers
- more than Rs. 50 billion went back to the producer members in 1999–2000 as money for their milk, which in turn was pumped into sustaining India's rural economy
- a nationwide network of multi-tier producers' co-operatives, democratic in structure and managed professionally, came into existence resulting in millions of small producers participating in an economic enterprise that helped improve the quality of their lives
- the manufacture of dairy equipment grew to meet most of the indigenous industry needs
- the quality of milch animals improved with their per lactation yields increasing and their inter-calving periods coming down. This translated to more earnings for the producers
- a wide network of research institutions to work on various aspects of dairy development, animal sciences and rural development were established and
- production grew at 4–5% per annum during 1970–99 as against less than 1% before.

Before the third phase of Operation Flood was launched, NDDB itself underwent structural changes as a result of the LK Jha committee recommendations. The dairy board, (a society), and the Indian Dairy Corporation, (a company), were merged by an Act of Parliament in 1988. The new statutory corporate body retained the old name—National Dairy Development Board (NDDB) and almost all of the autonomy that the Board has enjoyed all along. The NDDB Act 1987 declared the board an institution of national importance—a tribute to its outstanding stature and achievements over the decades.

One of the key initiatives on dairy development was the launching of technology mission by the Government of India in the beginning of the 1990s with the objective of establishing linkages between programmes launched under Operation Flood, NDDB, the Central Department of Animal Husbandry and Dairying and the state governments. The aim was to avoid overlap in activities and focus on necessary policy changes.

To give one example of an attempted establishing linkages, the focus throughout the earlier plan periods had been on expanding the capabilities and coverage of the state

departments of animal husbandry, the emphasis being on curative services delivered through 50 thousand institutions and a mind-boggling number of professional staff (36 thousand) and para-veterinarians (70 thousand). This had resulted in a comparative neglect of disease investigation and control. The synergistic exploitation of these services together with those established under Operation Flood by NDDB did not materialise. The quality of services delivered by governmental departments is a matter of serious concern, strapped as they are by fiscal pressures to meet burgeoning establishment and staff salary costs.

A significant strategy change that was put through was the promulgation of the Milk and Milk Products Order 1992 which made it mandatory for all plants handling more than 10 thousand litres of milk per day and 500 t of total solids to register themselves and renew their registration every 3 years. The order also placed limits on the quantity of milk and restrictions on the areas from which it was collected. Behind this order were genuine fears expressed by dairy co-operatives that private dairies would live off the past investment made by them in this sector without contributing to productivity enhancement or committing capacities to liquid milk supplies. However, on sustained pressure from the private dairies the order was amended in 1993 rendering it almost toothless. The amendment increased the registration limit to 75 thousand liters and 3750 t per day.

Breeding policies

A broad national breeding policy was formally put through by the state and central governments in 1962. The breeding policy covered (a) selective breeding of the pure India dairy breeds of cattle for milk production, (b) selective breeding of pure Indian draught breeds of cattle for better draft animals, (c) selective breeding of dual-purpose breeds for improving both their milk and work outputs, and (d) grading up of the nondescript Indian cattle with selected India donor breeds for improving their body size and milk/work output.

Crossbreeding was also introduced in nondescript cattle using select exotic breeds and became the official policy of the government by 1969. It was decided to limit their exotic inheritance to 50%.

In all these years the basic policy had hardly changed. In formulating the breeding policy the need of the farmer was never taken into consideration. In spite of the detailed breeding guidelines, the animals continue to breed as per the wishes of the farmer and the traditional bull keeper. Another reason for this is the very limited reach of the state machinery.

Although policy guidelines were very clear on crossbreeding, in reality this tool was and is being indiscriminately used and has led to the dilution of some good Indian breeds. Another reason is the low improvement achieved through selective breeding of pure indigenous breeds due to the unavailability of quality breeding bulls and the difficulty in popularising artificial insemination.

The programme for production of superior quality bulls for breeding caught the attention of the planners only in the eighth plan period. Adequate allocation was included for bull production under the eighth plan. However, the State Departments of Animal Husbandry did not initiate action.

India has perhaps the world's largest artificial insemination (AI) network for the breeding of cattle and buffalo—over 30 thousand AI outlets in the government departments and 10.5 thousand in the milk co-operatives. The ones operated in the government sector are stationary ones and the farmers have to reach up to them to service their animals. This becomes a big limitation on their utilisation. The co-operative sector (AI centres) however delivers services at their village society premises. In spite of the fairly large network, the system as a whole covers less than 20% of adult female among cattle and less than 10% of buffalo population. The quality of the services in the government sector is generally perceived as poor. The government, alive to this fact, has recently instituted a restructuring of the entire breeding infrastructure, institutions and breeding operations.

Co-operative law

No study of co-operative dairy development in India is complete without reference to the broad legal framework in which co-operatives function. The fate of dairying in India is inextricably linked to the environment and the laws governing co-operatives. Another peculiar aspect of co-operative dairying in India has been the dual influence it has had to work under. It is expected to deliver market results as any business organisation should while conforming to age-old co-operative laws.

One of the impediments affecting the functioning of co-operatives in general is the restrictive co-operative legislation. Co-operative laws, both central and state, have remained largely unchanged despite the need for an enabling legislative framework consistent with the changed economic environment, and the challenges and competition that the co-operatives are faced with. The present co-operative laws do not provide freedom to the co-operatives for appointing and removing professionals—timely audit of accounts by hiring duly qualified auditors and holding elections on their own. Besides, there are several other restrictive provisions which necessitate co-operatives seeking the prior permission of the registrar of co-operative societies or the government before taking decisions related to new investments, use of surplus funds and other business decisions. The provisions contained in the laws do not enable co-operatives to function in accordance with the principles of co-operation as enunciated in the International Co-operative Alliance (ICA). On the contrary, they provide ample opportunities for the politicisation and bureaucratisation of the co-operatives. The laws in general have inhibited the emergence of true leadership, professional management and democratic functioning of the co-operatives.

The Government of Andhra Pradesh (in southern India), however, has been a trendsetter in providing an enabling legislation where genuine co-operatives can flourish. The AP Mutually Aided Co-operative Societies (APMACS) Act is on the lines of Model Co-operative Act drafted by a committee appointed by the Planning Commission of India. The APMACS is a parallel co-operative legislation enacted by the state for the benefit of those co-operatives which do not need state support in the form of government funds. Subsequent to the enactment of this Act, NDDB has been encouraging the existing milk unions and their constituent village dairy co-operatives to get registered under this MACS Act which provides them freedom for operations at the same time ensuring accountability at all levels.

Two milk unions, namely, Guntur and Visakha in Andhra Pradesh, have already registered themselves under this Act, and others in AP are expected to follow them. Bihar, Jammu and Kashmir and Madhya Pradesh are some states, which have followed the example of Andhra Pradesh and have enacted similar parallel co-operative acts.

At the national level a bill has been tabled before Parliament, prepared on the lines of Model Co-operative Act to replace the existing Multi-State Co-operative Societies Act 1984. A few other states such as Maharashtra and Orissa have also taken initiatives towards parallel co-operative legislation on the lines of APMACS Act. However, the process involved in the changes to the co-operative legislation has been found to be very slow and it could take several years more before other states in the country enact such enabling co-operative legislation. If co-operatives have to wait for the reforms to take place it is felt that they would lose ground giving way for the competitors to flourish particularly in view of the prevailing climate of privatisation, liberalisation and globalisation. Therefore, there should be more options than are currently available, and co-operatives should choose those best suited to them. An alternative has been proposed in the form of producer companies bill based on the recommendation of the Alagh Committee, which recommended that a chapter be introduced in the existing Companies Act 1956 so as to enable incorporation of co-operatives as companies, and conversion of existing co-operatives into companies while accommodating the unique elements of co-operative business within a regulatory framework similar to that of private limited companies. Thus, the producer company would be for all practical purpose a co-operative type of enterprise following the principles of co-operation laid down by the ICA, named as Mutual Assistance Principles in the proposed Bill. The challenge ahead for NDDB is to educate and encourage the dairy co-operative unions in the country to come out of their existing legislative framework and get registered under the new law(s) available.

Education and research

As early as 1928, the Royal Commission on Agriculture aptly noted in no sphere has scientific research conferred greater benefit on agriculture than by provision of means of controlling livestock diseases. Based on its recommendation, the Indian Council of Agricultural Research (ICAR) was set up in 1929 to undertake, promote and co-ordinate education, research and extension education in agriculture, including Dairy Science and Animal Husbandry. ICAR fulfils its responsibility through its own institutions and by supporting the activities in state agricultural universities and in selected institutions through appropriate assistance and guidance.

The ICAR system includes several premier national research institutes specifically addressing problems of the livestock production systems sector-wise, industry-wise and species-wise. In all, these institutes together employ some 831 scientists, 1025 supporting staff, and spend annually some Rs. 3951.13 on research.

ICAR and universities of agricultural sciences have some notable and important successes to their credit. Many would agree, however, that we have a long way to go in relation to both the need and the investment. Sometimes our research has been unrelated to

the production constraints of farmers and the commercial requirements of the market. There is a need for incorporating the farmers' and societal values based on our traditions into the research agenda, and also look at the reality of farmers' problems, constraints and opportunities from the farmers' perspective rather than from their own.

In respect of research, the national agricultural policy should commit government to a significant reorientation by accepting the recommendations of the GVK Rao Committee. One immediate priority would be to refocus our research on the needs of farmers and consumers through the mechanism of an empowered management committee in each important area of research. These management committees—which with respect to budget, planning and operations would function as a Board of Directors—would include a genuine producer representative, one member each from a co-operative and privately held firm engaged in the field, a distinguished scientist, a technologist and a chairperson widely recognised for eminence in that field of agriculture, dairy, forestry, animal husbandry production. The Department of Agriculture Research and Education in the Ministry of Agriculture could then reorient its role to centralise administrative and policy concerns, allowing scientists to return from Krishi Bhavan and other offices to their fields and laboratories.

The globalisation of research, extension and training must address the global challenge implied by the comparison of milk output per animal and per capita availability. A quarter of the world's dairy cattle produce two-thirds of the milk supply. For example, although India produces more than 13% of the world's milk supply, it has over 16% of the world's bovine population (1997). All reasons for the low average output per animal in India must be examined.

Not much attention has been paid to developing linkages with the potential users of research within the country. NDDB has been very effective in applying research and development findings to practical situations. More active collaboration between institutions like NDDB and NDRI would ensure that more of the nation's scientific resources are harnessed to tackle the enormous task of enhancing efficiency at all steps in the milk chain—from utilisation of feed and animal resources to developing new dairy products.

What makes it more urgent in the case of India is the wide gap between the result achieved in research trials, and the national average for many technical coefficients such as milk output per animal, calving intervals and processing loss. While productivity improvement in cereals were stimulated by the Green Revolution in the 1970s, significant increase in the production of livestock food products in developing countries were only achieved in the 1980s.

It is high time that government evolves a national research policy on animal science, and draws up related strategies to rationalise research resources—both human and material—to ensure accountability and reprioritisation, reducing the number of the research institutions. It is also necessary to reorganise the management structure of these institutes and to put them under powerful and apolitical boards, vested with full authority to govern and control these institutes autonomously.

The need for so many institutions—almost one for each species of domestic animal and their contributions to the livestock industry over the years—is a matter of concern and needs very close scrutiny and review by the government.

In the foregoing pages I have set out some of the important facets of national policies supporting smallholders as they have evolved over the years. The narration is by no means complete, as it has not looked at linkages in terms of shrinking common property resources with its attendant freewheeling exploitation of such resources by vested interests in the villages. That would merit a separate paper covering natural resource management area, a subject by itself. Similarly, I have not looked at disease surveillance, disease prevention and other such development tasks. That would involve a discussion of the role of government and restructuring government services and delivery systems to limit itself to tasks that are best characterised as 'public good' activities, and essentially performing its governance role.

Liberalisation of the Indian economy and the dairy sector

Marginal and small farmers constitute the core dairy production group in India and they, along with the landless, constitute over 75% of all milk producers in the country (as also membership of milk co-operatives). The benefits of liberalisation of the Indian economy unfortunately have completely bypassed them. For example, the single most critical legislation dealing with their livelihoods, the Co-operative Societies Act, is yet to be liberalised. The act in its present form is restrictive and continues to inhibit the potential and growth of the co-operative movement.

The GATT Agreement and the WTO Regulations now expose them to global competition, while the Indian Government has not been able to provide them the minimum protection and support measures permissible under the WTO, under provisions for poverty alleviation and livelihood protection. India's inability to conform to the SPS regulations (animal epidemic control) further compounds the misery of the Indian smallholder, as Indian livestock products on this count are precluded from the world markets. Even under the minimum access clause, India finds it difficult to export livestock products, while under the same clause India is obliged to allow imports. In spite of these consequences India is yet to put together legislations with pervasive, nation-wide jurisdiction to prevent and control animal epidemics.

The codex standards for foods of livestock origin are far too stringent and are applied differentially for the developed and developing countries, even though they are to be based on science and hazard analysis. Unfortunately they are often not and member countries (developed countries especially) are permitted to alter and enhance the standards according to their individual threat perceptions. India's bound tariffs for milk products are quite low compared with those of most developed countries: 40% except for fresh milk which is 100%; yoghurt, buttermilk and whey products: 50% and milk powders 0%! Recent negotiations have helped India to raise tariff for milk powders to 15% for import of up to 10 thousand tonnes and 60% for quantities over 10 thousand tonnes.

Marketing in the co-operative sector

A beginning for mutual co-operation for marketing of milk and products among the milk unions in Gujarat started with the formation of the Gujarat Co-operative Milk Marketing Federation (GCMMF) in the early seventies. This was carried forward to include the entire co-operative network under Operation Flood when the National Co-operative Dairy Federation of India was activated and relocated in Anand. The natural next step for the co-operatives was to pool brand equity among the member federations and to initiate joint marketing under the now famous Operation Flood logo. Joint programming of the product mix and sharing the production responsibility among the NCDFI member federations/unions have forged a formidable marketing block for the milk co-operatives in India.

The future

Flowing from the narration of the evolution of policies supporting small dairy holders, the following would be the areas which need the attention of planners:

1. amendment in the co-operative laws and provision of alternative legal frameworks for loosening the current restrictive control over the co-operatives
2. enacting laws for control of infectious diseases of animals, disease surveillance, drug and vaccine quality enforcement
3. productivity enhancement to make milk production far more remunerative
4. quality of milk products to be improved to bring them in line with international standards
5. streamline policies in the area of commodity import
6. monitor world trade scenario including tariff and non-tariff barriers, dumping, etc. to protect our farmers
7. redefining the role of government in this sector including the service delivery system, establishing autonomous livestock development boards to take charge of current governmental infrastructure and
8. impact evaluation of Operation Flood on rural dairy sector.

A case study on environmental impacts of peri-urban dairy colonies in Thailand: Environmental impacts of old and new dairy farms

P. Skunmun and C. Chantalakhana

Buffalo and Beef Production Research and Development (R&D) Centre
Suwanvajokkasit Animal R&D Institute, Kasetsart University,
P.O. Box 1014, Kasetsart PO, Chathuchak, Bangkok 10903, Thailand

Introduction

During recent years there has appeared to be more public concern in Thailand about the impacts of animal production, especially pig and poultry farming, on human well being and the environment. Moreover, due to the expansion of residential areas and urbanisation, many animal farms that used to be located outside cities have found themselves in community housing areas or peri-urban areas. Smallholder dairy farms are generally centred around a milk collection centre or co-operative milk processing facilities. In many cases, due to the limitation of land area and the increase in number of family farms, the disposal of dairy wastes can become a potential threat to the community environment. It is therefore important to study the long-term impact of smallholder dairy farming on the environment, especially in situations where dairy wastes have not been fully managed.

Nong Pho was once a rural dairy farming area (between 1960 and 1980) but due to increasing urbanisation it has nowadays become peri-urban (Chantalakhana and Skunmun 2002). Farmlands have been fragmented because of population growth, while lack of waste management and disposal systems on congested smallholder dairy farms have in the long term appeared to cause degradation of farm environmental conditions. Nong Pho Dairy Co-operative (NPDC) could serve as a good case to study possible impacts of smallholder dairying on farm environments, illustrating what happens if animal wastes are not well managed. Lessons learned from such a study could help identify ways and means of conserving environmental quality. Therefore, this study aims to examine water, soil and air quality on dairy, and to assess the possible impacts of dairying on farmers and their neighbouring households.

Methodology

Site of investigation and farm samples

Forty-seven smallholder dairy farms were used in this study, 43 farms from an older dairy co-operative (NPDC) and 4 farms from a relatively new one (Kamphaengsaen Dairy Co-operative, KSDC) located in Kamphaengsaen (KS) District, Nakhon Pathom Province. The two groups of farms were located approximately 30 km apart; agro-ecological conditions were similar for both groups.

Nong Pho (NP) dairy farms were purposely chosen from three areas: (A) an irrigated area where irrigation canals were available and existing dairy farms tended to be more congested; (B) a municipality area where certain public facilities, such as roads, telephones and sewage systems were available; and (C) a factory area where some manufacturing factories existed among dairy farms and could compete for certain resources, such as labour supplies at certain times of the year (Skunmun et al. 1999). From each specified area, three groups of sample dairy farms were chosen according to three different level of farm crowdedness (density), i.e. (NP1) very crowded, (NP2) crowded and (NP3) not crowded (see Table 1). Crowdedness of sample farms was based on physical proximity to neighbouring farms, stocking rates, location of dairy barns (e.g. barn under the house, barn attached to the house, barn separate but close to the house etc.) and surrounding conditions. Classification of the degree of farm crowdedness was based on subjective judgement of the co-operative dairy extension workers and the researchers. It was anticipated that more crowded farms would have greater difficulty in disposing of animal wastes and that this would be reflected by waste parameters measured by chemical analyses of farm water, soil and air.

Table 1. *Classification of investigated farms by area and level of crowdedness.*

Area	Level of crowdedness			KS
	NP1	NP2	NP3	
A	5	7	3	
B	4	6	4	
C	5	5	4	
Total			43	4

KS = Kamphaengsaen; NP1 = Nong Pho: very crowded;

NP2 = Nong Pho: crowded; NP3 = Nong Pho: not crowded;

A = irrigated areas; B = municipality areas; C = factory areas.

Data collection

Data concerning economic background of farm families and general farming practices were recorded at the beginning of this study (November 1996) through farmer interviews at farm sites using a prepared questionnaire, and direct observation or data collection by project technicians.

Data concerning smallholder dairy production systems and management of resources included animal stock, housing and management, feed and feeding, milk and milking and manure and wastes.

Data were collected concerning the effects of dairy waste on the quality of water, soil and air.

Water samples

Water samples consisted of water from three sources: wastewater from dairy barns, well water and water from public waterways passing near to sample farms.

Wastewater

Wastewater samples were collected from liquid-waste disposal ditches behind cow barns; these ditches had cement or earthen floors. One sample of wastewater from each farm was collected every month during a 12-month period (May 1996 to April 1997) for physicochemical analysis. The following wastewater parameters were measured: pH value, electrical conductivity (EC), total solids (TS), chemical oxygen demand (COD), biological oxygen demand (BOD), ammonia nitrogen ($\text{NH}_3\text{-N}$) and nitrate nitrogen ($\text{NO}_3\text{-N}$).

Well water

Most smallholder dairy farms (63–77%) at NP and all farms at KS obtained their water supply from deep wells. Samples were collected from wells of NP farms at the depths of 6 m ($n = 1$); 20–30 m ($n = 5$); and 32–50 m ($n = 7$); and from a KS farm at the depth of 32–50 m ($n = 1$). A water sample from each well was taken three times/year (i.e. in May (summer), July (rainy season) and January (cool season)) for physicochemical analysis. The following properties were measured: pH value, hardness, EC, and levels of chloride, nitrate, total coliforms and faecal coliforms.

Water from public waterways

Water samples from public waterways were collected at four locations (small canals) at NP. For each location, 1 sample was collected every month for 12 months, so that physicochemical analysis could be carried out to measure the same set of parameters as examined for wastewater from the dairy barns.

Soil samples

On 16 farms at NP and 1 farm at KS, soil samples from farm areas that farmers commonly used for drying and storing manure were collected once every season (in May, August and January) for chemical analysis. The following soil parameters were measured: pH value, EC and levels of potassium (K), phosphate (P_2O_5), total nitrogen (N), $\text{NH}_3\text{-N}$, and $\text{NO}_3\text{-N}$.

Air samples

Air samples were taken from eight farms: three were from farm density level 1 or 2 with one in each area (irrigated, municipality and factory); three were from farm density level 3 with one in each area; and the other 2 selected farms were partially closed barns. The samples were collected twice per day (at 1000 and 1400 hours) and three times per year (in summer, and the early and late rainy seasons). Four gases were measured: ammonia (NH₃), carbon dioxide (CO₂), oxygen (O₂) and methyl mercaptan (CH₃-SH).

Impacts of dairying on dairy farmers and neighbouring people were evaluated through interview at household (HH) level using a prepared questionnaire, and through direct observation or data collection by project technicians. Interviews were carried out with 125 households: (i) 42 main dairy farm HH; (ii) 43 non-dairy farm HH located ≤ 0.5 km from the main dairy farm HH in (i); and (iii) 40 non-dairy farm HH located > 5 km away from the HH in (i).

Results and discussion

Socio-economic background of sample farms

As shown in Table 2, the farmers from NP had been involved in dairying for between 18 ± 9 and 19 ± 7 years, while those from KS had only been involved for 8 ± 3 years.

Table 2. Background data for Nong Pho (NP) farmers.

Item	Level of crowdedness		
	NP1	NP2	NP3
Total number of farms	14	18	12 ¹
Age of farmers (years) ²	52 ± 14	45 ± 14	49 ± 12
Education to grade 4 (%)	57	92	67
Number of family members ²	5.4 ± 2	4.5 ± 2	4.8 ± 1
Farmers who received some dairy training (%)	86	78	83
Family labour (head) ²	3.1 ± 1	2.7 ± 1	2.8 ± 1
Male	1.3	1.3	1.3
Female	1.8	1.4	1.5
Local residence (years)	> 50	31–50	31–50
Average size of landholding within the village (hectares)	1	0.6	0.9
Length of involvement in dairying (years) ²	18 ± 7	19 ± 7	18 ± 8

1. One of these farms gave up dairy farming shortly after the survey was carried out.

2. Values given are means $\pm$ standard deviations.

NP1 = Nong Pho: very crowded; NP2 = Nong Pho: crowded; and NP3 = Nong Pho: not crowded.

Source: Chantalakhana and Skunmun (1999).

Most of the farmers had only completed fourth-grade education but had received some dairy training, which was offered traditionally by the NPDC. The average size of

landholding per farm, not including land owned by some of the farmers outside their farm, was 0.6–1.0 ha. Farm labour came almost totally from family labour with the exception of some extra labour hired to take care of occasional needs, for instance when a family member was away from home.

Dairy production systems and management of resources

Dairy barns and management

Ninety-five per cent of the 43 sample farms had an area of less than 0.32 ha for family housing and dairy raising; this did not include the forage growing areas of some farms, which were usually distant or isolated from the barn area. All of the NP1 farm areas were less than 0.16 ha, while only 83% of NP2 and 58% of NP3 farms had dairying areas which were smaller than 0.16 ha. The average number of dairy cows per farm was 22.7, 26.2 and 19.3 for NP1, NP2 and NP3 groups of farms, respectively. Milking cows and some dry cows were kept in an open stall barn, which also served as a milking parlour. Fifty to eighty-nine per cent of the farms kept milking cows tied to their stall all the time while some farms (5–35%) let the cows outside the barn for part of the day. Only a few farms had small pasture plots for milking cows to rest outside the barn during part of the day.

None of the cow barns had walls. Commonly, they were constructed with a tile roof and cement floor, and with open stalls for individual cows. Feed and water were given to cows in the same feed trough. Most cow barns were either attached to the family house, were located under the house in the case of a two-storey house or were only a few metres away from the house. Some barns even shared the same roof with the family house.

Manure and other farm waste

Cow manure is another important product of dairy farms, both in terms of smallholder farm income and as a problem for waste management. At NP farms, cows with a body weight of 450 kg produced an amount of wet manure equivalent to about 6% of their body weight (about 27 kg) each day. Each NP farm of an average size (in terms of number of animals varying in body weights) would, therefore, produce about half a tonne of wet manure (85% moisture) per day.

Cow manure was removed from the barns every day and stored nearby, where it was spread over the soil surface of an open area and sun dried. Dry manure (approximately 15% moisture) was commonly sold to farmers in other locations for use as fertiliser. Farm-gate prices were = 1 baht/kg (US\$ 1 = 43 Thai baht in March 2001). Chemical analyses of wet cow manure for N, phosphorus (P) and K showed that the level of N in manure ranged from 0.96 to 2.12%; P from 0.33 to 0.79%; and K from 0.53 to 0.87% (Chantalakhana and Skunmun 1999).

It was estimated that the total number of about 4000 smallholder NP farms produced 2 million kilogrammes or 2000 t of cow manure each day, plus an approximately equal amount (by weight) of wastewater and other liquid wastes, such as animal urine. If not properly managed and utilised these animal wastes could create pollution problems to farm environments and surrounding areas (Tietjen 1987; Archer and Nicholson 1992; Wood and Hattey 1995; Daliparthi et al. 1995; Paik et al. 1996). The status of cattle wastes management and utilisation in smallholder NP farms is shown in Figure 1.

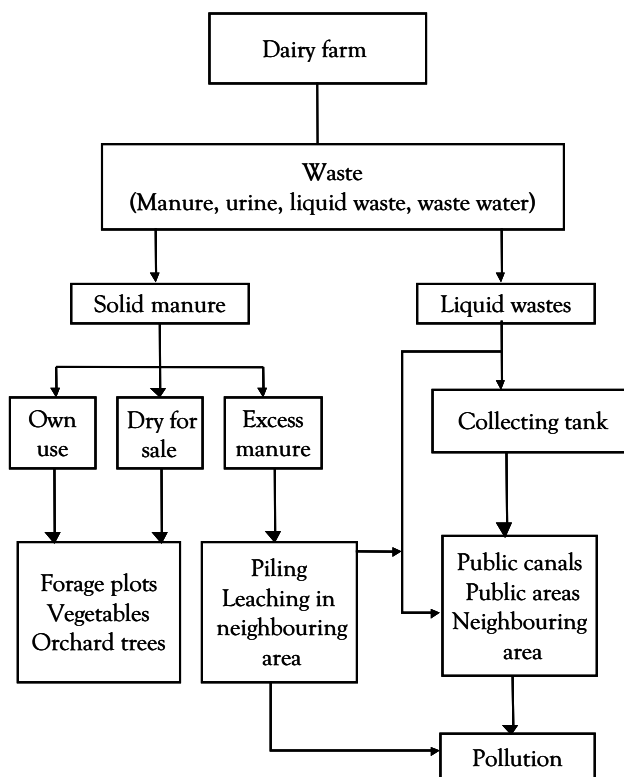


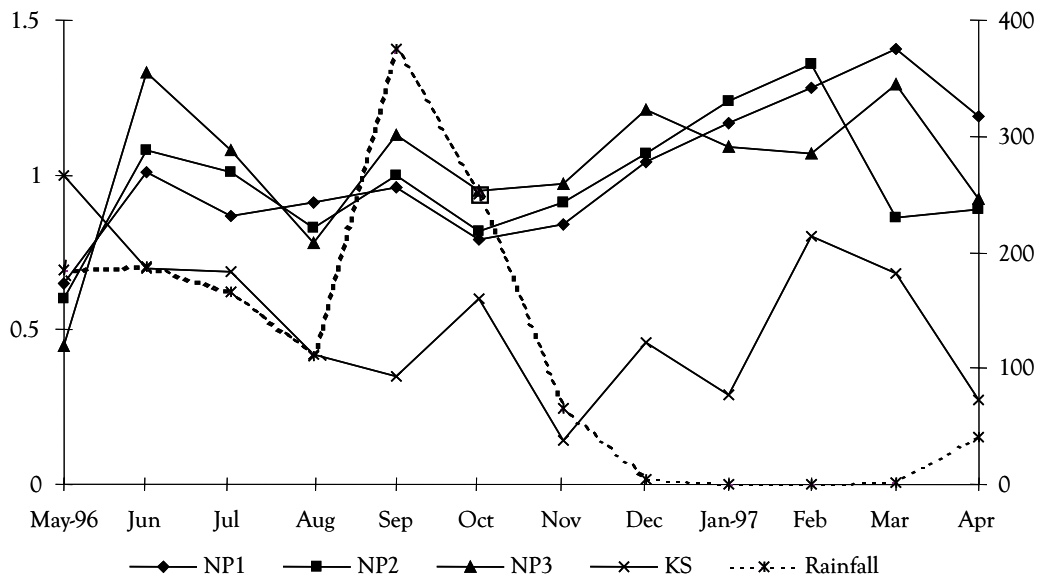
Figure 1. Use of dairy wastes and management of their excess on smallholder farms.

Effect of dairy wastes on water, soil and air

Water

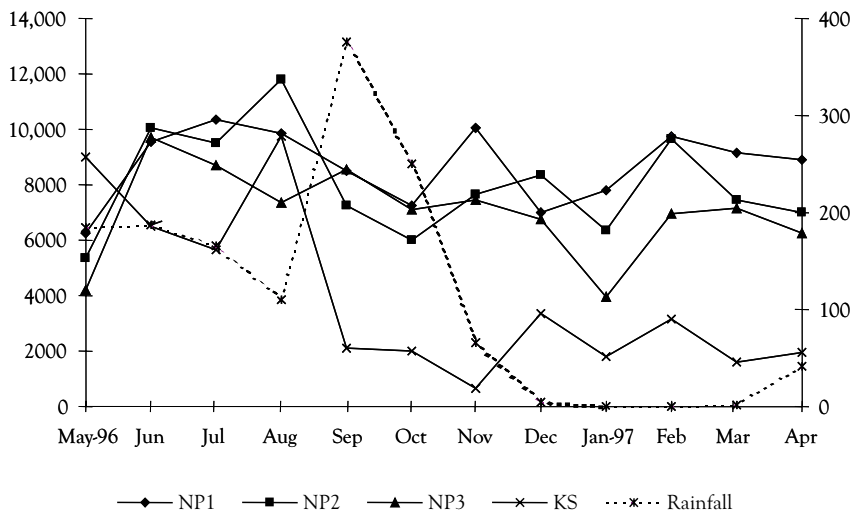
Differences in wastewater parameters between old and new dairy farms

Physicochemical properties of wastewater were studied during a 12-month period to compare a group of smallholder dairy farms (43 farms) from older sites (NP) with another group (4 farms) from new site (KS). Results indicated consistently that wastewater samples from NP farms had higher levels of every parameter than samples from KS farms. Figures 2, 3 and 4 show monthly averages for TS, COD and BOD in the two groups of farms. For each



KS = Kamphaengsaen; NP1 = Nong Pho: very crowded; NP2 = Nong Pho: crowded; NP3 = Nong Pho: not crowded.

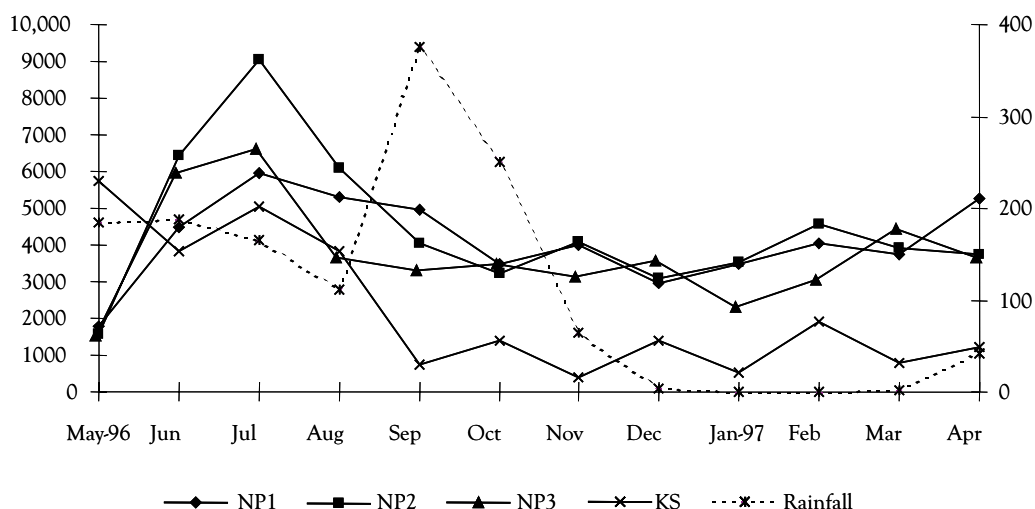
Figure 2. Monthly averages of TS (total solids) in wastewater from the dairy farms.



KS = Kamphaengsaen; NP1 = Nong Pho: very crowded; NP2 = Nong Pho: crowded; NP3 = Nong Pho: not crowded.

Figure 3. Monthly averages of COD (chemical oxygen demand) in wastewater from the dairy farms.

month, analysis of variance was used to compare the water parameters of NP farms (NP1, NP2 and NP3) and those of KS farms (see Chantalakhana et al. 1999 for more details). The least significant difference (lsd) was used to test the difference among the sample means of the four groups (Table 3).



KS = Kamphaengsaen; NP1 = Nong Pho: very crowded; NP2 = Nong Pho: crowded; and NP3 = Nong Pho: not crowded.

Figure 4. Monthly averages of BOD (biological oxygen demand) in wastewater from the dairy farms.

It can be seen that wastewater from older and more crowded dairy farms contained much higher levels of all wastewater parameters than wastewater from relatively new farms in uncrowded areas. The levels of COD and BOD, as well as EC and TS of KS farms were much lower, in some cases almost a half of the NP averages. Average levels of $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$ at KS farms were, in most cases, less than a half of the NP values. The pH values of wastewater from NP farms were a little higher than values for KS farms; this difference was significant.

Table 3. Significant differences between wastewater parameters of NP and KS farms.

Parameter	Unit	Average				Sig. ¹	Lsd (0.05)	Lsd (0.01)
		NP1	NP2	NP3	KS			
EC	ms	10.79	10.7	10.51	5.88	**	2.5	3.32
TS	%	1.006	0.961	0.998	0.534	**	0.238	0.313
COD	ppm	8.86	7.992	7.063	3.954	**	1.625	2.135
BOD	ppm	3.882	4.262	3.461	2.226	*	1.083	1.424
$\text{NH}_3\text{-N}$	ppm	847	837	743	286	*	365	480
$\text{NO}_3\text{-N}$	ppm	11.87	12.12	11.67	5.41	**	3.3	4.34
pH	—	8.03	8	7.97	7.76	*	0.183	0.24

1. Significant difference between KS average and lowest NP average, * = $P < 0.05$; ** = $P < 0.01$.

Lsd = least significant difference; KS = Kamphaengsaen; NP1 = Nong Pho: very crowded; NP2 = Nong Pho: crowded; NP3 = Nong Pho: not crowded; EC = electrical conductivity; TS = total solids; COD = chemical oxygen demand; BOD = biological oxygen demand; $\text{NH}_3\text{-N}$ = ammonia nitrogen; $\text{NO}_3\text{-N}$ = nitrate nitrogen.

Due to the high degree of farm crowdedness at NP and longer existence of NP dairy farms, with minimal waste management systems, liquid wastes containing high levels of

organic and inorganic substances were being released from dairy barns into the surrounding areas. These substances could eventually cause serious environmental pollution. The KS dairy farms were newer, were located in a more open and expanded area, and were releasing wastewater, which appeared to contain less organic and inorganic substances than wastewater from NP farms. In the long term, however, the situation of KS farms could become similar to that of NP farms if dairy farming becomes more intensive without the development of effective waste management facilities.

Differences in wastewater parameters due to other factors

For the NP farm data, analysis of variance for each parameter of the wastewater was conducted using hierarchical classification with unequal subclass numbers (see Chantalakhana et al. 1999 for more details).

Seasonal variation

The differences in wastewater parameters due to season (i.e. summer (March–June), rainy season (July–October) and dry or cool season (November–February)) were not significant except for $\text{NO}_3\text{-N}$ ($P < 0.05$). The differences between months within season were highly significant for BOD and TS but not significant for the other parameters.

Variation due to area and farm crowdedness

The differences in wastewater parameters between different farm areas (irrigated, municipality and factory) were not significant except that for $\text{NO}_3\text{-N}$ ($P < 0.05$). The 12-month average of $\text{NO}_3\text{-N}$ in wastewater from the farms in irrigated areas (13.4 ppm) was slightly higher than the averages for the other two areas (10.1 and 10.5 ppm, respectively). Degree of farm crowdedness had highly significant effects on the values for COD and BOD, with very crowded farms in irrigated and municipality areas having the highest averages, but the highest values being seen in some crowded farms in factory areas. The differences in EC values due to farm crowdedness were also significant, while differences for the rest of the parameters (pH, TS, $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$) were not.

Relationships between wastewater parameters

Simple correlation coefficients between pairs of the wastewater parameters were calculated for each month of the 12-month period. The correlation estimates, which were consistently significant or highly significant, are shown in Table 4. Some wastewater parameters were highly correlated, for example TS with COD, BOD and $\text{NH}_3\text{-N}$, and COD with BOD. These results indicated that when certain parameters were highly correlated, the level of one could be used to predict the level of the other. This information can be particularly useful when chemical analysis of a particular parameter in wastewater is not possible either due to high costs or a lack of laboratory equipment. For example, EC was highly correlated with TS in this

study, as also reported by Menasveta (1995), which means that either one of these two parameters can be used to assess water quality.

Table 4. Correlation coefficients of wastewater parameters.

Correlation coefficient		Lowest-highest estimate	Significant level and number of estimates	
			P<0.05	P<0.01
pH	EC	0.326-0.699	1	11
	NH ₃ -N	0.305-0.791	2	10
EC	TS	0.622-0.936	0	12
	COD	0.464-0.869	0	12
	BOD	0.402-0.784	0	12
	NH ₃ -N	0.382-0.904	1	11
TS	COD	0.634-0.896	0	12
	BOD	0.432-0.882	0	12
	NH ₃ -N	0.447-0.793	0	12
COD	BOD	0.432-0.902	0	12

EC = electrical conductivity; TS = total solids; COD = chemical oxygen demand; BOD = biological oxygen demand; NH₃-N = ammonia nitrogen.

Properties of water from wells and public waterways

Well water: Some chemical and biological properties of well water, which were examined in this study, are shown in Table 5. In general, many of the quality criteria (pH, EC, chloride and hardness) for the well water used on dairy farms (mostly from deep wells of 20–50 m in depth) were close to government standards for deep-well water.

Table 5. Some parameters of well water from dairy farms.

Parameter	Standard ¹ for underground water	NP farms				KS farms	
		May	July	January	Average	Range	Average
pH	7.0–8.5	6.56–6.79	6.69–8.16	6.97–7.73	6.8–7.6	7.01–7.62	7.3
EC	0.0005–1 ms	0.5–6.3	0.49–5.8	0.53–6.05	0.62–6.05	1.2–1.65	1.43
Chloride	250–600 ppm	22–664	27–642	41–619	39–605	104–173	144
Nitrate	<10 ppm	0–39	0–38	0–31	0.3–36	6.7–37	21
Hardness	300–500 ppm	123–1474	91–1202	84–1267	97–1314	352–523	446
Total coliforms	2.2 MPN/100 ml	0–2400	0–2400	0–2400	0–1673	0–33	16
Faecal coliforms	2.2 MPN/100 ml	0–2400	0–2400	0–350	0–1656	0–33	16

1. Sirisingh (1982).

NP = Nong Pho; KS = Kamphaengsaen; EC = electrical conductivity; MPN = most probable number.

However, some water samples contained high levels of nitrate, total coliforms and faecal coliforms, which indicated that there was contamination, possibly due to seepage of liquid manure into underground water. The water samples from a shallow well had much higher values for EC and hardness, and higher levels of chloride and nitrate than the water from

deep wells. Moreover, level of faecal coliforms was as high as 2400 MPN/100 ml in shallow well samples. Gould (1995) studied the nitrate contamination of underground water on dairy farms and reported that only 47% of water samples from deep wells (>18 m deep) and only 14% of samples from less deep wells (<18 m deep) contained less than 10 mg/litre of nitrate. Contamination was mainly from the cow resting area.

Water samples from public waterways: The water samples used in this study were collected from four small canals (sites i, ii, iii and iv) which passed by some of the dairy farms at NP. The values for water parameters (averages for a 12-month observation period) are shown in Table 6. The values of EC, TS, COD and BOD were markedly higher for water samples from site (i) than for samples from the other three sites because the canal at site (i) was very near to a dairy barn where liquid manure could contaminate the water samples easily. No definite seasonal trend of canal water parameters was observed during the 12-month period of study.

Table 6. Parameters of water samples from four public waterways.

Parameter	Unit	Public waterway: site			
		i	ii	iii	iv
pH		6.86	6.65	6.78	7.17
EC	ms	3.01	1.28	1.49	2.26
TS	%	0.74	0.1	0.11	0.26
COD	ppm	3107	1134	339	597
BOD	ppm	1060	144	131	258
NH ₃ -N	ppm	47.67	28.33	31.83	42.18
NO ₃ -N	ppm	7.7	8.27	3.37	4.27

EC = electrical conductivity; TS = total solids; COD = chemical oxygen demand; BOD = biological oxygen demand; NH₃-N = ammonia nitrogen; NO₃-N = nitrate nitrogen.

Soil

The results from soil sample analysis are presented in Table 7. Soil samples were collected from 16 farms at NP and 1 farm at KS, and from virgin soils at NP and KS, which were land areas where no cropping and no fertiliser had been applied in the past. Soil samples from areas that had been exposed to cow manure for a long time appeared to have much higher values of EC, K, P₂O₅ and NO₃-N, but not consistently for total N and NH₃-N than samples from virgin soils. The values for NO₃-N in the soil samples from NP farms were 1.5–35 times as high as the level in virgin soils, while those from the KS farm were only 2.6–3.1 times as high.

In comparison with virgin soil, many of the farm soil samples had lower values of total N; this could indicate more leaching and conversion of N in farm soils. The levels of K in both NP and KS farm soils were 8–30 times larger than the level for virgin soil. Obviously, soil components such as NO₃-N could leach from the topsoil if it was exposed to manure for a long period of time and could eventually contaminate underground water.

Table 7. Physicochemical analysis of soil samples from dairy farms.

Parameter	NP virgin soil		NP (16 farms)			
	1	2	May	August	January	Average
pH	6.81	7.53	6.47–8.29	6.45–7.56	6.89–8.24	6.70–7.88
EC	0.05	0.54	0.30–1.85	0.23–1.50	0.23–1.20	0.31–1.45
K	100.4	90.1	1244–3851	387–3264	914–2884	848–3176
P ₂ O ₅	7.9	7.88	7.1–169.3	26.5–369.1	6.5–194.7	14.4–224.3
Total N	0.06	0.09	0.003–0.064	0.006–0.670	0.084–0.300	0.046–0.120
NH ₃ -N	1.05	0.52	0.10–1.22	0–1.75	0.52–1.40	0.44–0.96
NO ₃ -N	0.91	0.84	3.36–31.92	1.40–13.16	1.40–8.57	3.10–13.77

Parameter	KS virgin soil	KS (1 farm)			
		May	August	March	Average
pH	7.58	8.55	8.22	8	8.26
EC	0.52	0.35	0.49	2.8	1.21
K	315	1904.9	1804	1604.5	1771.1
P ₂ O ₅	13.75	13.49	56.31	97.94	55.91
Total N	0.015	0.02	0.02	0.09	0.04
NH ₃ -N	0.98	1.22	0.35	0.28	0.62
NO ₃ -N	1.75	5.35	4.55	6.16	5.37

NP = Nong Pho; KS = Kamphaengsaen; EC = electrical conductivity (ms); K = potassium (mg/kg); P₂O₅ = phosphate (mg/100g); total N = total nitrogen (g/100g); NH₃-N = ammonia nitrogen (mg/100g); NO₃-N = nitrate nitrogen (mg/100g).

Air

Concentrations of four gases (O₂, CO₂, CH₃-SH and NH₃) were determined in the barns of eight dairy farms at NP. Samples were collected from one NP1 or NP2 farm and one NP3 farm in each area (irrigated, municipality and factory) and from two partially closed barns. There were no significant differences between the amounts of O₂ and CO₂ measured at 1000 and 1400 hours, or among the barns. The average levels of O₂ in the barns were 20.19 and 20.62% in March–April and May–June, respectively (range 19 to 21%), while the standard level of O₂ in the atmosphere is 21%.

According to Thai regulations for working in partially enclosed places, the O₂ level should not be lower than 18%, while the USA Occupational Safety and Health Act of 1970 cites a level of 19.5%. The average levels of CO₂ in the barns were 0.039 and 0.032% in March–April and May–June, respectively (range 0.03–0.05%), which were close to the normal level of CO₂ in the atmosphere (0.03%) (Muller 1987). CH₃-SH, which normally has a bad smell, was undetectable in the barns. However, the instrument used could only detect this gas when the concentration was higher than 5 ppm. The levels of NH₃ varied from 0.04 to 3.33 ppm; the highest level was found in one of the partially enclosed barns at 1400 hours. Seasonal differences in levels of these gases in the dairy barns determined at 1000 and 1400 hours are shown in Table 8. In the case of NH₃, an 8-hour air collection in the dairy barns was also conducted to trap the amount of NH₃ emitted from dairy wastes

during the daytime (see more details in Chantalakhana and Skunmun 1999). Nearer to average levels of NH_3 were found in summer than in the early and late rainy seasons (0.44, 0.31 and 0.29 ppm, respectively).

Table 8. Average levels (mean $\pm$ standard deviation) of oxygen (O_2), carbon dioxide (CO_2) and ammonia (NH_3) in dairy barns.

Gas	Time of measurement	March–April	May–June	September
O_2 (%)	1000 and 1400 hours ¹	20.19 $\pm$ 0.59	20.62 $\pm$ 0.50	–
CO_2 (%)	1000 and 1400 hours	0.039 $\pm$ 0.004	0.032 $\pm$ 0.004	0.034 $\pm$ 0.006
NH_3 (ppm)	1000 and 1400 hours	0.83 $\pm$ 0.56	0.95 $\pm$ 0.84	1.04 $\pm$ 0.84
NH_3 (ppm)	8 hours during the day ²	0.44 $\pm$ 0.19	0.31 $\pm$ 0.11	0.29 $\pm$ 0.17
Temperature ($^{\circ}\text{C}$)	8 hr during the day	34.36 $\pm$ 2.92	34.12 $\pm$ 2.22	33.06 $\pm$ 2.14

1. Using gas detection.

2. Using chemical analysis

Giesy et al. (1994) reported that the average level of NH_3 from a dairy farm in Florida, USA, was 3.2 ppm (range 1–8 ppm), which was five times higher than the levels found in this study. However, even in Florida, the concentrations of NH_3 did not exceed the safe levels for human health.

Impacts of dairying on dairy farmers and surrounding people

Impacts of dairying on people were evaluated through interviews at household (HH) level using a prepared questionnaire, and by direct observation or data collection. Three groups of people were targeted, namely: 1) dairy farm HH; 2) non-dairy farm HH located ≤ 0.5 km from the dairy barn; and 3) non-dairy farm HH located >5 km away from the dairy barn. The findings are summarised here in relation to three important aspects.

Nuisance from dairying to people

Only people in non-dairy farm HH (53, 50 and 27% of HH, respectively, in areas A, B and C) said that dairying caused some nuisance to them. Specific nuisances ranked from high to low were as follows: the smell of manure and urine; flies; bellowing noise; and dust from dry manure. However, there was no real objection from the non-dairy farm HH as dairy production had been established in the area for a long time.

People's perceptions of the effects of dairy waste on the environment

Positive and negative effects of dairying on water, soil and air were mentioned. All dairy farmers appreciated the benefits of manure for increasing soil fertility, while a lower

percentage of those in group 2 (7–14%) indicated an adverse effect of manure on soil salinisation. Most people in non-dairy farm groups agreed that dairying created undesirable smells and water pollution to the community. All dairy farmers argued that dairy wastes created water pollution at NP for only a short period of time in the rainy season, but that this was much less than the pollution caused by wastewater from factories located around NP.

People's health

Results showed no significant difference in the disease incidences in a year and similar percentages of occurrences among the three groups of people. Important diseases, ranked in decreasing order of occurrence, were respiratory diseases, skin diseases, diarrhoea and allergy. Causes of these diseases could not be identified specifically due to the involvement of many factors. Results of this study indicated no specific negative effect of dairying on human health.

Conclusion and recommendations

The results from this investigation clearly showed the need for implementing appropriate waste management systems by smallholder dairy farms in Thailand and in other developing countries. Although each farm may have only small numbers of dairy animals (in this case approximately 20 animals), when a large number of farms exist in a small area, the bulk of animal wastes produced each day can create long-term environmental problems for farmers themselves, and for other people in neighbouring areas. Liquid wastes from dairy farms can contaminate water resources and public waterways. Piling and drying of manure on land surfaces that are bare of vegetation can result in leaching and seeping of inorganic and organic matter into underground water. It is recommended that low-cost cement floors should be constructed for drying manure on smallholder dairy farms. Moreover, cement drainage ditches should be constructed for wastewater and liquid manure disposal, and sewage tanks for holding liquid waste outside dairy barns. These low-cost facilities should be viewed as a short-term solution, but should help to prevent much of the pollution from dairy farms. Other long-term investment, such as central water treatment systems or biogas digesters, may also be useful but requires careful planning with active farmer participation in the decision making process.

Smallholder dairy development in tropical countries, especially in South-East Asia, has many common features. Dairy operations have been mostly on a small scale, with a limited land area and a location near to a milk collection centre or dairy co-operative; consequently, there is a general problem of dairy waste management and disposal.

Future national dairy development programmes should incorporate activities concerning environmental protection, for example:

- providing information to create awareness among all concerned about the possible long-term effects of smallholder dairy colonies in peri-urban areas

- dairy training for smallholder farmers emphasising waste management practices to minimise pollution due to dairy farming
- other preventive measures to prevent environmental pollution arising from dairy practices
- monitoring of farm surroundings, such as analysis of water, soil and air, to observe any change in environmental quality.

Dairy co-operatives or farmer groups should be provided with appropriate information concerning:

- possible long-term environmental impacts of smallholder dairy colonies
- sanitary measures to safeguard against risks to human health
- zoonotic diseases and their prevention.

Research and education in animal waste management, as well as those aspects mentioned above should be given high priority by national government agencies and educational institutions.

Construction of appropriate animal waste management facilities should be encouraged or supported by the national government with the co-operation of dairy co-operatives or farmer groups, for example:

- construction of cement floors for manure drying and storage to prevent seepage of manure liquid
- construction of central water treatment facilities for dairy colonies where many smallholder dairy farms are located, with initial support from the government
- smallholder farmers should be encouraged to use biogas digesters to utilise animal manure as an energy source, while promoting waste management and farm sanitation.

Acknowledgements

This research project was financially supported by the Thailand Research Fund (TRF) through the TRF Senior Research Fellow Project. The TRF is an autonomous research funding agency of the Government of Thailand.

References

- Archer J.R. and Nicholson R.J. 1992. Liquid wastes from farm animal enterprises. In: Phillips C. and Piggins D. (eds), *Farm animals and the environment*. CAB (Commonwealth Agricultural Bureau) International, Wallingford, UK. pp. 325–344.
- Chantalakhana C. and Skunmun P. (eds). 1999. *Dairy farms and environment*. Buffalo and Beef Production R&D Centre, SARDI, Kasetsart University, Bangkok, Thailand. 402 pp. (In Thai).
- Chantalakhana C. and Skunmun P. 2002. Dairy development in Thailand and a case study on environmental impacts of peri-urban dairy colonies. Part I. Smallholder dairy development. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India and ILRI (International Livestock Research Institute) Nairobi, Kenya.

- Chantalakhana C., Korpraditsakul R., Skunmun P. and Poondusit T. 1999. Environmental conditions and resource management of some smallholder dairy farms in Thailand. II. Effects of dairy wastes on water and soil. *Asian–Australian Journal of Animal Science* 12(2):220–225.
- Daliparthi J., Herbert S.J. and Veneman P.L.M. 1995. Excess dairy manure management: Impacts on ground water quality. In: Steedle K. (ed), *Animal waste and the land–water interface*. Lewis Publishers, New York, New York, USA. pp. 355–362.
- Giesy R.G., Giesy J.G., Harris B. (Jr.), Bray D.R., Bucklin R.A. and van Horn H.H. (Jr). 1994. Survey of ammonia levels in large Florida dairy barns. In: Bucklin R. (ed), *Proceedings of the third international dairy housing conference held at Orlando, Florida, USA, 2–5 February 1994*. American Society of Agricultural Engineers, St. Joseph, Michigan, USA. pp. 362–366.
- Gould M.C. 1995. Nitrate–nitrogen levels in well water in the little River/Rooty Creek agricultural non-point source hydrological unit area. In: Steedle K. (ed), *Animal waste and the land–water interface*. Lewis Publishers, New York, USA. pp. 251–255.
- Menasveta P. 1995. *Water resources and pollution problems*. Chulalongkorn Publishing Office, Bangkok, Thailand. 318 pp. (In Thai).
- Muller W. 1987. Effects of odours on man and animals. In: Strauch D. (ed), *Animal production and environmental health*. Elsevier Science Publishers B.V., Amsterdam, The Netherlands. pp. 21–25.
- Paik I.K., Blair R. and Jacob J. 1996. Strategies to reduce environmental pollution from animal manure: Principles and nutritional management—A review. *Asian–Australasian Journal of Animal Sciences* 9(6):615–635.
- Sirisingh K. 1982. *Chemical of water, wastewater and analysis*. Mahidol University, Bangkok, Thailand. pp 38. (In Thai).
- Skunmun P., Boonsom J., Kaewsuwan S. and Chantalakhana C. 1999. Environmental conditions and resource management in smallholder dairy farms in Thailand. I. Production systems and management of resources. *Asian–Australasian Journal of Animal Sciences* 2(2):215–219.
- Tietjen C. 1987. Influence of faecal wastes on soil, plant, surface water and ground water. In: Strauch D. (ed), *Animal production and environmental health*. Elsevier Science Publishers B.V., Amsterdam, The Netherlands. pp. 203–216.
- Wood C.W. and Hattey J.A. 1995. Impacts of long-term manure applications on soil chemical, microbiological and physical properties. In: Strauch D. (ed), *Animal production and environmental health*. Elsevier Science Publishers B.V., Amsterdam, The Netherlands. pp. 419–426.

Evolution of dairy policies for smallholder production and marketing in Tanzania

L.R. Kurwijila

Department of Animal Science and Production, Sokoine University of Agriculture
P.O. Box 3004, Morogoro, Tanzania

Introduction

Dairying in Tanzania has progressed a long way. Efforts to develop the dairy industry in Tanzania started as far back as the 1950s and early 1960s. These included selection work for milk production potential among indigenous zebu stock (Getz 1974; Mpiri 1994), cross-breeding and production of the synthetic dual-purpose Mpwapwa breed. These efforts did not result in widespread adoption of dairying by smallholder farmers. A few commercial settler farms thrived. Efforts to develop a parastatal commercial dairying sector were initiated in 1975 under World Bank IDA (International Development Association) credit. Private initiatives in commercial dairying were stifled by the Tanzania socialist policies of the 1970s and early 1980s.

By the mid-1980s, it was realised that to transform the dairy sector, smallholder production had to be encouraged and promoted not only as a means of achieving national self-sufficiency in milk and milk products but also as a means of rural poverty alleviation (MALD 1983).

Hence from the mid-1980s, a number of smallholder dairy development programmes were initiated in various parts of the country. The overall policy objective has been attainment of self-sufficiency in milk and milk products. Various strategies have been adopted to achieve a rapid increase in dairy cattle numbers and their productivity. There have been successes and failures. The net result of these efforts to date are summarised below.

The livestock population is made up of about 15.6 million cattle, 10.7 million goats, 3.5 million sheep, 435 thousand pigs and 26 million poultry (Bureau of Statistics 1996). Of the 15.6 million cattle, only 2% (about 300 thousand) are crossbred or grade dairy animals, which produce about 246 million litres of the estimated total of 889 million litres (MoAC/SUA/ILRI 1998). With a population of about 29 million people, the per capita consumption of milk has been estimated at about 30 litres/annum. Official figures give an estimate of 22 litres/person per year. The paucity of data makes accurate projections impossible. Nevertheless, both the cattle population and the milk supply and consumption are unevenly distributed. There are 20 administrative regions in the country but two-thirds of the improved dairy cattle are found in just two of the northern highland regions, Arusha and Kilimanjaro. Traditional cattle are concentrated in five (Shinyanga, Mwanza, Singida,

Dodoma and Arusha) regions, which account for about 60% of all traditional cattle and a similar proportion of milk offtake (Bureau of Statistics 1996).

The purpose of this case study is to examine the various approaches and policies that have been pursued towards achieving dairy development and self-sufficiency in the supply of milk and milk products in Tanzania. The paper will draw attention to the processes that have been involved, the successes and failures and lessons, which can be learnt from the experiences gained over the years. It starts with a general historical background of dairy industry development before and after independence in 1961. Finally, the paper discusses future strategies to address the identified constraints and exploit opportunities that exist in Tanzania for further development of the dairy industry. Areas requiring further research are also discussed.

Methodology

The study is based on published scientific literature, unpublished project reports, conference proceedings particularly those of the Tanzania Society of Animal Production Conference Series (27 volumes 1973–2000), discussions with peers as well as the author's own experience with Tanzania dairy industry development since 1976. Factual data are used to illustrate the trends in development of various strategies, which have been pursued to achieve the stated objectives.

The issues

The issues at stake in developing a dairy industry in Tanzania include:

- a) Sources, types and quality of genetic material for milk production. Here the fundamental issue is the need for quality and relevance of improved dairy cattle breeds as compared with indigenous zebu cattle, both of which have advantages and disadvantages.
- b) Policy and institutional set up is another issue, which has evolved over time. Tanzania has gone through various phase of dairy development in which the government, the private commercial farmers, the traditional cattle herders and smallholder dairy farmers have played different roles at specific periods depending on policy changes.
- c) Structural changes in both the government and the private sectors, including fiscal policies and market conditions, have also impacted on the development process.
- d) The role of research in dairy development appears obscure to policy makers. What has been the role of research in raising productivity, efficiency in milk production, processing and marketing? Are there areas for future research?
- e) Which aspects of Tanzania's development effort can be regarded as a success or failure, what lessons can be learnt from the Tanzania experience and what are the future prospects and constraints to be overcome?

Historical overview of dairy development policies and strategies: 1930s to 2000

Dairy cattle improvement strategies

Various strategies to improve and expand the dairy industry base in Tanzania have been attempted with varying degrees of success or failure. These are briefly reviewed below.

Early selection work

The milk production potential of the Tanzania Shorthorn Zebu (TSZ) is generally low with estimates ranging from 530–950 kg per lactation of 232–257 days long (Msechu et al. 1987; Msechu 1988). Efforts to raise local cattle productivity in Zanzibar (Tidbury 1954) and Uganda (Williams and Bunge 1952) achieved only a limited increase in yields to levels not exceeding 920–950 kg per lactation (Mpiri 1994). Since most selection work was done on station with improved management, it was not easy to isolate the effect of genetic improvement due to selection on the apparent improvement in productivity.

In view of these limitations, further work on improvement of traditional zebu cattle for milk production had focused on cross-breeding. Cross-breeding zebu cows with *Bos taurus* cattle raises the productivity of the crossbred animals to 1500–1700 litres per lactation, i.e. a doubling of the potential yield of the zebu in one generation. However, with cross-breeding comes the dilution of genetic resistance to tropical diseases and the requirements for improved feeding and management; moreover, cross-breeding may pose a threat to long-term genetic conservation of local genetic resources.

Development of the Mpwapwa breed

In view of the limitations of cross-breeding and subsequent upgrading towards *Bos taurus*, between 1932 and 1935 the Ministry of Agriculture under the colonial government initiated work to crossbreed exotic dairy cattle with indigenous zebu at Mpwapwa livestock research station. As a result, the Mpwapwa synthetic breed was developed with an average composition of 35% Red Sindhi, 20% Sahiwal, 10% Boran, 20% TSZ, 5% Ankole and about 10% exotic blood, mainly Ayrshire. The herd was closed in 1956 for selection work. The average milk yield was reported to be about 1660 kg per lactation (Das et al. 1986). The unfortunate part of the Mpwapwa cattle story is that most of the developmental work took place on station. On-farm evaluation of the Mpwapwa cattle only started in 1986 (Kasonta and Mkonyi 1990). The recorded performance was a lactation milk yield of 1626 kg in 300-day lactation. Calving intervals averaged 498 days. Average daily milk yield was 5.5 kg (Rushalaza et al. 1993). Unfortunately, no efforts were made to multiply the Mpwapwa breed for distribution to smallholder farmers. To date the Mpwapwa breed remains under exploited and the herd population has dwindled over the years. The Food and Agriculture Organization of the United Nations (FAO) has already declared the Mpwapwa an endangered breed. Reliable

information indicates that currently there are less than 100 breeding females in the various research stations in the country. Further conservation work for the breed has been in the pipeline for sometime now, but so far no support has been forthcoming.

Direct importation of *Bos taurus* dairy breeds

Tanzania has imported live heifers and bulls from various parts of the world. Massive importation took place in the 1970s when heifers and bulls were air freighted from the USA, New Zealand, Kenya and Zimbabwe. Between 1975 and 1993, 1039 heifers from New Zealand and USA were imported into the country. A World Bank loan and grants from Heifer Project International (HPI) were instrumental in effecting these importations. No hard figures are available on national total importation. At Kitulo dairy farm, for example, between October 1975 and October 1978, 890 HPI-donated heifers were received. The aim was to stock large-scale farms where the animals would multiply and thereafter, surplus heifers would be distributed to smallholder farmers. However, due to poor reproductive performance and high mortality rates, no appreciable surplus heifers have been generated from the parastatal farms.

Cross-breeding of zebu cattle with *Bos taurus*

Use of village bull centres

Under the 1975 Dairy Development Programme, about 50 village dairy farm units were planned for establishment under village government (communal) ownership; this was under the now defunct *Ujamaa* socialist policy. Farmers in the selected model villages were provided with a few dairy cattle and a bull, which could be used to mate with the dairy cattle and the indigenous stock. Management of the dairy herd was under the management of village government with the designated managers having very little decision making power. None of these village dairy farms ever prospered, largely because of poor management.

Government/project bull centres

Another strategy, which has been tested in Tanzania, was the provision of government or project operated bull centres, which were supposed to serve farmers of one or several villages. The management of the bull centre was carried out by the government/project extension service. This was attempted in the early stages of the Swiss funded Southern Highlands Development Project (Mchau and Mwakatumbula 1996). This approach was never successful due to poor management of the bulls.

Cross-breeding using artificial insemination

Artificial insemination (AI) has not been used significantly as a way of producing F_1 crossbreds within the farmers' own traditional herds. The main limitation has been lack of

necessary infrastructure for an extensive AI scheme. AI has been used with some measure of success on parastatal ranches and in heifer breeding units (HBUs). The National Artificial Insemination Centre (NAIC) at Usa River, Arusha, has been constrained by a number of operational problems including shortage of liquid nitrogen for much of the 1980s and a poor AI delivery system. Only about 2000–5000 inseminations are performed per year. Field operations have now been privatised, but the operation of NAIC is still under government control.

Heifer breeding units (HBUs)

To increase the supply of F₁ dairy heifers, heifer breeding units (HBUs) or livestock multiplication units (LMUs) were established. The plan was to have one HBU in each region. HBUs were stocked with TSZ or Boran cows for cross-breeding with exotic sires, mainly Friesian, Ayrshire and Brown Swiss. By the late 1980s, seventeen regions had already established their HBUs through World Food Programme (WFP) and government funding.

About 2000 heifers were produced from these units annually against an estimated national demand of 8000 heifers (Massae 1993) and a production target of 5000 heifers per year (MALD 1989). The performance of HBUs has thus been rather low and action towards privatisation of some HBUs is underway in accordance with the World Bank supported Agricultural Sector Management Programme (ASMP).

Heifer-in-trust (HIT) schemes

The heifer-in-trust (HIT) scheme was introduced by HPI working with the Lutheran Church in Arusha, northern Tanzania in 1978. It is a strategy considered appropriate for resource-poor farmers, especially women. The HIT approach involves loaning a pregnant heifer to a recipient who in turn is required to pay back to the scheme a pregnant heifer born on his/her farm. They are required to meet certain conditions which usually include preparing a zero grazing unit, planting at least one acre of fodder grass/legume, attending training and the keeping of records. The initial prototype model introduced by HPI in 1978, beginning with 33 heifers in three villages, has since been adopted with modifications by several dairy development programmes (Kinsey 1998). Dutch-funded projects in the Tanga and Kagera regions have used this approach quite successfully. Later on, HIT was used by the Southern Highlands Dairy Development Programme (SHDDP) and the WFP (Tan 2247) project. For successful implementation, a lot of close follow-up, called monitoring in the Kagera Livestock Development Project (KALIDEP), together with appropriate extension services, has to be provided on a continuous basis. This means the external costs to the farmer can be quite high, up to 40% of the producer price of milk (Rutamu and Munster 1998). The recovery rate for pregnant heifers varies but with good monitoring, a recovery/pass-on rate of 60–70% has been achieved (Houterman et al. 1993; Nzunda 1998). Table 1 and the discussions on the individual smallholder dairy development programmes show the success of HIT schemes in Tanzania.

The repayment (pass-on rate) has been highest in the Kagera project (KALIDEP) because of very close monitoring and a strong farmer-training component in the project

(Houterman et al. 1993; Rugambwa et al. 1995; de Wolf 1995). Even with very close monitoring systems such as those practised in the KALIDEP project, a pass-on rate of only 62.5% could be achieved in an interval of 4 years between the supply of the original heifer and the pass-on heifer (Houterman et al. 1993).

Table 1. Performance of heifer-in-trust (HIT) dairy schemes in Kagera and Tanga regions by 1991–92.

Period supplied	Dairy development programmes			
	KALIDEP	TSDDP	ECLT	
	1980–87	1987–89	1984–86	1987–89
Number of farmers given HIT heifers	567	596	116	214
Total number of HIT heifers supplied	640	623	116	214
HIT heifers dead/stolen/slaughtered	58	22	–	–
Animals withdrawn	13	8	–	–
Farmers with animals	503	582	–	–
Pass-on heifers produced	–	–	–	109
Pass-on heifers paid	66	11	19	–
% pass-on heifers (new farmers) in 4–5 years	10.36	1.84	1.64	–

KALIDEP = Kagera Livestock Development Project; TSDDP = Tanga Smallholder Dairy Development Project.

Source: Adapted from de Jong (1996).

Improved feeding/management of traditional cattle

The poor milk production of zebu cattle takes place under extremely poor management and other stress factors (e.g. water shortage). Modest improvements in milk production of zebu cattle may be achieved through better management practices. However, this strategy has rarely been pursued although reports from the field have shown some positive results (Mahunda 1995). Improved feeding and management of TSZ including better access to water and disease control measures may, within the limits imposed by inherent genetic potential, increase milk yield above current levels.

Institutional and policy framework for dairy development

The role of government institutions

In the past, the government played a key role in steering dairy development in Tanzania by being directly involved in production, processing and marketing and through its policies, laws and regulations. During the colonial period, there were a few large-scale farms; after independence most of the large dairy farms were nationalised in 1967 and operated by parastatal organisations. This was in line with policies of that time: socialism (*ujamaa*) and self-reliance. The aim was to increase milk production to cope with the rapidly increasing urban demand and to reduce dependency on the importation of milk and milk products.

For a long time, the livestock policies put forward by the government aimed at supplying milk to urban centres, especially Dar es Salaam, as cheaply as possible (Sumberg 1997). The most definite policy on livestock development since independence was formulated in 1983.

However, a number of development efforts and strategies were in place before the livestock development policy of 1983 to increase milk yields in Tanzania (MALD 1983).

Between 1961 and 1965, the operation of the dairy industry in Tanzania was governed by the Dairy Industry Ordinance No. 61 of 1961, Cap 456 of the laws of the then Tanganyika. Under this law, Zonal Dairy Boards (ZDBs) were established in 'areas which produced sufficient amounts of milk to warrant establishment of a dairy plant' (Boki 1998). The ZDBs' functions were:

- to open and run dairy farms and milk processing plants
- to collect, cool and market milk and milk products from farmers
- to strengthen the link between farmers, milk processors and distributors
- to conduct market research and education relevant to specialised groups within the dairy sector
- to provide essential services to dairy farmers and processors (registration, licensing, veterinary services, livestock inputs, and testing and grading of milk).

ZDBs were allowed to charge fees for registration, licensing and other services and to appoint inspectors etc. Farmers, mostly settler farmers, owned between 15 and 40% of the share capital in the processing plants.

The first and second Five-Year Development Plans (1964–69 and 1969–74) observed with concern the growing gap between domestic milk production and national milk demand. This prompted the establishment, under the Dairy Industry Act No. 32 of 1965 Cap 590 of the laws of Tanzania, of a government-controlled, National Dairy Board (NDB) in 1965. The NDB was charged with the following functions:

- to advise the government on all matters affecting the dairy sector
- to promote, organise and regulate, and to develop the production, processing, marketing and distribution of milk and milk products
- to establish and run dairy farms and milk processing plants
- to register and license all dairy industry players (importers, distributors, processors, retailers etc.)
- to fix milk prices
- to make bylaws for safeguarding the dairy sector
- to promote milk marketing development research in relation to milk and milk products
- to improve the quality of milk and milk products.

The period 1965–70 was marked by the nationalisation of large-scale dairy farms and processing plants. Farmers, thus, lost the 15–40% shares they held in the milk processing plants and the plants lost their partnership with the farmers. The NDB became moribund in 1973 when the Minister of Agriculture did not appoint new board members upon expiry of its tenure. Instead, a Livestock Development Authority (LIDA) was formed in 1974 to oversee the functioning of two subsidiary companies: the Dairy Farming Company (DAFCO) and Tanzania Dairies Ltd. (TDL).

The third Five-Year Development Plan (1975–80) was earmarked as the plan for attaining self-sufficiency in dairy products and thus a long-term National Dairy Plan was launched so as to achieve this goal. DAFCO and TDL were established with the aim of ensuring smooth running of the dairy industry. Yet performance of all these dairy

parastatals was disappointing due to management problems, foreign currency shortages and non-availability of suitable dairy cattle to increase milk production. Table 2 shows policy and institutional changes in dairy development since independence in 1961.

Table 2. Policy, regulation and institutional development of the Tanzania Dairy Industry (1961–98).

Year	Policy/regulation	Institutional structures	Remarks/functions
1961–65	Dairy Industry Ordinance	Zonal Dairy Boards	Participants were farmers, milk transporters, milk processors, distributors, importers and consumers
1965	Dairy Industry Act No. 32 of 1965 Cap. 590	National Dairy Board (NDB) established	-ditto-
1973			NDB not reconstituted by the minister responsible for agriculture after expiry of its term in 1973
1974	Tanzania Livestock Development Authority (LIDA) established by Act of Parliament	LIDA established as a holding company for TLMC; Tanzania Feeds Co. Ltd; and later TDL and DAFCO	LIDA and its subsidiaries undertook some of the functions of the NDB. Dairy Act has, however, not been repealed to date
1975	TDL established by Act of Parliament DAFCO established by Act of Parliament	Operated as subsidiary of LIDA with 7 dairy plants -ditto- with large-scale dairy farms	
1978	Food Quality Control Act established by Act of Parliament	National Food Control Commission established under same act	
1981	Food Quality Control Act 1978 reviewed		
1983	Tanzania Livestock Policy established	Smallholder dairy development projects started in Kagera (KALIDEP); in Tanga TSDDP; SHDDP expanded; HBUs	Policy on raw milk sales to consumers where dairy plants existed not followed up by legislation
1988	Milk pricing decontrolled		
1995	TDL liquidated		
1996–98	TDL plants privatised; some DAFCO farms privatised		Royal Dairies took over the Dar es Salaam plant; Tabora; Tanga; Musoma and Arusha plants have been bought

TLMC = Tanzania Livestock marketing Commission; TSDDP = Tanga Smallholder Dairy Development Project; SHDDP = Southern Highlands Dairy Development Programme; KALIDEP = Kagera Livestock Development Project; TDL = Tanzania Dairies Ltd.; DAFCO = Dairy Farming Company.

Donor support in dairy development

In the area of dairy development, the largest single input was the IDA credit for Phase One Dairy Development. This attracted a number of multilateral and bilateral programmes in support of the dairy industry; support was mainly in the form of technical assistance. There

were other significant multilateral and bilateral inputs, but these were directed more towards the commercial or large-scale milk sector, which produces and supplies milk for the urban population.

The most significant dairy development projects since 1975 were described below.

Phase One Dairy Development (IDA Credit 580 TA)

The first major long-term Dairy Development Programme in Tanzania was conceived and prepared by the government in 1974 and submitted to the World Bank (IDA) for funding in May 1975. The components of the programme included support for the rehabilitation and expansion of commercial dairy production on parastatal farms, improvement of milk collection and processing facilities, and provision of dairy heifers through the establishment of livestock multiplication units (LMUs).

The total cost of the programme was estimated at US\$ 15.3 million of which IDA approved a credit ceiling of US\$ 10 million; the balance was to be financed by the Government of Tanzania and the beneficiaries of the credit.

The objective of the project was to increase milk production in government and parastatal farms, many of which already existed and urgently required substantial investment and improved management. The milk produced would help thus to fill the large deficit of dairy products for the major urban markets and reduce imports of dairy products.

Food commodity projects

Dairy commodity projects were linked to dairy investment projects in the livestock sector. Funds generated from the sale of recombining materials (skim milk powder and butter oil) to TDL being allocated specifically to dairy projects. Specific attention was given to dairy development by WFP and the EEC (European Economic Community).

WFP assistance (1975–95): The WFP Dairy Aid Project (TAN 2247) started in 1975 with a pilot project to supply commodity aid (skim milk powder (SMP) and butter oil) to Tanzania for the financing of development projects. The function of WFP food aid in dairy development was to supply milk powder and butter oil to dairy plants for recombining purposes to increase the availability of milk. However, the main objective of WFP assistance was to generate funds from the sales of dairy commodities for further investment in dairy projects aimed at improving milk production, collection and processing facilities.

The programme was not very successful with the exception of support to HBUs. Funds generated in local currency were inadequate or misallocated to non-productive uses, such as investments in real estate in urban centres. The shortage of foreign exchange and imported dairy inputs continued to jeopardise the dairy development in Tanzania.

EU (European Union) assistance: The EU has been assisting Tanzania by providing milk powder and butter oil for recombining purposes. Funds generated from the proceeds were also supposed to be used for the development of livestock projects. Most of the funds generated were used to finance other livestock projects, besides dairy projects. The objective

of providing milk powder and butter oil to milk plants for recombining purposes to increase the availability of milk in the country has been successful. However, in terms of local dairy development achieved by investing the revenues of the programme in the industry, the programme can be considered as a failure. Funds generated by the EU commodity aid were handled together with WFP funds under Project TAN 2247.

Smallholder dairy development programmes

The poor performance of the large-scale parastatal dairy sector and *ujamaa* farms prompted the government to change its dairy industry strategy towards small-scale farmers. This started in 1978 with the Small-Scale Dairy Development Programme (SSDDP) implemented with Swiss Government bilateral assistance.

The Small-Scale Dairy Development in Iringa and Mbeya regions: The project started in 1978, as the SSDDP. After an initial phase of animal multiplication at the Sao Hill–Iringa livestock multiplication unit, support to bull centres and distribution of heifers to farmers, the project has evolved through eight phases to become the SHDDP. Since 1993, the project adopted the HIT scheme to distribute heifers to resource-poor farmers, as well as supporting dairy extension services in the two regions. Over 2000 farmers in the two regions have taken up dairy farming. By 1998, the population of dairy cattle managed in this project was 5026 (including over 2800 cows) with the capacity to produce 5 million litres of milk per year.

The Dutch funded projects Kagera Livestock Development Project (KALIDEP): Dutch government's support to the dairy industry in Kagera region started in 1976 and in 1982 the project became known as the Kagera Smallholder Dairy Extension Project (KSHDEP). Because of increased pressure for the supply of crossbred dairy animals, in 1988 a crossbreeding programme aimed at transforming the indigenous cattle through crossbreeding on farmers' own farms by AI rather than at HBU only was initiated. It became known as Kagera Indigenous Livestock Improvement Project (KILIP). KILIP sought to improve veterinary, extension and input supply services not only on smallholder dairy farms but to indigenous livestock keepers as well. This aimed to improve productivity of the traditional cattle and to create an environment conducive to crossbreeding of indigenous cattle with exotic dairy cattle, whose crossbred offspring would benefit a much larger population of the Kagera farming community. The results of this novel approach have not been analysed and/or published. However, under KALIDEP (1990–94, KALIDEP Phase I; 1995–99, KALIDEP Phase II) crossbreeding of indigenous cattle was pursued with difficulty. For example, in 1996–97, only 255 inseminations were performed on indigenous cattle (Silas et al. 1998). KALIDEP has three components, heifer breeding at Kikulula HBU, a farmer-training centre at Kikulula and an extension package. By 1998, the project was serving 4880 dairy farmers who kept a total of 11,134 dairy cattle (3893 cows). Total annual milk production has increased from 160 thousand litres in 1983 to over 6 million litres in 1998 (Silas et al. 1998).

The Tanga Smallholder Dairy Development Project (TSDDP): This is another project funded by both the Dutch and Tanzanian Governments. It began in 1985 with five farmers and seven cows. The project had three components, the Muruazi HBU, the Buhuri Farmer Training Centre and extension services. By 1998, the total number of farmers in the project was over 2471, owning 7768 dairy animals. A similar number of farmers and dairy cattle are assumed to be operating outside the project monitoring system (Zylstra 1998). Annual milk production increased from about 100 thousand litres in 1985 to about 4 million litres in 1998 for project farmers or 6 million litres overall. It is reported that the subsidy element in services received by farmers amounted to about 75 Tanzania shillings (TSh) (US\$ 1 = 680 Tsh in June 1998) per litre produced or 40% of the average producer price of milk (Rutamu and Munster 1998).

The WFP TAN 2247: From 1992, the WFP TAN 2247, using funds for the last consignment of food commodity aid, became directly involved in the promotion of smallholder dairying in six districts of Tanzania (Rukwa, Ruvuma, Kwimba, Mtwara, Lindi and Ukerewe (Nzunda 1998a)). The strategy adopted was the HIT scheme. A total of 2409 heifers was loaned to 1635 HIT farmers. Milk production improved from 2061 litres per annum to 3,705,313 litres in five years. Average production was 5.8 litres/cow per day. The repayment rate was 56.8% (Nzunda 1998b). The cost of the subsidy was, however, not given.

Other projects

Other donor countries and organisations have also supported development of the Tanzanian dairy industry in the past. New Zealand supplied spare parts for the milk processing plant in Tanga and the Livestock Training Institute in Tengeru, Arusha. Sweden provided support to AI—the National Artificial Insemination Centre (NAIC), Arusha. The centre produces semen, which is being used throughout the country. The Federal Republic of Germany provided assistance to smallholder development in Lushoto and support to the regional veterinary service at Tanga. Finland provided assistance to Elecster milk processing plant in Mbeya (in 1976). Ireland has provided support to dairy farms and heifer breeding units at Kilosa, Morogoro Region. Austria has provided support to small-scale dairy farmers of the Dar es Salaam and coastal regions and to pastoralist producers around Dar es Salaam since 1993 (Morungu and Mshana 1993; Mtumwa and Mwashia 1995). This has mainly been marketing support through provision of technical assistance and soft loans. Recently the Austroproject Association has extended its involvement into the revival of the once vibrant traditional herds based dairy industry in Mara, around the shores of Lake Victoria. The United Kingdom has provided support to the large-scale dairy farm and HBU at West Kilimanjaro). The Heifer Project International works through the Lutheran Church. It pioneered the HIT scheme when, in 1978, 33 heifers were distributed to farmers in three villages around Arusha. Dairy stock is mostly imported for distribution to resource-poor farmers. The HPI led HIT scheme had, by 1998, been able to reach 17 thousand farmers distributed across every region of Tanzania (Kinsey 1998). The USA, through the United States Agency for International Development, has made its contribution to the development of small-scale producers with a strong emphasis on training in extension,

particularly training carried out in Rural Development Centres throughout Tanzania. It has provided buildings, equipment and transport facilities for small farmers. Japan through its development agency JICA (Japan International Cooperation Agency) has provided support to pasture seed production and funding for HIT schemes. The United Nations Development Program and FAO have provided support to smallholder dairy development in the Arusha and Kilimanjaro regions.

Developments in milk marketing policies

Domestic milk marketing

A recent study by MoAC/SUA/ILRI (1998) showed that informal milk marketing dominates the milk marketing chain whereby up to 60% of marketed milk passes directly from producers to consumers. Milk vendors play a very significant role, supplying in some cases (e.g. Shinyanga and Mwanza) nearly all the milk that is brought in from outside the town boundaries (Sumberg 1996).

Milk producers prefer to sell directly to consumers where they can obtain a high price. Milk processing plants pay farmers only about 50–60% of the price farmers get by selling directly to consumers. Hence, milk-processing plants become selling points of last resort. As a result, most milk processing plants even small- to medium-scale plants operate at less than 50% of installed capacity (Kurwijila 2002). The recent introduction of value added tax (at 20%) on dairy products other than liquid milk, means that dairy produce is out of the reach of a large section of the population. Hence there is a scramble for the Dar es Salaam market as a population of over 2.5 million people and high average incomes make it an attractive market for processed dairy products. Milk processors complain of unfair competition from informal milk marketing agents. Furthermore, adulteration of milk seems to be widespread according to a recent study (Loth et al. 1998).

The regional markets are relatively undeveloped and quickly become saturated, particularly as many urban dwellers have taken up dairying to produce milk within intra-urban and/or peri-urban areas. Enforcement of milk processing is difficult, impractical and perhaps unnecessary and counterproductive at the current level of market forces (supply, demand and purchasing power and preferences of consumers—Kurwijila et al. 1995).

One of the many constraints is the seasonal variation in milk supply and demand. Supply of milk is generally high during the rainy season when dairy feeds are adequate compared with the dry season when feeds are scarce. Demand for milk, especially sour milk, varies between the cool and hot seasons (Kurwijila et al. 1995).

Urban and peri-urban dairying

Urban and peri-urban dairying is principally a response to market opportunities and constraints. It can be traced back to the pre-independence years. In a recent study of the Dar

es Salaam milk market, Sumberg (1996, 1997) found that the first dairying activity was the establishment of government dairy farms within and around Dar es Salaam as early as 1921. Today, government policy (MALD 1983) encourages peri-urban dairying and tolerates the keeping of animals within the city boundaries (Mougeot 1994; Mlozi 1995; Malongo and Mlozi 1997). The factors which have justified the keeping of dairy cattle within and around cities in Tanzania have included the need for civil servants to 'make ends meet', the high price of raw milk in urban centres relative to the price in remote rural areas and the poor milk marketing infrastructure.

In view of the illegal nature of urban dairying (it is officially prohibited or limited to a few zero grazed cows only), government policy in Tanzania has over the years encouraged the development of peri-urban dairying (MALD 1983) and smallholder dairying (Melewas 1996). Peri-urban dairying in particular offers enormous potential for the supply of milk to rapidly expanding cities in Tanzania due to the following reasons:

- a) Proximity to urban centres provides easy access to milk markets, which offer a good price.
- b) Better access to land resources provides a cheaper source of animal feedstuffs.
- c) It is more environmentally sustainable than urban dairy farming.

Dairy imports

Even after cessation of dairy commodity aid, Tanzania still imports milk and milk products to fill the demand-supply gap. The majority of milk processors complain bitterly against competition from milk imports, which they see to be unfair in view of allegations of tax evasion by importers and use of export subsidies in the countries of origin especially the EU (Verwer 1999). Verwer (1999) showed that about 27 million litres of liquid milk equivalent (LME) is being imported into Tanzania each year. The study by Verwer (1999) unfortunately did not reveal how much of the 27 million litres LME was actually taxed and how much was exempted from applicable taxes under the guise of religious/relief organisations. Nevertheless it is important to examine the impact of imports on the local market: is it significant enough to stifle development of the domestic dairy industry?

If one considers the estimated level of milk imports of 5–27 million litres LME/annum against the estimated total production of 886 million litres/annum by the year 2000 (MoAC/SUA/ILRI 1998), the 0.6–3.0% share of imports may seem insignificant. However, the real impact on the market should be compared with the volume of milk that is marketed in Tanzania's urban centres. It is estimated that only 10% and 67% of milk, respectively, from traditional (67 million litres) and improved dairy cattle (143 million litres) is marketed. The rest is consumed by the family or exchanged within the neighbourhood (MoAC/SUA/ILRI 1998). This means that the 27 million litres of imported milk is competing against approximately 209 million litres of locally produced milk (total market = 236 million litres/annum). The real impact of imports is, therefore, 11% share of the total local urban milk market.

It is arguable as to how significant the impact of this level of imports is on the local dairy industry. While the effect on milk producers depends largely on the relative cost (parity

price) of imported milk, which has been shown to be no cheaper (if properly taxed) than locally produced milk (NEI 1999). The impact on milk processors is significant as imported products compete directly with locally processed milk (35–40 million litres/annum), which has in turn still to compete with intra-urban produced milk, as well as informally marketed raw milk from peri-urban and rural areas. Imports take up about 40% of the (67 million litres/annum) processed milk market (40 million litres locally processed + 27 million litres of imports), which significantly affect local processors. Other factors, such as low plant capacity utilisation, high processing costs (e.g. electricity tariffs and VAT on processed products) all have a bearing on the competitiveness of the local milk processing industry and should be given due consideration. The government is under pressure from the processing subsector to limit imports. However, the official government policy is to provide a level playing field by ensuring that imports are properly taxed and to take measures against dumping of substandard products. A review of the domestic tax regime is another avenue under consideration.

Taxation policy

There are numerous taxes on the livestock subsector. Most taxes are known in the district but the implementation of taxes varies widely between districts. There are districts that charge a fee on livestock for education and there are districts which levy a yearly livestock tax.

The Tanzania dairy subsector is protected by an import duty of 30% on dairy products as well as the 20% VAT charged on milk powder. However, the sector is complaining about illegal imports. Companies that reconstitute milk powder and fresh milk have an important comparative advantage to those that collect and process local milk. Generally, the milk processing industry faces the following taxes on inputs and outputs:

- (a) stamp duty at 1.2%
- (b) withholding tax at 2%
- (c) industrial cess replaced by a cess of 0.25 TSh/litre
- (d) sales tax at 30% on butter, cheese and yoghurt
- (e) packaging materials—import duty at 30%
- (f) electricity—sales tax at 5%.

Packaging materials and electricity are the major variable cost items for the dairy industry. The import duty on packaging materials is considered as a major constraint by the sector. The sales tax on cheese, butter and ghee hampers profitable production from fresh milk in the formal sector. As such, the formal sector cannot compete with imports and with informal sector production. However, butter and cheese production would allow the sector to process milk during the rainy season when milk production reaches its seasonal maximum and demand its seasonal minimum.

VAT has been introduced recently and is raised on processed products. Most agricultural products are exempted, as long as they are unprocessed or have undergone only

simple processing (pasteurising and packing). However, packaging materials for the dairy industry are subject to VAT (20%).

New dairy development policy

Following the 1998 dairy development conference involving dairy industry stakeholders, there was a resolution to elaborate a new dairy industry policy within the context of the Agriculture and Livestock Policy of 1997. The dairy industry will operate under the following policy framework and objectives.

Within the context of the agricultural subsector, the overall goals will be the exploitation of available resources for commercialisation and market orientation of cattle keeping to raise incomes of smallholder farmers and improve living standards in rural areas through dairying (Melewas 1996).

According to a draft dairy industry development policy currently under discussion by stakeholders, the overall objectives of the dairy industry will be to:

- improve food security of the nation by increasing output, quality and availability of milk and milk products
- keep pace with increasing demand, milk production will have to grow at the rate of $\geq 3\%$ per annum through the combined effect of dairy herd expansion and improved productivity of both the zebu and dairy herd
- improve standard of living in rural areas through increased income generation from milk production, processing and marketing
- contribute to foreign exchange earnings through savings on milk and chemical fertiliser imports, and by producing surplus milk for export in the long term
- develop and introduce new technologies, which increase the productivity of labour and land
- promote integrated and sustainable use and management of natural resources such as land, soil, water, vegetation and the use of alternative energy sources (e.g. biogas to conserve the environment)
- encourage equal opportunities for men and women in terms of access to and control over land, animals and their products, as well as access to education and information necessary for dairy development.

At the national level, the need for regulatory agencies to provide 'a level playing ground' and basis for standards and quality assurance for the dairy industry cannot be ignored. Already in Tanzania, since 1998, a task force is working towards formation of an autonomous, democratic National Dairy Board, independent from the government to be funded and controlled by the industry/stakeholders. The specific roles of the proposed dairy board will include the following:

- dairy industry quality assurance
- overall development of the dairy industry
- in collaboration with the MoAC (Ministry of Agriculture and Co-operatives), initiate dairy industry reviews
- in collaboration with MoAC, manage dairy industry information systems

- monitoring of import and export of milk and milk products
- support dairy industry development through positive interventions, such as offering training when and if necessary
- ensure the observance of hygiene in the entire dairy industry chain
- in collaboration with TBS (Tanzania Bureau of Standards), set milk and milk products standards, and in collaboration with NFCC (National Food Control Commission) ensure compliance with these standards
- initiate and co-ordinate dairy industry research
- contribute to milk consumption promotion, through generic advertisement etc.
- disseminate information
- lobby interest for the dairy industry
- support research, education and training
- administer dairy development funds.

Farmer organisations

The official policy in Tanzania is to encourage farmer organisation through co-operatives, associations and informal groups. However, given the past government's interference in the running of co-operatives in the country, the development of dairy co-operatives has been very slow. There are very few successful dairy co-operative societies to date. To give the co-operative movement a new impetus, a full Ministry for Co-operatives has been created, but it will take time before the impact of this new initiative is realised. The new vision is to have independent co-operatives controlled by stakeholders.

Lessons from the Tanzania experience and future prospects

Although more than 40 years of the dairy development process have not brought the spectacular achievements witnessed in Operation Flood in India, positive improvements have been made, especially since the mid-1980s when emphasis changed from large-scale government farms to smallholder dairy development.

Use of dairy commodity aid

Funds generated from the sale of dairy commodity aid (WFP and EU) were put to various uses, but the most evidently useful outputs have been support to HBUs/LMUs and to farmer training. This has contributed to establishment of a genetic resource base and skills for the future growth of the dairy industry. It is noteworthy that the availability of food commodity aid did not encourage the local industries to put up infrastructure to procure

local milk. This was because imported milk powder tended to be cheaper and of course more convenient to handle (Kurwijila 2002).

Dairy herd growth and breeding

In smallholder farms, a herd growth of 6% per annum has been achieved. This is attributed to close monitoring; farmer training and extension services which were subsidised by donor-funded dairy development projects. Under the current move to privatise most services, the challenging question is how to internalise some costs such as those for extension services, training, control of epidemic diseases such as contagious bovine pleuropneumonia (CBPP) and delivery of AI services, which seem to have elements of public good but may cost more than the smallholder farmers can afford, at least in the short term. A gradual and selective scaling down of donor/government subsidies is considered to be the only logical approach if loss of advances already made is to be avoided.

Heifer-in-trust schemes

The HIT scheme, although requiring a lot of organisation, commitment, coherence and discipline on part of the recipients, has proved to be a useful tool in reaching out to resource-poor farmers in rural areas. The associated subsidy element can be quite high (40% of the cost price of milk) and the challenge in the future is how to internalise a substantial part of the costs. The Swiss funded Smallholder Dairy Development Project in the southern highlands now in its 9th and final phase, has embraced an exit strategy that hopes to empower farmer group networks (in terms of organisation capability) to run the HIT schemes in the future.

Milk processing and marketing

As was the case with production activities, milk processing and marketing by government agents did not work efficiently in Tanzania. The emerging private sector is struggling against (unfair) competition from the informal sector. Quality assurance systems are weak or absent and competition from imports is mainly on the basis of quality differences rather than price differences. Improvements in processing, quality assurance and efficiency are necessary for survival in an increasingly liberalised, global market. Self-regulation rather than control from the government is required. This implies the industry will have to organise itself to better face the challenges of today and tomorrow.

Institutional set-up and farmer organisations

The experience in Tanzania has demonstrated that it is the private farmers who can make good farmers. At the smallholder sector level, dairying clearly benefits women and is a strong tool for poverty eradication. Parastatal dairy farming and processing proved to be a

complete failure. The future lies with the private sector. However, with smallholder farmers one cannot talk of them surviving on a private sector basis without using the co-operation tool. Hence there is a need to establish stakeholder-based associations/co-operatives on the principle of shared goals and objectives.

Issues of concern and researchable problems

A recent rapid appraisal study on the dairy subsector carried out by the International Livestock Research Institute (ILRI) in collaboration with the MoAC and the Sokoine University of Agriculture (MoAC/SUA/ILRI 1998) identifies a number of issues that need to be addressed in relation to sustainable dairy production systems in Tanzania.

Seasonality of feed supply

In both urban and peri-urban dairy production systems, scarcity of feed and its seasonal fluctuations in both quality and quantity are major constraints. Technologies to alleviate this constraint are required and should continue to attract researchers' efforts and resources in both the short- and long-term perspective.

Feed and manure markets in and around urban centres

The dependency of the urban dairy production system on feed supplies from outside the farm holdings, coupled with environmental concerns regarding urban dairying and the problem of nutrient cycling in the cut and carry system dominating the smallholder subsector are issues which have to be addressed for sustainable productivity of peri-urban dairy farming.

High milk price levels and fluctuations

There are wide spatial and temporal variations in milk prices in Tanzania. Producer prices have fallen recently and farmers are complaining. The mechanisms of price determination are not well understood. The uncertainty about price movements in the dairy subsector could undermine sustainability of smallholder dairying, which has shown itself to be strongly supportive of livelihoods in many resource-poor households. Studies are required to define more precisely price formations from production to marketing in order to influence correct, economic, technical and policy decisions in the entire dairy subsector.

Public health concerns regarding informal milk marketing

Apart from the problem of adulteration, informal milk marketing dominating the dairy industry in Tanzania is invariably associated with zoonotic risks. Indeed some location-

specific research results have shown that bovine tuberculosis may be a potential risk if the reported prevalence rates of 8–15% in herds which have been tested (Markham 1995; Kazwala 1996; Darbon et al. 1997; Minja et al. 1998) are representative of the national scenario. This danger is often dismissed when it is assumed that most consumers of liquid milk boil it before consumption. However, a substantial proportion of milk marketed as raw milk is consumed as spontaneously fermented milk without prior heat treatment. While lactic acid fermentation has been reported to eliminate some pathogenic enterobacteria, there is evidence that some strains of *Mycobacterium* spp. could survive prolonged incubation in sour milk (Minja et al. 1998). In order to assess the significance or otherwise of such a threat, it is important to assess first the prevalence rate and the extents to which various traditional milk processing methods eliminate the various zoonotic risks. It is only after the full facts are known that informed policy recommendations could be made on the regulation of informal milk marketing systems in Tanzania and elsewhere in sub-Saharan Africa.

Conclusions

The case of Tanzania has demonstrated that:

- Government and donor-funded interventions have a catalytic effect on dairy industry development.
- The private sector and smallholder farmers are the most efficient vehicles for dairy development.
- Heifer-in-trust schemes are a good way of involving resource-poor farmers in dairying.
- Urban and peri-urban dairying is a response to market opportunities and constraints in the dairy sector, particularly weak infrastructure and the high price differential between the urban/peri-urban interface and remote rural areas.
- Research and development is required in addressing issues, which hamper efficiency in production, processing and marketing of milk.

References

- Boki. 1998. The Tanzania National Dairy Board Discussion Paper. In: de Wolff et al. (eds), *Proceedings of the 2nd National Dairy Development Conference held at Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 153–162.
- Bureau of Statistics. 1996. *National Sample Survey of Agriculture 1994/95*. Tanzania Mainland Report. Volume II. Bureau of Statistics, Planning Commission, Dar es Salaam, Tanzania.
- Darbon C.J., Kazwala R.R. and Kambarage D.M. 1997. Bovine tuberculosis research programme in Tanzania: Interim results. In: Berrad J., Bouchriti N. and Bouslikhane M. (eds), *Animal tuberculosis in Africa and the Middle East*. Actes Editions, Rabat, Morocco. pp. 191–198.
- Das S.M., Mgheni M., Msechu J.K.K. and Mpiri D.B. 1986. Association between milk production and reproductive efficiency traits in Mpwapwa cattle and their crosses. *Proceedings of the Tanzania Society of Animal Production* 13:167–182.

- Getz W.R. 1974. Cattle breeding and selection work in Tanzania based on the Tanzania Shorthorn Zebu. A review. *Proceedings of the Tanzania Society of Animal Production* 1:62–73.
- Houterman J.F., Dummer R.M., Litalala E.M. and de Wolf J.T. 1993. Quantitative aspects of heifer-in-trust schemes: The Kagera experience. *Proceedings of the 20th scientific conference of the Tanzania Society of Animal Production* 20:168–188.
- de Jong R. 1996. *Dairy stock development and milk production with smallholders*. PhD thesis, Wageningen Agricultural University, Wageningen, The Netherlands.
- Kasonta J.S. and Mkonyi J.I. 1990. The performance of Mpwapu breed cattle under smallholder dairy farmer management in a rural area. *Proceedings of the Tanzania Society of Animal Production* 17:8–14.
- Kazwala R.R. 1996. *Molecular epidemiology of bovine tuberculosis in Tanzania*. PhD thesis, University of Edinburgh, Edinburgh, UK.
- Kinsey E. 1998. Exit strategies for donors of heifer projects (HIT schemes) to ensure their continuation: In: de Wolff et al. (eds), *Proceedings of the 2nd National Dairy Development Conference held at Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 38–43.
- Kurwijila L.R. 2002. An overview of dairy development in Tanzania. In: Rangneker D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints: Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001*. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Kurwijila L.R., Mdoe N., Nyange D.N., Auerböck R.M. and Mallya H.N. 1995. Assessment of fresh milk and milk products consumption in Dar es Salaam. Report to the Austroproject Association. The Austro Project Association, Dar es Salaam, Tanzania. (Unpublished Report)
- Loth S., Kurwijila L.R., Mdoe N.S.Y., Mchau K.W. and Auerböck R.M. 1998. Milk quality variations in alternative milk production and marketing systems in the Morogoro and Dar es Salaam milk shed areas. *Proceedings of the Tanzania Society of Animal Production* 25:174–186.
- MALD (Ministry of Agriculture and Livestock Development). 1983. *The Tanzania Livestock Policy*. Government Printer, Dar es Salaam, Tanzania.
- MALD (Ministry of Agriculture and Livestock Development). 1989. *Livestock Development Programme 1989–2000. Main report: Subsector summaries*. Ministry of Agriculture, Dar es Salaam, Tanzania.
- Mahunda M. 1995. Strategies for increasing livestock production: Livestock production policies—A view from field. *Proceedings of the Tanzania Society of Animal Production* 22:261–273.
- Malongo R.S. and Mlozi M.R.S. 1997. Urban and peri-urban livestock farming and the environment. *Proceedings of the Tanzania Society of Animal Production* 24:43–62.
- Markham A.E.G. 1995. *Bovine tuberculosis in the Southern Highlands Province of the Tanganyika*. PhD thesis, University of London, London, UK.
- Massae E.E. 1993. Experiences with dairy development in Tanzania. In: Mann E.J. and Brookes B. (eds), *Proceedings of a seminar on dairy development policy and implementation: Sharing experiences between Africa and Asia, Harare, Zimbabwe, 12–16 July 1993*. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. pp. 56–63.
- Mchau K.W. and Mwakatumbula I.D.A. 1996. Dairy cattle recording under smallholder conditions in Iringa and Mbeya regions. In: Kifaro G.C., Petersen P.H. and Lock A. (eds), *Dairy recording in Tanzania. Proceedings of a workshop, Mkonge Hotel, Tanga, Tanzania, 9–11 August 1995*. Sokoine University of Agriculture, Makerere University, ENRECA Project. pp. 37–44.

- Melewas J.N. 1996. Future function, policies and strategies of the livestock sector: Creating an enabling environment for private sector involvement in increasing livestock production. *Proceedings of the Tanzania Society of Animal Production* 23:116–130.
- Minja M.G., Kurwijila L.R. and Kazwala R.R. 1998. Occurrence and survival of mycobacteria species in fermented milk from traditional cattle herds: A case study of Usangu Plains, Southern Highlands, Tanzania. *Proceedings of the Tanzania Society of Animal Production* 25:199–202.
- Mlozi M.R.S. 1995. *Information and the problems of urban agriculture in Tanzania. Intentions and realisations*. PhD thesis, University of British Columbia, Vancouver, Canada.
- MoAC (Ministry of Agriculture and Co-operatives)/SUA (Sokoine University of Agriculture)/ILRI (International Livestock Research Institute). 1998. *Tanzania dairy subsector: A rapid appraisal*. Volume 3. Main Report. ILRI, Nairobi, Kenya.
- Morungu L.S. and Mshana Y.A.K. 1993. Smallholder dairying in the southern highlands of Tanzania. *Proceedings of the 20th scientific conference of the Tanzania Society of Animal Production* 20:189–209.
- Mougeout L.J.A. 1994. African city farming from a world perspective. In: Egziabher A.G., Lee-Smith D., Maxiwell D.G., Memon P.A., Mougeout L.J.A. and Sawio C.J. (eds), *Cities feeding people: An examination of urban agriculture in East Africa*. IDRC (International Development Research Centre), Ottawa, Canada.
- Mpiri D.B. 1994. Improving cattle productivity in Tanzania. Ministry of Agriculture, Dar es Salaam, Tanzania.
- Msechu J.K.K. 1988. Contribution of milk from the traditional livestock sector in Tanzania. *Proceedings of the Tanzania Society of Animal Production* 15:199–215.
- Msechu J.K.K., Das S.M. and Mpiri D.B. 1987. Improvement of zebu cattle productivity through breeding. *Proceedings of the Tanzania Society of Animal Production* 14:1–22.
- Mtumwa A. and Mwashia P.S. 1995. The strategy for sustainable dairy development in Tanzania. *Conference of the Tanzania Society of Animal Production* 11:36–72.
- NEI (Netherlands Economic Institute). 1999. Livestock sector review. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. Mission Report. Netherlands Economic Institute, Rotterdam, The Netherlands.
- Nzunda B. 1998a. The government privatisation policy of the dairy service and the services in perspective with the WFP TAN 2247 dairy Development Project. In: de Wolff et al. (eds), *Proceedings of the 2nd national dairy development conference, AICC, Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 44–49.
- Nzunda B. 1998b. Socio-economic aspects of smallholder dairy farmers for project WFP TAN 2247 dairy development. In: de Wolff et al. (eds), *Proceedings of the 2nd national dairy development conference, AICC, Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 109–122.
- Rugambwa V.K., de Wolf J., Stanslaus D. and Litalala E.M. 1995. Credit facilities and heifer supply within the Kagera Livestock Development Programme—Tanzania. In: Kurwijila et al. (eds), *Proceedings of the FAO workshop on market orientation of small scale milk producers and their organisations held at Morogoro, Tanzania, 20–24 March 1995*. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy, and Sokoine University of Agriculture, Morogoro, Tanzania. pp. 66–76.
- Rushalaza V.G., Kasonta J.S., Nkundu D.R. and Jumbe B.H. 1993. On-farm performance evaluation of the dual purpose Mpwapwa breed cattle in semi-arid central Tanzania. *Proceedings of the Tanzania Society of Animal Production* 20:62–70.
- Rutamu I. and Munster B.V. 1998. Institutional options in Tanga dairy sector: Costs, subsidy and equity issues. In: de Wolff et al. (eds), *Proceedings of the 2nd national dairy development conference held*

- at Arusha, Tanzania, 5–7 August 1998. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 30–37.
- Silas O., Masuruli B. and Stanslaus D. 1998. Privatisation of the dairy sector services: Its effect to the smallholder farmers in Kagera and the role of KALIDEP project. In: de Wolff et al. (eds), *Proceedings of the 2nd national dairy development conference held at Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 18–29.
- Sumberg J. 1996. *Livestock production in peri-urban areas of Africa: An analysis of Dar es Salaam, Mwanza and Shinyanga in Tanzania*. Research report submitted to the ODA Livestock Systems Research Programme. Overseas Development Group, University of East Anglia, Norwich, UK.
- Sumberg J.E. 1997. Policy, milk and the Dar es Salaam peri-urban zone: A new future or an old development theme? *Land Policy* 14(4):277–293.
- Tidbury G.E. 1954. The selection and breeding of zebu cattle in Zanzibar. *East African Agricultural Journal* 19:219.
- Verwer S. 1999. *Pulverising Pow(d)er: The impact of incoherent European policies on dairy farmers in Tanzania and Jamaica*. MSc thesis, Catholic University, Nijmegen, The Netherlands.
- Williams E. and Bunge V.A. 1952. Development of the zebu herd of Bukedi cattle at Serere, Uganda. *Imperial Journal of Experimental Agriculture* 20:142.
- de Wolff J. 1995. Privatisation and livestock owners organisations in Kagera. In: Kurwijila et al. (eds), *Proceedings of the FAO workshop on market orientation of small scale milk producers and their organisations held at Morogoro, Tanzania, 20–24 March 1995*. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy, and Sokoine University of Agriculture, Morogoro, Tanzania. pp. 94–103.
- Zylstra L. 1998. Milk marketing in Tanga region. In: de Wolff et al. (eds), *Proceedings of the 2nd national dairy development conference held at Arusha, Tanzania, 5–7 August 1998*. Ministry of Agriculture and Co-operatives, Dar es Salaam, Tanzania. pp. 87–93.

Theme 3: National dairy policies (including policies for related research, extension, development and training) for smallholder production and marketing

Plenary discussion

After the presentation of the three papers on national dairy policies, the plenary discussion addressed issues related to the role of governments in support of domestic dairy development. The debate was continued during the theme 3 group discussion (see below).

The issues and concerns raised in the plenary were:

1. Corruption and governance have an impact on the dairy industry: this has adversely affected the running of co-operatives in some countries.
2. The role of government in relation to policy issues has to be clearly defined. Policy options are more likely to have an impact than technological options.
3. Government policies tend to address objectives related to raising taxes rather than motivating the dairy sector *per se*.
4. High taxes on dairy products make them too expensive for many consumers. If tax revenues were ploughed back into agriculture rather than being used to contribute to other programmes like defence, the taxation would not be a problem.
5. Reducing taxes on imported milk products (e.g. in Tanzania under pressure from processing plants) has a negative effect on local producers.
6. Trade issues are particularly important where milk consumption is traditionally low.
7. For South-East Asia there is a need to balance discussion towards biological rather than policy issues. There is a need to address the issues of promotion of technology delivery, how to incorporate dairy into traditional systems while ensuring sustainability and how to use germplasm effectively.

These issues and the related topics that emerged from the presentations in themes 1 and 2 were subsequently discussed in small groups of the workshop participants. The outcomes for theme 3 are given below.

Group discussion

In common with the other groups, a set of questions guided the theme 3 discussions. The questions presented to the group addressed the role of governments in dairy development and specific issues related to breeding and marketing policies.

The questions were:

1. Are national breeding policies for smallholder dairy required? If so, what should be their basis, and how and by whom should they be implemented?
2. Crossbreeds play an increasingly important role in smallholder dairy; how best can this process be supported, given the observed failures and successes of breeding programmes in the South?
3. In many countries indigenous breeds managed in traditional systems predominate. What lessons are there from the approaches taken within the South to support the extraction of milk for the market?
4. Generally government interventions in dairy development (parastatal companies; management of co-operatives etc.) have not been productive. How can government better serve smallholder dairy development today?

The group combined their responses to questions 1 and 2 (breeding policy and programmes), addressed question 4 (the role of government) and discussed an additional topic, smallholder credit schemes.

The group responses were given below.

Breeding policies and crossbreeding programmes

Approaches

- a. Heifer-in-trust schemes
 - Success, but only outside government
 - Non-government organisations (NGO) and community approach successful
- b. Government farms
 - Inefficient
 - Unsure whether needed for keeping pure stock
- c. Artificial insemination (government, co-operative, NGO, private)
 - Must be needs-based, which differs regionally
- d. Bull stations/breed policy

For all approaches, must consider:

- Environment, feed/fodder supply
- Farmer capacity
- Ability to enforce and sustain
- Demand for outputs/milk
- Locally targeted

Private sector and the market must play a strong role.

There is a need to strengthen training for breeding management.

How can government better serve smallholder dairy development?

Do

- Provide services where there is market failure.

- Infrastructure (roads, water and electricity supplies).
- Protect industry.
- Enabling regulatory framework.
- Environment monitoring and regulation.
- Framework for institutional development.
- Enabling environment for competitive private sector.

Don't

- Get involved in markets.
- Make rules that cannot be enforced or that do not serve farmers/consumers.
- Get involved in production and distribution (drugs etc.).
- Over-tax dairy industry.
- Subsidise.
- Restrict land management.

Smallholder credit schemes

Successes

IRDP—cash for cows	– Subsidy
Micro-credit	– Grameen Bank of Bangladesh in cash
	– Others in kind

Appropriate schemes include:

- Appropriate periods, payment terms of low rates for poorer.
- Lines to output markets, co-operatives, services.
- Women link.
- Targeting to those in need.
- Credit conditions must fit (collateral etc.).

After the plenary presentation of the outcomes of the group discussion, these additional points were highlighted:

- Governments should not make rules that cannot be enforced.
- Sometimes governments do not know they are making the wrong rules and as a result, there are many redundant rules which lead to corruption.
- Research has shown that differential credit is a problem. Subsidised credit does not work because some can benefit more than others can. Other methods of helping smallholders should be devised.

Conclusions

As in theme 1, the presentations, the supporting papers and their discussion highlighted the commonality within the South of many of the policy, organisational and institutional

issues affecting the efficacy of dairy development's contribution to the livelihoods of producers and traders. Central to successful dairy development was the need to clearly define the complementary roles of government and the private sector, and to ensure that legislation and its interpretation were supportive of the efforts of poor dairy producers and traders to meet the requirements of consumers. The actions agreed by participants to achieve those aims are presented in the workshop recommendations.

Theme 4: Institutional structures to sustain smallholder dairy marketing

Small-scale processing and marketing in Bangladesh including reference to micro-credit facilities (good market access)—Milk Vita: A case study

G.C. Saha and S.A.M.A. Haque

Bangladesh Milk Producers' Co-operative Union Ltd., Dugdha Bhaban, 139-140 Tejgaon I/A, Dhaka - 1208, Bangladesh

Tel. 00-880-2-882 6888 or 881-3614. Fax 00-880-2-882 6880

E-mail:milkvita@bangla.net

Introduction

It might be amidst golden sunshine or in misty hazy fog, there might even be some silver splashes of rain, whatever the weather, for the last few years the rural people of some selected areas of Bangladesh have been experiencing a new scenario twice a day, at dawn and at dusk. At the very start of the day and at the end, they see many men, women and children, irrespective of age, caste and creed, passing down the road carrying buckets, pails or big drums, all filled with milk. Their destination is the milk collection society, where they supply milk in a systematically maintained procedure. In this way, they neither have to wait for a purchaser in a market place, nor do they have to bargain for a price. The society offers them a year-round guaranteed market with remunerative price on qualitative composition of the milk supplied.

Mr Abdus Samad, a 50-year-old milk producer from Reshombari Samity in Baghabarighat, the largest milk producing area in the country, disclosed that he has been supplying milk to the society for the last 20 years and through the society he has received a fair price. 'There is no scope to deceive farmers in relation to the price or weight of milk, which usually happens when milk is sold to middlemen', he opined. He stated further that 'Milk Vita has meticulously changed the socio-economic pattern of the area'. 'For example' he added 'in the past, people from the villages used to starve because of financial limitations. There was hardly any means for agricultural production, but now there are electricity supplies, freezers and television sets in many of the houses.' Mrs Sandhya Rani Bala, a housewife and a member of the Women Milk Producers' Co-operative Society of Tekerhat area opined that 'for the very poor people in this area, the milk society has opened up a new avenue of earning'. She explained that the cattle keeping practices are mostly maintained by women and as such, current economic returns have energised the women to intensify their dairy activities.

Raihan, a young schoolboy from the Rangpur area, explained that he helps his family in supplying milk to the society before going to school. He said that a few years previously, his father had to go to the market to sell milk; this wasted much of his father's valuable time

since in the very small township the market for milk was inadequate. He added that ‘the society has initiated a guaranteed market, which has in turn allowed my father to go to his work at the time he chooses’.

This is not just the story of Samad, Sandhya and Raihan, but of 60 thousand milk producing co-operative farmers in Bangladesh, an agro-based country where the majority of the population lives in rural areas. Ninety percent of the rural people are farmers and are associated directly or indirectly with agricultural production and the distribution process.

Population growth, flood, drought and the gradual decrease in size of land holding due to family division etc. have to some extent crippled the rural economy. As such, the majority of the rural people live below the poverty level. With the limited resources available, the poor, landless and marginal farmers of the country traditionally rely on agricultural practices for their livelihoods.

By way of mechanisation, the modern world has adopted technologically advanced methods in agricultural production. However, in Bangladesh, 90% of agro-activities are performed with cattle draft power. Besides, cattle are also used for cartage, oil production processes and crop harvesting, as well as their use as an excellent protein source in human food. In Bangladesh, there are 23.4 million head of cattle, 0.82 million buffalo, 33.5 million goats and 1.11 million sheep (Table 1).

Table 1. *Number of livestock (millions) in Bangladesh by species, 1991–98.*

Year	Cattle	Buffalo	Goats	Sheep
1991–92	22.83	0.73	25.40	0.95
1992–93	23.01	0.73	27.49	0.99
1993–94	23.12	0.78	29.74	1.04
1994–95	23.15	0.80	32.18	1.05
1995–96	23.19	0.80	33.02	1.07
1996–97	23.32	0.81	33.33	1.08
1997–98	23.40	0.82	33.50	1.11
Total increment from base year (%)	2.50	12.33	31.89	16.84

Source: Livestock Directorate (1998).

Milking cows constitute 45% of the cattle population and on average, each cow produces about 200–300 litres of milk in a lactation period of 180–240 days. Crossbred cattle are used in some selected ‘milk-pocket’ areas of the country; these cattle produce 800–1000 litres of milk/cow in a 210- to a 240-day lactation period.

The objective of the Fifth Five-Year Plan for the country, was to increase the income and thereby the purchasing power of poor people. The plan identified the landless and marginal farmers, and women traditionally engaged in the management of milking cows as its target beneficiaries for livestock development.

Currently, milk production is estimated at 1.62 million tonnes of which approximately 90% is from cows and the remaining 10% is from goats and buffalo. These figures do not include the quantity of milk consumed in Bangladesh, about 1.77 millions tonnes/year, which is received from domestic production and the liquid milk equivalent (LME) of imported milk powder.

Hard-earned foreign exchange is used to purchase imports of dairy products. In recent years, the annual cost of imports has ranged from 2000–2500 million taka (US\$ 1 = taka 57 at the 2001 exchange rate). The amount and value of milk powder imported into Bangladesh each year between 1990 and 2000 are shown in Table 2.

Table 2. Amount and value of milk powder imports in Bangladesh, 1990–2000.

Years	Tonnes ($\times 10^3$)	Taka ² ($\times 10^9$)
1990–91	60	4.3
1991–92	55	4.5
1992–93	45	3.5
1993–94	35	3.0
1994–95	25	2.5
1995–96	21	2.4
1996–97	20	2.3
1997–98	19	2.2
1998–99	18	2.2
1999–2000 ¹	18	2.0

1. Estimated values.

2. US\$ 1 = taka 57 in 2001.

Source: Milk Vita primary data (2000).

UN assistance to the project (1973–90)

Since inception, the Food and Agriculture Organization of the United Nations (FAO) maintained association with the project through Technical Assistance Programme projects in three phases. This support was continued up to 1990 under the financing of United Nations Development Programme (UNDP). These UNDP-funded projects contributed effectively to the materialisation of the initial objectives of the Co-operative Dairy Complex through overall assistance in engineering, technology, management, finance and accounts, and human resources development.

The philosophy of the AMUL (Anand Milk Union Ltd.) pattern of India was the basis for Milk Vita's organisational activities. However, unlike the situation in India, Milk Vita did not receive any sort of financial assistance in the form of grants from the Government of Bangladesh or any other international donor agencies for organised dairy development activities.

Nevertheless, through the repeated requests of the organisation and based on the recommendations of United Nations (UN) study reports (Hossain 1982; Juneja et al. 1984, Kurien 1987) a financial re-structuring was carried out in 1994. This involved waiver of the accumulated interest on investment cost of the project along with a 50–50-equity participation system by the government and the Bangladesh Milk Producers' Co-operative Union Ltd. (BMPCUL).

Background to the existing project

The story of dairying in Bangladesh starts long ago. In 1946, during the undivided Indo-Pak-Bangla period, National Nutrients Co. Ltd. (at the time an all-Indian organisation) planned to establish a small dairy plant with the capacity to handle 2000 litres of milk/day at Lahiri Mohanpur, Pabna (presently the Sirajganj District). Though the machinery for the plant was duly imported and the construction work also started, the plant was not completed because of the partition of India and Pakistan in 1947.

Thereafter, in 1952 a young businessman, Mr Mokhlesur, exchanged his Calcutta (India) property for all the assets of the original entrepreneur, which were at the time lying idle in the plant area. Within a couple of years he completed the plant under the name of Eastern Milk Products and managed to process and market milk, butter and ghee with a brand name of Milk Vita. In spite of the vigorous efforts of the new entrepreneur the business was not a financial success.

As a result, through government patronisation, a co-operative system was introduced in the management and operation of the plant. In 1965, the first milk producers' co-operative society was formed in the area within the apex organisation of the Eastern Milk Producers' Co-operative Union Ltd. Gradually about 100 village milk producers' co-operative societies were formed across the Lahiri Mohanpur plant area. However, the economic condition of the Lahiri Mohanpur Dairy at Pabna did not improve and therefore the apex milk union handed over its management to the Co-operative Marketing Society. At the same time, another private dairy organisation was facing financial problems. This organisation, named ASTO Dairy, was engaged in processing milk in bottles at Tejgaon, Dhaka. ASTO Dairy was also handed over to the Co-operative Marketing Society by the government. However, performance of the enterprises was never improved.

New venture

In 1972, soon after independence, the Government of the People's Republic of Bangladesh initiated two major surveys (1972; Nielsen 1973) for the rehabilitation of the two existing dairy plants, i.e. the Lahiri Mohanpur Dairy at Pabna and the ASTO Dairy at Dhaka. The surveys received financial support from the UNDP and the Danish International Development Agency (DANIDA). Based on the recommendations of the surveys, the government started a new development project, the Co-operative Dairy Complex, based on the AMUL Pattern, India (Latif 1973). New project areas were identified and the earlier two dairies, along with their assets and liabilities, were amalgamated into the project. The organisational name of the project, the Eastern Milk Producers' Co-operative Union Ltd., was maintained until 1977 when it was changed to the Bangladesh Milk Producers' Co-operative Union Ltd.

The government received taka 129.67 million in financial assistance (comprising local currency = 84.77 million and foreign currency = 44.90 million) for the project as a grant from the Danish Government. This money was loaned to the project implementing

organisation at an interest rate of 9% per annum for the local currency and at 3% per annum for the foreign currency components.

Adopting the philosophy of the AMUL Pattern, the initial project in Bangladesh envisaged, that under the fold of the primary milk producers' co-operative societies, milk would be purchased from individual poor, marginal and landless milk producing farmers at a fair price, twice a day, i.e. in the morning and evening.

The project assured a regular and guaranteed market for sale of milk by the farmers, transportation of collected milk to the rural plants for preliminary processing and further transportation of milk to the production plants for final processing into market milk and milk products. The previously used brand name, Milk Vita, was used for these products.

Basic infrastructure

Under the project, a co-operative infrastructure for the milk producer farmers was created in four milk-shed areas, viz. Tangail, Tekerhat, Baghabarighat (Sirajganj) and Manikganj, along with the construction of five new dairy plants at Dhaka, Tangail, Tekerhat, Baghabarighat and Manikganj.

Thereafter, in recent years, with BMPCUL's own resources six more chilling plants were added to the infrastructure at Sreenagar, Rangpur, Bhangura, Lakshmipur, Lahiri Mohanpur and Bhairab (Table 3).

Table 3. *Plants of the Co-operative Dairy Complex.*

Location	Distance from Dhaka (km)	Nature of plant	Handling capacity ($\times 10^3$ litres/day)	Date operation commenced
Mirpur (Dhaka)	10	Milk and milk products processing	110	May 1976
Tangail (Tangail)	100	Milk chilling	10	June 1975
Manikgonj (Manikgonj)	90	Milk chilling	10	September 1975
Takerhat (Madaripur)	190	Milk pasteurisation	25	December 1977
Baghabarighat (Sirajganj)	125	Milk products processing	162	November 1977
Srinagar (Munshigonj)	30	Milk chilling	5	October 1993
Rangpur (Rangpur)	300	Milk chilling	10	December 1995
Bhangura (Pabna)	155	Milk chilling	50	October 1999
Raipur (Luxmipur)	280	Milk chilling	10	Collection not yet started
Lahiri Mohanpur (Sirajganj)	155	Milk chilling	10	November 2000
Bhairab (Kishorgonj)	75	Milk chilling	5	Construction in process

The current trend of milk collection requires expansion of the plants, along with establishment of new chilling centres to facilitate proper handling of milk.

BMRE project of the Co-operative Dairy Complex

Soon after the establishment of the Co-operative Dairy Complex, a project entitled 'Consolidation of the Co-operative Dairy Complex' was initiated. At a cost 25.93 million taka, including 16.18 million taka in foreign exchange, the consolidation project was implemented between 1979 and 1982 (Chowdhury 1979). Thereafter, a project entitled 'Balancing, modernisation, rehabilitation and expansion of the Co-operative Dairy Complex' (BMRE) was implemented by the organisation at a total cost of 263.69 million taka, including a foreign exchange component of 200.18 million taka (Haque 1994). Out of the total cost of 263.69 million taka, the Government of Bangladesh's contribution amounted to 155.05 million taka and BMPCUL's share to 108.64 million taka. Furthermore, out of the total Government of Bangladesh (GoB) fund of 155.05 million taka, 139.52 million taka was loaned at an interest rate of 7.5%. The balance 15.53 million taka was offered as equity. The repayment schedule for the loan including interest will be active from 2005–06 as per agreement with the Ministry of Finance.

Implementation of the project has, so far, made enormous impact on the overall activities of the organisation. Through the replacement of old, torn and ineffective machinery parts and equipment, the project's factories have regained their full capacity, which had previously fallen to about 50% and had threatened to financially ruin the plants.

Objectives and activities

The objectives of the Co-operative Dairy Complex project were outlined as:

- Raising subsidiary income of poor, landless and marginal farmers living in relatively remote rural areas of the country by way of purchasing their produced milk at a reasonable price through a guaranteed market under the co-operative fold and
- Ensuring the regular supply of safe, hygienic and nutritious milk and milk products to city dwellers at a fair price.

Through its relentless activities in tune with the objectives, the organisation has succeeded in bringing over 60 thousand farmer members into the fold of 400 village milk producers' co-operative societies, which deliver milk to the organisation.

Thus, around 400 thousand farmer-family members are benefiting from this organisation. Moreover, the activities of Milk Vita have created about 4000 job opportunities in the rural areas with a further 750 jobs in the processing plants. The co-operative members receive a reasonable price, based on quality, for the milk produced by their cattle and have a guaranteed market for their milk. Furthermore, the project infrastructure could drive away the traditional *ghoses*, the middle men, who for centuries have exploited farmers by paying low prices and cheating when weighing the produce. The co-operative farmers are also given incentive bonuses/compensatory prices against their milk supply. In addition to the benefits considered above, the organisation also extends the following services to farmers:

- free of charge medicare (preventive and curative) for all cattle belonging to co-operative society members, with emergency services for 24 hours/day

- free of charge vaccination against common epidemic diseases
- free of charge artificial insemination services with deep-frozen semen for upgrading local breeds
- fodder extension consultancy services for high yields of raw milk
- arrangement of *bathan* land (pasture grazing land) from the government on soft terms for grazing cattle belonging to milk co-operative farmers
- distribution of primarily processed balanced concentrated cattle feed (crude form) on a 'no profit no loss' basis to the member farmers
- arrangement of interest-free loans to the member farmers for cattle purchase
- investment in rickshaw delivery vans for provision to marketing society members on a hire–purchase basis with easy instalments for repayment
- national and international training for better animal husbandry practices by the farmers
- imparting knowledge and information through routine display of audio-visual shows regarding improved cattle keeping practices and co-operative management and
- arrangement of national and international training/study tours for the member farmers in order to acquaint them with up-to-date knowledge of the dairy sectors and cattle rearing.

All these services are designed for the farmers' benefit and to achieve self-sufficiency in national milk production (Table 4). Participation of farmers in Milk Vita activities is maintaining a continuous increase in the government's poverty alleviation programme.

Table 4. *Services provided to the co-operative farmers.*

Year	Number of members ($\times 10^3$)	Number of treatments ($\times 10^3$)	Number of vaccinations ($\times 10^3$)	Number of artificial inseminations ($\times 10^3$)
1991–92	30.50	31.26	16.04	14.89
1992–93	34.82	32.66	19.87	21.62
1993–94	36.30	48.56	26.01	23.25
1994–95	42.50	60.68	28.65	16.25
1995–96	45.61	71.16	38.50	15.48
1996–97	47.99	92.57	35.61	22.52
1997–98	48.33	101.77	42.84	23.58
1998–99	49.36	98.03	60.27	28.58
1999–2000	59.62	68.75	60.03	37.42

Source: Milk Vita primary data (2000).

Micro-credit facilities of Milk Vita

Milk Vita plays a very important role in the economic development of milk producing farmers through purchase of milk from them and timely payment. However, the organisation does not have much investment in the micro-credit sector.

To facilitate purchase of cattle for poor member farmers, the organisation has invested about 10 million taka every year since 1994.

The loan is interest-free and through weekly deductions of repayment instalments from the milk bill, 100% recovery of loans is occurring without hindrance. The recovered loan is 'recycled' along with new additions to the fund; this increases the number of recipients each year. This credit facility has made a significant impact. The farmers are expecting a further increase in the yearly loan amount.

Performance of the co-operatives

Product marketing

The major products of Milk Vita include: pasteurised liquid milk, butter, ghee, ice-cream and ice lollies, full cream milk powder, skim milk powder, flavoured milk, sweet curd, cone ice cream, cream and rasa malai (sweetmeats). With the gradual expansion of the organisation, Milk Vita has been paying due attention to addition of new products to the product range and to the maintenance of overall quality and hygienic conditions.

Milk Vita's products are mainly marketed in major cities through established marketing networks of rickshaw van co-operative societies in addition to the formal retail agencies and wholesaling distributors. Milk Vita's marketing operation through the Milk Distributors' Rickshaw Van Co-operative Society is another unique example depicting success of co-operative systems in the country. In this process, the common rickshaw-pullers have formed societies, which have been supplied with locally fabricated insulated milk delivery vans on a hire-purchase basis.

It has been observed that most of the pullers have become the owners of the rickshaw vans paying off the dues through their income from the delivery of milk and milk products to retail shops. Presently, there are five milk distributors' rickshaw societies of which one society is established in a 10-storeyed house.

Financial status

The organisation emerged as a net profit earning enterprise after 18 years of operation (Table 5). This was mainly achieved as a result of some appropriate activities initiated by the government. One major activity was a reshuffle of the top management level of the organisation in 1991. This was based on the recommendations of a study by Khan et al. (1990), who was sponsored by the Co-operative Ministry of the Government. The reshuffle included the assignment of qualified and experienced professionals to manage the organisation, in place of the previous deputation of government officials.

Simultaneously, at the management committee level, democratically elected farmers' representatives took control of the organisation, in place of the government-nominated officials who previously comprised the majority of the committee. In the new pattern, out of a total of nine members, six members are elected from the primary milk producers' co-operative societies, including the chairperson and vice chairperson, and the other three members are nominated by the government.

Table 5. *Earnings from the marketing of the major dairy products.*

Year	Milk ($\times 10^6$ taka)	Butter ($\times 10^6$ taka)	Ghee ($\times 10^6$ taka)	Ice cream ($\times 10^6$ taka)
1991–92	90.49	38.72	2.69	4.05
1992–93	139.51	43.70	6.93	7.29
1993–94	209.72	42.15	11.08	10.16
1994–95	293.44	49.39	15.66	12.38
1995–96	349.03	55.18	22.22	7.84
1996–97	381.46	46.08	24.18	11.34
1997–98	504.93	63.72	20.11	19.83
1998–99	594.69	64.96	37.52	26.50
1999–2000	678.69	68.98	29.82	26.06

Source: Milk Vita primary data (2000).

These two major changes were the basis for revolutionary progress in the operation of the organisation and for the first time in the organisation's history; a net profit was earned in 1991–92. This achievement added tremendous momentum to the operation of the organisation, both at the rural and urban levels. In the rural sector, milk production has increased and at the urban level, marketing opportunities have expanded, effectively contributing additional earnings to the organisation. Since then, the organisation has made an annual net profit for the last nine consecutive years (Table 6).

Table 6. *Milk Vita profit/loss account.*

Years	Profit/loss (–) ($\times 10^6$ taka)
1990–91	–9.02
1991–92	8.05
1992–93	30.22
1993–94	43.50
1994–95	49.65
1995–96	31.14
1996–97	41.22
1997–98	47.73
1998–99	44.04
1999–2000	34.86

Source: Milk Vita primary data (2000).

With the achievement of a net profit, Milk Vita has started to pay off its Government of Bangladesh investment loan along with disbursement of dividends. BMPCUL's success in making a net profit is a shining example to the country's co-operative movement, following which farmers have been encouraged to intensify their cattle keeping practices and to use crossbred cattle to increase milk yields.

In recent years, milk producers have received a fair price for milk, as well as incentive bonuses/compensatory prices. This has added tremendously to the income of the farmers,

raising their living standards. Moreover, this has also encouraged the farmers to construct their own society office buildings along with making investments in social activities. Number of societies is being increased every year with the coverage of a larger number of villages in the milk-shed area, along with villages in new areas. Consequently, there has been a continuous increase in milk collection as shown in Table 7.

Table 7. Milk collection and price paid to the rural producers.

Year	Milk ($\times 10^6$ litres)	Average milk fat (%)	Average price/litre (Taka)	Taka ($\times 10^6$)
1990-91	6.22	4.4	10.77	66.99
1991-92	6.48	4.6	11.68	75.69
1992-93	10.24	5.0	11.57	118.51
1993-94	12.05	5.1	11.77	141.94
1994-95	17.45	4.4	13.49	235.57
1995-96	18.33	5.2	14.33	262.77
1996-97	19.46	5.0	15.67	305.04
1997-98	26.52	4.7	15.87	420.96
1998-99	29.47	4.4	15.85	467.33
1999-2000	33.99	4.7	16.10	547.56

Source: Milk Vita primary data (2000).

Impact of the project

BMPCUL, dedicated to the rural socio-economic development of Bangladesh, has emerged as a pioneering co-operative organisation in the country. Its area of operation in the rural sector is spread over six milk-shed areas (viz. Tangail, Mainikganj, Tekerhat, Srinagar, Rangpur and Baghabarighat) covering about 15 districts with 41 police stations and 925 villages.

Through planned activities for the last three decades, BMPCUL has made a significant impact on the national economy and has especially benefited farmers in the milk production sector. The direct beneficiaries of the project activities are:

- Sixty thousand poor, landless and marginal milk producing farmers, who were earlier exploited by the traditional middlemen (*ghoses*), but are presently receiving a fair price for their milk in a guaranteed market
- A large number of city dwellers receiving a continuous supply of pure, safe, hygienic and nutritious milk and milk products at a reasonable price
- More than 500 rickshaw pullers' co-operative members engaged in the distribution process receiving a daily cash income, thus maintaining their livelihoods along with the livelihoods of their dependent family members
- More than 4 thousand people who are employed in jobs, directly and indirectly created, in milk production and transportation, both in rural and urban areas

- Nearly 750 people engaged in the different plants and head office of the organisation who earn livelihoods for themselves and their families and
- 100 new co-operative farmers every year who receive interest-free credit for cattle purchase.

In fact, through the planned activities, Milk Vita is helping to fulfil the demands of the poverty alleviation programme by way of socio-economic development of the poor, marginal and landless milk producing co-operative farmers. Furthermore, it is also helping to increase supply of quality milk and milk products to city dwellers, thereby helping to meet the nutritional demand of the country.

As such, a recent case study by FAO (Dugdill and Bennett 2000) has rightfully acknowledged that:

Some 25 years on, Milk Vita is a flourishing concern. This can be seen not only from its encouraging financial performance and ambitious plans for growth, but from its recent imitators who have set up similar enterprises to collect, process and market 50 million litres of milk annually.

Future plans of BMPCUL

The annual nutritional demand for milk in Bangladesh is 10.5 millions tonnes (based on 125 million people with a per capita requirement of 240 g/day), which differs by 83.14% from the national consumption figure of 1.77 millions tonnes. Of the amount consumed, only 3.4% is obtained from processing plants and the rest (96.6%) is obtained from indigenous sources. There is, thus, enormous scope for Milk Vita to provide processed products to consumers. However, meeting the nutritional demand is a huge national task. Moreover, it is dependent on the purchasing capacity of the consumers. Therefore, any projection of milk and milk product demands for Bangladesh needs to be made through a vivid study.

The success of Milk Vita with further scope for expansion in the processing sector has encouraged the organisation to plan for the expansion of its activities with the addition of a number of processing facilities to increase product diversity. These expansion programmes include:

- Expansion of the current handling capacity of the existing plants
- Establishment of a number of chilling plants
- Acquisition of *bathan* land from the government for permanent use as grazing land by the milk producer farmers
- Establishment of an ultra-high temperature milk plant
- Establishment of a cattle feed plant
- Expansion of the chocolate crunch making plant into a confectionery plant
- Establishment of a water treatment plant and
- Replication of the project in other areas of the country, especially in the divisional head quarters, such as Chittagong, Khulna and Rajshahi.

These plans are expected to allow Milk Vita to contribute further to the development of the dairy sector in Bangladesh. An increasing supply of milk and milk products under the Milk Vita model will in turn result in further socio-economic progress.

Major constraints

Dairy policy matters

A dairy policy, including short- and long-term dairy development programmes along with other pertinent issues, was perceived to be necessary from the very inception of dairy development activities in Bangladesh. This matter was brought to the attention of the concerned authority on several occasions with no result. Due to the lack of such a policy, neither are the milk producers protected by way of having a fair price from the purchaser, nor is the import of milk powder into the country being rationalised. A dairy policy is required to promulgate specific taxation guidelines, standardisation of indigenous milk production, and cattle keeping and milk production rules along with all the relevant issues.

In 1984, the study report of Juneja Mission of FAO, sponsored by the attached UN project, included proposals for short- and long-term programmes of dairy development in Bangladesh along with the framing of dairy policy and formation of the Bangladesh Dairy Development Board. Unfortunately, there was no response to these proposals.

Again in 1987, in a study sponsored by the UNDP/FAO, Dr Verges Kurien (Chairperson of the National Dairy Development Board of India) advocated for dairy policy and for formation of a dairy board in due course, along with some other pragmatic and important dairy development plans and programmes. The report did not bring about significant development on the issue. However, in 1991–92, a one-page milk policy was incorporated into the livestock policies of Bangladesh but this did not take into account the need for dairy development in the country (Fisheries and Livestock Ministry 1992).

Financial limitation

Since inception, Milk Vita has not received any grants in the form of cash or commodity assistance from the government or from any national or international donor agency. This has limited the organisation's ability to carry out its development activities, since the size of net profit has not been enough to cater for its development plans.

Competition in the market

In addition to competition from imported milk powder, which is comparatively cheaper, Milk Vita presently also faces competition from domestic processing sources (Table 8).

Table 8. Comparison between the price of local liquid milk and imported milk powder.

Items	Price/kg of milk powder (taka)	Liquid milk equivalent (litres)	Price of liquid milk (taka/litre)	Price of liquid milk (US\$/litre) ¹
Imported milk powder	145.00	8.00	18.12	0.31
Local liquid milk	–	–	23.50	0.41

1. US\$ 1 = 57 taka at 2001 exchange rate.

Source: Milk Vita primary data (2000).

This situation, however, is being improved. Nevertheless, in recent years several new ventures in milk and milk product processing and marketing have been initiated in Bangladesh. Although most of the organisations produce very small quantities of milk (Table 9), the Bangladeshi market for processed milk is increasing thereby encouraging milk producers to make further investments.

Table 9. *Daily sales of processed liquid milk by manufacturer.*

Name of enterprise	Average milk sales ($\times 10^3$ litres/day)	Market share (%)
Milk Vita	110	62.16
Arong	38	21.48
Amomilk	4	2.26
Shelaida	4	2.26
Bikrampur	3	1.69
Savar Dairy	3	1.69
Aftab Dairy	5	2.82
Safa Dairy	3	1.69
Tulip Dairy	7	3.95
Total	177	100

Source: Milk Vita primary data (2000).

Constraints outlined

Through analysing its overall activities, Milk Vita outlines the following major constraints:

- lack of an appropriate and detailed dairy policy issues like product standardisation, taxation, infrastructure development, price, import rationalisation and product safety measures to aid the Bangladeshi dairy development process
- competition from imported milk powder and milk products along with domestic production
- non-congenial taxation policies and rate for its routine imported items
- shortage of quality cattle feed at a reasonable price
- lack of funds for the timely materialisation of its planned activities
- lack of support from the government, and national and international donor agencies in the undertaking of a massive dairy development programme for the country, similar to Operation Milk Flood I, II and III in India and
- absence of adequate training facilities and support to adopt new technologies.

Rapid removal of these constraints will aid the attainment of self-sufficiency by the country's milk production sector, within the shortest possible time.

Conclusions

Milk Vita has emerged as a successful co-operative endeavour in Bangladesh. It provides poor, landless and marginal milk producer farmers and women in the associated

communities with regular supplementary incomes. It has shown itself capable of strengthening its activities further to increase dairy production and thereby to contribute effectively to the national economy through a strong and viable organisation of small farmers. Therefore, Milk Vita recommends:

- framing, within a given period of time, of an appropriate dairy policy for the country depicting all pertinent issues
- formation of the Dairy Development Board of Bangladesh with professionals of the sector assuring adequate authority and autonomy (Rahman et al. 2000)
- acquisition of *bathan* land for farmers' cattle grazing
- government, national and international assistance in the milk sector both for plant establishment and infrastructural support
- replication of the Milk Vita model in other parts of Bangladesh through government initiatives and funding for the benefit of both farmers and consumers and
- channelling the government's poverty alleviation programmes through the infrastructure of Milk Vita in all the milk-shed areas of the country.

Implementation of these major issues by the relevant quarters will contribute effectively in increasing domestic agricultural production.

References

- Chowdhury A.M. 1979. *Consolidation of Co-operative Dairy Complex*, (Official Project Document). BMPCUL (Bangladesh Milk Producers' Co-operative Union Ltd.), Dhaka, Bangladesh, 48 pp.
- Dugdill B.T. and Bennett A. 2000. *Milk Vita in Bangladesh—A Case Study*. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. 13 pp.
- Fisheries and Livestock Ministry. 1992. *Livestock Development Policy*. Ministry of Livestock, Government of Bangladesh, Dhaka, Bangladesh. 12 pp.
- Haque S.A.M.A. 1994. *Balancing, modernisation, rehabilitation and expansion of the Co-operative Dairy Complex*. (Official Project Document). BMPCUL (Bangladesh Milk Producers' Co-operative Union Ltd.), Dhaka, Bangladesh. 55 pp.
- Hossain M. 1982. *Conversion of government loans and investments in Co-operative Dairy Complex into grant*. (An official proposal to the Government of Bangladesh), Bangladesh Milk Producers' Co-operative Union Ltd. (BMPCUL), Dhaka, Bangladesh. 17 pp.
- Juneja G.C., Gansey H.J.G. and Mertin R.G. 1984. *National Co-operative Dairy Development Plan*. FAO (Food and Agricultural Organization of the United Nations) AG: DP/BGD/79/033 Field Document-6, Co-operative Dairy Organization and Extension Programme (Phase-II), Dhaka, Bangladesh. 150 pp.
- Kastrup D. 1972. *Observation and recommendation regarding development of Lahirimohanpur Plant, Pabna District, Bangladesh*. DANIDA (Danish International Development Agency), Gulshan, Dhaka, Bangladesh. 18 pp.
- Khan M.H., Patwary M.S., Hossain M.S. and Nath S.R. 1990. *Milk for our people—A state of art study on the supply of milk throughout Bangladesh by the Co-operative Societies of Milk Producers*. (Official Project Document). Co-operative Directorate, Motijheel, Dhaka, Bangladesh. 100 pp.
- Kurien V. 1987. *A strategy for dairy development in Bangladesh*. NDDB (National Dairy Development Board), Anand, India. 24 pp.

- Latif S. 1973. *Co-operative dairy complex project*. (Official Project Document). BMPCUL (Bangladesh Milk Producers' Co-operative Union Ltd.), Dhaka, Bangladesh. 37 pp.
- Livestock Directorate. 1998. *Development and activities*. Livestock Directorate, Dhaka, Bangladesh. 136 pp.
- Nielsen P. 1973. *Survey report and recommendations–Lahirimohanpur and ASTO Dairies, Bangladesh*. DANIDA (Danish International Development Agency), Gulshan, Dhaka, Bangladesh. 38 pp.
- Rahman M., Ali M.M.I. and Haque S.A.M.A. 2000. *A policy study on the dairy development in Bangladesh*. (Official Project Document). Bureau of Sociological and Economic Research and Training. BAU (Bangladesh Agricultural University), Mymensingh, Bangladesh. 92 pp.

Institutional structure to sustain smallholder dairy marketing—The Amul model

B.M. Vyas

Managing Director, Gujarat Co-operative Milk Marketing Federation Limited
Anand 388001, India

The Amul story

In the 1940s, in the district of Kaira in the State of Gujarat, India, a unique experiment was conducted that became one of the most celebrated success stories of India. At that time, in Gujarat, milk was obtained from farmers by private milk contractors and by a private company, Polson's Dairy in Anand, the headquarters of the district. The company had a virtual stranglehold on the farmers, deciding the prices both of the procured as well as the sold milk. The company arranged to collect, chill and supply milk to the Bombay Milk Scheme, which supplied milk to the metropolis of Bombay, and to cities in Gujarat. Polson's Dairy also extracted dairy products such as cheese and butter. Polson's Dairy exploited its monopoly fully; the farmers were forced to accept very low prices for their products, and the decisions of the company regarding the quality and even the quantity of the milk supplied by the farmers were final.

In 1946, inspired by Sardar Vallabhbhai Patel, a local farmer, freedom fighter and social worker, named Tribhuvandas Patel, organised the farmers into co-operatives, which would procure milk from the farmers, process the milk and sell it in Bombay to customers including the Bombay Milk Scheme. Purely by chance, in 1949, a mechanical engineer named Verghese Kurien, who had just completed his studies in engineering in the USA, came to India and was posted by the Government of India to a job at the Dairy Research Institute at Anand. Settling down in Anand was hardly a part of his career plans; however, a meeting with Tribhuvandas Patel changed his life and changed India's dairy industry.

What Mr Patel requested of Dr Kurien was hardly to bring about such a revolution. All he wanted was help in solving various problems with bringing into working order some of the equipment just purchased by his co-operative, especially the chilling and pasteurising equipment. These items of equipment malfunctioned, leading to the rejection of large quantities of milk by the Bombay Milk Scheme.

Dr Kurien's involvement with the Kaira District Co-operative Milk Producers' Union Limited (KDCMPUL; the registered name of the co-operative) grew rapidly. Initially he merely provided technical assistance in repairing, maintaining and ordering new equipment but subsequently he became involved with the larger sociological issues involved in organising the farmers into co-operatives and running these co-operatives effectively. He observed the exploitation of farmers by the private milk contractors and Polson's Dairy, and noted how the co-operatives could transform the lives of the members.

The most important feature of these co-operatives is that they are run purely as farmers' co-operatives, with all the major decisions being taken by the farmers themselves. The co-operatives are not 'run' by a separate bureaucracy with vested interests of its own; the farmers are truly in charge of their own decisions. Any farmer can become a member by committing to supply a certain quantity of milk for a certain number of days in a year and shall continue to be a member only if he keeps up this commitment. Each day, the farmers (or actually, in most cases, their wives and daughters) bring their milk to the village collection centres where quantity of milk is checked in full view of all and quality (milk fat content) is checked using a simple device, again in full view of all. The farmers are paid in the evening for the milk they supplied in the morning, and in the morning for the evening's milk. This prompt settlement in cash is a great attraction to the farmers who are usually cash starved. Thanks to the above system, there are no disputes regarding quantity or quality of the milk supplied by each farmer.

It was soon realised that it was not enough to merely act as the collection and selling agents for the farmers. A variety of support services were also required to enable the farmers continue selling milk of adequate quality and to avoid disasters such as the death of their cattle (for a family owning just one or two cattle and depending on its/their milk for their income, death of a cow could indeed be a disaster). The farmers were progressively given new services such as veterinary care for their cattle, supply of good quality cattle feed, education on better feeding of cattle and facilities for artificial insemination of their cattle. All these were strictly on payment basis; none of the services were free.

This experiment of organising farmers into co-operatives was one of the most successful interventions in India. A very loyal clientele was built up who experienced prosperity on a scale they could not have dreamt of 10 years earlier. With good prices paid for their milk, raising milch cattle could become a good supplementary source of revenue to many households. The co-operatives were expanded to cover more and more areas of Gujarat and in each area, a network of local village level co-operatives and district level co-operatives were formed on a pattern similar to that at Anand (the so called Anand Pattern). In 1955, KDCMPUL changed its name to Anand Milk Union Limited, which lent itself to a catchy abbreviation, Amul, which meant priceless in Sanskrit. The word was also easy to pronounce, easy to remember and carried a wholly positive connotation. It became the flagship brand name for the entire dairy products made by this union.

In 1954, Amul built a plant to convert surplus milk produced in the cold seasons into milk powder and butter. In 1958, a plant to manufacture cheese and one to produce baby food were added—for the first time in the world, these products were made from buffalo milk. Subsequent years saw the addition of more plants to produce different products. Starting from a daily procurement of 250 litres in 1946, Amul had become a milk giant with a large procurement base and a product mix that had evolved by challenging the conventional technology.

On his visit to Anand in 1965, the then Prime Minister of India, Lal Bahadur Shastri, was impressed by what he saw—a system that procured, processed and delivered high quality milk to distant markets cost efficiently. Shastri could also see the difference that the income from milk had made to the standard of living of farmers in the area. What impressed him the most was that Amul had done all this without government assistance, in marked

contrast to a number of government sponsored dairy programmes that were doing poorly in terms of procuring and marketing good quality milk and boosting farmers' incomes. Shastri asked Dr Kurien to replicate Anand's success all over India.

A pattern similar to the Anand Pattern was to be built in other states of India. This was carried out under a programme launched by the Government of India, entitled 'Operation Flood'. The operation was co-ordinated by the National Dairy Development Board (NDDB), a body formed by the Government of India with this specific objective.

Backdrop to Operation Flood

India has traditionally been known as the land of 'milk and honey'. Dairying was an important contributor to the village economy in ancient India. Much folklore has been woven around the people involved in this profession. Gradually, however, dairying lost its charm in the face of competition from many other professions that surfaced after the effects of the industrial revolution started to show in India.

With increased industrialisation, urban centres started to appear in all corners of the country. With their very high population densities, these cities made very good markets for milk and milk products. These urban pockets, however, proved to be the biggest enemies to the sacred and useful profession of dairying. Very few individuals practised dairying, since keeping and maintaining cattle needed large spaces and these were not available in densely populated cities.

The liquid milk schemes did not have the capacity to serve their cities' entire needs. Also, as modern dairies, they could not indulge in dilution of the milk. For some time—when imported milk powder was cheap and the government had foreign exchange to spare—they used imported milk powder to subsidise their operations and expand somewhat their meagre supplies of milk. Few milk schemes, however, covered more than one-third of their city's needs. Moreover, when they depressed prices by the use of imported powder, they discouraged local milk production. More recently, most liquid milk schemes have increased their prices, only to have the private vendors match this price increase so that, aided by dilution, they could continue to outbid the milk scheme for rural milk in the city's milk-shed areas.

The ultimate loser was the common man and his infants. In the city, he saw milk getting more dilute and more expensive each year, whilst the city got filthier and unhealthier to live in. In the countryside, the ordinary milk producer saw his best milch animals going to the city for premature slaughter, while the milk produced by his remaining, lower-yielding milch animals still brought him only a small share of the rupees which the city consumers paid for that milk.

Operation Flood

This was the anti-dairy development cycle that Operation Flood sought to reverse by the use of a glut of donated milk products from abroad. These surpluses were used in two ways to

speed up Indian dairy development. First, the donated milk products were used to reconstitute milk, and therefore provide the major cities' liquid milk schemes with enough milk to obtain a commanding share of their markets. Secondly, the funds realised from reconstitution and sale of donated products were used to resettle city-kept milch animals and permit their progeny to multiply, to increase organised milk production, procurement and processing, and to stabilise the major liquid milk schemes' position in their markets. The objectives of Operation Flood can be summarised as follows:

1. To enable each city's liquid milk scheme to restructure and capture a commanding share of its market
2. To identify and satisfy the needs of milk consumers and producers, so that consumers' preferences can be fulfilled economically and producers can obtain a larger share of the rupees paid by consumers for their milk
3. To facilitate long-term productive investment in dairying and cattle development and
4. To ensure a sufficient supply of personnel to handle each facet of the project.

The three phases of Operation Flood succeeded in fulfilling a major part of their objectives. Today, there are 22 state federations in India, with 170 district level unions, more than 76 thousand village level co-operative societies and 11 million milk producer members in the different states. These co-operatives collect an average of 15 million litres of milk each day. Fresh liquid milk, packed and branded, is marketed in over 1000 cities and towns in India by these co-operatives; annual sales turnover exceeds 80 billion Indian rupees (Rs) (US\$ 1 = Rs 45.5). The Anand Pattern has been tested out of Anand and out of Gujarat; it has been found to be a robust structure, wherever it has not been tampered with.

The NDDDB invested about Rs 20 billion in the Operation Flood programme over two decades (1971–94). During this period, milk production in India increased by 40 million tonnes from 20 million tonnes in 1970 to 60 million tonnes in the 1990s. No other development project in the world has yielded such a huge incremental return, Rs 400 billion against a total investment of Rs 20 billion. These concerted efforts in dairy development have made India the largest producer of milk in the world.

Structure of the Anand Pattern

The basic unit in the Anand Pattern is the village milk producers' co-operative—a voluntary association of milk producers in a village who wish to market their milk collectively. All of the village milk producers' co-operatives (primaries) in a district are members of their district co-operative milk producers' union.

Every milk producer can become a member of the co-operative society. At a general meeting of members, representatives are selected to form a managing committee, which frames the policies of the society to govern the day-to-day affairs relating to milk. Milk collection, the testing for milk fat content, sale of cattle feed etc. is handled by paid employees from the same village. Each society also provides artificial insemination (AI) services and veterinary first aid (VFA). Thus, these primaries also generate local employment in the rural community.

Each producer's milk is tested for fat percentage (many also measure solids-not-fat) and is paid for, on the basis of the quality of the milk. Usually, the morning milk is paid for in the evening and the evening milk is paid for the next morning.

The primary milk producers' societies are affiliated to a district union, which owns and operates a feeder/balancing dairy cattle feed plant and facilities for production of semen and its distribution. The union also operates a network of veterinary services to provide routine and emergency services for animal health care.

The chairpersons of village societies elect the board of directors of the union, which frames the policies for the day-to-day management of the union's centralised facilities for milk collection, processing and marketing and also technical inputs. Each union is managed professionally by a managing director, who reports to the elected chairman and a board of directors. The dairy, owned by a union, usually has a milk processing plant to convert seasonal surpluses of liquid milk into milk powder and other conserved products. With the help of the dairy plant, the union is able to ensure that the milk producers get 80–90% of the lean season price even in the flush season. The farmers are, therefore, able to get a good price for the bulk of the milk that is produced in the flush season. This has enabled the farmers to get 20–40% higher prices than they would have if they had not been a part of the co-operative system. Before the co-operatives, the middlemen usually paid only 60–70% of the lean season price in the flush season.

The bulk of out-of-pocket expenditure on milk production was for the purchase of cattle feed ingredients, such as oilseed cakes, cottonseed etc. The cattle feed plant owned and operated by the co-operative is able to provide nutritionally balanced cattle feed at prices 40% lower than the prices of traditional feeds. The village milk producers' co-operative societies (primaries) market this cattle feed.

Milk producers are able to substantially increase their returns from milk production because of better returns for their milk and lower feeding costs. The milk collected from the village is usually sent to the co-operative dairy using trucks hired by the co-operative union. Each co-operative dairy tries to market the bulk of its milk as liquid milk and converts surplus milk into products with a longer shelf life. Professional managers employed by the co-operative ensure that they get the best returns for their produce. The profits made by the dairy are redistributed to the milk producers as a subsidiary payment. Many societies are able to pay substantial amounts as bonuses to their milk producers, based on the proportion of business contributed to the co-operatives.

Management of dairy co-operatives

In Anand Pattern Co-operatives, while the producers themselves determine the policies, the opportunity is provided to the professionals to implement the policies as well as to manage the operations. Even at the village level (primaries), the nine-member management committee determines how best they should function within the prescribed framework, how best its members' interests can be protected and how best the societies can function as viable business units. However, at this stage, the managing committee of nine members does the routine work of management itself. For carrying out day-to-day work, necessary

manpower from the same village is trained and deployed. These persons are the employees of the respective village co-operatives; the nine-member committee takes decisions about their continuance of service or dismissal.

At the district union level, the board includes the chairpersons from only the affiliated milk co-operative societies, which are qualified to send their representatives (of the 17 members on the board, 12 are chairpersons of the affiliated primaries). One of them is elected as the chairperson of the board. While this board formulates policies at the district level, the qualified professionals headed by a managing director carry out the day-to-day management.

The primary societies in a particular milk shed federate and form a dairy co-operative milk producers union. As more district unions were organised in Gujarat State, it was felt necessary to organise a federal body at the state level. This federal body exists to co-ordinate the overall activities of the district unions, to provide a platform for sharing common benefits, to avoid competition between the district unions and to ensure rigid quality control for the production of top quality milk products. The state federation provides the direct link between the district milk co-operatives and the National Milk Grid (NMG). The NMG co-ordinates, at the national level, the supply of milk from the surplus-producing areas to the potential urban consumer markets. It helps to moderate the seasonal and regional imbalance between demand and supply of milk.

The National Co-operative Dairy Federation of India (NCDFI), a federal society, was formally established in 1970 as a national level apex organisation. Now it has been restructured through affiliation with its member apex co-operatives at the state levels. The NCDFI, thus, provides the basic institutional framework for better co-ordination, monitoring and guidance, and gives adequate direction to the state federations to ensure a stronger co-operative milk marketing system in the country. The NCDFI is the apex body of all the state dairy federations in the country, which have been entrusted with the management of the NMG activities. To facilitate operations of the NMG, four regional programming committees have been established by the NCDFI, which meet periodically in their respective regions. These committees provide a platform for the participating federations to transact business and share each other's experiences in the management of milk procurement, handling and marketing. The activities of the four programming committees are co-ordinated by a central programming committee.

Even at the profit-sharing level, the distribution is made in proportion to the volume of business contributed by each member; therefore, bonuses etc. are determined from the value of the commodity supplied by the members. This in turn ensures that while the co-operative does business, it also makes its members quality conscious.

The Anand Pattern co-operatives have also taken into consideration the capabilities of each tier, vis-à-vis the systems they should own. These systems include the processing, marketing, advertisement and input organisation etc. along with the large capital-based operations that are owned either by the district union (the second tier) or the state federation (third tier). The primary co-operatives, on the other hand, act as procurement units for the individual members and as retail outlets for the union/federation to ensure that inputs reach the individual members at the village level on time.

This two-way constant communication, between the primary unit at the village level and the district/state level bodies, has guarded the Anand Pattern co-operatives against the

dangers faced by large co-operatives which tend to drift away from individuals, as they grow larger. Thus, the Anand Pattern co-operatives ensure that the services required, to market the produce or to improve production, reach their members.

Today in Gujarat, under the Anand Pattern system, there are 11 thousand village level co-operatives with a total membership of 2.1 million milk producers affiliated to 12 district level unions. These unions federate into a state level apex marketing organisation known as the Gujarat Co-operative Milk Marketing Federation (GCMMF). The GCMMF was established in 1973 with the objective of providing the milk producers of Gujarat with their own marketing and distribution network. This aimed to give them access to the most important link in the system—the customer. The farmers had realised that marketing was the key to the success of the Anand Pattern and to their success when they had control over the marketing system. The results are evident. Today, GCMMF is India's largest food products marketing organisation with an annual sales turnover exceeding Rs 22 billion (about US\$ 483.5 million). The Amul brand is among the most popular brands in the country.

Objectives and business philosophy of GCMMF

The main stakeholder of GCMMF is the farmer member for whose welfare GCMMF exists. GCMMF states that its main objective is the 'carrying out of activities for the economic development of agriculturists by efficiently organising marketing of milk and dairy produce, veterinary medicines, vaccines and other animal health products, agricultural produce in raw and/or processed form and other allied produce'.

GCMMF aims to market the dairy and agricultural products of co-operatives through:

- common branding
- centralised marketing
- centralised quality control
- centralised purchases and
- efficient pooling of milk.

GCMMF has declared that its business philosophy is as follows:

- to serve the interests of milk producers and
- to provide quality products that offer the best value to consumers for money spent.

The biggest strength of GCMMF is the trust that it has created in the minds of its consumers regarding the quality of its products. Amul stands for guaranteed purity of whatever products it produces. None of its products are adulterated. In India, where such trust is hard to come by, this could provide a central anchor for GCMMF's future business plans.

Organisational structure of GCMMF

GCMMF is a lean organisation, a strategy that is believed to provide it with a cost advantage. At its headquarters in Anand, four general managers (GMs) and four assistant general managers (AGMs) assist the managing director (MD). The four AGMs look after the

functions of marketing, systems, co-operative services and technical projects, respectively. The four GMs are in charge of marketing (dairy products), human resources development and marketing (Dhara and new business), finance and quality assurance, respectively.

The whole country is divided into five zones, each headed by a zonal manager responsible for the sales of all products within his zone. These managers report to the MD but functionally each also reports to the various AGMs/GMs at the headquarters. There are 50 sales offices spread across the country (of which only two are in Gujarat); a sales manager heads each office and is assisted by sales officers and field salespersons. The entire country has been represented in this structure. GCMMF has one overseas office in Dubai.

GCMMF's growth chart

Even at the time of its formation, GCMMF had three major products in its portfolio: liquid milk, butter and milk powder. Gradually, many new products were added to its range, largely milk derivatives. In liquid milk alone, it sells full cream milk, semi-skim milk and skim milk; these products are labelled and sold in readily identifiable pouches. By reducing the fat content of milk, not only can GCMMF sell the fat derivatives (such as cream and butter) but also the resultant skimmed milks can be made available at cheaper prices, so that poorer people can also afford to drink milk. In the 1970s, Amul introduced its processed cheddar cheese, a malt based beverage called Nutramul and chocolates. In 1983, cheese spread was launched by GCMMF. In the same year, it also entered the sweet product market (milk based) through the introduction of Amul shrikhand, a sweetish sour item produced from milk and curd (a form of yoghurt). Amulya, a dairy whitener was introduced and it soon became the market leader. In the 1990s, Amul introduced a variety of new products: a condensed milk called Amul Mithaimate; Amul Lite, a low-fat, low cholesterol spread; and Amul ice cream. After 1996, a still greater variety of products was introduced: pizza (mozzarella) cheese, cheese slices, malai paneer (a form of cottage cheese) and gulab jamun (a primer for processing by deep-frying to make a sweet called gulab jamun).

In 1996, Amul launched its Amul brand ice cream. India's ice cream market was estimated to be worth around Rs 8 billion in the year 2000 (about US\$ 175.8 million). GCMMF launched its ice creams in fourteen flavours in the city of Mumbai (Bombay) and Gujarat State. At launch, prices were about 30% lower than the prevailing prices and GCMMF also emphasised that the ice cream did not contain any gelatin. In less than a year, Amul ice cream commanded a market share of about 55% in Gujarat and 30% in Mumbai; by the year 2000, its share in India as a whole had reached 30%. In 1997, Amul achieved further success when it managed to get various co-operatives in the country, trying to launch their own ice cream brands, to sell all their ice creams under the Amul brand name. This enabled GCMMF to benefit from the capacity of many of the more than 170 co-operative unions in the country, with a milk procurement of more than 15 million litres/day, located close to the markets.

By the year 2000, its product range was truly expansive: three varieties of milk, flavoured milk, buttermilk, four varieties of milk powder, two varieties of butter, five varieties of cheese, two varieties of ghee (clarified butter), chocolates, chocolate drinks, sweets, ice cream, edible oils and fruit and vegetable based products. The latest additions to the range

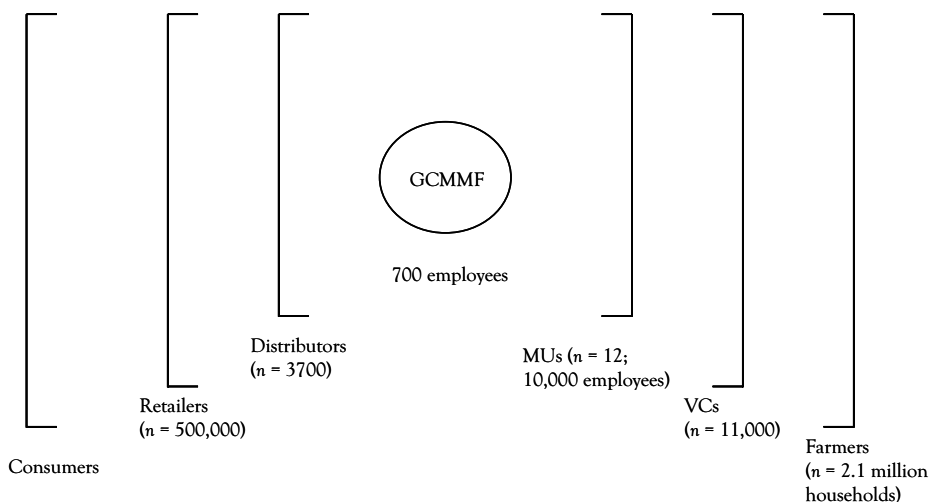
of brands marketed by GCMMF are Masti Dahi (curd) and Amul Taaza (long-life milk). In the year 1999–2000, GCMMF had a total turnover of Rs 22.2 billion (about US\$ 550 million).

Change management at GCMMF

In 1991, the previously protected Indian economy first became exposed to the ‘winds of liberalisation’ when the government opened up the sector to global competition. The Government of India passed the Milk and Milk Products Order (MMPO) in 1992, whereby the milk collection sheds allotted to different co-operative unions were protected from the entry of new enterprises, which otherwise would have competed for the procurement of milk from the milk sheds. With the liberalised import regime and reduced import duties on most food and dairy products, it became clear that it was necessary to deal with the upcoming competition.

The co-operatives needed to change in speed and direction. The existing set up of governance needed a complete shift of paradigm. The impending challenge necessitated the organisations to anticipate change and be prepared for it by bringing about change in the way they worked and thought. The competition would force all to be customer focused and to plan for innovation and continuous improvements in the quality of all aspects—products, service, processes and systems.

It was at about this time in GCMMF that ‘change management’ was considered to bring about improvements in the existing management systems with quality as the cutting edge (Figure 1). It was also decided that all the links on the production and marketing side had to be involved in the process of change management, to make it a real and a complete success (Table 1).



GCMMF = Gujarat Co-operative Milk Marketing Federation; MUs = Member Unions; VCs = Village Co-operatives.

Figure 1. *Scope of change management.*

Table 1. *Summary of change management initiatives implemented for the various links of the chain.*

Distributor	GCMMF	Member unions	Village co-operatives
• Vision mission workshop • Amul Yatra • Amul quality circle	• Vision 2005 • Introspection on values • Identification of strategic thrust areas • Strategy deployment (Hoshin Kanri) Kaizen movement • Housekeeping • Small group activity (SGA) • International training programmes on change management • Transformational leadership • Internal consultant development • ISO (International Organization for Standardization) certification	• Vision mission workshop • Identification of strategic thrust areas • Strategy deployment • Kaizen • Housekeeping • Small group activities • ISO and HACCP (hazard analysis critical control point) certification • International training programme on change management • Internal consultant development	• Housekeeping • Village self leadership development programme • Women's leadership development programme • ISO certification

The two areas, which need special attention, are that of 'customer focus' and 'quality orientation'. These areas will be the foundation stones for providing a competitive edge to small-scale producers' co-operative organisations. With the competition intensifying and the consumer becoming more demanding than ever before, it is imperative that such organisations remain very close to the consumer; the consumer needs to be central to all decisions. Furthermore, with the increasing level of consumer education and the potential issue of non-tariff barriers looming large over prospective exports to other countries, organisations must keep up with the pace of technology, upgrading to attain higher levels of quality delivery.

To cope with the impending changes and to outperform the competition, the institutional structure created so far, now needs to abide by a new set of paradigms, acting sooner and faster, with focus on customer and quality. Only this can ensure stable and consistent returns to the milk producers who depend on these economic activities as tools for their social development.

Points for discussion

1. Would the Anand model find universal acceptance?
2. What are the alternative structures/options for smallholder dairy organisations?
3. What are the innovations that the Anand model can embrace to be more effective?

Small-scale milk marketing and processing in Ethiopia

Tsehay Redda

Ministry of Agriculture, P.O. Box 3431, Addis Ababa, Ethiopia

Introduction

Agriculture is the basis of Ethiopia's economy and is the most important economic sector in terms of generation of foreign currency. The current Ethiopian agricultural policy, which advocates self-sufficiency in food, has led the Ministry of Agriculture to spearhead the intensification of activities in support of agricultural development. One concern is the overall improvement and development of the livestock sector.

The contribution of livestock and livestock products to the agricultural economy is significant, accounting for 40% (Winrock International 1992) excluding the value of draft power, fuel, manure and transportation. They are a source of income, which can be used by rural populations to purchase basic needs and agricultural inputs. Livestock comes second to coffee in foreign exchange earnings. Its contribution can equally well be expressed at household level by its role in enhancing income, food security and social status.

Ethiopia has the largest livestock population in Africa estimated at about 35 million tropical livestock units. However, milk production is very low and is estimated at about 1.2 million tonnes per annum, increasing at a rate of 1.2% for milk produced from indigenous stock and 3.5% for milk produced from improved stock (Annex I). Conversely, the human population of Ethiopia is estimated at about 62 million, increasing at a rate of 3% per annum (CSA 1996; values projected for the year 2000). To this effect the per caput consumption of milk is 19 kg/year (Annex I); this value is lower than African and world per capita averages, which are 27 kg/year and 100 kg/year (Saxena et al. 1997), respectively. Accordingly, about 495 thousand tonnes and 5 million tonnes of milk is required annually to feed the Ethiopian population as per the African and world averages, respectively. This indicates the probability of a wide gap between the current supply of and the demand for milk in Ethiopia.

During the past two decades, to offset the shortfall in milk production, the import dependency of Ethiopia for milk and milk products has increased. For example, between 1977 and 1989, level of dependency increased from 4.1 to 12.8% as a result of food aid, a World Food Programme (WFP) milk powder, and a level of dairy production development that has lagged behind the demand. These factors have eroded the contribution of milk production to food security (Staal and Shapiro 1996). Furthermore, imported milk powder, equivalent to about 11,213 litres of liquid milk per day, has a market share of 23% (Belachew et al. 1994) in Addis Ababa. Since 1989, importation of WFP milk powder has

decreased and nowadays it is not imported; however, importation of other processed dairy products, which are marketed in supermarkets, is increasing.

The highlands of Ethiopia, which are very well suited for dairying, represent almost 50% (Winrock International 1992) of the total highland regions of sub-Saharan Africa. A country endowed with such enormous livestock resources and climatic situations conducive to livestock production should not be allowed to continue importation of dairy products. Self-sufficiency in dairy products should be encouraged to optimise the use of available resources to fill the gap between demand and supply.

To bridge this gap, it is necessary to design appropriate and sustainable dairy development strategies based on 'felt' needs of smallholder farmers. Smallholder farmers represent about 85% of the population and are responsible for 98% of total milk production (MoA 1998). Milk is a cash crop and dairy farming is an investment option for smallholder farmers.

Rapidly increasing population size with expanding rural population and growing urban population will create even greater markets and growth of demand for dairy products. This increase in demand for milk and dairy products affords greater opportunities and potentials for milk producers and for development of the milk production and processing industry. However, lack of awareness in the field of dairy technology, poor milk marketing and inadequate processing structures/systems continue to be major constraints. Milk marketing and processing is compulsory in dairy industry development and has been found to be a key factor to success.

Cognisant of these facts, the Ministry of Agriculture has formulated a strategy to improve milk marketing and processing in the villages. The strategy is to develop an environment for smallholder dairy farmers, which enables farmers to immediately respond to the market demand. That is, at village level, to develop the market for the existing sellable surplus, regardless of the quantity, so that the producers will be stimulated gradually to satisfy the market. It is believed that, development of a marketing structure will create the incentive to improve production.

This report examines small-scale milk collection, processing and marketing operations of an introduced output-oriented model for dairy development. Moreover, it outlines a story, which helped the initiative to improve rural milk marketing and processing systems in Ethiopia. The report is based entirely on field experiences gained during implementation of the government's dairy development strategy. The results are expected to furnish essential information and experiences for future dairy development efforts under similar situations in Ethiopia and in other East African countries.

Milk production system in Ethiopia

The milk production system in Ethiopia, in respect to marketing situations, can be broadly categorised into the following three systems:

1. The urban milk production system (the city, Addis Ababa, and regional towns).
2. The peri-urban milk production system (proximity to Addis Ababa and regional towns).

3. The rural milk production system (farmers in the villages).

In all the systems, the liquid milk and milk products markets are dominated by informal marketing systems.

Urban milk production

One of the largest sources of milk in Addis Ababa/regional towns is that from intra-urban milk producers. A total of 5167 small- medium- and large-scale dairy farmers exist in and around Addis Ababa (Region 14 Addis Ababa Agricultural Bureau survey report quoted by Azage and Alemu 1998). Total milk production from these dairy farmers amounts to 34.649 million litres/annum. Of this total, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed, mainly into butter and *ayib* (Azage and Alemu 1998). The producers deliver milk to consumers or consumers may collect it at the producer's gate. Studies indicate that in terms of volume 71% of intra-urban producers sell milk directly to consumers (Belachew et al. 1994). Payment to producers is generally on a monthly basis. This house-to-house milk marketing system is traditional, but it poses risks to consumers. The milk being marketed under this system is of questionable quality, it is not pasteurised and there is a possibility of adulteration. Although, some farmers produce good quality milk, hygienic quality and composition of most milk marketed in such production systems is poor. Moreover, price is high even when quality of milk is low. No standards, quality control mechanisms or dairy policy exist to safeguard consumers. Regional towns face the same situation and there are limited data relating to existing milk marketing systems in regional towns.

Peri-urban milk production

This includes smallholder and commercial dairy farmers working in the proximity of the city of Addis Ababa and other regional towns. Most of the improved dairy stock in Ethiopia is used for this type of production. Until recently, formalised milk marketing of standardised and pasteurised milk to the city was monopolised by the Dairy Development Enterprise (DDE). However, contribution to the total domestic milk supply for Addis Ababa remained at only 14% (Belachew et al. 1994). Currently, smallholder farmers' milk marketing units, the DDE, Mama agro-industry and private dairy farmers in and around Addis Ababa are supplying dairy products to the city market. There is a lack of information to explain the milk-marketing situation in other regions. Nowadays, many investors are interested in participating in the development of the dairy industry through the peri-urban milk production system.

Rural milk production

This subsistence type of production is the predominant milk production system accounting for over 97% of total national milk production (Staal and Shapiro 1996). In this system, there are pocket areas where crossbred dairy stock are distributed, but largely the system is

based on low producing indigenous breeds of zebu cattle. Livestock are kept under traditional management conditions and generally obtain most of their feed from native vegetation, aftermath grazing and crop residues.

In these areas, milk is processed on farm using traditional technologies to produce products like butter, ghee, *ayib* and sour milk, which can be sold. Such techniques have long been used for processing the supply of milk; they seem to provide the only option for conversion of milk into stable marketable products. The bulk of butter and *ayib* in the highlands is channelled through the informal market. Farmers, mainly women, take the products on a weekly or monthly basis to market places or sell at the farm gate to brokers who take the commodities to local or, more distant markets where there is a demand.

In pastoral areas, diet is based on fresh/sour milk and leftover milk is poorly utilised. The herd size per household is large and hence there is a greater surplus of milk/person than in the highlands. Market access in this production system is a critical factor.

Smallholder Dairy Development Project

Smallholder farmers in Ethiopia represent 85% of the country's population. Recognising this indisputable fact and the role that smallholder farmers could play in the development of the dairy industry in Ethiopia, the government is being assisted by bilateral donor agencies. This is evidenced by the realisation of pilot projects that included the promotion of village level small-scale dairy processing units in their programmes. The Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP) assisted such projects that ran from 1990–94, and the Finland Government funded the Smallholder Dairy Development Project (SDDP) implemented from 1995–2000.

During this time, village level milk marketing units were established (2 by FAO/TCP (Technical Cooperation Programme) and WFP pilot projects and 30 by SDDP) that are presently owned by farmers milk marketing groups/co-operatives; all are successful and are operating profitably. Success of these units is founded on the strength of organisation of the groups formed and leadership and management standards attained in the collection, processing and marketing of dairy products. Each of these small and farmer-based enterprises is operated strictly on business terms. The introduced technology or model chosen by each project was of appropriate level for farmers to handle it with ease and confidence.

In the original project document, SDDP planned to establish only five farmer-based milk units on a pilot project basis. However, subsequently, 30 milk units were established because of requests from farmers and Regional Agricultural bureaus. It is difficult to overrule the interest of farmers.

The trend observed so far indicates, with a greater number of similar independent milk marketing groups possibly mushrooming out, that there will be clusters of milk marketing units spread across the country. In the future, some of these clusters of units may eventually merge and consolidate to establish larger and more advanced milk-processing plants, and more efficient distribution networks. This would take advantage of the economies of scale and would increase the distances over which products could be marketed. Bigger

co-operatives can generally afford the resources necessary for these developments, such as capital, marketing, land and labour. In such a setting, the milk-marketing units would be responsible for collection of raw milk from farmers and delivery of bulk milk to the processing centre owned by the society of the clustered groups. Currently, this proposition may seem far-fetched since it is difficult to visualise these developments whilst the dairy sector is still in a rudimentary stage of development; however, it is a vision that should not be ruled out. A clear and responsive, slow but sure, short- and long-term development programme, supported by unwavering policy guidelines could bring the vision into reality.

The remainder of the paper will focus on the milk marketing and processing component of the SDDP project. SDDP has the following six components, which have different strategies of implementation:

1. Fodder production and animal feeding
2. Dairy cattle breeding and management
3. Animal health
4. Milk marketing and processing
5. Agro-forestry and water management
6. Appropriate technology.

The project is addressing and implementing the component activities integrally as a package. The project is co-ordinated by the Ministry of Agriculture and implementation of the field activities is being carried out through the regional agricultural extension network, and the zonal and *wereda* agricultural offices.

Farmers' milk marketing groups

The market groups are conceptualised and framed to operate as profitable milk units where smallholders organise themselves in collecting, processing and marketing of milk and value-added milk products. This approach aims at maintaining and enhancing the groups so that they become independent entities at the community level. In the context of SDDP, a milk marketing group can be defined as a group of smallholder farmers who individually produce at least one litre of saleable milk/day, and are willing to form a group in order to collectively process and market their milk. The milk marketing groups are named following their locality's or peasant association's name.

The idea of group work and formation of a group is not new to Ethiopia or, for that matter, to Africa. Different traditional local groups can be identified. For example, women organise themselves voluntarily into groups known as 'milk *equb*' and 'butter *equb*'. Under these arrangements, individuals gather either their milk or butter and contribute it to other members in turn. When the turn of receiving comes, each member gets in a single bulk the amount that she has contributed bit by bit to the others. In this way, instead of going daily to market with her own small amount of produce, the individual will go once weekly or fortnightly to market with a larger volume of produce to sell. The arrangement not only saves members from going to market daily, but also provides them, when they go to sell, with an amount of milk that brings them a more meaningful amount of money to take home.

Edir is another kind of grouping in rural and urban communities where individuals organise themselves and build up common savings through periodic contribution. Moreover, there is also *debo* where, seasonally, groups of farmers combine their labour for farm work support and as a group focus on each member's individual plot in turn. Such group formation is self initiated and not imposed and the groups serve their purposes well in rural communities. Understanding of the rural set-up in terms of social fabric and the farming system practised are key factors to long lasting formation of farmers' groups in the peasant sector.

The formation of milk marketing groups was based, in many respects, on the above traditional background. Interested farmers were invited to be members of the group rather than the entire peasant association membership. At the beginning, however, the establishment of milk marketing groups took more time than originally anticipated. This was because smallholder farmers showed reservation for any form of collective ownership and co-operative work. The farmers remembered the unfortunate experience of collectivisation under the socialist regime. Formation of a group could still face difficulties in areas where producers' co-operatives have been in operation, even though the word 'group' was coined to dissociate this work from past co-operative functions. Producers' co-operative dairy farms established under the socialist regime have all failed. Dairy stocks were sold mainly to urban dairy farmers and nearby smallholder farmers. The lesson learnt was that farmers should produce milk privately but sell milk collectively, mainly because the amount of sellable milk produced per household is too small to market it separately. To this effect, Ethiopian co-operative law is in place, which again creates an environment conducive to co-operative development.

The farmers' milk marketing groups, though based on strict business terms, are witnessed by the producers to be more development oriented, long lasting and reliable market outlets. The element of sustainability is more firmly built into this group approach than into the approach of the private milk traders' rural collection scheme. In the latter scheme, farmers are persuaded to sell milk to these traders but often the purchasing is not reliable. Disappearance or undue delay of payments by these traders is not uncommon. The major reasons that the milk groups are successful is that farmers need only to transport milk over short distances to sell it and are marketing high-value and compacted products such as butter.

Milk collection

A one-tier structure was adopted under this model (Figure 1). Each centre serves both as a milk collection and processing site. Milk is collected from nearby farmers and processed at the centre. Manually operated milk equipment and machines such as milk separators, butter churns etc. are used in handling the milk. Products are marketed at the same place or transported to outlets elsewhere. The advantages of these centres to producers include not only the creation of market outlets and transformation of milk into items with a longer shelf life, but also facilitation of the production of value-added products. This model requires no electric power supply and cooling facilities. All that a milk collection and processing unit

requires is a functional building to shelter the utensils and equipment and a capacity to handle 500 litres of milk every day.

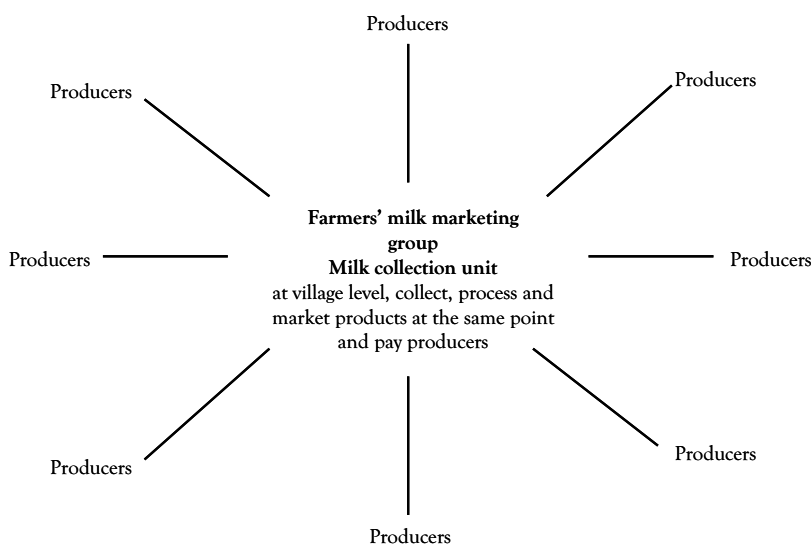


Figure 1. *The model for village milk units.*

In this model, it is assumed that half of the daily milk production will be used for household consumption while the other half is allocated for sale. Milk produced in the morning is sold to the milk units and the afternoon milk is used for home consumption and processing. Direct household needs for milk are not entirely disrupted since only part of the milk produced is marketed. Nowadays, because of increased production, farmers are requesting that they can also supply afternoon milk to the units.

The marketable surplus of milk/farmer per day varies on the bases of season and number of milking cows owned. Amount of milk brought to the units ranges from 1 to 17 litres/day per farmer. The overall average volume of milk delivered to the units/farmer per day is five litres. On arrival at the centre, the milk is tested for hygiene and adulteration using organoleptic and lactometer readings. Milk is weighed using graduated aluminium milk gauges. The quantity of milk received is registered daily and indicated next to the producer's name in a milk record book. A volume-based payment is made to suppliers every 15 days.

Total amount of milk delivered by farmers to a single unit varies from 60 to 700 litres/day. The quantity of milk delivered to the milk units has increased over the years, as more farmers join the units. The increase in quantity is the result of more farmers choosing this outlet for their milk and long periods of fasting observed by followers of the Coptic Orthodox church, during which no milk is consumed. There are over 200 days each year during which followers of the orthodox faith abstain from the consumption of any food of animal origin. At the beginning of the project, the units were able to take all the milk delivered by farmers; however, after three to four years of service the units did not have the capacity to receive all the milk supplied, especially during fasting days. This indicates that at

some stage the model requires modification or changes to its approach. This problem arose this year in the Oromia Region, Fitcha area. Nevertheless, most of the units have developed the capacity to secure market outlets for such overflow. In short, the units have the following features:

- they are readily accessible to farmers due to their location in the community/villages
- they are a secured market outlet for milk
- they secure regular income to smallholder dairy farmers
- the system is simple and farmers can handle it easily
- electric power supply and cooling facilities are not required
- they reduce labour demand on women.

Milk processing and marketing

Milk received by the unit is processed into various milk products (Figure 2), namely, cream, skim milk, sour skim milk (*ergo*), butter and *ayib* (soft curd-type cottage cheese made in many parts of Ethiopia). Butter is the major value-added product produced at the units.

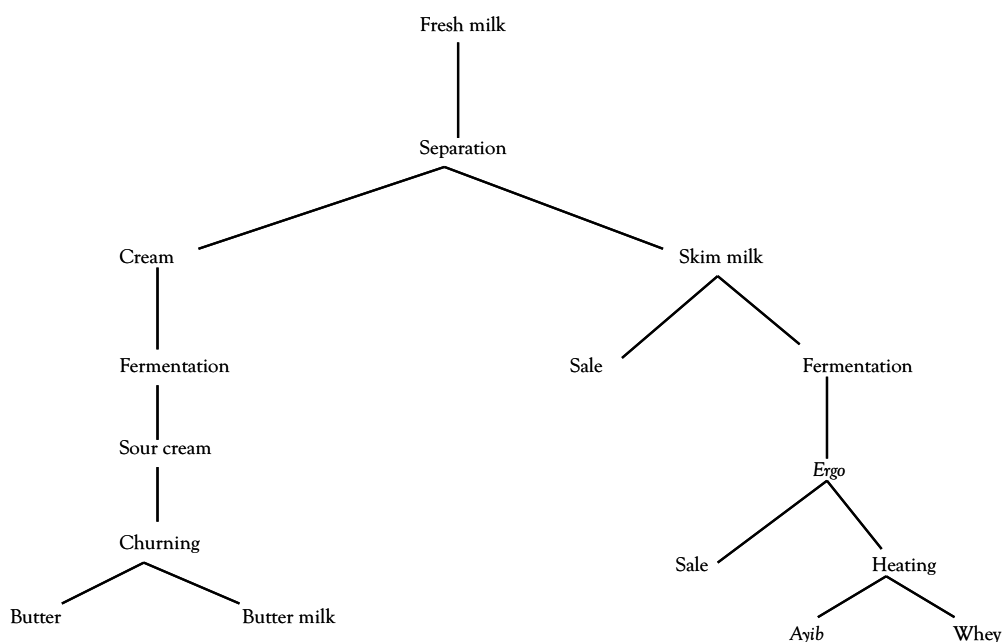


Figure 2. Flow diagram showing products from fresh milk.

Studies indicate that butter making is an ancient practice that goes back as far as 2000 BC to the time of Egyptian civilisation. Butter making may have begun at a similar time in Ethiopia. The traditional Ethiopian practice is to accumulate the milk for two to three days

until it is sour. A clay pot or calabash is then used to churn the sour milk. Butter is used for cash generation, cooking Ethiopian dishes, and medicinal and cosmetic purposes (e.g. application to the braided hair of women). In almost all societies of Ethiopia, women are responsible for butter. In general, husbands or men do not decide what is done with butter produced at home. The contribution of dairy products to the gross value of livestock production is not known but in peri-urban areas about 20% of average income was derived from dairy products (Winrock International 1992).

At the units, however, the cream obtained is used for butter making while the skim milk is sold back to farmers or to any other customer for *ergo* or *ayib* making. Variation is observed among the units in the extent of the marketing outlet for skim milk. In some units, consumers readily take the skim milk but this is not always the case; nevertheless, it has now become an accepted product for consumption. Skim milk is an affordable product to poor farmers who do not own cows. It can be consumed directly or used to produce *ayib* if required. There are some places in the countryside where it is not yet socially acceptable to sell fluid milk directly to friends and relatives. The existence of the units is helping to free both producers and consumers from this social barrier; it encourages free access to milk and dairy products.

Overall day-to-day operation and management of the units is the responsibility of the respective farmers' milk marketing group members and trained milk technicians employed by the group.

One season's samples taken from Lemu milk marketing unit (Oromia Region) by the International Livestock Research Institute (ILRI) dairy technology unit at Debre Zeit, showed the average fat content of whole milk, cream and skim milk to be 4.7%, 59% and 0.18%, respectively.

The buying and selling prices of milk and milk products have seasonal variations and have no fixed price as such. The change in prices is normally decided at a meeting held by the group members.

It is clear that processing at the units transforms milk into items with a longer shelf life and into value-added products. Nonetheless, the units can also be regarded as centres in a cycle of smallholder dairy development because creating a market outlet for available milk precipitates sales. The subsequent boost in sales stimulates farmers to be more responsive in accepting advice given relating to cattle and milk management (improved feeding, nutrition, breeding, health and hygiene). Improved management then brings about increases in milk yield. Increased milk yields lead to increased incomes and more flow of milk into the units. Increased flow increases the amount of milk available to consumers at a competitive price. The resultant increase in consumption results in increases in demand and consequently the development cycle continues.

Income generation

Even though a farmer can supply as much as 17 litres/day or as little as 1 litre/day, as stated earlier, the average volume of milk delivered/farmer per day is about 5 litres. The processing unit gate price for one litre of milk varies from 1.25 to 1.50 Ethiopian birr (EB) (EB 1 = US\$

8.4). If EB 1.25/litre is assumed as the price for calculation purposes, it can safely be said that a farmer can earn about EB 188 or more each month from the sale of morning milk. Most of the women farmer suppliers get an income above the quoted average figure.

The above explanation indicates the size of income obtained from sales of milk from the individual farmer's point of view. From the farmers' milk marketing unit point of view, income varies greatly depending on factors including location, unit's management and amount of milk received. In general, all farmers' milk marketing units are profitably run and the total revenue collected comes from sales of butter, fresh skim milk, and skim milk *ergo* and *ayib*. Most revenue is collected from the sales of butter as it has a high market value. Over half of the revenue is used to pay suppliers for raw milk purchased.

In general, with this type of project approach, a production level of 1600–2000 litres of milk/cow per annum is easily obtained under smallholder conditions. Production of 1600 litres provides a gross margin of almost EB 2000 to the owner of a crossbred cow, whereas production by a local cow gives a gross margin of EB 240–480. Farmers owning more than two improved cows can earn an income up to EB 5000/year. For comparison the gross domestic product (GDP) per capita in Ethiopia is about EB 770 (Ojala 1998). Dairying is an investment option for farmers, which can provide a sustaining family income.

Employment

The units have created employment opportunities in rural areas. In addition to the labour and time spent on managerial and marketing aspects by the milk marketing group members, at initiation each unit employs four permanent workers. Of the four workers, two are milk technicians who are responsible for running the milk unit's daily operation and are trained by the project in rural dairy technology, product marketing and equipment handling. The other two are a cleaner and a guard. Their salaries are paid monthly from the profit of the respective milk-marketing group. As the volume of milk handled increases, the units call for more employees.

Conclusion and recommendations

Market-oriented agricultural production would secure food supply to the rapidly growing non-farming community; create employment and promote economic development in rural societies. Marketing services are critical to rural as well as to urban food security. The experience shared in this report shows that, at all levels, interventions have to be market-oriented.

In the past, we have seen many interventions for increasing production, but much less focus on marketing services. Government engagements have focused on input oriented systems aimed at tackling problems that restricted milk production and not on output and the issues of milk market and milk disposal. For increased milk production, development of appropriate milk marketing and processing systems is now recognised as an overdue issue. Unless firm and steady steps are taken immediately and on a wider scale, output will be

frustrated further. In general, the introduction of improved marketing is pivotal to an increase in production.

Recommendations are as follows:

- Farmers' milk marketing groups are identified as being essential to dairy development and are necessary to overcome the problems of collection, transportation, processing and marketing of milk. The establishment of producers' organisation should continue to be promoted more vigorously by the relevant organisations and the producers' groups strengthened through accelerated training and extension education programmes.
- Dairying is a labour-demanding farm activity. The crossbred cow is more time and labour demanding than the indigenous cow. The higher the level of exotic blood the greater the time and labour inputs that are required for milking, processing, marketing, feeding and manure disposal etc. Much of these burdens rest on the shoulders of women. Under the SDDP, efforts were made to introduce locally produced improved wooden and stainless steel churns to reduce labour required in back yard butter making. Churning normally takes almost 3 hours using traditional churns while with improved, larger capacity churns it takes only 15–20 minutes. The introduction of marketing units in the villages also reduces the labour demand on women, as almost 50% of milk production is sold to the units rather than processed at home. Nevertheless, more is required and the vital role of women in the traditional livestock production system should be given due regard in improvement and enrichment through extension education.
- The traditional cattle keepers in the pastoral areas have more surplus milk per capita than their fellow highlanders. Due to the larger size of herds they are faced with a surplus of milk during the rainy and peak lactation seasons. A significant amount of milk could be obtained from this supply source if seasonally operating milk units were considered. It would also create a source of income for the pastoralists. Hence, support must be given to improve pastoral society milk production from the indigenous stock.
- In the past, research in Ethiopia has focused largely on biological problems. There has been limited adaptive research undertaken. Importance of on-farm research, and studies and adoption of technologies should be stressed by extension workers. Moreover, milk marketing and processing is one of the major obstacles to dairy industry development, hence it requires a thorough investigation and research should take the lead. Activities requiring investigation include: productive management strategies for the units; milk marketing systems research; preservation methods for dairy products; research in the field of dairy co-operative development; small-scale dairy machinery; and traditional and improved processing techniques.

A story/lesson learned

I would like to share with you the reasons why and how I developed an interest towards developing small-scale milk processing and marketing as a path for dairy expansion. Moreover, I wish to explain why I keep saying that there is a need for overall change of approach which perhaps still runs contrary to the beliefs of most of my colleagues.

Let me take you to the southern part of Ethiopia (the coffee growing area) where I was assigned as a junior livestock expert soon after completion of my undergraduate studies. In particular, I would like to take you to the peasant association areas (45 km south of Awassa). This was a place where at that time we had established a dairy farm, based on 10 in-calf crossbred (Holstein × Boran) heifers that the government provided to start producers' co-operative dairy farms. Before the heifers were taken to the area, farmers met the preconditions for receipt of the heifers. Farmers had constructed a partitioned shed for heifers, cows, calves and a breeding bull and they had allocated grazing areas and land to grow improved pasture crops. At the time, at the country level, two livestock projects, the Fourth Livestock Development Project (FLDP) and the Dairy Rehabilitation Development Project (DRDP) were ongoing. Neither project covered the Southern Zone (the Debub ketena under the previous structure). However, the DRDP tried to give a little assistance to this zone towards the end of its life. Furthermore, although the FLDP was not functioning fully in the area, they provided most of the forage seeds required by the southern region. One of the forage seeds distributed was alfalfa seed. Wenenata dairy farm was one of the dairy farms that received this seed for pasture establishment.

One day, as usual, I went to visit the farm and to see how the alfalfa was growing in that area. It was the first experience farmers had had of growing alfalfa in that area. I visited the cows, calves born, the shed etc. and it seemed that everything was in order. I then walked into the grazing area, mainly to see the alfalfa field. The farmers accompanied me, throughout this inspection process. When I reached the alfalfa field, which was initially well established, I found it to be full of weeds; it was hardly possible to see the alfalfa plants. It was all weeds. I was very disappointed, mainly because alfalfa seed is expensive; at that time the price of one kg of alfalfa seed was about EB 37, that is about EB 3700 per quintal (US\$ 1 = EB 2.10). In addition, improved forage seeds were hard to obtain, as officially the area was not a beneficiary member region of the FLDP. It required a lot of personal effort to bring the seed on time to farmers so that they could sow and utilise it to improve production. As I saw it then, it was a total failure. I tried to control my feelings and asked the farmers around me to explain why they didn't weed it on time and utilise it. All they said was they would weed it immediately and promised that for my next visit, everything would be in order. Somehow I sensed that their acceptance to weed was not from their hearts, but only to please me. I realised more discussions with them were needed to find out all about it. Towards the end of a half-day free discussion covering all the activities of the dairy farm, one old farmer came up with the real reason for the neglect of the alfalfa pasture. He explained that they were producing about 40 litres of milk/day and although they could easily sell half of it to nearby consumers, they did not have a market for the remaining milk.

He asked why they were being pushed to feed the cows well and produce milk for which there was no market. Additionally, he said 'we know quite well that it will be to our advantage to produce more and market more, but this is not the situation now'. He then questioned me by asking 'how would you help us to get a market for our extra milk'? With the background and experience I had at that time, I was not prepared for his question and was unable to provide a solution for their problem. However, for me it was the most important and greatest lesson gained from that discussion, not the sort of experience one

can get from a University. I concluded that, if promotion of improved dairying in the villages is not linked with appropriate marketing arrangements, it is a futile exercise.

I brought this new outlook back from the field and I tried to sell it across to my colleagues in office. But no one seemed to have an interest at the time except the farmers and a handful of professionals. For Wenenata, I tried to link the milk marketing to a nearby hospital and a cream separator was also introduced. But my efforts didn't resolve the problem very well, as my approach was not clearly conceptualised then. It was a dilemma to me as it was difficult to abandon the interest of the farmers. They had clearly identified their problem. There on, whenever I got the forum I began and continued to raise the farmers' problem as an issue. Through the course of time I faced very many challenges and resistance in many meetings and conferences. Whenever I tried to explain the crucial nature of the marketing function in promoting dairying in the villages, the acceptance was poor and listeners were very few. The conviction was that what is important for Ethiopia is to *produce milk not to sell milk*. This statement sounded logical to officials but was not of any substantial value to the farmers who were producing the milk unless there was a market for their produce.

Time has gone by and here we are now ladies and gentleman. Even now, very many experts in the field of extension and research tend to pay little attention to milk processing and marketing. Milk is highly perishable, unless it is all consumed immediately or processed soon after production, it is clear that it will be wasted. I don't think we can afford to simply waste the milk produced, particularly as Ethiopia is such a poor country. It is also wrong to encourage poor farmers to run improved dairying schemes and make them invest their money where they can't recover their costs.

For future success in the field of dairying, there should emanate from dairy professionals a determination to resolve the smallholders' problems. So let us put our hands together and direct our future dairy development to be output/market oriented so that smallholders can optimise their benefits from dairying.

References

- Azage Tegegne and Alemu Gebre Wold. 1998. Prospects for peri-urban dairy development in Ethiopia. In: *ESAP (Ethiopian Society of Animal Production), fifth national conference of Ethiopian Society of Animal Production, Addis Ababa, Ethiopia, 15–17 May 1997*. ESAP, Addis Ababa, Ethiopia. pp. 28–39.
- Belachew Hurisa, Ahmed Mohammed, Haileleul Teferi and Abebe Lema. 1994. *Dairy products marketing survey in Addis Ababa and the surroundings*. DDE (Dairy Development Enterprise), Addis Ababa, Ethiopia.
- CSA (Central Statistics Authority). 1996. *Report on human population. Volume II*. Statistical Bulletin 152. CSA, Addis Ababa, Ethiopia.
- Debrah S. and Berhanu Anteneh. 1991. *Dairy marketing in Ethiopia*. ILCA Research Report 19. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 21 pp.
- ILCA (International Livestock Centre for Africa). 1993. *Handbook of African livestock statistics*. ILCA, Addis Ababa, Ethiopia.

- MoA (Ministry of Agriculture). 1998. *The role of village dairy co-operatives in dairy development: Prospects for improving dairy in Ethiopia*. SDDP (Smallholder Dairy Development Project), Addis Ababa, Ethiopia.
- Ojala R. 1998. *SDDP milk marketing study on farmers' milk processing units*. SDDP (Smallholder Dairy Development Project), Addis Ababa, Ethiopia.
- Saxena M.M., Katpatal B.G. and Pandey H.S. 1997. Study of milk constituents and their yield in Holstein-Friesian cows. *Indian Journal of Animal Production and Management* 13(3):127-130.
- Staal S.J. and Shapiro B.I. 1996. *The economic impact of public policy on smallholder peri-urban dairy producers in and around Addis Ababa*. ESAP Publication 2. ESAP (Ethiopian Society of Animal Production), Addis Ababa, Ethiopia. 57 pp.
- Tsehay Redda. 1995. *Smallholder dairy development pilot project termination report*. FAO/TCP/WFP (Food and Agriculture Organization of the United Nations/Technical Cooperation Programme/World Food Programme). FAO, Rome, Italy.
- Tsehay Redda. 1998. *Prospects for improving dairy in Ethiopia*. SDDP proceedings. MoA, Addis Ababa, Ethiopia.
- Tsehay Redda. 1998. Milk processing and marketing options for rural small-scale producers. In: *ESAP (Ethiopian Society of Animal Production), fifth national conference of Ethiopian Society of Animal Production, Addis Ababa, Ethiopia, 15-17 May 1997*. ESAP, Addis Ababa, Ethiopia. pp. 61-71.
- Winrock International. 1992. *Assessment of animal agriculture in sub-Saharan Africa*. Winrock International Institute for Animal Agriculture, Morilton, Arkansas, USA.

Annex I. Fresh cow milk yield estimate and consumption rate

Assumptions and information used to estimate milk production and consumption rate

Local stock (indigenous cattle)

1. Milk yield/cow per annum is 213 kg (ILCA 1993) remains the same for the coming 5 years; any increase in productivity is considered to be negligible.
2. Lactating cows form 12.5% of the total herd population (estimated based on field data, unpublished).
3. Annual growth rate of cattle population is assumed to be 1.2% (average for sub-Saharan Africa, computed from Winrock International (1992)).

Improved stock (crossbred and exotic cattle)

1. Milk yield/cow per annum is 2400 kg (estimated average milk production from smallholder farmer and commercial private farmers) remains the same for the coming 5 years; any increase in productivity is considered to be negligible.
2. Twenty-six per cent of the total improved herd population is considered as lactating cows (field data).
3. Annual growth rate of cattle population is assumed to be 10% (estimated).
4. Improved stock population is estimated at 300 thousand head (regional bureau report).

General

1. Milk consumption average for most African countries is 27 litres/annum.
2. Milk consumption world average is 100 litres/annum.
3. Goat, camel and sheep milk are not considered in the calculation.

Population

Human population is taken from CSA (1996) survey report and projected data for year 2000 is given in the report.

Estimated milk production and consumption rate of Ethiopia

Year	Cattle population		Lactating cows		Milk production ($\times 10^9$)	Human population ($\times 10^6$)	Per capita consumption (kg)
	Ind. ($\times 10^6$)	Imp. ($\times 10^3$)	Ind. ($\times 10^6$)	Imp. ($\times 10^3$)			
1997	33	–	4.125	–	–	56.600	16
1998	33.399	300	4.174	78	1.076	58.298	18
1999	33.800	330	4.225	85.8	1.105	60.046	18
2000	34.206	363	4.275	94.38	1.137	61.848	19
2001	34.616	399.3	4.327	103.8	1.161	63.703	19
2002	35.032	439.2	4.379	114.2	1.206	65.614	19
2003	35.452	483.1	4.431	125.6	1.245	67.583	19
2004	35.878	531.4	4.484	138.18	1.286	69.610	19
2005	36.308	584.6	4.583	152	1.341	71.699	19

Ind. = Indigenous stock; Imp. = Improved stock.

Impacts of liberalisation in Kenya's dairy sector

J. Omiti

Institute of Policy Analysis and Research (IPAR), P.O. Box 45843, Nairobi, Kenya
E-mail: jmomiti@ipar.or.ke

Background

The dairy industry has experienced three periods of major shifts of pricing policy since 1965. In the first period lasting until 1971, a milk quota and contract pricing system guided dairy production. Dairy marketing was undertaken by a number of independent factories, processing and selling dairy produce in a relatively free market system. The pricing policy aimed at increased production for domestic and export markets. Between 1971 and 1992, a pan-territorial liberalised production and uniform pricing system guided dairy production and marketing. During this period, producer and consumer prices were determined by the Ministries of Agriculture and Finance, based on recommendations on milk procurement, processing and distribution costs. In 1992, the government liberalised the dairy industry (Omiti and Muma 2000).

A variety of reforms

Since the early 1980s, the government of Kenya has instituted a number of economic and institutional reforms aimed at improving economic performance and macro-economic stability. In general, these reforms have aimed at reducing or removing government support and its direct participation in various sectors of the economy. Such measures have included withdrawal of subsidies, price deregulation, trade, non-participation in input markets etc. This is expected to permit the forces of supply and demand to determine the production, distribution and marketing of various goods and services in the economy and thus promote efficiency, flexibility and economic growth.

In the dairy sector, some of the major reforms have included: (i) selling veterinary drugs at full cost in 1988, (ii) price liberalisation for animal feeds in 1989, (iii) transfer of the management of cattle dips to community groups in 1989, (iv) privatisation of artificial insemination (AI) services in 1991, (v) decontrolling of milk prices and liberalisation of the dairy sector in 1992, and (vi) privatisation of clinical (veterinary) services in 1994.

Slow pace of reforms

Before assessing the impacts of these reforms, it is worth noting some preliminary impediments to adequate and acceptable implementation of these reforms. Many of these reforms have not:

- i. been accompanied by sufficient publicity to permit farmers and the business community to organise alternative means of accessing various inputs and services
- ii. adequately involved major stakeholders to avoid conflicts in implementation and policy such as protection of vulnerable groups in their food security status (i.e. social dimensions of structural adjustment programmes)
- iii. been sufficiently co-ordinated within and across different sectors of the economy; or,
- iv. provided adequate time to permit the private sector or farmers' organisations to take over responsibilities hitherto shouldered by government or quasi-public institutions.

Many of these reform programmes had generic difficulties in implementation including:

- i. focusing on funding of the preparatory stages for adjustment (e.g. policy papers, desktop studies etc.) rather than on implementation aspects
- ii. setting too many conditionalities whose meaning was rather ambiguous and
- iii. placing great confidence on a small number of key functionaries in government whose replacement/removal could substantially affect the likelihood of success of the reform programme(s).

A case study of impacts in a liberalising dairy sector

Price liberalisation has borne mixed impacts along the dairy production–marketing–consumption continuum in general. There are indications of differential impacts on input supply especially on veterinary services, milk prices, and private-sector participation in milk processing and marketing. The dairy sector is also experiencing serious problems due to macro-economic difficulties, decreasing budgetary support, inefficiencies in pricing and marketing, high input costs, institutional and governance problems, and low adoption of dairy technologies. A major policy challenge is the slow evolution of an efficient private-sector to provide farm inputs, financial and marketing services, technical support including veterinary and breeding services in a liberalising market system to increase sectoral employment, farm incomes and social welfare. This case study describes some of the impacts of liberalisation of the dairy sector in Kenya.

Impacts on milk prices

Farm-level milk production is influenced by a number of important variables including socio-economic factors, demographic variables, infrastructure, farming practices, factor markets, disease and parasite control, institutions of collective action (co-operatives), biotechnology and policy factors. Through time, smallholder farmers have gradually

increased their participation in market-oriented milk production through upgrading of their local dairy breeds. Smallholder farms average 2 ha and contribute to about 80% of marketed milk production (MoA 1997). Milk production is based on grade cattle (e.g. Friesians) and their crossbreeds, which numbered about 3.2 million in 1999. Over the years, there has been increased milk production despite periodic fluctuations, often associated with weather changes. Annual milk production is estimated at 2.5 million tonnes serving an estimated demand for 2.3 million tonnes. However, demand is expected to outpace supply as from the year 2005 onwards.

Production costs are nearly equal to producer prices in most milk-producing areas. With increasing input costs, profit margins are not large for most operators. Although import and export parity prices seem to have been achieved, there has been a debatable decline of 4% in real producer milk prices, in some areas. However, it is believed that most dairy farmers across the country generate good returns, especially from the milk they sell to neighbours/other consumers, which regularly constitutes over 50% of all their marketed milk. In many instances, reforms do not seem to have led to greater price competition amongst milk processors as they are geographically scattered and tend to significantly influence regional farm-gate prices following the collapse of Kenya Co-operative Creameries (KCC). However, a major positive impact of price liberalisation is the reduction in delays of farmer payments for their milk sold to now largely private factories.

Accessibility and cost of breeding services

The dairy breeding policy has focused on upgrading the local zebu through artificial insemination (AI), use of elite bulls or imported germplasm to increase milk production while controlling breeding diseases. AI has been privately operated in large-scale farms since 1935 and government provided to smallholders since 1966. Due to government financial constraints and withdrawal of donor support, AI services were privatised in 1991.

Since privatisation of the service, there has been a gradual but significant decline in AI coverage irrespective of whether it is offered by the public or private sector (Table 1). Second, a number of private AI service providers have emerged but are concentrated in areas with high densities of dairy cattle, which more or less justifies demand. Third, the relative cost per insemination of AI from the privatised service is considered prohibitive to the majority of farmers, especially smallholders, having escalated from about 10 Kenya shillings (KSh) (US\$ 1 = KSh 17.37 on 2nd June 1989) per insemination in the late 1980s to about KSh 250–300 in the mid 1990s (US\$ 1 = KSh 53.98 on 2nd June 1995).

Available evidence suggests that private veterinarians cannot profitably offer breeding services at current prices and conditions. This has serious technical and policy implications. First, most of the previous significant achievements in technology adoption (e.g. high milk yields) will be reversed, especially amongst the smallholders. Second, an increasing number of farmers are resorting to using inferior bulls. It is estimated that only about 20% of the dairy herd used AI in the late 1990s. Third, there will be shortfalls in milk production in the medium term (i.e. 5–10 years) that have critical policy implications on food security, malnutrition and commercial dairy imports. Policy support is required to facilitate the entry

and active participation of private investors to offer breeding services in the broad context of sectoral development. It is necessary to have regulatory mechanisms to maintain the quality of semen, and organise and monitor various breeding organisations so that they are managed efficiently and sustainably.

Table 1. Number of artificial inseminations (AI) 1990–1997, by province.

Year/ province	AI by	1990	1991	1992	1993	1994	1995	1996	1997
Central	Public	211,847	120,298	105,512	71,296	55,198	55,512	27,772	3737
	Private	–	–	7479	19,269	32,720	51,793	69,908	73,165
Western	Public	9197	5534	5922	4226	3523	4271	4341	1468
	Private	–	–	–	–	–	412	1042	1047
Rift Valley	Public	84,451	52,852	42,237	30,201	23,515	24,343	16,439	–
	Private	–	–	–	192	810	3470	9677	8976
Nyanza	Public	7908	3109	2136	2490	2318	3300	2405	812
	Private	–	–	–	–	253	331	333	349
Eastern	Public	74,134	55,363	35,400	24,276	18,887	9326	11,377	–
	Private	–	–	360	397	298	3231	10,961	14,568
Coast	Public	6824	4947	2943	2584	1006	983	840	–
	Private	–	–	–	–	–	–	38	–
Nairobi	Public	–	2613	1104	714	638	579	95	–
	Private	–	–	–	6	217	371	622	539
National totals		394,361	244,716	203,093	155,651	139,383	157,927	155,850	104,661
Public – totals		394,361	244,716	195,254	135,787	105,085	98,319	63,269	6017
Private – totals		–	–	7839	19,864	34,298	59,608	92,581	98,644

Source: MoA (1999b). Data for periods after 1997 are not reliably available.

Availability and quality of manufactured feeds

Milk production is mainly based on natural forages. In most cases, concentrate feeds are given to animals during particular physiological phases such as lactation. Generally, there has been low usage of manufactured feeds due to controls on distribution and marketing prior to reforms in the animal feeds sector in 1989. With price, more feed manufacturers and traders have entered the feeds market and there is an upward trend in feed supply. Animal feedstuffs are now more accessible in most areas. The role of government is at present confined to monitoring and regulating feed standards, trading practices, policy and institutional support (FAO 1993; MoA 1999b).

There are, however, a number of issues regarding the animal feeds subsector. First, on most farms, there is inadequate fodder production due to decreasing farm sizes and increasing competition for land between enterprises. Second, there are seasonal fluctuations in feed quality and quantity, especially on most smallholder farms (MoA 1997). Third, there is inadequate technical and market information among millers, traders, extension agents and farmers in the production, stocking, selling and utilisation of animal feeds. Fourth, government agencies such as the Kenya Bureau of Standards have inadequate technical and

human resources to enforce and monitor various requirements for feed standards (FAO 1993). Fifth, inputs (e.g. fertiliser) that would promote fodder production are expensive in relative terms. This calls for policy to facilitate key stakeholders (e.g. government, manufacturers, farmers' organisations etc.) to set rules for feed standards, transactions and their enforcement. Emphasis is required on on-farm research to facilitate greater production and utilisation of fodder and farm by-products rather than on reliance on concentrates.

Impacts on dairy research and extension

Impacts on research and extension services have borne mixed results. With government financial constraints and diminishing donor support in the 1990s, public expenditure in dairy research has continued to decline. The dairy sector is experiencing major drawbacks in realising higher returns to research investments. These include: (i) inadequate physical and human resources, (ii) weak research-extension-farmer linkages, (iii) low extension to farmer ratios, (iv) failure to effectively co-ordinate sectoral investments, and (v) lack of an appropriate institutional and legal framework to provide stakeholders with key direction(s) on sectoral development. These problems demonstrate the need for revitalising research with the support and participation of international, national and non-government research organisations. However, linkages must be streamlined to increase inputs in adaptive research. Mechanisms must be worked out to increase and sustain funding to national research institutions. Better co-ordination of various donor-supported programmes is also required to enhance the chances of greater impact.

Individual farmer extension seems to have had limited impact due to high investment requirements, non-availability of extension materials and narrower farmer coverage. Subsequent revisions of extension approaches have faced government budgetary constraints and so have not been effective or timely, especially with regard to transport and operational costs. Cultural and gender barriers to extension have not been adequately addressed to make extension more effective (MoA 1996). There are weak extension linkages to research and policy-making bodies; consequently some extension messages are irrelevant or misdirected. Moreover, extension materials for privatised extension, which address various information gaps to stakeholders, are not available. In addition, education and training programmes are also not sufficiently harmonised with research and extension requirements. There is need for a more coherent national extension policy to better serve dairy development goals such as organisational linkages, education and training. Policy should encourage private institutions involved in different extension services to satisfy emerging demands embedded in food security, privatisation and sectoral development.

Impacts on milk processing

Before reforms, the KCC had a national monopoly in milk processing and marketing with its network of 11 processing plants, 11 cooling centres and 26 sales depots which were spread countrywide. This network was facilitated by a network of reasonably motorable trunk and

feeder roads. KCC was also a buyer of last resort, guarantor of strategic milk reserves and the operator of the School Milk Programme initiated in the 1980s. The KCC benefited from direct public funding and government guaranteed external loans. Private sector participation in processing and marketing in the formal market was limited and in many cases, officially regulated by the Kenya Dairy Board (KDB). Despite the monopoly status, KCC continued to be plagued by a series of structural and operational inefficiencies such that it regularly experienced cash-flow problems to the extent of not paying farmers and creditors on time (FAO 1993; MoA 1996). Notably, corruption at KCC was in part a result of its parastatal or quasi-public nature and is a lesson for all countries and regions considering the promotion of participation of public organisations in direct processing and marketing.

With liberalisation of the industry from 1992 and the entry of the private sector, many aspects of dairy production, processing and marketing have continued to change. Competition for marketing functions has also increased considerably. There are about 45 milk processors already licensed by the KDB although only about 20 are functionally operational. The majority of these new dairies handle an average of about 20 thousand litres/day, although the largest plant has a daily intake of 110 thousand litres (Table 2).

Table 2. *Licensed milk processing factories.*

Name of processor	Daily intake (litres)
Kenya Co-operative Creameries (KCC) (National)	*1,204,000
Spin Knit	110,000
Meru Central (Meru)	36,440
Limuru Processors (Kiambu)	25,000
Ilara Dairies (Nakuru)	24,000
Kilifi Plantation (Kilifi)	16,300
Brookside (Kiambu)	16,000
Premier Dairy (Kericho)	16,000
Delamere Dairies (Naivasha)	15,000
Nyota Dairy (Kitale)	15,000
Donyo Lessos	10,000
Sotik Dairy (Kericho)	8000
Buyayi Dairy	5500
Taifa Estate	833
Danona Farm	730
Stanley & Sons	244
Kitinda Dairies (Bungoma)	(Under receivership)
Total	3,071,680

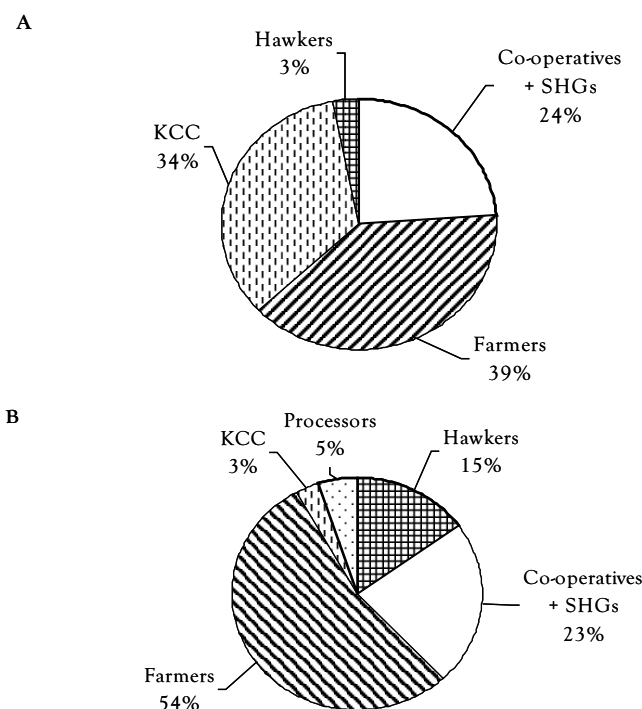
*KCC imported three quarters of the quantity for reconstitution from Zimbabwe.

Source: MoA (1999b).

Most other private processors operate in the range of 15 to 20 thousand litres/day and often behave as regional monopolies in a rather oligopolistic national formal milk market. The formal and informal milk market is dependent on the annual marketed surplus, largely from smallholder dairy producers. About 12% of marketed milk passes through the formal

market composed of KCC and some 45 private milk processors¹. The remainder is sold through: (i) direct sales to consumers, either individuals or organisations, which accounts for 633 million litres (58%); and (ii) co-operatives, self-help groups and small traders (e.g. milk bars, kiosks and mobile traders) who sell about 327 million litres (30%) to consumers (Omore et al. 1999). These quantities and their proportions will vary somewhat from year to year.

Following liberalisation, market shares in the informal sector have not changed radically. However, in the formal milk market, the greatest loser has been the former national monopoly (KCC), whose market share has decreased significantly. The biggest beneficiaries seem to be the smallholder farmers and itinerant traders, especially the hawkers (Figure 1).



KCC = Kenya Co-operative Creameries; SHGs = self-help groups.

Source: MoA (1987, 1999b).

Figure 1. Market shares for: A. Smallholder marketed milk, pre-reforms 1987; and B. Smallholder marketed milk, post-reforms 1997.

Despite liberalisation, old problems such as low producer prices, market malpractices and anti-competitive practices such as dumping of dairy products have persisted (Omiti et al. 1993;

1. The 133 million litres is equivalent to 70% of the estimated total of 190 million litres from small- and large-scale farms that were processed in 1997 (44 million litres by KCC and 146 million litres by other private processors). KCC alone processed slightly over 200 million litres in 1992–93 when milk marketing was liberalised, indicating that the total volume of processed milk has remained about the same over the period (Omore et al. 1999; Omiti and Muma 2000).

MoA 1999a). Evaluating the structure, conduct and performance of various marketing channels of inputs, commodities and services would be instrumental in identifying critical constraints and realistic opportunities for institutional changes aimed at improving dairy development. There is need to create and mobilise the necessary institutional capacity capable of identifying and addressing problems in both the informal and formal milk markets in order to expand the opportunity sets of different segments of the farming and business community.

Impacts on milk traders

Dairy reforms have contributed to increasing marketing margins for market agents, especially in milk deficit areas. Increasing competition for marketing functions such as collection, transportation, processing and distribution/retailing has increased income and employment opportunities, especially to milk vendors (Omiti and Muma 2000). Many small-scale market traders (often referred to as 'hawkers') generally each sell less than 120 litres of milk per day but this business activity enables them to earn a daily income equal to approximately twice the national average (Omore et al. 1999), which is a significant contribution to poverty reduction. Poverty reduction is a key national policy concern since more than half of the population lives below the poverty line (US\$ 1–2 per day).

Challenges and opportunities

Milk has no close substitute. Dairy policy has been and is currently devoted to the promotion, increase and sustainability of milk production to achieve self-sufficiency through research, extension, training, veterinary services, input supply, pricing and marketing. Like other sectors, dairying has experienced serious problems that have resulted in economic and institutional reforms. Price liberalisation has had mixed effects on inputs policy (especially for feeds), breeding services (especially AI), farm-level disease control strategies, research and extension, feeding strategies, technology adoption, milk marketing, institutional and legal frameworks, import–export parity prices and maintenance of strategic dairy reserves. In this section, emerging challenges and opportunities are highlighted to indicate potential areas of intervention for the facilitation of sectoral development.

Strengthening farmers' organisations

There are more than 5600 registered co-operatives with a total membership of over 2.5 million. Dairy co-operatives account for 34% of all co-operatives (MoA 1999a). They have contributed significantly to the development of smallholder dairying through milk marketing and provision of other services at relatively low costs (Owango et al. 1998). The share of milk supply produced by dairy co-operatives and/or unions reached its peak in 1987, accounting for 76% of KCC milk intake.

In the 1990s, performance of many co-operatives declined considerably due to political wrangles, management problems, stakeholder conflicts and greater competition from private processors. Other major obstacles affecting dairy co-operatives relate to the illiteracy of most farmers, the low level of educational or professional qualifications, and the lack of group dynamic skills among managers (MoA 1999b). These and other related problems of governance demonstrate the need to improve the management of co-operatives in the collective interest of sectoral development. Policy should set minimum requirements for educational or professional qualifications for co-operative leaders in order to institutionalise good governance, corporate accounting and transparent leadership. The recently revised Co-operatives Act provides the legal framework to deal with disputes (e.g. tribunals), better annual auditing of accounts for members, stricter supervision of co-operatives, unlinking of the government from the co-operative movement and easier legal reform processes.

Access to agricultural credit

Within the context of the dairy industry, there is a great need for credit for smallholder dairy development in order to accelerate agricultural development. The demand for rural credit has outstripped the supply over time. The current annual demand is estimated at 75 billion KSh while the supply stands at 18–22 billion KSh (MoA 1995; Kimuyu and Omiti 2000). The various intermediaries for finance and credit include commercial banks, non-bank financial institutions, the Agricultural Finance Corporation, agricultural boards, non-governmental organisations and rural–urban savings societies. The proportion of credit for agriculture constitutes only 10–12% of the total loan advances from these institutions. An analysis of the agricultural credit situation indicates: (i) an overall decline in total advances to the agricultural sector since the 1980s; (ii) bias towards large-scale enterprises, cash-oriented enterprises and short-term lending; (iii) bias towards urban enterprises; and (iv) capital flight from the rural areas (MoA 1995; Kimuyu and Omiti 2000).

Furthermore, many smallholders lack adequate finances to invest in dairy development because of constraints including:

- i. high interest rates and difficult collateral requirements, such as land title deeds or alternative tangible assets to cover for collateral
- ii. lack of comprehensive loan policies including inability of the Central Bank to enforce minimum lending requirements for agriculture (17% of deposits)
- iii. the banking industry view that lending to smallholders is risky, expensive and cumbersome to administer
- iv. risks associated with crop failures and livestock deaths
- v. inadequate agricultural lending expertise within financial institutions
- vi. low productivity and profitability of smallholder farms and
- vii. failure of co-ordination of policy on agriculture and rural credit issues and, therefore, policy on capital formation for agriculture etc.

Innovative and progressive institutional mechanisms are required to encourage formation of rural savings and credit co-operative organisations to supplement the facilities offered by other financial institutions, especially in rural areas. Benefits can also accrue from the establishment of accessible credit and information institutions for investment in dairy processing to encourage competition. Where cash is a serious constraint, designing appropriate institutional mechanisms for availing credit, bearing in mind the specific difficulties that subsistence-oriented farmers experience in repaying loans, would help to solve the cash liquidity problem(s).

Technical assistance and financial flows

Impact of donor and technical assistance has been phenomenal in building the dairy sector. Financial and technical aid has supported animal health services, adaptive research, extension, dairy training centres, privatisation of breeding and veterinary services, construction of milk processors and the strengthening of co-operative societies.

Lately, donor and technical aid has been withheld for a variety of reasons including those related to democratisation of the country's political system and governance of public organisations. However, the government and its development partners should articulate and implement various strategic exit, entry and maintenance plans for restructuring, privatisation and commercialisation of agricultural services, gradually to permit adequate monitoring and evaluation of outcomes, especially for institutional and policy issues.

Investment in infrastructure development

The poor state of rural infrastructure (e.g. roads, water and communications) still plagues the dairy industry. Infrastructure greatly facilitates marketing of high-value and perishable agricultural products such as milk. Improvements in infrastructure have immediate implications on marketing costs and farm incomes; farmers spend less time travelling to and from markets, human drudgery in marketing farm produce is reduced, and leisure and labour productivity is improved.

Better infrastructure has implications for profitability of time-sensitive enterprises such as dairying. For vehicle operators, improvements in infrastructure lead to lower vehicle operating costs, and thus higher incomes in the transportation and distribution sectors. Reduced transportation costs for farmers also lead to direct income gains because of lower transport expenses and reduced transportation losses, and may result in general improvement in rural incomes and livelihoods. Greater policy support is required to strengthen inter-sectoral linkages with the ministries in charge of infrastructure in order to ensure rehabilitation and maintenance of rural access roads (especially feeder roads) and thereby assist in the timely and efficient delivery of inputs and marketing of farm produce.

Differential impacts on gender, production costs and farm incomes

If efficiency is improved through reforms, then liberalisation reforms are expected to bear differential effects on various segments of the farming and business community. It is important, from a policy perspective, to understand the effects of reforms on incomes, technological practices, access to inputs etc. Some of the relevant policy issues include examination of the effects of reforms on incomes for different categories of farmers/ investors. This should include gender differentiation arising from, or exacerbated by, policy reforms in farming or business occupations. Changes in prices and institutional arrangements often create hardships or conflicts between investment and consumption, producers and consumers, and the electorate and the elected. Policy research can advise on the nature and magnitude of these trade-offs to minimise the required trade-offs, improve negotiations and improve policy outcomes. It is necessary to evaluate the emerging/ changing roles of institutions, private sector initiatives, and the delivery of goods and services by paying particular attention to the changing gender roles, and women's and self-help organisations in farming and associated activities.

Delivery of inputs and quality control programmes

With the relaxation of various movement and marketing restrictions, it is feared that control of diseases, pests and other quality control measures may be ignored or not routinely institutionalised at the farm or regional levels. It is therefore important to understand:

- i. What kinds of institutions have emerged since the economic and institutional reforms came into place. For example, how many private traders have started providing farm inputs and services since the policy reforms were adopted?
- ii. How has the structure of marketing channels for these goods and services changed since the liberalisation process begun? What are the important emerging marketing channels for the delivery of farm inputs and produce?
- iii. The merits and obstacles to enhanced competition in the delivery of goods and services by different public and private sector organisations.
- iv. The changes emerging in the quality and appropriateness of alternative means of delivering such inputs and services, and the policy changes that may be required to enhance emerging mechanisms for more efficient delivery.

Globalisation and domestic industry

Globalisation offers opportunities for expanding trade but presents tough policy, technical and administrative issues for domestic industry to remain competitive. In recent years, there have been media reports of commodities that have found their way into the domestic market at questionable prices. Such low prices have an obvious depressing effect on

domestic production and affect those engaged in the industry. Also some commodity aid for sectoral development has not been used or targeted properly. Policy research can offer useful insights into the costs of unfair competition, dumping and unfair business practices for both the country and its citizenry.

References

- FAO (Food and Agriculture Organization of the United Nations). 1993. Kenya Dairy Development Project, Preparation Report. Report 34/93 CP-KEN 33. FAO, Rome, Italy.
- Kimuyu P. and Omiti J. 2000. *Institutional impediments to micro and small enterprises (MSE) access to credit in Kenya*. Discussion Paper 26/2000. IPAR (Institute of Policy Analysis and Research), Nairobi, Kenya. 42 pp.
- MoA (Ministry of Agriculture). 1987. *Animal Production Annual Report 1987*. MoA, Nairobi, Kenya.
- MoA (Ministry of Agriculture). 1995. National dairy development desk study—Tick control. Consultancy Study Report. MoA, Nairobi, Kenya.
- MoA (Ministry of Agriculture). 1996. ASIP preparation study: Alternative approaches to agricultural extension. Consultancy Report by Agrisystems. MoA, Nairobi, Kenya.
- MoA (Ministry of Agriculture). 1997. *Animal Production Annual Report 1997*. MoA, Nairobi, Kenya.
- MoA (Ministry of Agriculture). 1999a. Kenya dairy development policy, toward the development of a sustainable dairy industry. Technical Paper. MoA, Nairobi, Kenya.
- MoA (Ministry of Agriculture). 1999b. Production and use of concentrates in smallholder dairy sector in Kenya, study done for smallholder dairy project (research and development). Ministry of Agriculture and Livestock Development, Nairobi, Kenya.
- Omiti J. and Muma M. 2000. *Policy and institutional strategies to commercialise the dairy sector in Kenya*. Occasional Paper 6/2000. IPAR (Institute of Policy Analysis and Research), Nairobi, Kenya. 25 pp.
- Omiti J., Mbogoh S. and Odhiambo M. 1993. An economic analysis of marketed milk production in Kenya over the 1957–85. *East African Agricultural Forestry Journal* 58(4):141–153.
- Omore A., Muriuki H., Kenyanjui M., Owango M. and Staal S. 1999. *The Kenya dairy subsector: A rapid appraisal*. MoA/KARI/ILRI Collaborative Research Report, Smallholder Dairy (R&D) Project, Nairobi, Kenya. 51 pp.
- Owango M., Lukuyu B., Staal S.J., Kenyanjui M., Njubi D. and Thorpe W. 1998. Dairy co-operatives and policy reform in Kenya: Effects of livestock service and milk market liberalisation. *Food Policy Journal* 23(2):173–185.

Institutional structure to sustain smallholder dairy production and marketing in China

J.X. Liu¹ and Z.E. Zhou²

1. College of Animal Sciences, Zhejiang University, Hangzhou 310029, P.R. China

2. Animal Production and Health Bureau, Zhejiang Provincial Department of Agriculture, 310020 Hangzhou, P.R. China

Introduction

Dairy is the most underdeveloped area in animal production in China. Annual per capita milk production for Chinese citizens was only 6.6 kg in 1997, which was one-sixteenth of world average (Jiang 1999). The government of China has paid much attention to the adjustment of composition of animal agriculture (MOA 2000). Dairy production has been most prioritised to develop recently. Based on Chinese Association of Dairy Cattle, smallholder dairy production accounted for 76.8% of total dairy cattle in China (Li 2000). When millions are involved in milk production, dairying becomes a very competitive business. It is necessary to set up a harmonious relationship with millions of farmers particularly on the pricing of raw milk and sharing of the business profit. Processing of milk for rural producer and urban consumer is the key to the development of a dairy industry anywhere. If the demand exceeds supply, milk producers could get away with unreasonable prices, but, if they are to sustain growth, the pricing has to be reasonable.

Traditional milk trade usually failed to fully exploit the potential, charge unreasonably high prices during the lean periods and pay unreasonably low prices to the farmers in the flush season. Through the high-speed outspreading period from late 1990s, China dairy industry has entered into the structural adjustment period since 1993. Institutional structure to sustain smallholder dairy production and marketing is being formed. This paper will introduce these structures and review the constraints and plans to overcome them.

The discussions on institutional structures, service delivery systems, constraints etc. are based on available published reports, interviews and surveys. Interviews were carried out with dairy researchers, extension experts and farmers. Surveys were conducted in Jinhua—the largest dairy county in Zhejiang Province—where typical smallholder dairy systems exist.

Institutional structures for dairy production and marketing

Institutions for milk collection, processing and marketing

The combination of enterprise and farmers is the main institutional structure for dairy development programme in China (Tuo 1999). Milk is a perishable product. Absence of chilling facilities, high ambient temperatures and lack of hygiene aggravate the problem of marketing milk. Milk production based on smallholders can be sustained only if facilities are provided to process and market milk. Processing of milk is therefore the most important operation in dairy development programme.

Government and/or private entrepreneurs establish enterprises that collect, process and market milk as fresh, milk powder and/or milk-contained drink. These enterprises not only deal with milk processing and marketing as well as feed processing, but also are involved in other activities. In China they are called 'leading enterprises'.

The leading enterprise may be a food processing co-operation, industrial group or a large business unit, which may be state-owned, collective or private ownership. They generally hold milk processing plants or facilities. There is easier access to capital for commercial enterprises, because their assets and lands title can be secured as collateral. The leading enterprises coordinate with local administrative departments to obtain lands, usually in the form of rent. In addition they serve as support organisation to help farmers with a series of services (Jia 2000). Farmers may obtain dairy cattle from the enterprise in the form of lease or at lower prices. Enterprises also supply farmers with technical advices on feeding, management and health, technological training etc.

Depending on the ownership of land and animals, there are several types of institutional structure for combination of enterprise and farmers in China.

Category I. Enterprises in this category don't hold lands and farm. They have to collect milk from individual farmers and then process and market milk. This is an original organised structure. Usually the enterprise makes contracts in advance with individual farmers, in which the price and quality of milk are contained. Depending on the size of the farm, the enterprise may contract with several individual farmers. Farm size ranges from several to hundreds of dairy cattle. In some cases enterprises collect from specialised villages where lots of farmers exist.

Category II. Enterprises in this category possess their own lands or hold lands on lease. They build animal houses by themselves and then lease to farmers or loan to farmers on the cuff. Then milk-processing plant affiliated to the enterprise assures the purchase of milk from the farmers at reasonable prices, which are dependent on the quality of milk. Specialised villages and regions can be set up for dairy keeping.

Category III. These are leading enterprises in form of joint-stock company set up by farmers and/or collectives. They are responsible for rent of lands, planning of production, and processing and marketing of milk. Farmers are producers of milk and stockholder of the enterprise as well. Therefore they can benefit from milk production and from profit sharing.

Category IV. This category consists of the enterprises, which hold both their own milk-processing plant and dairy farms. Within the enterprise there are different divisions, some of which are responsible for cattle feeding, some for milk processing and marketing, and some for feed processing and even trade. Strictly speaking, these enterprises may not be classified into the category of smallholder. However, they can be considered to be an advanced smallholder dairy production systems. When the enterprise has private ownership, the enterprise per se is a combination of milk processing plant and dairy farm.

Institutions to provide breeding, health and advisory services

In addition to the enterprises, governmental stations of animal production and health services are responsible for the breeding and health programmes and extension of advanced technology for smallholder farmers. Artificial insemination is widely used in dairy production. Animal production and health stations organise introduction of frozen semen of excellent bulls from out regions. They provide advisory services on feeding, management and prevention and treatment of diseases.

Other related support systems

There are provincial, municipal and prefecture associations for dairy industry, which also play an important role in development of smallholder dairy production. These associations hold training course and extension demonstration to improve farmers' knowledge of dairy science and extend new technology. Even the most illiterate farmer is responsive to new technology, provided its economic benefits are clearly demonstrated in the prevailing farm situation. Associations also organise farmers to attend and participate in symposia or workshops to exchange their experiences and lessons.

Constraints of smallholder dairy systems

With speedy development of dairy production, Chinese dairy industry faces some constraints (Liu et al. 2001). As a part of the whole industry, smallholder dairy systems have some of the same constraints.

Unfavourable administrative systems

Administrative departments are used to plan the system of the economy, which had been executed for a long time since the founding of the People's Republic of China. Each department does things in its own way and lack close co-operation sometimes. There is little capable, centralised and high efficiency organisation to co-ordinate dairy production and marketing systems. Although they coordinate the relationships to some extent between enterprises and between enterprise and farmer, dairy associations are not administrative

organisations and have no powerful capacity to deal with the relationships well. As a result, dairy production, supply and marketing are out of line with each other, which restricts development of dairy production and decrease the efficiency of production.

Small scale and relatively weak leading enterprise

Except for limited enterprises, most of milk-processing enterprises are of small scale with a few technical staff and inferior processing facilities, especially those belonging to private sectors. The dairy products are of low quality and the profits are low and even deficit. These enterprises lack actual co-operation, but execute ceaselessly irregular and invalid competition with each other. They contend for milk sources during the lean season when there is no milk enough to be marketed, but in the flush season they demand a lower price, lower the class of milk, and even refuse to purchase milk from farmers. Thus there exists speculated contradiction between continuity of milk production and discontinuity of milk purchasing by processing plants. This exerts to some extents an adverse effect on productive enthusiasm of dairy farmers.

Limited lands and environmental aspects

With the development of dairy production, malpractice that mankind and animals coexist in the same places is getting severe. Spaces are limited and, on the other hand, there are environmental pollutions from animal manures. There are strict regulations for land use, so farmers cannot build animal house in their fields as they wish. Depending on our own survey in this region, farm size is very small, a farmer holding 3–5 heads of dairy cattle on average. While they are making great contributions to dairy industry, smallholder producers are incapable of dealing with animal manures, which has been one of the most constrained factors for dairy production in China.

On the other hand, land tenure for forage production was not a constraint, but the tenure rights by farmers are not secure. Many farmers do not own their land or hold only limited lands if any. They have use rights but have no guarantee that they will next year have access to the same land they till this year. As a result farmers may be discouraged from investing in land improvements. In general, it is thought that insecurity of tenure may inhibit the adoption of certain technologies.

Poor knowledge of advanced dairy science and technology

Although administrative organisation and dairy association hold training courses for farmers sometimes, most farmers had relatively poor knowledge of advanced dairy science and technology. The animals are still offered feeds as they have. Some farmers don't fully understand the complex of ruminant nutrition and supply their cows with too much concentrate mixture, resulting in high incidence of digestive abnormality symptoms and high loss of profits.

Problems in feeding and managements

1. Insufficient supply of green forage and unreasonable diet formulation: With limited lands, many smallholder farmers are insufficient in green forage and cultivated grass. In some cases cereal straws and stovers are main roughages particularly in midsummer and in severe winter. Hay and silage are seldom used in dairy diets, and a large proportion of concentrate mixtures are fed to cows. As a result dairy productivity is not high, and, furthermore, contents of dry matter and fat are relatively low. In Jinhua county for example, milk yield for 305 days is only 4750 kg with 2.9% of milk fat (Zou 1999).
2. High incidence of foot and skin diseases: Due to limited lands, animals have to be kept in-house all the day. In addition to little outhouse movement and lack of sunshine, they are not timely hoof-mended and receive little body scrubbing. This has exerted an adverse effect on milk production.
3. High bacterial accounts in fresh milk: Inadequate hygiene facilities, incomplete environmental disinfection and unsanitary milking result in milk of poor quality. Bacterial accounts in fresh milk are usually much higher than the criteria.
4. Imperfect breeding systems: Few specialised organisations are responsible for breeding and improvement of dairy cattle for smallholders. With the exception that service stations replace their bulls replacement heifers receive little selection. In addition, lack of complete pedigree results in frequent occurrence of inbreeding. As a result entire improvement of dairy cattle is slow.

Limited variety of dairy products and weak capability for competition

Besides the small scale, most of smallholder dairy enterprises produce limited variety of milk products. Predominant product is milk powder, which accounts for 54% of milk-processing products (Luo 1999). In some provinces, proportions of milk powder are as high as 90% of dairy products. Condensed milk and malt milk account for 20% and 20% respectively. There are very small amounts of yoghurt, fermented milk, cheese and butter.

Plans to overcome the constraints

Consummation of administrative systems

It is necessary to set up capable, centralised and highly efficient organisations to coordinate smallholder dairy production and marketing systems. Although some favourable policies have been taken for examples on land use, governments should play a more important role in these institutions. They should consider the totality of dairy industry and focus on planning, monitoring the implementation of dairy development programmes and with wider policy matters concerning the organisational issues, use of resources and the strategies to meet local requirements for milk and milk products and external trade. These

organisations will also be responsible for pricing of milk, which may change with milk composition and productive seasons.

Support of leading enterprise and strengthening of competitive capability

Leading enterprises may control the development of dairy production, processing and marketing. Dairy production and marketing structure need to be adjusted to promote industrialisation and intensification. Current small and weak enterprises may be amalgamated and/or reconstituted to form new stronger leading enterprise. Meanwhile dairy products should be diversified and famous brands should be made to strengthen the competitive capability. After China participates in the World Trade Organization, the competition would be keener particularly with international products. Thirteen out of the top 25 milk-producing countries have exported their dairy products to China and the imported products amounted to 100 thousand tonnes in 1998, which accounted for 20 % of total dairy products in China (Chen 2000)

Socialised service systems

There is a need for innovative programmes that make greater resources (credit, lands, feeds, research and technology) and extension-oriented support services (marketing, training, field programmes and demonstration centers) available to small farmers. In addition to the current systems, advisory services for finance, credit and laws are necessary for the farmers. Diseases such as tuberculosis and brucellosis should be regularly supervised and inspected to ensure animal health and safety for producers and consumers. Another function of support services is to advocate nutrition of milk and milk consumption. A plan for pupils to drink milk is one of these activities and should be promoted.

Scaling-up and extensive training of smallholder dairy farmers

Moderate scale of dairy farms should be encouraged. Scale of 20 heads seems to be suitable for smallholder farmers, as there is no need for employees in this scale. When the farm size is too small it is difficult to ensure the safety for milk and producers. Many smallholder farmers are less educated. Training, especially the type that has a practical orientation towards the reality of small farm systems and involves task-oriented teaching and demonstration units has considerable merit. Administrative stations and dairy associations may hold regular lecturing course and symposium to train not only dairy farmers, but also local extension workers and even administrators to improve their knowledge of advanced dairy science and technology.

Implications and lessons learned

Dairy enterprise and farmers are like a commensal, and they supplement, condition and accelerate each other. Combination of a leading enterprise and small farms is the best way to sustain smallholder dairy production and marketing in China. It is necessary to scale-up the leading enterprises to strengthen their competitive capability, especially for international competition. Moderate scale of dairy farms should be encouraged, as it is difficult to ensure the safety for milk and producers in small size farms. Government should pay more important role in institutional infrastructure for smallholder dairy production particularly for policy issues on land use, financing and feed trade.

Questions for discussion

- What is the optimal size of smallholder farmers, which should sustain the development of this system? What scale of land is suitable for the leading enterprise/co-operative, farms and dairy cattle?
- Advanced technologies and smallholder farms – are they contradictory?
- What is the respective role of the state sponsored and co-operatively organised support services in market-oriented smallholder dairy systems?
- What is the optimal way to co-ordinate the relationship and distribution of profits between producers, processors and marketers as well as other sectors such as stakeholders?

References

- Chen X. 2000. Are we ready to join the WTO? *Shanghai Dairy* 23(1):8–9.
- Jia Z. 2000. Investment in dairy industry to found production base and speedy development of dairy production with one action. *China Dairy Cattle* 2:6–7.
- Jiang J. 1999. Way to speed up development of dairy production in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 408–410.
- Li Y. 2000. Grasping of opportunity to promote the development of dairy production in China. *China Dairy Cattle* 3:4–5.
- Liu J.X., Wu Y.M. and Zhou Z.E. 2002. Current situation and prospect for dairy production in China. In: Rangnekar D. and Thorpe W. (eds), *Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDDB, Anand, India, 13–16 March 2001*. NDDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Luo C. 1999. Current situation and development prospect of dairy industry in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 421–429.
- Ministry of Agriculture, P.R.C. 2000. Adjustment of composition of animal agricultures: Key point in animal development in 2000. <http://www.cav.net.cn/xmj/jyh/new032102.html>

- Tuo G. 1999. Five-decade retrospection and vista of dairy production in China. In: Wang H. (ed), *Five-decade development of dairy production in China*. Ocean Publishing House, Beijing, China. pp. 3–13.
- Zhou Y. 1999. Jinhua County calls for rural dairy bases to be turned into market. *China Dairy Cattle* 3:9–11.

Theme 4: Institutional structures to sustain smallholder dairy marketing

Plenary discussion

After the presentation of the five case-study papers on marketing institutions and policies, the points raised in the plenary discussion related to ensuring accountability to stakeholders and the management and impacts of the liberalisation of markets. The debate on accountability, on organisational structures and on policies supportive of responsive markets was continued during the theme 3 group discussion (see below).

The issues and concerns raised in the plenary were:

1. One of the essential ingredients to the success of the Amul model is the integrity of the management.
2. A democratic management structure is important to the success of co-operative/group approaches to dairy marketing.
3. Liberalising the economy favours businesses and areas with comparative advantages (e.g. in Australia where milk production is now concentrated in Victoria) and increased competitiveness in the industry and in the economy. But these changes may not necessarily be favourable to smallholders.
4. Liberalisation needs to be a gradual process because, given time, industry improves but at a cost. One benefit of a managed transition is that there is time to plan for these costs.

These and the related issues from the plenary discussion of the presentations in themes 5 and 6 were subsequently discussed in small groups of workshop participants.

The outcomes for theme 4 are given below.

Group discussion

As with the other groups, the theme 4 discussions were guided by a set of questions. The questions presented to the group addressed collective action and supply and demand issues.

The questions were:

1. Traditional (informal) milk marketing systems dominate in sub-Saharan Africa and South Asia. How can these markets be better served to the benefit of consumers and smallholder producers?
2. Matching milk supply to demand seasonally is a major challenge for smallholder dairying particularly in rain-fed systems. What lessons are there from the experiences in the South to address this challenge?
3. Under what conditions will the 'Amul' model be replicable? If those conditions cannot be met, what alternative approaches should be supported?

4. What is required to make collective action groups effective?

The group responses were outlined in the following section.

How to serve better traditional markets for benefit of consumers and smallholder producers?

Why is there an informal (traditional) system?

- It has evolved itself historically and is in place, unless replaced by a western-style 'organised' sector.
 - Price structure within the formal and informal systems.
 - Lack of well structured marketing system.
 - Scale of handling is too small.
 - Scattered production of milk/agricultural commodities.
 - Farmers can possibly add value to commodities.
 - Strong marketing forces have been driving the system.
- What benefits must reach the smallholder producer?

- Infrastructure for easier access to market.
- Remunerative prices.
- Education for reducing cost of production/marketing and improvement of quality.
- Encourage transition from informal to formal.

What benefit must reach the consumer?

- Quality.
- Price.
- Education of consumer for enhanced awareness.

Matching milk supplies to seasonal demand

- Ensure availability of green feeds uniformly all round the year through improved cropping system.
- Technological interventions to convert seasonal excesses into intermediate products with long shelf life for reconstitution during dry season/periods of high market demand.
- Specialised dairying in regions where milk production could be staggered.
- Networking of organised markets to meet seasonal variations in milk production.

Preconditions for replication of Amul model: What are the alternatives?

- Farmers' will to organise themselves into a group effort.
- Market-driven production system.
- Leadership at farmers' level.
- Freedom from external controls (political, bureaucratic).
- Empowerment of farmers.

Alternatives—Key ingredients

- Transparency.
- Accountability/trust.
- Market-oriented.
- Prices and services.
- Quality and price for consumers.

Requirements to make collective action groups effective?

- Enabling regulatory framework.
- Well-structured organisational framework.
- Markets not distorted by taxes and controls.
- Market demand for products produced by the collective group of smallholders.

Conclusions

The presentations, the supporting papers and the discussion relating to institutional structures to sustain smallholder dairy marketing showed the key role that market orientation and an enabling regulatory framework play in supporting smallholder dairy development and its competitiveness

s. Allied to that is the accountability of the group's managers to the group's members as a pre-requisite for effective collective-action groups. The importance of these issues was highlighted in the workshop recommendations where ways of contributing to achieving the objectives are presented.

**Theme 5: Effective and efficient
livestock services for smallholder
dairy production**

Package of improved livestock services through co-operatives: A case study of the Mehsana¹ District Milk Producers' Union Ltd., Gujarat, India

M.P.G. Kurup

National Dairy Development Board (NDDB), India
E-mail: mpgkurup@wilnwtonline.net/mpgkurup@yahoo.com

Introduction

Gujarat is one of the most highly industrialised and progressive states in India, with high rates of growth both for industry as well as for agriculture. Gujarat is also the leader and trendsetter in India for organised dairy development in the co-operative sector. The Anand Pattern of co-operative movement is made up of a three tier co-operative structure comprising: (i) Dairy Co-operative Societies (DCSs) in villages; (ii) District Milk Producers' Unions (DCMPUs) affiliating the DCSs in districts; and (iii) the apex Co-operative Milk Marketing Federation affiliating the district unions at the state level. This model has now become the most stunningly effective institutional model for rural milk production and dairy development in India. These co-operatives, at all three levels, are fully owned by the members, enjoy complete autonomy and are directly managed by them through the boards of directors, elected by them from among themselves.

The Gujarat Co-operative Milk Marketing Federation (GCMMF), the apex body of the Gujarat milk co-operatives (13 district milk unions), is today the single largest food company in India and is the owner of the brand name 'Amul', famous all over the world for milk and milk products. In 1999–2000, the federation handled some 1.6 million tonnes of milk (daily average of some 4.4 thousand tonnes) collected by its member unions and had a turnover of Rs. 22.20 billion (US\$ 1 = Indian Rupees 46.7 on 1 January 2001). Milk and milk products of Amul and its sister brand 'Sagar', are marketed all over India and in quite a few countries overseas. The Mehsana Milk Union, affiliated to this federation, is one of its founder members and a co-owner.

1. Districts in Gujarat state were reorganised recently. The total number of districts now is 25. However, this does not affect the case study as Mehsana district lost only one of its 11 Talukas and the Mehsana Milk Union's jurisdiction continues to include all the 11 Talukas in undivided Mehsana.

The setting: Mehsana District

Mehsana is one of the 19 districts in the state of Gujarat, eighth in the order of size, with 9027 km² as its total area, located in North Gujarat between the Rann (Desert) of Kutch to the west and the districts of Sabarkantha to the east, Banaskantha to the north and Ahmedabad forming the southern border. Mehsana was a part of the state of Baroda until the reorganisation of States post independence and enjoys a somewhat higher social development index compared to state averages. The literacy rate in the district for example is 55% as against the state average of 51% and it has a large basic educational infrastructure. The human population in Mehsana District was 2.94 million in 1991 and some 80% of them live in rural areas. The district had 11 Talukas (administrative divisions), 1093 inhabited villages and 15 urban agglomerations or towns, but only one out of them has a population of more than 100 thousand. The projected population in the district for 2001, based on the 1981–91 decennial growth rate, is 3.39 million.

About 0.94 million hectares are cropped in the district. Rainfall is medium (600–700 mm) and spread over 8 months, but most of it (90%) comes during the months of June to September. Mehsana is one of the top four irrigated districts in Gujarat and the sources of irrigation are deep bore wells (almost 70%), surface wells, tanks and canals. The gross irrigated area is 0.50 million hectares, over 50% of the total cropped area. Major crops grown in the district, in the order of area cultivated, are oil seeds, pearl millet, wheat, sorghum, rice and pulses; the minor crops are cotton, castor and psillium.

Distribution of land holdings in Mehsana is highly inequitable; it is the same as in the rest of the state and the country. Marginal and small farmers account for 61.45% of the total holdings, but they own or operate less than 26% of the total farming land. The average land holding is 0.55 ha in the case of marginal farmers and 1.45 ha for smallholders. Many of these holdings are held jointly by several members of the family, mostly male siblings. The distribution of the operational land holdings across the different categories and milch animal holding within land holding categories are presented in Figures 1 and 2.

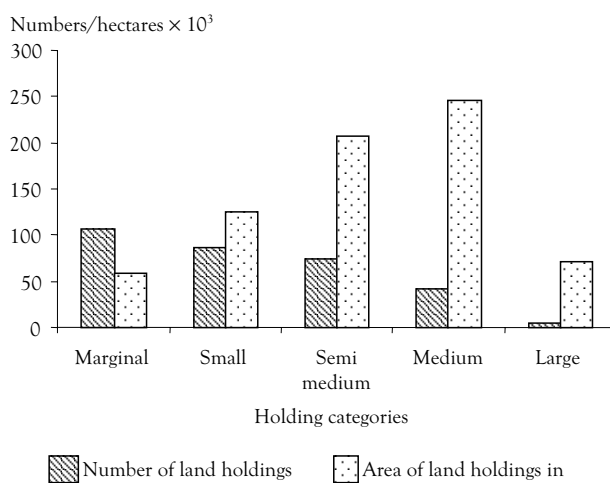
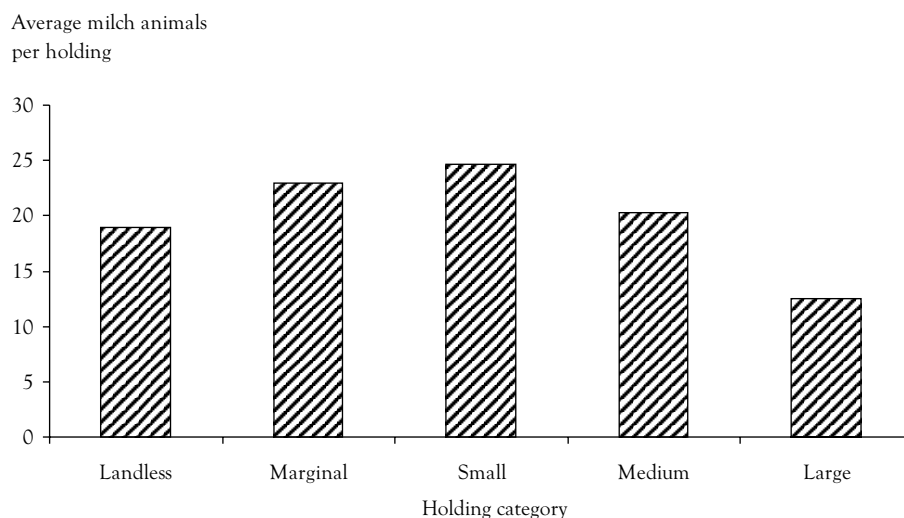


Figure 1. Land holding categories.



Note: Categories: marginal <1 ha; small 1–1.99 ha; semi-medium 2–3.99 ha; medium 4–9.99 ha; large >10 ha.

Figure 2. Average number of milch animals per land holding.

Livestock holdings in general and bovine holdings in particular appear to be more equitable than land holdings. Marginal and small farmers account for nearly 48% of the milch animals. Even land less agricultural labourers own milch animals in Mehsana and earn additional incomes from the sale of milk. Together these three categories form the core milk production sector and own over 67% of the milch animals. This too is consistent with the national trends. Milch animal holding per household among them varies, with an average of one to two cows or buffalo or a combination of the two.

Mehsana District is richly endowed with high quality cattle and buffalo; the district is the natural breeding tract of two of the most promising Indian Breeds—the Mehsani buffalo and the Kankrej cattle. Mehsani buffalo is a new breed buffalo in India. Historical evidence indicates that during the rule of the Gaekwad, Sayaji Rao of Baroda state, Murrah buffalo bulls were imported into the district from as far away as Alwar in north-eastern Rajasthan as a regular policy, for improving milk production in the local Surti breed of buffalo. The present day Mehsani buffalo evolved as the result of several generations of *inter se* mating of the Surti × Murrah hybrids under this policy. They are large animals closer to the Murrah breed in appearance, milk or fat yields and to the Surti in breeding efficiency. The Mehsani buffalo are good dairy animals and produce 1500–2000 kg of milk per lactation with 7% average fat. Data from the Dairy herd Improvement Programme Action (DIPA) Scheme of the Mehsana Union show that standard first lactation milk yields of progeny test heifers average some 1900 to 2070 kg and age at first calving average some 35 to 46 months, for records spread over 10 years between 1991–2000 and for some 3500 daughters under village conditions. High yielding females among the Mehsani buffalo produce 3000 to 3500 kg milk per lactation and such animals are regularly exported to Bombay city for commercial milk production in the city stables.

Kankrej cattle are large, white and majestic with adult body weight averaging 500–600 kg and full-grown breeding bulls weigh some 800 kg. They are officially listed as a dual-purpose breed, but are good milkers. Castrated Kankrej male (bullocks) are considered to be the best draft animals among cattle in India and have a power rating of 0.7 horse power. They can till some 0.3 ha of farm land in a 6 hour working day. Kankrej cows average some 1200 kg of milk per lactation with 4% fat. They have wide selection differential for production traits (a small percentage of the cows produce well over 3000 kg per lactation and institutional herds of Kankrej cows are known to have the first calf by the age of 36 months) and are excellent candidates for development as a commercially viable dairy breed through selective breeding.

The population of cattle and buffalo in Mehsana District in 1992 (results of the 1997 round of the quinquennial livestock census are not available as yet) is presented in Table 1. Milk production estimates for the state and for Mehsana District for 1995–96 are 4.61 and 0.65 million tonnes, respectively, roughly 60% of it is contributed by buffalo. Mehsana is a district with the highest milk production in Gujarat and accounts for some 14% of the state's total milk production.

Table 1. *Cattle and buffalo population in Mehsana District.*

No.	State and District	Cattle: Crossbred/indigenous	Buffalo
1	Gujarat	231,323/6,572,151	5,267,785
2	Mehsana	44,054/254,006*	635,762**
3	Per cent to state total	17.34/3.86	12.07

* Mostly made up of Kankrej and Kankrej type of cattle. ** Mostly made up of Mehsani and Mehsani type of buffalo.

The Mehsana District Milk Producers' Union Ltd.

The milk producers' co-operative movement started in Anand, Kaira District of Gujarat in the mid forties, set up by the milk producers and their enlightened leaders, as an alternative to the highly exploitative and unfair milk trade foisted on them by middlemen and private dairy companies in Anand and Bombay. The spectacular success of the Anand Milk Union Ltd (Amul), its rapid growth and democratic management set up, made it an ideal model for rural milk production and marketing for the rest of Gujarat. It enabled the milk producers to gain direct access to far flung urban milk markets, earn a lion's share of the consumer rupee for their products, eliminating middlemen. Shri. Mansinhbhai P. Patel, the then Vice President of the Mehsana District Development Board was inspired to copy the model in Mehsana for the benefit of the milk producers in that district. The Mehsana District Co-operative Milk Producers' Union Ltd. came into being in November 1960 with the help and sustained support of the Anand Milk Union. By 1965 the Mehsana Milk Union had its own dairy plant for processing the milk produced by its members. The Mehsana Union then proceeded to steadily build up an infrastructure for collection, processing, and marketing of the growing volumes of milk supplied by its members and to provide the members with all

inputs and services required by them to enhance milk production, reduce costs and improve farmers' incomes.

Mehsana Milk Union is registered under the Gujarat State Cooperative Societies Act of 1965 and is governed by the rules and regulations of this Act. The Act is more restrictive than enabling and is overdue for revision and modernisation. Though the union is strong and vibrant both in its structure as well as in financial terms, and even though it receives no financial assistance from the state government, the Act enables the government to intervene in the affairs of the union and to supercede its legally elected farmer board at will. There had been repeated demands from the farmer members and their elected leaders for review and revision of the Act.

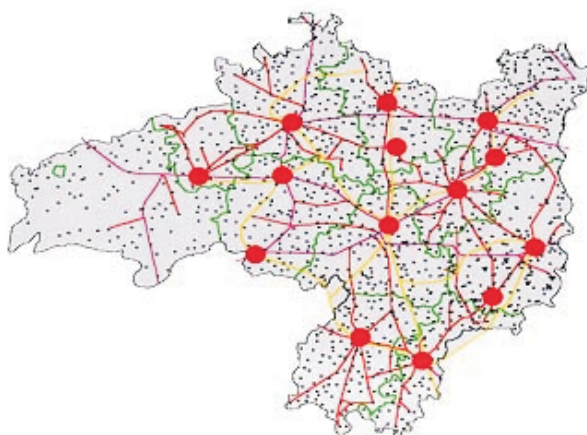
The management structure of the union comprises the Board—board from among the primary members nominated by the DCSs and a chairperson elected from among the board members. Professionals manage the union under the guidance and control of the board. The tenure of the chairperson is one year and a new chairperson is elected each year, even though the incumbent chairperson is eligible for re-election and is often re-elected for continuity and to support long-term development of the union. The present chairperson of the Mehsana Union, Mr Motibhai R. Chaudhury, had been the chairperson of the union for over 30 years. Elected boards from among the primary members of the society also govern the DCSs; and they in turn elect a chairperson from among them. The paid secretary of the DCS and his staff work under the supervision and control of the board.

Milk collection in Mehsana Milk Union follows the Anand Pattern Co-operative set up through village dairy co-operative societies in all major villages in the district, organised along viable milk collection routes (see Map). The DCSs collect milk from their members twice a day, test it for fat content and pay a quality based price to the members, twice daily. The milk collected is picked up by the route milk trucks or tankers twice a day and is delivered to the dairy plant or chilling plant of the union for processing or storage or marketing. Starting with 11 DCSs and an opening volume of some 5000 litres per day, the Mehsana Milk Union now covers the entire district, and has some 1078 dairy co-operative societies and, by 1999, a daily average milk collection volume of 1.13 million kg; and some 415.2 thousand tonnes annually. The end use of the milk collected is presented in Table 2.

Table 2. *End use of milk collected.*

No.	End use	Quantity ($\times 10^3$ t)
1	Liquid milk	32.1
2	Skim milk powder	9.7
3	Whole milk powder	3.1
4	Baby food	11
5	Dairy whitener	3.1
6	Table butter	8.3
7	White butter	1.2
8	Ghee (clarified butter)	4.71

Milk collection in Mehsana has seasonal swings, as buffalo are seasonal breeders with most of the freshening taking place in the monsoon and winter months. This influences milk



Source: GIS database, National Dairy Development Board, Anand.
 Notes: Dark dots indicate DCSs; large dots indicate urban agglomerations.

Map. Spread of dairy co-operative societies (DCSs) in Mehsana District.

procurement substantially. The lean flush ratio of procurement volumes is usually 1:2. This in turn influences the union's milk processing capacity, as the union has to pitch the dairy plant capacity to peak collection volumes. The union also has to programme its product mix in order to enable it to mop up all the surplus milk produced by the members during the flush. To have some influence on the milk production swing, the union practices a judicious milk price swing, paying farmers a lower price for the flush season milk and a rewarding increase in price for lean season production. Mehsana has now become the largest among the milk unions in Gujarat in terms of milk collection volumes and overall turn over. Milk procured by the union averages some 65% of buffalo milk and 35% cow milk. Pricing of milk is therefore based on a 'two axis pricing system' (valuing fat and solids-not-fat in milk on the basis of what the market pays for them and determining on that basis price parity between fat and solids-not-fat) to enable fair prices for both cow and buffalo milk, as they have distinctly different solids contents ratio. At the DCS level actual payment is made to members using a ready reckoner. The unions growth over the years 1960–2000 is presented in Table 3.

Table 3. Growth of the Mehsana Milk Union 1960–2000.

Growth factors	1960–61	1965–66	1972–73	1994–95	1999–2000
Dairy co-operative societies (no.)	11	239	407	1009	1078
Primary producer members (no.)	1000	22,000	70,000	289,600	366,555
Milk procurement (t)	219	13,602	–	257,200	415,200
Share capital ($\times 10^6$ Rs.)	0.01	0.28	4.08	42.1	49.09
Reserve and other funds ($\times 10^6$ Rs.)	0.01	1.56	19.54	143.5	187.19
Net worth of the union ($\times 10^6$ Rs.)	na	7.52	19.96	157.5	332.73
Value of milk purchased ($\times 10^6$ Rs.)	0.63	9.70	73.54	2355.8	5794.75
Turnover of the union ($\times 10^6$ Rs.)	0.12	12.16	101.38	3400.3	6870.00
Net profit of the union ($\times 10^6$ Rs.)	–	0.20	1.02	72.08	291.00

Livestock services in Mehsana District

Livestock services in Mehsana District come from two sources: (i) the State Department of Animal Husbandry (for all species and for all livestock owners); and (ii) the Mehsana Milk Union, exclusively for cattle and buffalo, owned by the union's members and by non-members who supply milk to the DCSs.

Livestock services offered by the state government

As in all other districts in the state, Mehsana has livestock services offered by the state government through the state department of animal husbandry and the institutions under it. These are the veterinary polyclinic (1), veterinary dispensaries (28), first aid veterinary centres (37) and mobile veterinary dispensary (1). A total of 67 veterinary institutions. Qualified veterinarians operate the hospitals or dispensaries and para-veterinary staff manage the other centres. In addition, the department operates an intensive cattle development project (ICDP) in Mehsana with 1 frozen semen production station and 8 artificial insemination (AI) centres, covering 20 villages. In 1995–96 the ICDP carried out some 14 thousand AI services in the district. The veterinary institutions deliver curative veterinary care for all species of livestock and AI for cattle and buffalo. All services offered by the department are delivered at the centre and the livestock owners have to take their animals to the centre for treatment or for AI services. All services offered by the department are free or are highly subsidised.

The quality of the service is poor and the institutions seldom have adequate drugs and medicines in stock, as they receive only a token supply from the department. A farmer gets only a prescription in these institutions and invariably he/she has to buy the drugs and pharmaceuticals from the retail trade. Fiscal deficits and budget constraints have reduced government support to these institutions to salaries of staff employed and establishment costs. The department of animal husbandry spends nearly 95% of the annual budget allocations it receives from the government (public funds) on salaries and establishment costs. Government veterinarians in Gujarat treat some 75% of the cases that come to them as private practice, delivered at the farmer's residence and charge fees and expenses close to market prices.

Production inputs and livestock services in Mehsana Union

The union, as a production support measure, purchases the milk production inputs and livestock services needed by the members. These fall into two distinct categories: (i) those that create a congenial environment for production and generate immediate responses from the milch animals; and (ii) those that bring about progressive and permanent improvements in productivity over the long term. Livestock in Mehsana villages are seldom managed optimally by the farmers and they are perpetually under nutritional and health

stress. The category (i) inputs and services are designed to relieve some of these stresses, so that the animal is enabled to respond quickly with moderate increases in output reducing the yield gap—the difference between potential and actual yields. Balanced, compounded cattle feed and improved fodder; preventive veterinary care for control of animal epidemics; curative veterinary services and extension support, fall in this category. Category (ii) inputs and services comprise AI to help reduce inter-calving period, improve fecundity and, with the use of high genetic quality semen (progeny testing of AI bulls), genetic and productivity improvement, generation after generation.

The inputs and services provided by the union are not targeted primarily towards the members and their milch stock, but are also provided to non-members who supply milk to the DCSs. All services are efficient and sensitive to the needs of the members. The inputs are all of a quality acceptable by the member producers, and access to the inputs and services is equal among members irrespective of the quantity of milk supplied or the location of the member's residence because the users of the inputs and services are the shareholders and owners of the union.

As far as possible the union uses the same channel, the DCS network, for milk collection to market the inputs and some of the services. The cattle and buffalo population that comes under the priority attention of the union are the milch animals owned by the members and their numbers are presented in Table 4.

Table 4. *Target animals for the union's inputs and services.*

No.	Category of animals	Kankrej cattle	Crossbred cattle	Mehsani buffalo
1	Breeding female	82,198	47,566	479,516
2	Breeding female in-milk in May 1999	41,823	29,380	246,602
3	Breeding female pregnant in May 1999	30,008	19,246	218,967

Implementation of the inputs and services for milk production in the Mehsana Union is the responsibility of the Dudh Sagar Research and Development Association, a specialist body and a registered society fully owned by the Union, with the chairperson of the union as its chairperson. The Research and Development Association was established in 1967 and is fully funded by the union; and some special programmes like the Mehsani Buffalo and Kankrej Cattle Sire Evaluation Programmes are jointly funded by the union and supporting agencies like the National dairy Development Board (NDDB). All input and extension activities discussed in the following paragraphs, except manufacture of balanced cattle feed, are managed and implemented by the Research and Development Association.

Compounded balanced cattle feed

Milk production in Mehsana is based entirely on crop residues (straw or stover of rice, pearl millet and sorghum), supplemented by chance grazing, cut green seasonal herbage and small quantities of balanced cattle feed manufactured by the union. The union has established two large modern feed milling plants with a combined capacity of 500 t of balanced feed output per day, one at Boriavi and the other at Ubkal in Mehsana District. The feed

composition is formulated by the animal nutritionist of the union, assisted by the NDDB's consultancy service, and is subject to strict quality control procedures (for both raw materials and finished product) to ensure that the feed meets all the nutritional requirements including minerals and micronutrients. The feed formulation process is a dynamic exercise, computerised and takes into account the seasonal fodder availability or varying seasonal availability and prices of raw materials all over India, and uses the least cost linear programming for utmost economy.

The union supplied some 171,597 t of feed (Sagar Dan) in 1999–2000, the entire quantity marketed through the DCSs for member consumption. The union does not market feed to the local trade, but helps other unions if spare capacity is available in the feed plants. As the policy of the union is to encourage traditional family milk production using available household resources, the recommended feed used by the farmers is 400 g of the feed per litre of buffalo milk of 7% fat and 9% solids-non-fat (SNF) and 300 g for cow milk of 4% fat and 8.5% SNF. Average feed consumption in 1999–2000 was consistent with the recommended dosage, some 410 g per litre of milk procured (cow and buffalo together) by the union. The feed is currently available to the farmer at the DCS at Rs. 5.00 per kg, while the ruling milk prices are Rs. 13.69 for buffalo milk and Rs. 8.81 for cow milk (same quality as discussed above). Therefore the farmer's out-of-pocket expenditure is Rs. 2.00 per litre for buffalo milk, and Rs. 1.50 for cow milk and for feed supplementation. All DCSs carry stocks of 'Sagar Dan' at all times and sell it to farmers loose or in bags as required by them. In addition, the union's feed plants manufacture special feeds such as by-pass protein, fat etc. for high yielding animals and mineral mixture is used to balance the feed and calf starters for calves. Another plant at Ubkal also manufactures urea–molasses blocks, a supplement used to enhance digestibility of straw-based ruminant diets.

Promotion of fodder production

Traditionally farmers in Mehsana use a small part of their pearl millet or sorghum grain crop as green fodder for milking animals. The union introduced cultivation of alfa alfa (*Lucerne*) as a standard practice for feeding milch animals and recommend cultivation of a tenth of an acre of the crop, per milch animal, in the winter season. The union procures and supplies good quality seeds from the market or buys from the members whatever they can produce and sell to other members. In 1999–2000 the union sold some 1724 kg of alfa alfa seeds to 51 DCSs (roughly to 250 ha belonging to 6250 farmers). Alfa alfa seeds are now stocked by the local retail trade in Mehsana District and a number of farmers buy seeds directly from the local markets as the practice of alfa alfa cultivation in winter months in Mehsana has now become a standard practice. Many farmers now raise alfa alfa in winter, take three cuts of green fodder and then let the plant seed for seed production. Other fodder seeds that the union promotes are oats, sorghum and maize.

Another promotional activity of the union for fodder production is variety trials on farmers' land for fodder varieties of sorghum and maize. Villages in Mehsana have common grazing lands attached to them from time immemorial. Private and public agents have usurped many of these areas for other purposes. Of the remaining areas some have been

taken over from the government by the DCSs and are used for producing fodder crops both as a demonstration, as well as a source of green fodder for the community. The extent varies and the number of DCSs carrying out the activity varies from year to year (see Annex).

Animal health care

The union has a three prong approach to animal health care: (i) veterinary first aid at the village level located in the DCSs (ii) mobile veterinary services operating from the union head quarters and delivering services at the farm gate and (iii) special animal health care camps for special ailments. In addition the union has a preventive veterinary health care programme for control and containment of epidemics.

Veterinary first aid

Every DCSs affiliated to the Mehsana Milk union is equipped with a veterinary first aid kit, which comes as a one-time gift from the union. The union also trains a nominee of the DCS from the same village as a first aid and AI worker for a period of six weeks in the union's training centre. The trainee would then become a part of the DCS staff and provide the members with veterinary first aid at all times since he resides in the DCS village. Replenishment of drugs and reagents in the kit is taken care of by the DCS and the service is provided free or at a token charge of Rs. 1 per visit. The first aid worker also acts as a sentinel against epidemics and reports any untoward animal health happenings in the village to the veterinary department of the union for immediate investigation. Mehsana Union has 1078 veterinary first aid units, one in each DCS. During 1999–2000 the first aid units treated a total of some 23,892 cases.

Mobile veterinary services

Members of the union are assured of the services of a qualified veterinarian at their doorstep. To fulfil this commitment the union operates 35 mobile veterinary clinics. Each mobile veterinary unit is provided with a vehicle and a staff of one veterinary doctor, one attendant and a driver. Invariably the vehicle is a hired one on long-term contract and the driver comes with the vehicle. Each mobile units is equipped with a good supply of medicines, drugs and all veterinary instruments for treatments and surgery, all consumables for practice and a radio-telephone for communication with the control room. The union's veterinary department has a control room and they receive calls from the members or from DCSs through the milk trucks' wireless telephones on a 24-hour basis. Each mobile unit operates along an established route and the vet in charge attends to calls falling on his route as advised by the control room from time to time. The services are delivered at the owners' doorstep and are charged at the rate of Rs. 40 for a fresh call and Rs. 20 for repeat calls. The charges cover the cost of transport, cost of all drugs and consumables, and the vets' fee. The calls cost the union some Rs. 77 per case. The expenses of the union for veterinary services

come out of the union's revenues and therefore are really paid for with the members' own money, but immediate charges are imposed on the members to avoid attracting unnecessary demands on the service. The 35 mobile veterinary units operating in Mehsana together treated some 234,196 cases in 1999–2000. The mobile units also carry frozen semen and on demand provide AI services. The staffs of the mobile units are all employees of the union and are paid salaries, allowances, other incentives and over time payments for their services. The charges collected from members for the veterinary services form part of the revenues of the union and are remitted to the union.

Animal health camps

Animal health camps are the union's answer to herd health problems like infertility, repeat breeders and metabolic disorders. Camps are invariably organised on the initiative of a cluster of DCSs with special herd health problems and are attended by a large number of farmers along with their animals requiring attention. In addition to the senior and experienced veterinarians of the union, specialists from the veterinary college, the universities and the State Department of Animal Husbandry join the camps and make their skills and experience available for solving problems. In 1999–2000 such camps provided by the Mehsana Union treated some 22,424 animals.

Preventive veterinary care

The union's veterinary department keeps vigil on epidemics in and around their area of operation and in the neighbouring states with the help of the NDDB's Animal Disease Research Laboratory and the State Department of Animal Husbandry. It takes decisive action to prevent epidemics or contain outbreaks in the district. The union participates in the NDDB-led geographical information system (GIS) for disease surveillance. The two most important diseases for Mehsana are haemorrhagic septicaemia (HS) and foot and mouth disease (FMD). Vaccination campaigns are mounted usually following the first report of outbreaks. Large numbers of cattle and buffalo, over half the population at risk in the case of FMD in the area, are protected by vaccination. In the case of HS, outbreaks are usually localised and only animals in contact and nearby areas are vaccinated to contain outbreaks. In 1999–2000 the union carried out some 282,650 vaccinations against FMD and some 62,878 vaccinations against HS.

Artificial insemination

The AI set up of the Mehsana Union is also based predominantly on the DCS network. AI centres are located in DCSs, each manned by a trained AI technician (veterinary first aid cum AI technician) who resides in the village and is easily available to the farmers. The centres are equipped with one liquid nitrogen container for the storage of frozen cattle and buffalo semen. Frozen semen and liquid nitrogen are supplied by the union once a month or as often

as required in case of emergencies. Farmers in the village bring their animals for AI to the centre, often not more than a two minute walk thus not putting the animals under any stress. In new areas the union has now started cluster AI centres to make more economic use of the equipment, reduce costs, use manpower more optimally, and to bring larger areas under AI coverage rapidly. The cluster AI centre operates from one DCS. It is mobile (a moped or scooter) and covers a cluster of up to ten DCSs daily. The farmer still has to bring the animals to the DCS for AI. Out of the 1078 societies spread over 11 Talukas of the union's area, only 349 have AI centres and another 130 are covered under cluster AI services. AI is yet to spread to other DCS areas. In 1999 the union's AI system carried out some 147.7 thousand AI in cattle and over 167 thousand in buffalo. The service is efficient and averages over the years a conception rate of 40–50% (some 2.5 AI per calf born, see Table 4). The spread of AI centres in the union's area is presented in Table 5. The DCS/Union charge the farmers Rs. 5 per AI, while the unions cost per AI comes to some Rs. 31.90. Here again the costs are met out of the unions revenues and hence is paid with farmers money.

Table 5. *Spread of artificial insemination (AI) centres in Mehsana Union.*

Taluka	AI Centres	
	DCS	Cluster
Chansma	27	–
Harij	5	2
Kadi	20	–
Kalol	24	1
Kheralu	48	–
Mehsana	43	1
Patan	11	2
Sami	1	1
Sidhpur	42	1
Vijapur	98	5
Visnagar	30	–
Total	349	13

Sperm station in Mehsana

The union has a well-equipped sperm station for the production of frozen semen in Jaguthan, which produces mainly Mehsani buffalo semen. This station is primarily concerned with frozen semen production for the ongoing Mehsani bull progeny testing programme of the union and carries stocks of frozen semen from under test as well as proven Mehsani bulls.

For the crossbreeding (local cattle) and the *inter se* mating programmes in crossbred cattle in Mehsana, the union buys Holstein–Friesian, Jersey and crossbred frozen semen from the Sabarmathi Ashram Goshala, Bidaj and Gujarat. The station has a capacity to

operate up to 60 bulls for frozen semen production and to stock up to 0.60 million doses of frozen semen. The status of the station in March 2000 is presented in Table 6.

Table 6. *Sperm station in Mehsana, status 2000.*

Category of bulls	No. of bulls	Category of bulls	Frozen semen doses
Mehsani buffalo	38	Frozen semen production 1999–2000	397,540
Kankrej cattle	2	Semen, Mehsani buffalo	437,307 stock
Crossbred Jersey cattle	1	Frozen semen, Holstein–Friesian	3367 stock
Crossbred HF cattle	12	Frozen semen, Jersey	12,856 stock
		Frozen semen, Kankrej	33,250 stock
		Frozen semen, cross bred HF (F ₁)	23884 stock
		Frozen semen, crossbred HF (F ₂)	2151 stock
		Frozen semen crossbred Jersey	25,589 stock
		Frozen semen test bulls (84)*	437,307 stock
		Frozen semen proven bulls (11)**	41,264 stock

* Mehsani bulls tested so far; ** Mehsani bulls proven so far (both part of the total Mehsani frozen semen stock at serial no. 2); HF= Holstein–Friesian.

Progeny testing of buffalo bulls

Starting 1987 the Mehsana Union has been participating in the NDDB-financed Dairy herd Improvement Programme Action (DIPA), for proving Mehsani bulls for the AI system in the union. The statistical design involves testing of provisionally selected bulls, at least 20 in a batch, testing mating a minimum of some 2000 randomly identified females per bull spread over the entire district, and collection of the first lactation records of daughters born. The principle of the test is to analyse the variance among the records, partition the genetic variance from the total variance and then work out the breeding value of the bulls.

The procedure in practice compares the standardised records of the daughters of each bull with the daughters of all other bulls and estimating the breeding values of the bulls using best linear unbiased prediction (BLUP). The bulls are then ranked according to their breeding value for milk yield as well as fat and protein yield and percentage (see Sire Index, Table 8). The top two or three bulls among them in each analysis are used for producing the breeding stock for the next generation. Mehsana has so far tested six batches of Mehsani bulls (total 84) and selected 11 as proven bulls. The summary of the test is presented in Tables 7 and 8.

While it is too early to comment on the impact of the test, the trends shown in Figure 3 indicates steady progress in the population. The union of course, needs to increase the number of bulls per batch, the number of recorded daughters per bull and the base population size (now the test is confined to 35 DCS areas; it should spread to the entire area of the union) in order to increase the accuracy of the test and gain substantial genetic improvements generation after generation. Records for 1997–2000 will be complete in a couple of years and this will help confirm the observed trends.

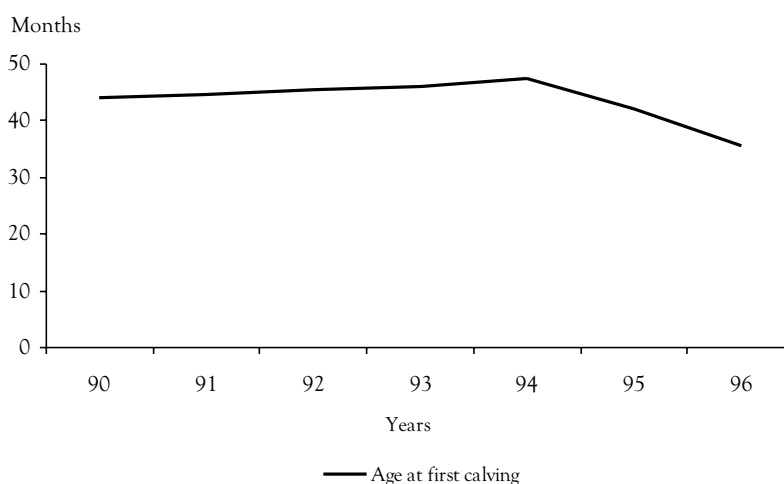
Table 7. Progeny test of Mehsani buffalo bulls.

Batch	Bulls	MFSL ¹	MAFC ²
		kg/daughters	months/daughters
1	13	1971/676	43.6/728
2	20	1918/681	44.1/743
3	12	1942/707	44.9/730
4	15	2033/296	45.5/346
5	12	1962/486	46.2/544
6	12	2007/234	41.9/295
7	11	2069/51	34.9/66

1. MFSL = mean first standard lactation; 2. MAFC = mean age at first calving.

Table 8. List of proven lactation of Mehsana bulls and their milk index.

No.	Bull no.	Daughters	Index/milk
1	117	29	+100.2
2	91	26	+86.9
3	114	23	+68.7
4	104	49	+54.9
5	75	24	+53.1
6	115	23	+47.7
7	53	19	+47.7
8	86	50	+46.6
9	20	58	+46.6
10	50	31	+44.9
11	24	40	+40.9

**Figure 3.** Age at first calving recorded for the period 1990-96.

Field recording of the test of daughters is carried out by the DCSs as are the fat tests of milk samples on the test dates. Supervision of the recording is excellent and the DCS set up has emerged as a most reliable village data collection network. All costs incurred by the DCSs are reimbursed by the union. The dairy improvement programme for Mehsana needs review and mid course correction to make the test more accurate and somewhat faster. The union has recently started a dairy improvement programme for testing Kankrej bulls and to introduce selective breeding of the Kankrej population using proven bulls.

Extension support

The Mehsana Union has a well focused extension support programme acting on two distinctly separate levels among the producer members: for co-operative development and for production enhancement and technology transfer. Both are designed as member education. Co-operative development activities get support and funds from the NDDB and this is the programme that keeps the hundreds of thousands of members well knitted and well informed of their responsibilities, rights and obligations to their co-operative institutions. The programmes consist of group meetings in villages, workshops and training of village opinion leaders, both men and women.

On the production front the programme comprises induction programmes of both men and women from member families. Groups of men and women from DCS areas are taken to the union head quarters regularly and are given well-focused exposure on the set up and functions of the union and their business progress. They also visit the feed plants, sperm station and the veterinary division and learn about feed formulations, nutrition and diets for milch animals, about AI and about animal diseases and vaccinations.

One bus load of men or women visit the union and the other institutions of the union every working day throughout the year. As a result, over the years every DCS village has several batches of men and women who have gone through the induction programmes and can explain and 'sell' the union and its input programmes and services. This has helped the union gain enormous credibility among the members by giving the members an overwhelming sense of ownership and has helped immensely in technology introduction and their rapid adoption by members.

Costs for inputs, services and extension support

The union's recurring costs together for all inputs and services for 1999–2000 add up to some Rs. 37.43 million, just 0.6% of the current year's turnover and less than Rs. 0.10 per litre of milk procured by the union in 1999–2000. The costs in the case of the extension support programme are even lower at 0.05% of the turnover and less than Rs. 0.01 per litre of milk procured.

Impact of the milk union and social dimensions

Milk production in Mehsana, like in the rest of the state and country, takes place in millions of tiny smallholdings. The landless, marginal and small farmers constitute the core milk production sector in Mehsana and account for nearly 89% of the union's primary members (see Table 9) and own some 80% of the milch cattle and buffalo. They also supply over 80% of all milk collected by the union.

Table 9. *Distribution of members in land holding categories (numbers and percentage of total).*

Land holding category	Numbers	Percentage of total
Landless	59,901	16.5
Marginal	122,708	33.8
Small	139,401	38.4
Others	41,022	11.3
Total	363,032	100

In 1999–2000, the average daily milk collection of the union was some 1.13 million litres, an average of 3.5 litres per member. Based on current prices for cow and buffalo milk, this collection volume equals to Rs. 12.50 million of income pumped into the district village economy in the district every day of the year and an average of some Rs. 35 per member (this calculation is only for an illustration of the impact on incomes. At any point of time not more than 60% of members will be pouring milk in the DCS on account of animals going dry during a part of the year) of the society as daily cash income from milk prices.

For a family living in rural Mehsana this amount is a substantial income and makes all the difference between starvation and prosperity. And this is only a subsidiary income. In addition to the direct price paid by the union at the time of purchase, the union ploughs back a substantial part of the annual profit to the farmer at the end of the year as a bonus, and the bonus often exceeds 20% of the milk price he/she receives in the year.

There are many other economic and social benefits impacting the individual members and the rural society as a whole. For example, the ability to improve capital formation and freedom from debts at the family level and daily transfer of wealth from urban to rural communities stimulate the rural economy to growth and stability. On the social front too the union and the co-operative movement have considerable impact on the village society particularly in removing social inequities and bringing in social discipline in day to day life. These are not discussed as part of this case study.

Lessons learned

1. In a country like India where milk production takes place in millions of tiny and smallholdings scattered across the length and breadth of the country, the Anand Pattern Co-operative is the most pragmatic institutional model for development of milk production and dairy development.

2. While farmer ownership and control are essential for rural enterprises to make them responsive to the aspirations of farmers and sensitive to their needs, it is essential to blend it with professional management for efficiency, economy, growth and prosperity.
3. Generation and supply of inputs and services for production enhancement are at their best when promoted and operated by farmer organisations for quality, economy of scale, efficiency and regularity.
4. The Indian farming communities have traditional wisdom and enormous farming skills; they are open to change, can accept responsibility and have among them natural leaders capable of rising to great heights.

Points for discussion

1. Key issues in organising smallholders into credible economic institutions.
2. Cost effective models for livestock services delivery.
3. Quality assurance in AI systems for smallholders.
4. Organisation of sire evaluation procedures for smallholder dairy production.
5. Non-formal approaches to extension support in smallholder dairy production systems.

Annex. Activities of the Mehsana Union (1994–2000)

Activities	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Milk procurement ($\times 10^6$ kg.)						
Buffalo	169.8	189.5	233.0	240.0	252.9	264.1
Cow	87.4	96.7	119.3	120.1	133.9	151.1
Total	257.2	286.2	352.3	361.0	386.8	415.2
Manufacture of products (t)						
Milk powders	24,315	25,332	30,593	36,404	30,128	29,679
Ghee (clarified butter)	8084	4396	6230	7022	5947	5311
Butter (includes white butter)		7347	10,364	9407	10,212	10,502
Sweetened condensed milk	–	125	959	1890	2710	3265
Sale of milk and products						
Liquid milk ($\times 10^6$ litre)	61.7	90.1	86.0	90.00	131.1	149.9
Milk products (t)	38,680	37,824	39,951	48,469	53,355	47,672
Sales turnover ($\times 10^6$ Rs.)	3400.3	4100.1	4554.2	5377.1	6529.8	6867.2
Breeding programme*						
Progeny testing						
No. of calves born	2272		2969	3548		
Conceived at age (in months)	30	31.7	33.5	35.01		
Average milk yield in 1st lactation	1993	1988	1971	2011		
Average milk yield in 2nd lactation	2254					
No. of frozen semen centres	371	355	355	357	372	378
Insemination cow	103,549	103,395	122,557	137,102	168,450	147,700
Insemination Buffalo	121,660	135,012	147,632	158,924	178,231	167,040
Feed and fodder						

Cont'd

Activities	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Cattle feed, calf starter and urea-molasses blocks	86,338	92,997	113,475	128,779	143,154	171,556
Fodder farms (ha)	120	97	97	97		74
Production of green fodder (t)	2807	2213	3164	2156	1465	1871
Production of dry fodder (t)	38	53	44	37	19	4
No. of beneficiaries	2618	3615	3906	4398	2052	2245
Small	929	1197	1534	1673	606	647
Marginal	531	587	725	1075	498	553
Landless	952	1599	1415	1322	822	849
Others	204	232	232	319	126	196
Hand chaff cutters (no.)	4538	3864	3929	2678	4424	2761
Subsidy paid (Rs.)	385,730	349,145	368,490	261,105	487,638	323,027
Improved sickles (no.)	7730	9771	11,334	4725	10,286	6040
Subsidy (Rs.)	23,310	29,313	34,002	14,157	30,858	18,120
No. of fodder demonstration						
Fodder farms in DCS	104					30
Supply of improved seeds (Qts.)	230.94	244.5	877.0	425.8	104.2	8.56
Subsidy provided (Rs.)	166,160	212,840	30,250			14,980
Co-operative development						
Women participants (no.)	11,661	24,318	18,042	15,847	27,728	20,401
Men participants (no.)	7415	17,123	15,196	14,086	18,060	15,332
Management committee						
members (no.)	665	1488	1467	1447	2053	2159
Farmer induction programme (no.)	19,741	42,929	34,705	31,380	41,841	37,892

Activities	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Milk days celebrations						
No. of participants (women)	1838	4132	1850			2900
Veterinary treatment	279,575	241,533	259,230	268,462	288,247	284,780
Cases treated on special visits	159,198	142,949	176,945	180,207	198,227	234,196
FMD vaccinations (no.)	117,574	140,202	204,740	175,846	199,055	282,650
Hemorrhagic septicemia	106,625	82,472	64,797	42,224	64,795	62,878
Social welfare schemes						
No. of women beneficiaries	180	80	85			
Cumulative no. since inception	3650	3730	3815			
Amount (× 10 ⁶ Rs.)	3.528	1.231	0.881			
Cumulative amount (× 10 ⁶ Rs.)	18.134	19.365	20.246			
Group insurance scheme						
For members of DCS (no.)	883	893	897	911	936	955
Women insured	67,180	62,127	69,047	78,520	85,000	102,670
Male members insured	100,934	99,460	97,589	102,071	105,924	127,241
Subsidy provided by union						
Amount (× 10 ⁶ Rs.)	1.443	1.936	1.488	1.603	2.541	3.137
Claims settled (no.)	1847	1773	2026	1584	2264	1858
Amount received against claims (× 10 ⁶ Rs.)	9.315	9.00	10.490	8.46	12.30	9.75
Savings linked insurance scheme						
(a) DCS participating (no.)	233	230	228	234	233	240
(b) Claims settled	384	302	347	332	364	250

Cont'd

Activities	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Amount paid (× 10 ⁶ Rs.)	1.92	1.510	1.735	1.219	1.820	1.250
Group cattle insurance						
No. of participating DCS	452	415	420	287	388	272
No. of animals covered	73,096	71,751	73,092	55,839	83,239	82,650
Premium paid by union (× 10 ⁶ Rs.)	2.845	2529	-			
No. of claims settled	3924	2874	3763	3664	3667	5072
Amount paid (× 10 ⁶ Rs.)	16.189	7.628	19.646	20.011	23.283	27.614
DCS with Milko Tester machines (no.)		911	948	981	1014	1022
No. of Milko testers				1214	1282	1311
Automatic milk collection stations in DCS (no.)			25	25	92	98

* The numbers in rows 'Breeding programme', and 'Progeny testing' relate to sets of bulls tested, not years.

Contributions of Heifer Project International (HPI) to small-scale dairy development in Cameroon

R.M. Njwe¹, L.N. Kwinji¹, A.L. Gabche¹ and E.N. Tambi²

1. Heifer Project International–Cameroon, P.O. Box 467, Bamenda, Cameroon

E-mail: hpicam@douala.com

2. Organization of African Unity/Inter African Bureau of Animal Resources (OAU/IBAR)

P.O. Box 30786, Nairobi, Kenya

E-mail: Tambi.PACE@OAU-IBAR.org

Introduction

In the last three decades, several attempts have been made to develop the dairy sector in Cameroon. These efforts have principally focused on genetic improvement through cross-breeding local with exotic breeds of cattle; improving nutrition through pasture improvement and supplementary feeding; better health, hygiene and sanitation; and better access to markets for dairy products (IRZV 1990). In spite of all these efforts, dairy production is still on a small-scale, experimental and embryonic level compared to the dairy industry in developed countries.

Heifer Project International (HPI) is an ecumenical, Christian and charitable non-governmental organisation (NGO), supported by contributions from those who believe in HPI's basic commitment to helping resource-poor people help themselves and their communities. An American called Dan West founded it in 1944. The mission of HPI is to work in partnership with others, to alleviate hunger, poverty and environmental degradation by: a) responding to requests for development assistance, including animals, training and technical assistance, which enables families to seek self-reliance in food production and income generation on a sustainable basis; b) enabling people to share 'pass on the gift' in a way that enhances dignity and offers everyone the opportunity to make a difference in the struggle to alleviate hunger and poverty; c) educating people about the root causes of hunger and poverty based on HPI's experiences and insight gained from working with animals in development since 1944; d) supporting people in sustainable development and the stewardship of the environment through responsible management of animal resources.

HPI combats hunger, alleviates rural poverty and restores the environment by providing appropriate livestock, training and related services to small-scale farmers worldwide. The organisation helps farmers utilise livestock as an integral component of sustainable agriculture and holistic development.

Animals in all projects must have access to adequate feed, water and shelter and be humanely treated. Project participants are given training and on-site technical advice to

improve their skills and knowledge in animal care, planning and management. The type of animals used in projects varies according to local needs and requests. Former experience, natural resources and marketability of surplus production are also taken into account. Projects are selected on the basis of meeting HPI's twelve 'Cornerstones for Just and Sustainable Development'. The 12 factors form the acronym PASSING on the GIFTS.

The factors or cornerstones are: Passing on the Gift, Accountability, Sharing and caring, Sustainability and Self-reliance, Improved Animal Management, Nutrition and Income, Gender and Family Focus, on the Genuine Need and Justice, Improving the Environment, Full Participation, Training and Education and Spirituality.

HPI's key concept is that each recipient must pass on offspring of the farm animals they receive to others. This principle, called 'passing on the gift', assures that each participant in the program becomes a donor to others, enhancing dignity and participation in each project. 'Passing on the gift' also helps communities to become self-sustaining. Many project holder's work out agreements to return several offspring, one to be donated to another family, and another for support of the local organisation's ongoing training and follow up needs.

HPI projects strengthen rural families and communities through improved nourishment, increased production and the dissemination of skills and knowledge for self-reliance. Care for the earth's natural resources are emphasised through training in livestock management, pasture improvement, soil conservation, forestation and water harvesting.

During the last 5.6 decades, more than a million families in 110 countries who once faced starvation have become self-reliant as a result of the work of Heifer for Relief—now . Presently, HPI has small-scale rural livestock projects in 45 countries around the world in four geographical zones: Africa (Burkina Faso, Ghana, Cameroon, Rwanda, Uganda, Kenya, Tanzania, Zambia, Zimbabwe, South Africa and Mozambique); South East Asia (Afghanistan, Bangladesh, India, Nepal, Thailand, Laos, Cambodia, Vietnam, Indonesia, Philippines, Mongolia, Myanmar, Democratic People's Republic of Korea, Pakistan and China); Central and Eastern Europe (Albania, Slovakia, Georgia, Lithuania, Russia, Armenia, Poland, Romania and Ukraine); North America (Canada, USA and Mexico); and Latin America and the Caribbean (Guatemala, Dominican Republic, Haiti, Nicaragua, El Salvador, Honduras, Ecuador, Peru and Bolivia). These small-scale projects involve the following animal species in various ecological regions of the world: guinea pig, pig, chicken, duck, rabbit, sheep, goat, cow, water buffalo, camel, donkey, earthworm, fish, geese, guinea fowl, horse, mule, alpaca, llama, silkworm, turkey and yak.

The Heifer Project International (HPI) has been involved in dairy development in Cameroon since 1974. Prior to this period, Cameroon was a typical tropical developing country with relatively little or no dairy tradition apart from milking of cattle under an extensive traditional system of management. HPI's first attempt to ensure the development of dairy industry in Cameroon began in 1974 with the introduction of 22 Holstein-Friesian and Jersey cattle imported from the United States. The aim of this importation was to improve the genetic make up of the local Gudali, Red Mbororo and White Fulani cattle through crossbreeding for improved milk production. Additional imports of 22 and 79 Holstein and Jersey cattle were undertaken in 1976 and 1981, respectively. Working jointly with the Institute of Animal Research (IAR), HPI began distributing crossbred dairy cows to smallholder farmers in 1978. By 1981, a semi-intensive dairy production system based on

crossbred cattle was underway in the North West Province of Cameroon. In 1994 more emphasis was placed on a zero-grazing dairy production using purebred Holstein and Friesian cattle, the aim being to achieve milk production levels comparable to those of the developed countries. The North West province has an altitude ranging from 900 to 3003 metres above sea level and the climate is generally cool throughout the year.

This report examines the role that HPI has played in dairy development in Cameroon, the impact it has had on the target population and its socio-economic environment and the lessons that can be learnt from the HPI dairy development strategy. The report begins with a brief review of dairy production in Cameroon, followed by the dairy development strategy adopted by HPI. Next is summary of the results obtained under the HPI strategy and then the impact of these results on target farmers. The constraints that the dairy sector still faces in Cameroon are presented followed finally by the implications and lessons drawn from the HPI intervention in Cameroon.

Dairy production in Cameroon

A number of studies have presented a critical review of dairy development in Cameroon (Atekwana and Maximuangu 1981; Njwe 1984; Tambi 1991). Overall, the studies suggest that dairy production in Cameroon is relatively recent, beginning only in the early part of the 20th Century. Records on the German, English and French colonial periods in Cameroon indicate that in 1914 the English Army that defeated the Germans in the Littoral region of the country found a well developed dairy farm stocked with Swiss Highland cattle in Buea (Spencer 1915). In Djutittsa and Kuti in the West Province of Cameroon dairy farms were also available (Crawford 1916).

Reports from the Buea Farms indicate that during the period 1954–56 Friesian–Montbeliard crossbred were producing an average daily milk yield of 1.25 gallons (CDC Report 1954–1956). Recently at the IAR Bambui, Kamga et al. (1987) reported an average daily milk yield obtained from local pastures of 6.67 litres compared to 9.49 litres per day obtained from improved and well-managed pastures. Goldman et al. (1985) reported daily milk yield from Gudali and local zebu cattle grazed on native pastures and fed concentrate supplements of 2.34 and 2.97 litres per animal during the dry and rainy seasons, respectively. From studies conducted at IAR Wakwa, Tambi (1991) showed that apart from high mortality rates (39.9%) Holstein–Friesians performed relatively better under tropical conditions than local Gudalis. Their milk production averaged 3431 litres for a lactation period of 283 days (12.1 litres/day) (and their calving interval of 383 days and average age at first calving of 940 days were relatively shorter than the local Gudalis. The cross-breeds (Holstein × Gudali) had a relatively lower mortality rate (11.8%) and their milk production averaged 1524 litres for a lactation period of 256 days (5.9 litres/day) while the local Gudalis had a low mortality rate of 4.3% and an average milk production of 483 litres for a lactation period of 168 days (2.9 litres/day). Raising cattle on local pastures without adequate supplementation tends to limit milk production from both the local and crossbred cattle.

In Cameroon most of the local breeds of livestock are raised under the extensive system. This system is popular in the Adamawa, Far North, North, North-West and West Provinces

of the country. The system is based on indigenous breeds of zebu cattle notably the Gudali, Red Mbororo and White Fulani. The animals are grazed extensively on natural pastures year round. Improved pastures are lacking and supplementary feeding with concentrates and minerals are totally absent. During the wet season the cattle are grazed on hilltops and slopes and during the dry season they are taken on transhumance to river valleys after crops have been harvested. Meat is the major product of this system while milk production is secondary. Animals are milked once a day and the average daily milk yield is 2–3 litres per lactating cow. A larger portion of the milk is consumed by the family. Dams and calves are not separated until weaning.

Achieving increased and sustainable dairy production requires a radical departure from the extensive system of dairy production clearly evident in Cameroon. Kenya's experience in smallholder dairy development has shown that semi-intensive and zero-grazing dairy units are viable alternative strategies for meeting increased demand for dairy products. HPI has been the pioneering organisation involved in the introduction of semi-intensive and zero-grazing dairy production strategies in Cameroon.

HPI/Cameroon small-scale dairy development strategy

HPI works with limited resources families within sub-urban and peri-urban areas with the aim of alleviating poverty and malnutrition. In Cameroon, HPI staff contact existing farming groups in needy communities and sensitise them on the benefits of zero-grazing small-scale dairy farming. Those farming groups that are interested in small-scale dairy farming then make a request to the HPI screening committee. They are required to submit the internal rules and regulations governing the group together with other relevant documents to substantiate their existence and credibility as a Common Initiative Group (CIG).

Selected groups are given basic village-based training on the different aspects of zero-grazing dairy production. The choice of zero-grazing arose from the need to reduce the incidence of ticks on animals, especially when they are allowed to graze on infested pastures. The first batches of purebred Holstein cattle introduced at the National Research Stations at Bambui and Wakwa were eliminated by ticks, as a result of inadequate preventive measures. This led to a recommendation of cross bred animals with local cattle which produce lower yields of milk but better resistance to tick borne diseases by the Livestock Research Institute in Cameroon. The zero-grazing system had been tested in Uganda and Tanzania and had resulted in rapid increases in milk production by small-scale rural farmers. The adoption in Cameroon was therefore an extension of the successful experience in East Africa. Recently, researchers of the Livestock Research Institute have approached HPI to collaborate in a joint research program that will quantify the performance of these animals under on-farm conditions, since the results available were under on-station conditions. HPI has welcomed this collaboration. The government does not provide grants to HPI but readily grants import permits for cattle from East Africa and exonerates all taxes related to importation.

The training involves site selection, pasture improvement, agro-forestry, on-farm-feed production, routine cattle management, cattle breeding and reproduction, milk production and handling, animal housing, health, marketing and book keeping and co-operative development. They are also educated on the HPI philosophy and the concept of 'passing on the gift' (POG).

Heifer Project International has developed a set of essential principles called the HPI Cornerstones for Just and Sustainable Development. All organisations and farmer groups are screened, monitored and evaluated according to these principles, and project plans made by groups take these factors into consideration.

After this initial training, refresher courses are organised to fill up any gaps from the basic training. Regular extension follow-up is also provided to the farmers during the entire duration of HPI's assistance. During the follow-up, HPI staff collaborates with experienced farmers as well as other technical collaborators from the Ministries of Agriculture, Livestock and scientific Research and other NGOs.

After the initial training, farmers are required to have a minimum of 0.5 ha of improved pastures (Guatemala, Elephant grass and *Brachiaria* spp, mixed with legumes such as *Stylosanthes*, Lablab and *Desmodium* spp) and 500 to 1000 established leguminous fodder trees (*Calliandra*, *Leuceana*, *Acacia* etc). A completed Kenyan model zero-grazing stable (consisting of feeders, drinkers, sleeping cubicles, walk yard, calf pen, milking parlour etc.) has to be constructed before qualifying to receive a zero-grazing purebred Holstein-Friesian cattle from HPI on the POG basis. As part of the contribution to the project, farmers provide land, family labour and local materials during the lifetime of the project. HPI provides training, extension follow-up services, agricultural inputs [initial supply of pasture seeds, cement for floors, veterinary drugs] dairy cattle quarantine and placements, technical services and financial support [including farmer exchange visits]. Although the financial and technical assistance lasted for 3 years, the technical follow-up has continued for another 2 years. Micro credit financing to help boost production and milk marketing is offered to groups after 3 years of assistance provided they submit an application for short-term loans for a viable project. The application is recommended by HPI to the Cameroon Credit Union League (CAMCUL).

Before and after animal placement, there is a joint follow-up by farmers and HPI in the areas of agro forestry, pasture establishment, pasture seed and hay production, artificial insemination, vaccination and TB screening. Farmers also submit quarterly progress monitoring information on indicators such as milk production, consumption, marketing, manure production, utilisation and sales, calving, gender and group leadership issues which are analysed and sent to donors and farmers periodically.

Description of project area

The HPI smallholder dairy development project operates in the North West Province (NWP), one of Cameroon's ten provinces. It is situated between latitudes 5.30° and 7.20° north of the Equator and between longitudes 7.7° and 11.5° east of the Greenwich Meridian. The topography is mountainous and the altitude ranges from 800 to 2200 m with an average of 1200

metres above sea level. Temperature ranges from 15–24°C. The average annual rainfall is 1500 mm. It is unimodal and the peak occurs in September. The annual relative humidity varies from 50% in the dry season to 70% in the wet season. There are two distinct seasons: the dry season, which occurs between mid-November to mid-March and the rainy season from mid-March to mid-November. Sunshine hours range from 8 hours to 17 hours in the dry seasons and 09 hours to 13 hours in the rainy season. Generally, the highlands have a cool climate all year round which is less stressful to dairy animals of temperate origin than that the hot lowlands.

The soils of the NWP are not uniform. In Bamenda, the provincial capital, the soils are ferralitic with outcrops of recent volcanic soils. Overgrazing and poor cultural practices have resulted in a decline of the fertility of soils. The vegetation is predominantly savannah with *Sporobolus africanus* as the predominant natural pasture. This grass has a low nutritive value. The forage species found in the zero-grazed pastures in the farms where the study was carried out were: grasses (*Tripsacum laxum*, *Pennisetum purpureum*, *Brachiaria ruziziensis*), legumes (*Desmodium intortum*, *Desmodium uncinatum* and *Stylosanthes guyanensis*) and browse plants (*Calliandra calothyrsus*, *Leucaena leucocephala* and *Erithina poeppigiana*). The population density of the NWP is about 80 persons/km². With increasing population, the pressure on the limited land has increased due to intensification of agriculture. The size of household land has been decreasing.

Establishment of small-scale zero-grazing dairy units

The two breeds of cattle currently being used for small-scale dairy development in Cameroon are Holstein and Friesians, imported into Cameroon from Ireland in 1995 and from Kenya in 1997. The dairy cows from Ireland were previously raised by various Irish farmers who then gave them as a donation for the pilot zero-grazing small-scale dairy development in Cameroon. The original batch of animals that arrived in Cameroon consisted of 20 pregnant heifers. These animals have reproduced during the last three years. The dairy animals imported from Kenya are purchased from commercial farms with funds provided by Wild Geese (Holland) and Heifer Project International in the United States. The animals were brought in by air to Yaounde in June 1997 and then moved by truck to Bamenda. Both batches of animals were quarantined for one month before being distributed to farmers. All of them were at the end of the first lactation. The method of breeding was artificial insemination (AI) using Holstein–Friesian semen from Ireland and American Breeder Service.

Animals were maintained in stables (3 m high, 8–10 m long and 6.5 m wide) made of 2 cubicles, a raised floor calf pen, a milk parlour, corridor, store and feeders. The roof of the stable was either made of grass thatch, raffia thatch or aluminium sheets. The floor was designed to slope into a gutter on one side to ease evacuation of urine and faeces, which ultimately were utilised as farmyard manure. Close to the stable was an open-air enclosure for exercise.

Dairy cows were maintained under zero grazing. Fresh forage was cut, chopped and fed to animals three times a day at 8 am, 12 noon and 5 pm. About 30–50 kg of chopped forage was served during 24 hours. Legumes such as *Desmodium*, *Leucaena* and *Calliandra* were given to animals once every fortnight. Concentrate was served at the time of milking. The amount given was proportional to milk yield (1 kg for every kg of milk produced after 10 litres of milk). Concentrate supplements were prepared on-farm based on a formula

recommended by HPI. The main ingredients used for composing rations were wheat or rice bran (20%), cotton seed cake or soya bean meal (20%), corn flour (50%), bone meal (0.5%) and salt (2.5%). Water was served *ad libitum*. In addition, crop residues such as fresh corn stalks, bean stems and leaves and plantain leaves were given to animals whenever they were available. Lactating animals were hand milked twice a day at 6:00 a.m. and 5:00 p.m. Calves were bucket-fed with milk until the age of 4 months, when they were weaned. Animals were dewormed every three months and sprayed against ticks every month.

Information was obtained from farmers about the management system through interviews, special information recording forms left with farmers in which milk yield, concentrate fed, breeding and calving dates, body weight measurement, birth and weaning weight, age at first calving, calving interval and gestation duration were estimated. A graduated tape (39–900 kg) was used to estimate body weight of animals through an indirect method of measuring heart girth. Mean values from the data collected were compared using a t-test.

Performance of smallholder zero-grazing dairy units

Table 1 presents a summary of some reproduction and production parameters of purebred Holstein–Friesian cattle introduced in the peri-urban area of Bamenda, Cameroon. Average milk yield during the first lactation was 3208 kg while the range was 1920 to 4700 kg. During the second lactation, average milk yield was 4284 kg. This was an increase of 20% over the first lactation milk yield. The milk yield obtained during the first lactation is higher than 2318 kg obtained in Ethiopia (Kiwuwa et al. 1983), 2889 kg in Haryana, India (Duc and Taneja 1984) and 2495 kg in Kenya (Meyn and Wikins 1974). This figure is also similar to 3392 kg obtained on-station at Bambui (IRZ 1984) and 3286 kg obtained in Nigeria by Sohael (1984).

It should be pointed out that during the first lactations a number of farmers were still having their first experience in handling dairy cattle under zero grazing. Most of them had not mastered the skills required for managing dairy cattle. Thus, errors were often made in rationing feed to animals, budgeting feed to last throughout the dry season, treatment against worms according to the schedule provided by HPI during training sessions, milking animals efficiently and feeding calves adequately. There were a lot of variations in lactation period even though the average during the first and second lactations was 315 and 270 days, respectively. Poor ability of new farmers to detect heat, differences in rations and management practices could have been responsible for the differences. It was observed that some animals were still in high milk production after 10 months of lactation and the farmers allowed milking to continue even though they were supposed to dry-off such animals. The average lactation period of 315 days observed during the first lactation is similar to 329 days obtained at IRZ Bambui Station (1984), 322 days reported in Kenya (Meyn and Wilkins 1974), but higher than 283 reported in Nigeria (Sohael 1984).

Birth weight of calves ranged from 29–50 kg with an average of 43 kg for female calves and 38.5 kg for male calves. At weaning calves weighed an average of 83 kg whereas male calves weighed 67 kg. Bull calves generally had higher average daily weight gains (0.475 kg) than female calves (0.425 kg).

Table 1. *Reproduction and production parameters of Holstein–Friesian dairy cattle under smallholder management in peri-urban areas of Bamenda, Cameroon.*

Parameter	Number of animals (n)	Average	Standard deviation
Birth weight (kg)			
Male calves	13	38.5	4.1
Female calves	17	42.7	5.8
Weaning weight (kg)			
Male calves	13	67.3	8.1
Female calves	17	83.0	21.0
Daily weight gain (kg)			
Male calves	13	0.475	0.191
Female	17	0.425	0.153
Mortality rate (%)	49	18.4	–
Calving rate (%)	18	95.5	–
Age at first calving	40	32.5	3.5
Calving interval (months)	16	15	2.0
Milk Production			
First lactation (kg)	24	3208	808
Second lactation (kg)	12	4284	1626
Lactation duration (days)			
First lactation	24	315	29
Second lactation	12	270	36

Source: HPI/ Cameroon (1999).

Age at first calving was 32.5 months. This value is higher than 28 months observed in the USA (Branton et al. 1966) and 30 months in Nigeria (Sohael 1984). The 32.5 months obtained on-farm is similar to 32 months reported at the Bambui Research Station (IRZ 1984), and 32 months in Haryana, India (Duc and Taneja 1984), but lower than 36 months reported in Ethiopia (Kiwuwa et al. 1983) for the same breed.

The mean calving interval was 15 months (12 to 18 months range), which is similar to 14 months at Bambui Research Station in the same location. Meanwhile, Meyn and Wilkins (1974) reported calving intervals of Holstein–Friesian of 14 months, while Sohael (1984) obtained 13 months in Nigeria. The problem of animals not being bred on time on-farm has often increased the calving intervals.

Costs and benefits of smallholder zero-grazing dairy production

To determine whether the introduction of a zero-grazing dairy production unit in the smallholder mixed farming system is profitable, a partial budget analysis was conducted for farms in two different locations—Mezam and Donga/Mantung Divisions of the NWP. The partial budget analysis does not examine the profit or loss situation of the whole smallholder

mixed farming system but the net increase or decrease in farm income resulting from the introduction of a zero-grazing unit. The analysis compares the cost of the additional investment (including the opportunity cost) required for introducing the zero-grazing units with the marginal or additional increase in benefits that the new activity will bring. The introduced new activities involve the purchase of heifers (valued at 1.2 million FCFA (US\$ 1846.00)), the construction of a fenced stable and crush, establishment of improved pastures and the provision of veterinary services. Benefit items generally involve the value of the animal (obtained on a POG basis), sales of milk, pasture seeds and cow dung, the value of milk consumed at home and cost saved.

Tables 2 and 3 present the benefits derived from introducing a zero-grazing dairy production unit in Mezam and Donga/Mantung Divisions, respectively. The additional cost of the intervention is estimated at 1.8 million FCFA (US\$ 2804.00) in Mezam Division and 1.9 million FCFA (US\$ 2883.00) in Donga/Mantung Division. The cost of a heifer accounts for about two-thirds of the total operation cost. Given that the opportunity cost of

Table 2. *Partial budget for a zero-grazing dairy production unit in Mezam Division.*

Cost/benefit item	Amount	
	FCFA ($\times 10^3$)	US\$
Costs		
Animals	1200	1846
Infrastructure		
Crush	112.86	174
Fence	67.1	103
Stable	96.3	148
Pasture improvement		
Fertiliser	17.67	27
Operating costs		
Hired labour	75.2	116
Veterinary services	–	
	9.11	
Repairs	7	14
Revenue forgone	244.3	376
Total cost	1822.7	2804
Benefits		
POG heifers	1200	1846
Culled cattle	268.75	413
Milk sales	321.8	495
Home milk consumption	256.3	394
Cow dung	19	29
Pasture seed sales	6.8	11
Costs saved	47.56	73
Total benefits	2120.2	3261
Net benefits	297.56	457

Source: HPI/Cameroon (1999).

labour in the mixed smallholder farming system of the NWP is not zero and the fact that farmers must abstain from some farm activities to concentrate on dairy production, the foregone income was estimated at 244,330 FCFA (US\$ 376.00) and 343,440 FCFA (US\$ 528.00) in Mezam and Donga/Mantung Divisions, respectively. This item accounts for the second largest share of the total cost.

Table 3. *Partial budget for a zero-grazing dairy production unit in Donga/Mantung Division.*

Cost/Benefit item	Amount	
	FCFA ($\times 10^3$)	US\$
Costs		
Animals	1200	1846
Infrastructure		
Crush	36.5	56
Fence	108.6	167
Stable	86.4	133
Pasture improvement		
Fertiliser	23.4	36
Operating costs		
Hired labour	55.89	86
Veterinary services	-	
Repairs	19.4	30
Revenue forgone	343.3	528
Total cost	1873.6	2882
Benefits		
POG heifers	1200	1846
Culled cattle	-	-
Milk sales	178	274
Home milk consumption	256.28	394
Cow dung	19	29
Pasture seed sales	12.75	20
Costs saved	360	554
Total benefits	2026	3117
Net benefits	152.4	235

Source: HPI/Cameroon (1999).

The total benefit is estimated at 2.1 million FCFA (US\$ 3262.00) in Mezam Division and 2.0 million FCFA (US\$ 3117.00) in Donga/Mantung Division. A comparison of the additional benefit with the additional cost of introducing the new intervention suggests that zero-grazing dairy production is profitable in both locations with net benefits of 297,560 FCFA (US\$ 458.00) in Mezam Division and 152,400 FCFA (US\$ 234.00). The positive returns derived from these two locations have important implications for increased adoption of smallholder zero-grazing dairy production in Cameroon. As long as farmers know that their labour will be compensated for, and if the opportunities are provided as is being done through HPI, they will get involved in dairy production.

Impact of HPI dairy development project on the target population and its socio-economic environment

An evaluation of the HPI small-scale dairy development project in Cameroon was carried out in 1999. From this evaluation several issues concerning impact and problems confronting farmers were raised for discussions.

The general framework for impact evaluation required information at the beginning, during and after the project had ended. In order to measure the degree of achievements of planned goals, it was necessary to identify both the anticipated and unanticipated consequences of the project and to examine the long-term sustainability of the benefits. In the case of HPI/Cameroon, no baseline study was carried out to identify the level or degree of development of the dairy enterprise in the project area before the introduction of this activity. However, since for the target population of HPI, the dairy enterprise was completely a new activity; all direct and indirect consequences such as dairy production and revenues thereby generated, increased productivity of other farm crops due to the use of cow dung manure, diversification to other animal production enterprises, family consumption of fresh milk and the degree of participation of the target population etc. could be considered as impact measures likely to be attributed to the project. This part of the analysis, which was highly qualitative, was based on the personal observations of the evaluation team and oral interviews with the beneficiaries.

Other socio-economic impacts of the project include: change in people's social value about livestock raising (now considered as wealth rather than an element of social status); change in consumption patterns or habits to include milk and other dairy products; intensification of exchange and relations with other economic agents in their environments; diversifications of economic activities (farm and off-farm); change in farming systems and structure to include livestock production in general and dairy production and marketing in particular.

In terms of sustainability of project benefits, the process of POG financial autonomy, level of technical knowledge, number of weaned farmers still in business, level of profitability and periodic follow-up by HPI etc. were considered as key progress indicators.

Assessment of technical and institutional sustainability of dairy

When farmer groups are screened by HPI for assistance, they usually benefit from a technical package that supports them in pasture development, shed construction, protection of animal health and a training they receive in husbandry techniques, feeding and milk hygiene. After the first year farmers are gradually informed to paying for services. This reduces the dependency syndrome by the time the financial assistance ends in three years. Farmers join the milk farmers association, which brings them in contact with the milk

factory. Thus they have a direct linkage with the milk marketing system. In fact, HPI plays no role in their day-to-day milk sale mechanism. At the beginning of the project a single pregnant heifer is given to each family. Normally, they would obtain a calf a year, and where such calves are females they are able to fulfil the POG contract within the first 2 years and any subsequent calves become the property of the family. Depending on family size, 2 or 3 females would be maintained for milk production, while other subsequent calves are sold. With 2 or 3 lactating cows, the family is assured of 40–80 litres of milk a day, which is an encouraging income in rural areas when the milk is delivered to the factory. Although there are some marketing problems for farmers far from urban centres, it is our strong conviction that the problem is temporal. Efforts being made by HPI to improve milk marketing will eventually improve the situation. At the moment we have hundreds of farmers that are ready to receive animals, but our main constraint is the source of Holstein or Jersey cows.

Nutrition

One of the basic objectives of HPI is to improve the nutritional status of its target population through the introduction of dairy farming. Field observations and discussions with the beneficiaries of the dairy programme have showed that the dairy enterprise has totally been embraced by the target population and their consumption of dairy products (milk) had increased; thus improving their nutritional status. All households involved in dairy farming have reported that their consumption of milk has increased and this was evident from the food health of their children. For example, before the introduction of dairy farming to the target population, about 36% of the surveyed households confirmed that they were not consuming milk but all dairy producers have become milk consumers. The income generated from the sales of fresh milk has also gone a long way to increase the basket of food consumed by the household in the rural area. The request for more dairy animals by the target population is a clear indication that the dairy enterprise is worthwhile in the rural environment.

Impact on crop production

Apart from direct milk production that has increased, the introduction of dairy production has an important effect on the overall farming system. Particularly, the use of cow dung in the farming system had greatly improved productivity (especially for maize and vegetables) as reported by all the surveyed households. In addition, the use of cow dung has reduced the use of fertiliser; thus by saving costs or expenditures, the farmers have gained from the project. In the majority of cases (about 80% of the households surveyed) cow dung has replaced the use of inorganic fertiliser completely.

The availability of cow dung has enabled farmers to intensify food crop production and in some cases they have introduced new crops such as huckleberry, garden eggs, cabbage, carrots and other vegetables, which grow faster with the application of cow dung manure. In terms of environmental protection, the use of cow dung is more environmentally friendly

and has a long lasting effect on soil fertility than chemical fertilisers that easily leach. By and large, the introduction of livestock production in general and of the dairy production in particular has broadened the structure of the farming system, and has diversified the sources of farm income for dairy farmers.

Diversification into other livestock species

In order to reduce or diversify risks in livestock production, HPI, in addition to introducing the dairy programme, has encouraged the production of other small livestock by the farm family. These additional livestock species include among others: pigs, poultry, rabbits, guinea pigs etc. Farmers themselves have also intensified the production of goats or sheep (80% of the surveyed households), which was formerly done on a limited scale. Livestock and food crop production are complementary enterprises. The management practices of the farm family as observed on the field show that their complementarities are well understood. Beans or maize haulms and corn stalks are fed to livestock, while animals wastes are used as inputs for food crop production. This is an efficient allocation of limited resources within the farming system and results in an increase of productivity of both crop and livestock.

Impact on farm income

In the project area, the various sources of revenue were identified in the farming system. These include sales of surplus foodstuffs, small ruminants, chickens or poultry products, fresh milk from dairy farming etc. Off-farm sources of additional income include 'petty' trading between urban and rural areas, artisan and craftsmanship. All these activities were important to generate income in rural areas but made the framework of the evaluation difficult (time constraint and lack of information) to quantify the contribution of each source. For the dairy enterprise, which was one main focus in this evaluation, an attempt was made to evaluate its contributions to income generation through partial budgeting technique. The results showed a positive net benefit for the zero-grazing system. Generally, the dairy enterprise contributed positively to income generation by the farm family. To be more precise on its contribution, there is a need for in depth study of all the income-generating sources within the farm family.

Constraints to dairy production

Surveyed farmers were asked to rank in order of importance five major constraints faced in their dairy activities. The analysis of the results indicates that marketing is the major constraint for more than 90% of the farmers. This marketing problems could be broken down into poor road network coupled with lack of transport facilities; lack of processing and storage or conservation equipment for fresh milk; inadequate demand in the immediate environment of the farmers and low milk prices etc.

The second constraint is that of finance. Here, the problem is associated largely to insufficient savings to finance investments, limited access to credit as a result of land title requirements as collateral especially by credit union (CamCUL). Although access to 'Njangis' (informal credit) is relatively easier, about 80% of the farmers have reported that this source is inadequate in satisfying both social and productive needs.

The next most important constraint as mentioned by the farmers is animal health. Lack of drugs and the presence of ticks are the main problems cited by farmers (about 65%).

The fourth constraint is that of running costs for the dairy enterprise. More than 80% of the surveyed farmers have reported the lack of funds to purchase concentrates and also the fact that in some local markets concentrates are not available. The farmers (95%) consider that this problem is very crucial because poor feeding would result in poor health and low milk yield.

Farmers are not very satisfied with the practice of artificial insemination (AI) as about 60% of the farmers have reported to have successful insemination only after two to three trials. Because of this, the request for bulls for natural crossing has been on the increase. Besides, the high cost of liquid nitrogen is a serious drawback in operating an efficient AI system.

The scarcity of local supplies of heifers of exotic breeds like Holstein, Friesians and Jerseys is an important obstacle to the rapid expansion of small-scale dairy development based on zero grazing. Farmers ready to receive animals have to wait for up to 18 months to receive pregnant heifers.

Feed scarcity during the dry season is an important constraint to adequate feeding of animals and often results in lower milk yields and lower income. In fact, some farmers have to go a considerable distance from their homes to procure adequate forage for their animals.

Also stall-feeding of animals is labour-intensive most of the labour burden is particularly heavy during school time and during the dry season. It is not possible at this stage to provide figures on economic benefits or demonstrate whether these benefits outweigh the burden on the family. However, from the partial budget analysis realised, introduction of the dairy animal results in direct and indirect increase in family income.

The farmers' personal efforts to resolve most of these problems are fairly limited and leave much to be desired. In some cases such as marketing problems, farmers (about 80%) had not attempted any solution.

Implications and lessons learned

In general, the dairy enterprise is a viable enterprise in the project area. It has been totally embraced and fully integrated in the farming system by the target population. Dairy cattle have become part and parcel of the farm family as the animals are catered for just like a member of the household. Furthermore, the contribution of dairy cow to the farming system is highly commendable and widely acknowledged by the farm family in the project area. The constant supply of farmyard manure stimulates crop yields, especially in an era that fertilisers are scarce and expensive. The contribution of milk to the nutritional status of the farm family and its income generating capacity is viewed with a lot of satisfaction and optimism for the future by the beneficiaries.

Marketing among other constraints (finance, health etc.) is the most important factor determining the level of performance of the dairy enterprise. In the project area, the marketing system is poorly organised and this keeps the production potential below optimum despite the potential high demand for milk. The poor road infrastructure to some of the production areas is a serious obstacle that cannot be remedied by HPI nor the farmers. By the intervention of the government, paving such roads is under way so that they are more suitable for milk collection for the ultimate solution. It is only at such a time that SOTRAMILK milk processing enterprise can access all small-scale producers. The marketing system should be restructured by clearly defining the role of SOTRAMILK and by organising farmers in groups or co-operatives to integrate marketing aspects, especially ensuring adequate volume of milk to be collected at each collection point.

The demand for milk and milk products under the current project executed by HPI far exceeds production. Milk sales by small-scale dairy farmers (500 litres/day) and estimated daily fresh milk consumption in Bamenda municipality alone not exceeds 2500 litres/day. At this level of production, a small fraction of milk production is met by HPI small-scale farmers. The imported dairy products available are very expensive. This has made the demand for fresh milk even higher. To meet this high demand for milk by the rapidly growing population, and still maximise the use of land for other development activities, a zero-grazing scheme with properly trained and guided farmers can substantially solve this problem.

HPI is taking advantage of the existence of other institutions [Livestock Research Institute, KOSSAM company, CAMLAIT and Ministry of Livestock] already involved in milk production and marketing as an asset for the development of the dairy sector. Effective and cohesive linkage amongst these institutions will go a long way in improving dairy production and marketing both at national and regional levels. Such linkages would be realised through the establishment of a consultative committee involving all stakeholders to look into the problem of marketing. Cameroon has a large market in Nigeria [150 million kg] that can absorb milk and milk products even when the needs of the country are satisfied.

Farmer groups through which HPI intervenes would be well organised to integrate both the production and marketing of dairy products in their activities. Efforts by HPI in the past to promote marketing of milk and milk products through the Bamenda Co-operative Dairy Society (BCDS) failed as a result of mismanagement of funds by the executive. In fact, HPI purchased and installed a mechanical milking and pasteurising unit with the collaboration of the Livestock Research Institute, but it is not functional due to poor management. Five years ago, the dairy farmers co-operatives were provided minor shares in SOTRAMILK by a Dutch NGO called WILD GEENSE, but the farmers co-operative have not been able to have an influence in decision making. HPI is presently seeking ways of increasing the shares of farmers to a level that will enable them influence decisions in SOTRAMILK. Recently, HPI has started some efforts in Kenya aimed at improving the marketing of milk by smallholder farmer co-operatives. Farmers' co-operatives are involved in managing the milk collection centres. Money has been invested in cooling tanks at collection points. A relatively small effort has been started in Cameroon with funding from Rabobank Foundation in Holland. We hope this will improve milk marketing significantly when all the cooling centres are completely established.

From the observations made during the evaluation, demand for milk and milk products is still very high and the supply is largely unsatisfactory in the project area and its immediate environment. Only 5% of SOTRAMILK's daily processing requirement of 20 thousand litres per day is satisfied at the moment. SOTRAMILK has therefore no choice but to reconstitute imported powder milk to meet current processing needs. Increase in milk production by smallholder farmers in the region should gradually reduce the use of powder milk.

Moreover, HPI milk programme is still the only organised and assisted sector of the fresh milk production and distribution in the North-West Province and its immediate environ.

In order to facilitate access to smallholder farmers to financial services especially credit, the following points should be taken into consideration:

- Smallholder dairy farmers' savings can only finance on the average 19% of their investment needs. This is a clear indication that they need external financing and the necessity to intensify the existing micro-credit scheme.
- To improve on the existing micro-credit scheme, the philosophy behind group credit i.e. moral guarantee would be exploited rather than the present focus on land title and other assets that a group as an entity cannot present and thus limited access to credit.

The potential for savings mobilisation among farmers is not well targeted and fully exploited. For a viable micro credit program, HPI would target farmer groups that have a long history of existence and showing proof savings mobilisation and credit services, internal cohesion and good governance.

Questions for discussion

- A. How can we organise the link between national and international research and development organisations to stimulate sustainable market oriented small-scale dairy development in third world countries?
- B. How can we involve governments in dairy development in developing countries so that they formulate favourable policies to support small-scale market oriented dairy development?
- C. How then can we best integrate small-scale dairying into existing production systems without distorting traditional agricultural production patterns?
- D. How can we cope with small-scale dairy development under a situation where human population is rapidly growing; land holding per household is shrinking; and soil fertility is declining?
- E. How can we accelerate dairy development without the use of exotic parent stock that required higher management and inputs?
- F. How then can we develop a viable breeding scheme to serve scattered small-scale dairy farms, and to improve conception rate and decrease the high male to female offspring ratios produced from AI today?

References

- Atekwana J.A. and Maximuangu J.C. 1981. The performance of imported dairy cattle breeds in Cameroon. Paper presented at the Sixth Meeting of the African Scientific Council, Libreville, Gabon.
- Branton C., McDowell R.E. and Brown M.A. 1966. Zebu-European crossbreeding as basis of dairy cattle improvement in the USA. Southern Co-operative series Bulletin 114. Louisiana Agricultural Experimental Station, Baton Rouge, USA. 39 pp.
- CDC (Cameroon Development Co-operation) Report. Annual Reports 1954–56.
- Crawford Capt. 1916. Report on Djutittsa, Dschang, farms. Unpublished report.
- Duc N.V. and Taneja V.K. 1984. Comparative performance of purebred and crossbred grades in India. *Journal of Animal Science* 54(11):1023–1028.
- Goldman M. and Pingpoh D. 1985. The cost of producing fresh pasteurised milk sold in Bamenda. North-West Province. Institute of Animal Research, Science and Technology Review. Animal Science Series.
- HPI (Heifer Project International)/Cameroon. 1999. Dairy evaluation report 1999. (unpublished).
- IRZ (Institut de Recherche Zootechnique). 1984. Institut de Recherche Zootechnique. Annual Report.
- IRZV (Institute of Animal and Veterinary Research). 1990. Determining the research needs of the Institute of Animal and Veterinary Research, Yaounde, Cameroon.
- Kamga P., Tambi E. and Kamga P. 1987. Effect of elephant grass (*Pennisetum purpureum*) silage, fodder and *Brachiaria* pasture on milk production and composition: Income over feed cost in dairy cattle. Annual synthetic report. Institute of Animal Research, Bambui, Cameroon.
- Kiwuwa G.H., Trail J.C.M., Yousef M.K., Worku G., Anderson F.M. and Durkin J.W. 1983. *Crossbred dairy cattle productivity in Arsi Region, Ethiopia*. ILCA Research Report 11. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 29 pp.
- Meyn K. and Wilkins J.V. 1974. Breeding for milk in Kenya with particular reference to the Sahiwal Stud. *World Animal Review* 11:24–30.
- Njwe R.M. 1984. Provision of adequate animal protein to the Cameroon population by the year 2000 AD: Problems and prospects. University Center of Dschang, Cameroon.
- Sohael A.S. 1984. Milk production potential of cattle on the Jos Plateau. *Nigerian Livestock Farmers* 4(3):13–14.
- Spencer Capt. 1915. Report on Buea farms. (unpublished report).
- Tambi E.N. 1991. Dairy production in Cameroon: Growth, development, problems and solutions. *World Animal Review* 67(2):38–48.

Impact of integrated dairy and crop production technologies on smallholder dairy production in Haryana, India

B.N. Mathur and R.V. Singh

National Dairy Research Institute (NDRI), Indian Council of Agricultural Research (ICAR)
Karnal 132001, India

The Indian rural economy is characterised by complex farming systems and by a diverse environment and small resource base and by being risk prone. During the last four decades biological researchers have made significant contributions to research and development of transferable technologies in different farming systems. But most of these technologies are capital intensive in nature and the benefit of agricultural research and development activities has not reached all types of farming systems and all groups of the farmers uniformly due to socio-economic and cultural differences. Moreover, adoption of any technology depends upon its feasibility and suitability. A technology suitable for a particular environment, biophysical and socio-economic setting, often referred to as a micro situation, may not be an appropriate technology for other micro situations. So these technologies have mainly benefited the resource rich farmers who have access to capital, inputs and output markets. The smallholders (risk prone farmers) have lagged behind due to their poor resource base, low availability of capital and other resources. Further, for the development of appropriate technologies in agriculture and their successful adoption, knowledge of present farming situations and of the problem is a pre-requisite. In other words, a comprehensive farming systems approach is necessary for solving the problems of smallholders.

Researchers often do not have a proper understanding of their problems and of the environment of the smallholder, and there are weak linkages between the farmer and extension functionaries. It was, therefore, considered necessary to evolve, develop and transfer new technologies suitable to resource poor smallholders so that the benefits of development could be evenly distributed. For rural transformation social aspects are as important as technological aspects, and so the technologies evolved by different research institutions should be simultaneously tackled from social, economic, administrative, organisational and technical angles. With this in view, initiation of the Operational Research Project was recommended by the Working Group, which formulated the Fifth Five Year Plan of the Indian Council of Agricultural Research (ICAR). The project was expected to introduce science based land, animal and water management plans so that farming communities and smallholders could derive the maximum economic benefits with minimum risk and instability.

Project programme of National Dairy Research Institute (NDRI), Karnal

The National Dairy Research Institute (NDRI), Karnal embarked upon an Operational Research Project in June 1975 on 'Integrated milk and crop production for increased productivity, employment and farm income in the villages around Karnal'. The project, based on an integrated area development approach, collaborated with nationalised banks, livestock insurance companies, dairy plants, agricultural universities and research institutes, extension agencies, local administration, village punchayats (village councils) and the farmers of the area.

The project aimed at increasing employment and income levels of the farmers in general and weaker sections in particular through the transfer of new technology pertaining to dairy and crop enterprises in the mixed farming systems. Commensurate with the objectives of the project and felt needs of the people, two major action programmes were formulated on the basis of the findings of the informal and formal benchmark surveys conducted at the start of the project. These were the Dairy Development Programme and Crop Productivity Improvement Programme.

In the sphere of Dairy Development Programme, the project established a network of Dairy Vikas Kendras (DVKs) in the adopted villages with the co-operation of the village punchayats. The (DVKs) served as the nerve centre for all the development activities of the project like artificial insemination, pregnancy diagnosis, examination and treatment of animals for various reproductive disorders and other ailments, vaccinations against contagious diseases such as Foot-and-Mouth Disease, Haemorrhagic Septicaemia, Rinderpest and Black Quarter (Black leg). The farmers were also educated about various improved management practices on rearing of calves, balanced feeding, tick control measures and rational use of fertilisers and various plant protection chemicals. In addition, on-farm animal research trials were conducted to test and evaluate dairy production technologies.

The objective of Crop Productivity Improvement Programme was to increase per hectare yields of various cereals, fodder crops, pulses, oil-seeds and cash crops through the introduction of high yielding varieties (HYVs) and to recommend package of practices in the project area. This was achieved through conducting crop demonstrations and on-farm crop research trials mostly on small dairy holdings and making available various critical inputs like HYV seeds, fertilisers and plant protection chemicals.

A method of systematic record keeping was introduced to facilitate continuous monitoring of the progress of various dairy and crop production activities. Primary village surveys of all the households and socio-economic surveys of sample households were conducted in the project villages at suitable intervals for objective evaluation of the technology transfer programmes. Besides, exploratory and focussed rapid rural appraisals (RRAs) were also conducted to deal with various issues pertaining to dairy and crop production.

Objectives

Integration of activities and co-ordination of resources and research organisations form the important ingredients of the project. In view of the fact that a large proportion of milch animals are owned by the farmers with a weaker resource base, efforts to bring about improvement in dairy and crop production could bring about socio-economic change in the project area. Therefore, the objectives of the project were as below:

- to demonstrate and test the applicability of the improved packages of dairy farming practices on different size of farm holdings,
- to demonstrate the multiple cropping system of raising three or more crops in a year,
- to provide an insight to the scientists of the problems involved in the application of new technologies under field conditions, and
- to estimate the magnitude of additional income and employment generated in the study area.

Organisation and approach

It was considered that the best way for the project to succeed was to have a compact area of operation and organisation so that various programmes could be effectively implemented and at the same time the cost of administration and operation of the project would not become heavy.

Area of operation

Based on the needs of the farmers and their attitude and response towards the project programmes, a modest beginning was made with the adoption of nine villages in Karnal district in 1975. The programme evoked a positive response from the villages, which eventually led to subsequent adoption into the project of 40 villages within a radius of 35 km. These 40 villages formed a contiguous area and were divided into 4 clusters falling in three development blocks of Karnal district. Each cluster had a headquarter village for directing and controlling the programme.

Criteria for selection of villages

Various criteria were laid down and fixed for the selection of villages. For instance, the proximity of a village to NDRI, Karnal was considered an essential criterion for increasing the operational efficiency of the scientists. The villages, which were not covered by any other extension agency and offered virgin field for work, were selected so that duplication of services and facilities could be avoided. Villages which had more co-operative and responsive farmers willing to provide working space for the staff and to store various equipments and critical inputs were given preference in the selection.

Staffing pattern

A principal scientist (Agricultural Economist) headed the project team, which consisted of scientists, technicians and administrative and supporting staff. The positions originally provided by the Indian Council of Agricultural Research (ICAR) comprised a project officer and four subject matter specialists representing four different disciplines such as agronomy, animal health, farm management and extension education. Two senior research assistants were provided to undertake the collection, tabulation and analysis of data for monitoring the progress and evaluation of the programme. Besides, four stockmen and four field-men were provided to look after cattle development and crop improvement work, respectively, at the village level. Other ancillary staff provided in the project included a driver and administrative personnel. However, the staff positions underwent changes from time to time and were strengthened, particularly in the technical cadre, due to the expansion of the area of operation so that the benefits of the project's programme could be uniformly distributed.

Linkages

The Operational Research Project of , Karnal was an integrated development project. It integrated various dairy and crop enterprises on the one hand in the mixed farming systems, and with different institutions and agencies on the other. It was realised that integration and co-ordination are extremely important ingredients of project management for the desired success of the programme. Therefore, the project had close linkages with various institutions and organisations at village, district, state, national and international levels.

Technology transferred

The project aimed at increasing employment and income levels of farmers in general, and from the weaker section in particular, through the transfer of new technologies pertaining to dairy and crop enterprises in mixed farming systems. Various new technologies on dairying and crop production were identified and transferred in different farming systems through on-farm trials. The list of technologies transferred in the project are given below.

Technologies transferred through the dairy development programme

- genetic improvement through crossbreeding/upgrading of nondescript cows and buffalo
- prevention and control of contagious diseases
- efficacy of degcure mixture (a mineral mixture rich in sulphate used as a feed supplement) for the control and treatment of dagnella disease (selenium toxicity found mostly in buffaloes in northern parts of India).
- improved feeding of high yielding milch animals
- enrichment of crude forages through urea treatment and
- scientific management of reproductive disorders in dairy animals.

Technologies transferred through the crop improvement programme

- introduction of new fodder varieties and rotations to meet green fodder supply round the year
- introduction of new cropping systems
- improvement of productivity of fodder, cereal, pulse and oil seed crops
- diversification of farm production on smallholder farms
- optimum use of fertilisers and plant protection chemicals in different crops and
- testing and multiplication of new and high yielding varieties of different crops.

Methodology

In order to study the existing farming systems faced by the farmers, informal surveys in the form of group discussions with punchayat's members and farmers were conducted at the time of the adoption of a village. In-depth formal surveys, such as benchmark and socio-economic surveys, were also conducted.

Benchmark surveys

With a view to examining the existing situation of the farms and farmers for planning various development programmes in the project villages and evaluating the impact of the project programmes after suitable intervals, benchmark surveys were conducted in the selected villages. Data on parameters pertaining to dairy and crop enterprises were collected for the period 1974–75. In all, 653 small dairy holders were interviewed under the benchmark survey.

Socio-economic survey

The socio-economic and repeat surveys were conducted in the adopted villages of the project in order to assess the impact of the programme on farm economies. Before and after (BA) and with and without (W&W) approaches were followed to evaluate the impact of the programme on various parameters. The reference year for these surveys was 1995–96.

Methodology for impact evaluation

In order to evaluate the project and examine the impact of technology transfer programmes on various parameters, a multi-stage stratified random sampling technique was followed for selecting the sample households from extension and control areas. For the selection of extension villages, one village from each of the four clusters of the project villages, falling in the three blocks was randomly selected. A complete list of all the households of the selected

villages along with relevant details like size of land and cattle holdings was prepared. The number of dairy animals owned by smallholders varied from 1 to 10 milch animals. These small households were then classified into five groups viz. group I = landless; group II = land up to 1 ha; group III = land from 1 to 2 ha; group IV = land from 2 to 4 ha and group V = land above 4 ha.

Production traits of milch animals

Production traits of milch animals play a crucial role and have a profound influence on the cost and returns of any dairy enterprise. Important traits like age at first calving, days in milk, dry days, inter-calving period, proportion of milking and dry animals and the milk yield of the animals have been considered.

Age at first calving

Late maturity of dairy animals, resulting in the high cost of rearing the animals to the age of first calving, is one of the major causes for the uneconomic nature of dairying in India. The age at first calving is governed by biological factors like age at maturity and conception rate, which are again influenced by breeding, feeding, management and environmental factors. The average age at first calving was highest for local cattle followed by buffalo and lowest for crossbred cattle. In general, for the study area as a whole, the average age at first calving for the buffalo, crossbred cattle and local cattle was found to be 48, 37 and 49 months, respectively. In general, the age at first calving of buffalo and crossbred cows increased with the increase in the size group of farms.

Lactation length, dry days and inter-calving period

The lactation length affects the total milk production and consequently the returns from the dairy animals. The longer and prolonged dry period puts the dairy farmer in a disadvantageous position since the animals are to be fed and taken care of during this period too, increasing the cost of maintenance. The inter-calving period is the sum of days in milk and dry days or the period between two successive calvings. Short inter-calving periods leads to higher numbers of lactations in the production life of animals, which results in higher income from the sale of milk and animals.

During the inter-calving period of 446 days, buffalo remained in milk for about 309 days and were dry for about 137 days. The lactation length reported in the study area was 336 days in 1974–75. The dry days in the respective period were observed to be 210 days. The inter-calving period during the period was 546 days. This showed that over a period of time, there was a marked decrease in dry period and the inter-calving period, which could be attributed to the technological changes introduced.

In the case of crossbred cattle during the inter-calving period of 415 days, the animals were in milk for 300 days and dry for another 115 days. The results of the study conducted earlier in the same area revealed that the animals yielded milk for 357 days and were dry for

113 days, the inter-calving period being 470 days. The present study showed that the inter-calving period has decreased due to the impact of advanced new technologies.

Local cattle yielded milk for 327 days and were dry for 179 days, the inter-calving period being 506 days. The inter-calving period reported in the same area during 1974–75 was 495 days, which is in close proximity to the results obtained in the present study. The average dry period in the same period too was found to be 199 days, which is higher than the present investigation.

This all showed that the technological changes have resulted in lowering the dry period and the inter-calving period of buffalo and crossbred cattle, but with little effect on local cattle.

Proportion of animals in milk and dry

The quantity of milk production on a dairy farm does not depend upon the total number of animals present in the herd, but on the animals in milk. The economics of milk production is based upon the fact that the higher the proportion of animals in milk, the lower the cost of milk production. The proportion of animals in milk and dry among buffalo, crossbred cattle and local cattle showed that during the year, 64% buffalo, 70% crossbred cattle and 52% of local cattle were in milk, whereas the remaining 36, 30 and 48% were dry.

Impact of technology transfer programme

The examination of impact of evaluation of dairy and crop production technologies transferred in the adopted villages on parameters like animal and crop productivity along with gap and human labour absorption in dairy and crop farming systems are discussed in this section.

Productivity of milch animals

Productivity of milch animals is of vital importance to cattle keepers because it has direct influence on the costs and returns from dairy farming systems. Therefore, average milk yield of lactating and milch animals of different species was worked out for the project area and compared with that of animals in the control area, as well as with the benchmark period (Table 1).

The average milk yield per day of lactating and milch animals of different species in the project area were higher than those of control area and the benchmark period. The average annual change in milk yield of local milch cows, buffalo and crossbred cows of the project area was 7.97, 2.77 and 1.74%, respectively, over the benchmark period. Interestingly, the average milk yields of milch animals in the project area were also higher than those of control area. This could be mainly attributed to their poor feeding and management along with non-adoption of improved technologies for milk production in the control area. Thus, it can be concluded that transfer of new technologies had a positive impact on the productivity of milch animals.

Table 1. *Impact of dairy production technologies on animal productivity.*

Particulars	Benchmark	Control area	Project area	Annual percentage change over	
				Benchmark	Control area
Lactating animals (litres/day)					
Local cows	2.60	2.99	4.51	3.67	50.88
Buffalo	4.34	4.72	6.51	2.5	37.92
Crossbred cows	6.12	6.48	8.35	1.82	28.85
Milch animals (litres/day)					
Local cows	1.48	1.76	2.36	7.97	34.09
Buffalo	2.67	2.98	4.15	2.77	39.26
Crossbred cows	4.33	5.01	5.84	1.74	16.57

Productivity of crops

The per hectare yield of all the crops in the project area was higher than in the control area as well as in the benchmark period (Table 2). Per hectare yield of high yielding varieties of paddy and wheat was about 30 qt and 18 qt, respectively, during benchmark surveys, which increased to 56 qt and 40 qt. An annual increase of 5.5 and 7.65% over the base year.

Table 2. *Impact of crop production technologies on productivity of major crops (q/ha.)*

Crops	Benchmark	Control area	Project area	Annual percentage change over	
				Benchmark	Control area
Paddy (HYV)*	30	41	56	5.42	36.59
Paddy (basmati)	–	15	20	–	33.33
Wheat (HYV)	18	37	40	7.64	21.16
Berseem	421	681	789	5.46	15.86
Jowar	189	260	313	4.1	20.38

* HYV = high yielding variety.

However, the yields of paddy and wheat crops in the project area were higher by about 37 and 8%, respectively, over those of control area. Thus, it may be concluded that there was a positive impact of technology transfer on the productivity of crops.

Human labour absorption in dairy farming system

Transfer and adoption of new technologies for dairy production is expected to increase human labour absorption in dairy farming systems. It is well known that one of the most important objectives of technology transfer programmes is to increase productive employment. Therefore, it is important to assess the effect of new technologies for dairy production on the human labour absorption per household and per milch animal on different groups of sample households of the project and control areas.

The overall average human labour absorption per household in dairy farming system was about 187 man equivalent days (MED) per annum in the control area as against about

225 MEDs in the project area. and thus recorded. An increase of about 21 % over that of the control area (Table 3). Interestingly, group I households registered the highest labour absorption followed by group IV and group II.

Table 3. Human labour absorption in dairy farming system (MED*/household per annum).

Category of households	Control area	Project area	Annual percentage change over
Group I	120.45	172.01	42.81
Group II	144.63	177.48	22.71
Group III	196.19	204.86	4.42
Group IV	242.73	313.90	29.32
Group V	436.63	448.49	2.72
Overall	186.81	225.39	20.65

*MED = man equivalent day.

The average human labour employment per milch animal was higher in the project area than in the control area. Human labour use recorded for crossbred cow, buffalo and local cow was 79, 78 and 70 MEDs. which registered. An increase of about 5, 6 and 24% over the control area in case of crossbred cow, buffalo and local cow, respectively, (Table 4). It can be concluded that the adoption of new technologies for dairy production by the cattle keepers had positive influence on the human labour absorption in the project area.

Table 4. Human labour absorption by different species of milch animals (MED*/household per annum).

Category of households	Control area	Project area	Annual percentage change over
Crossbred cows	75.53	79.39	5.11
buffalo	74.29	78.48	5.64
Local cows	56.34	69.81	23.91

*MED = man equivalent day.

Human labour absorption in crop farming system

Human labour is one of the most important components in the cost structure of crop farming systems. The overall average human labour absorption per farm was about 305 MEDs in the project area as compared to 271 MEDs in the control area during the same period. An increase of about 12% over that of control area (Table 5).

Gender analysis in farming system

In order to fill the information gap about the women's role in various agricultural activities, an analysis was undertaken to assess female labour contribution to dairy and crop farming systems.

Table 5. Human labour absorption in crop farming system (MED*/household per annum).

Category of households	Control area	Project area	Annual percentage change over
Group II	106.48	99.2	7.34
Group III	218.36	196.15	11.32
Group IV	363.37	359.46	1.09
Group V	750.17	613.51	22.28
Overall	304.61	270.69	12.53

*MED = man equivalent day.

It was observed that there were 863 females per 1000 males in the study area as against 927 in the country, which showed that the sex ratio continued to favour men. The average literacy status of females was about 39% as against 53% for all the members in the households in the study area. The landless, labourers, recorded the lowest literacy status of both male and females among all the groups.

Female labour in dairy farming system

On an average, 242 man equivalent days (MEDs) were used in dairy farming systems, of which, about 81 days of labour, were contributed by the females on the sample households (Table 6). The practice of hiring female labour was mainly found on group IV and group V while it was negligible on other groups. The contribution of female labour to total labour use was the highest on the households where no male or female labour was hired. The average contribution of female labour in the sample households was about 33%.

Table 6. Female labour utilisation in dairy farming system (MED*/household per annum).

Category of household	Total human labour use	Female labour use			Contribution of female to total labour use (%)
		Family	Hired	Total	
Group I	151.62	70.38	–	70.38	46.42
Group II	217.91	55.85	0.73	56.58	25.97
Group III	276.99	73.41	6.89	80.3	28.99
Group IV	377.07	79.45	39.59	119.04	31.57
Group V	458.98	59	59.92	118.92	25.91
Overall	242.35	67.56 (83.76)	13.1 (16.24)	80.66 (100)	33.29

*MED = man equivalent day.

It was also noted that the contribution of females was 100% in preparation of milk products followed by cleaning of cattle-sheds, bringing fodder/grasses from the fields, feeding and chaffing operations. However, the contribution of female labour on lower groups was reported to be higher than the males, in almost all the dairy farming operations, except that in bringing fodder/grasses from the fields.

Female labour in crop farming system

The average female utilisation was about 78 days on the sample farms and thus females contributed about 24% to the total human labour used in crop farming; highest in group III households (Table 7). Planting and threshing operations were reported to be mainly done by females while males do field preparation, application of fertiliser, plant protection chemicals and irrigation. The remaining farm operations were jointly performed by men and women.

Table 7. Female labour utilisation in crop farming system (MED*/household per annum).

Category of household	Total human labour use	Female labour use			Contribution of female to total labour use (%)
		Family	Hired	Total	
Group II	89.37	21.16	–	21.16	23.68
Group III	210.29	41.32	24.19	65.51	31.15
Group IV	403.37	51.19	52.43	103.62	25.69
Group V	722.95	37.23	115.67	152.9	21.15
Overall	325.91	25.33	42.37	77.7	23.84

*MED = man equivalent day.

Economics of dairy and crop enterprises

Economics of production of enterprises reflect the economic viability and profitability in given situation, which is of great significance to the farmers, extension workers, scientists and administrators for making decisions.

Economics of milk production

To assess the economic viability of the relative performance of milch animals, data on various items of costs and returns were analysed for buffalo, crossbred cows and local cows maintained by the sample households (Table 8).

The results revealed that feed was the major cost component accounting for about 55, 56 and 57% in buffalo, crossbred and local cattle, respectively. The gross cost for the maintenance of buffalo, crossbred and local cow per annum was found to be Indian rupees (Rs.) 8961, 12,264 and 6315, respectively (US\$ 1 = 49 Indian Rupees). The net income from the buffalo and crossbred cows was Rs. 3500 and Rs. 3972, respectively. As compared to this, the net income from local cows was only marginal, i.e. Rs. 440 only. The family labour income generated from the buffalo, crossbred cow and local cows was Rs. 5530, Rs. 6816 and Rs. 1886, respectively. The average cost of production of a litre of milk from the respective breeds was Rs. 5.43, Rs. 5.27 and Rs. 6.74. The highest cost of production in case of local cows is mainly attributed to their lowest milk production during the year. It may therefore be suggested that concerted efforts should be made to bring down the cost of milk production through increasing the productivity of milch animals and reducing cost on feeds and fodder for higher profit to the small dairy holders.

Table 8. *Economics of milch animals (Rs./animal per annum).*

Items of cost/returns	Buffalo	Crossbred	Local cow
Variable cost			
Green fodder	2314.1	3237.55	1616.95
Dry fodder	890.6	1248.3	635.1
Concentrates	1686.3	2365.2	1354.15
Human labour	2029.4	2843.35	1445.4
Misc. recurring	197.1	277.4	153.3
Total variable cost	7117.5	9971.8	5204.9
Fixed cost			
Depreciation on fixed assets	766.5	784.75	368.65
Interest on fixed capital	1076.75	1507.45	740.95
Total fixed cost	1843.25	2292.20	1109.60
Gross cost (variable + fixed)	8960.75	12,264.00	6314.50
Cost of milk production (Rs./litre)	5.43	5.27	6.74
Milk production (litre/annum)	1514.75	2131.60	861.4
Value of milk	11,360.63	14,921.20	6029.80
Value of dung	1100.00	1315.00	725
Gross income	12,460.63	16,236.20	6754.80
Net income	3499.80	3972.20	440.3
Family labour income	5529.28	6815.55	1885.70

Economics of fodder crops

The gross cost of production of Jowar, maize and Berseem + mustard was Rs. 7501, Rs. 7064 and Rs. 9792 per hectare, respectively. Relatively higher use of human labour and higher seed cost were mainly responsible for the highest gross cost of Berseem production. Interestingly, the cost of fodder production per quintal (qt) varied within a narrow range of Rs. 14 per qt. for Berseem and Rs. 20 per qt. for Jowar. Berseem being a multi-cut variety was found to be a better fodder crop in the Kharif (July to October) season than other fodder crops due to its higher production potential (Table 9).

Economics of cereal crops

Available statistics indicate that paddy and wheat are the principal crops grown by the farmers in the project area. The maize crop for grain has been replaced by paddy in Kharif season. There has been a shift in the cropping pattern in the favour of cereal crops over a period of time. Therefore, it is very important to work out costs and returns for assessing the extent of profitability of cereal crops. It is worthwhile to mention here that interest on cash expenses has been charged for half the period crop stands (Table 10).

Table 9. Economics of fodder crops cultivation (Rs./ha).

Component of cost	Berseem	Maize	Jowar
Seed	1207.93	331.5	1092.70
Fertiliser	92.9	115.98	79.1
FYM (farm yard manure)	155.8	144.5	146.25
Irrigation	556.93	150.78	138.9
Tractor power	588.38	789.38	789.38
Labour	1976.84	696.23	419.4
Interest on cash expansion	274.07	–	–
Total variable cost	4841.85	2228.37	2665.73
Depreciation and interest on fixed capital	949.7	835.73	835.73
Land rent	4000.00	4000.00	4000.00
Total fixed cost	4949.70	4835.73	4835.75
Gross cost	9791.55	7064.10	7501.48
Production (qt)	722.26	389.85	381.25
Total income	14,445.20	9746.25	11,438.00
Net income/ha	4653.65	2682.15	3186.87
Cost of production (Rs./qt)	13.56	18.96	19.68

Table 10. Economics of cultivation of major cereal crops (Rs./ha).

Component of cost	Wheat	Paddy
Seed	742.15	181.23
Fertiliser	990	778.33
FYM (farm yard manure)	200	320
Irrigation	228.08	731.45
Plant protection	280	359.43
Tractor Power	1103.85	1249.85
Labour	1147.53	2532.48
Interest on cash expansion	269.5	349.97
Total variable cost	4961.17	6502.74
Depreciation and interest on fixed capital	835.73	835.73
Land rent	4000.00	400
Total fixed cost	4835.73	4835.73
Gross cost	9796.90	11,338.47
M.P. (Q) Main product (quintals)	42.2	51.13
B.P. (Q) By-product (quintals)	34.63	–
Total income	18,113.80	20,452.00
Net income per hectare	8316.90	9113.53
Cost of production with by-product	232.15	221.75
Without by-product	182.92	–

The total cost of production of HYVs of paddy and wheat crops was Rs. 11,338 and Rs. 9797 per hectare, respectively. The land rent was the major item of cost followed by human labour, tractor power, fertilisers, depreciation, interest and manure in case of HYVs of paddy and wheat crop. The net income per hectare from paddy crop was Rs. 9114 as compared to Rs. 2317 per hectare of wheat. The cost of production of paddy was Rs. 222 per quintal while it was Rs. 232 for wheat.

Conclusion

The two major planks of the project programme were the improvement in cattle development and crop productivity. The project had great impact on development of dairy and crop production systems, particularly for smallholders. It is interesting to note that 44,377 crossbred calves were born during 20 years of operation in the project area. Annual percentage increase in the productivity of buffalo and crossbred animals was prominent factor to provide income to smallholders. Animals worth of Rs. 278 lakhs were sold, 66 percent by smallholder farmers, the weaker group of farmers. The milk production of local cows, buffalo and crossbred cows increased markedly in the project areas as compared to control areas. Productivity of wheat and paddy improved in project area as compared to control area by 36 and 33%, in Berseem and Jowar by 17 and 20%, respectively. Similarly the transfer and adoption of improved technologies for dairy and crop production increased the human labour employment on all the groups of households. It may be concluded that the transfer and adoption of new technologies in dairy and crop production system had a positive and significant influence on the productivity of milch animals and crops, human labour employment and farm income on smallholders.

Based on the experiences gained in the project, it is suggested that the working model for all round development of smallholders dairy production should be developed and multiplied in different agro-climatic zones of the country. As was practised in the Operational Research Project of NDRI the model should provide regular artificial insemination services and health care facilities at the doorsteps of the farmers and dairy and crop production advisory services under one roof for the rapid increase in income and productivity of smallholder dairy farmers.

Further, it is suggested that for increasing productivity and income for small dairy holders, the following policy interventions should be considered:

- the cow milk prices, especially of crossbreeds, being offered by public and private sector dairy plants and milk vendors are very low. This is an impediment in the implementation of crossbreeding programmes. Therefore, there is a need to evolve and implement a rational milk pricing policy. A minimum support price of cow milk should be fixed
- there is need to formulate a suitable policy regarding crop and livestock insurance to safeguard against the natural calamities as well as mortality due to contagious diseases
- for strengthening the crop-livestock production system, it would be expedient to facilitate easiest access to availability of finances and
- seed production and multiplication should be taken up more vigorously in different agro-climatic zones to meet an increasing demand for seed of different fodder crops.

Decentralisation of services in Uganda: The formation of National Agricultural Advisory Services (NAADS)¹

S.M. Nahdy

Kawanda Agricultural Research Institute
P.O. Box 7065, Kampala, Uganda

Introduction

Background to the National Agricultural Advisory Services programme design

Since 1987, Uganda has made several advances in macro-economic and development reforms which have brought annual inflation down from 240% in 1985 to a stable single digit average of 6%, national economic growth of about 5% per annum and a growth of the monetary sector of 9% in the last decade (PEAP 1997). The country is now acknowledged as one of the few in sub-Saharan Africa making real progress towards economic development and assurance of social equity. Indeed, Uganda is the first country to receive Naples terms in a final settlement with the Paris Club Creditors involving a reduction in the stock of debt rather than restructuring of debt service due.

In spite of these remarkable advances, Uganda's population remains largely poor, with gross domestic product per capita averaging only about US\$ 330 and at least 40% of the people living in absolute poverty (PEAP 1997). The economy remains largely dependent on donor assistance and on agriculture for both food self-sufficiency and foreign exchange earnings. The economic gains have also generally not been matched by social or welfare advances. Thus, although the absolute poverty rate in Uganda has declined substantially from 56% in 1992 to 44% in 1997, not everyone has benefited, especially the rural poor who have remained outside the monetary economy, mainly producing for subsistence (PMA 2000). Food crops production still accounts for at least 65% of agricultural GDP of which livestock accounts for 16%, yet agriculture continues to be characterised by low productivity. The challenges of rural economic transformation and poverty eradication are thus linked to progress in the agricultural sector (PMA 2000).

In response to the above poverty and rural development challenges, the government designed a comprehensive medium term economic development action plan called the Poverty Eradication Action Plan (PEAP) in 1997. The major objective of PEAP is eradicating mass poverty, raising smallholder farmer household incomes and improving the

1. Paper presented at workshop by Mr Joseph Nsereko.

quality of life of the majority of the population. The primary strategy is to increase earnings from productive employment, including self-employment, with active participation by all in economic decision-making. Strong emphasis was placed on liberalisation and privatisation of supply of goods and services delivery and on the progressive commercialisation of public service provision. PEAP is being supported by the donor community, through the Highly Indebted Countries Initiative (HIPC) for debt forgiveness, among others. These resources are being channelled to the social sector, with focus on primary health care, primary education, rural feeder roads, water and sanitation and agricultural extension all of which manifest a poverty focus. The agricultural transformation process is being guided by the Plan for the Modernisation of Agriculture (PMA), designed to drive agriculture away from predominantly subsistence to commercial farming. The plan aims to overcome the key factors undermining agricultural productivity, namely: poor husbandry, low use of improved inputs, limited access to technical advice, poor access to credit, poor transport, communication and marketing infrastructures and insecure land tenure rights. Based on these needs, five programmes were identified for development and implementation, principal amongst which is the National Agricultural Advisory Services (NAADS) programme.

The rationale for the NAADS programme is the failure of the traditional extension approach to bring about greater productivity and expansion of agriculture, despite costly government interventions. The fundamental aim of the programme is to develop a decentralised, demand-driven, client-oriented and farmer-led agricultural service delivery system particularly targeting the poor and the women. The NAADS programme was prepared by a government task force, which consulted very widely with local governments, NGOs and other key stakeholders. It also worked in concert with, and got support from the Joint Donor Agriculture Sector Support Group in Uganda. Thus, wide consensus on strategy and implementation arrangement was achieved.

Source of material used in the study

Core materials used in the study include the following;

- The Poverty Eradication Action Plan (PEAP 1997), which provides the strategic framework for poverty eradication in Uganda
- The Plan for the Modernisation of Agriculture (PMA 2000), which provides strategies and principles for agricultural transformation
- The Strategic Framework on Agricultural Extension 1999, which lays down the strategic framework under which the agricultural extension in Uganda will operate, within the context of both the PEAP and the PMA and
- The National Agricultural Advisory Services (NAADS 2000) programme document, which provides implementation plan and guidelines for a demand driven, client-oriented and farmer-led agricultural advisory services.

Designing the strategic framework and implementation arrangement for NAADS

The agricultural sector overview from PMA perspective

Agriculture in Uganda has grown steadily (over 4% per annum) over the past ten years. According to the PMA (2000), this growth has accompanied a profound re-orientation of the public sector's role in the agricultural economy. This included significant liberalisation of the agricultural economy and complementary institutional reforms that downsized, privatised, and decentralised public agricultural institutions. The main sources of agricultural growth over the past ten years—expansion of area under cultivation and the gains from the government policy of liberalisation of the economy, which resulted in substantial improvements of incentives for farmers to produce—have largely been exhausted as sources of sustained growth. While area expansion will continue for some time, land is becoming increasingly scarce and continued expansion will not be able to keep pace with population growth. Even if it were possible, the growth impact of area expansion, by its very nature, would diminish over time because, among other things, it is primarily marginal and remote lands that are available for exploitation. Consequently, area expansion by itself will not be sufficient to maintain rural per capita incomes even at their present levels. Uganda has therefore to look to other sources of growth for the agricultural sector if rural development is to continue.

According to the PMA (2000), the two possible sources of growth for consideration are: a) increases in land and labour productivity; and, b) a shift in production patterns from low-value staples to higher-value commodities. Growth in the last two decades has occurred without substantial contribution from either of the two. Since the sixties, productivity of both land and labour suffered precipitous declines while production patterns have exhibited a structural shift towards relatively low-valued food crops. There is, therefore, great scope for improvement on both counts. The analysis underlying the PMA suggests that the low productivity observed in Ugandan agriculture today is not the consequence of a lack of research or extension activity, but attributed to poorly functioning farmer–extension–research linkages and the consequent failure of the research and extension systems to effectively respond to the real needs of the farmers.

On the basis of the above, the government formulated a Plan for the Modernisation of Agriculture (PMA), which assigns first priority on achieving greater relevance and effectiveness in both the research and extension programmes. Emphasis is placed not only on enhancing extension and research efforts but doing so under institutional arrangements that have been transformed to ensure effectiveness and increased responsiveness to farmers' needs. The PMA stipulates that 'increasing agricultural productivity and profitability and shifting from low-value staples to higher-valued commodities' shall be the key elements of agricultural development efforts. The means to achieve these are stated as:

- transformation of Uganda's low-input-low-output agriculture into a modern science-based market-oriented agriculture capable of sustaining growth and raising incomes of farm families and

- helping production patterns to shift from low-value staples to higher-value commodities. This will build on and expand the tradition of partial market-orientation in order to be able to increase their household incomes and food security.

The PMA recognises that other interventions outside agriculture (agricultural research and extension) are needed to catalyse the agricultural transformation process. Hence, in addition to agricultural extension (i.e. NAADS), the formulation of other multi-sectoral programmes is under way.

The PMA (2000) stipulates that the government has a key role in creating a conducive policy environment for all the multi-sectoral interventions developed within PMA context. However, in line with the government's policy of privatisation and liberalisation, the PMA demands of the private sector to involve itself in activities and programmes—such as research and extension—that hitherto have been exclusively in the public sector domain.

The formulation process of the NAADS strategy

Defining the vision and mission

As a first step in designing a template against which to select options for extension within the context of the current government policies and macro-economic reform in the agricultural sector, the task force developed the vision and mission for agricultural extension. Guidance was obtained from the PEAP and PMA document, specifically reflecting on and drawing from the vision and strategic purpose of PMA.

Under the PMA (2000), the role of government has been stated as ensuring that conducive policy environment exists for private entrepreneurs to undertake investment in the sector. With regard to the agricultural transformation process, increased farmers access to information, knowledge and promotion of the productivity enhancing technologies were highlighted as the key elements. In addition, attitudinal change by policy makers, implementers and the farmers themselves was identified as an important pre-requisite for agricultural transformation.

The vision, mission and strategy for extension had to be aligned with the above sectoral vision and strategy, while at the same time embracing the overarching government policies of decentralisation, liberalisation, privatisation and increased public participation in determining the national destiny. Given this background, the vision and mission for agricultural extension was formulated as follows.

Vision statement: Decentralised, farmer-owned and private-sector-serviced extension contributing to the realisation of the agricultural sector objectives.

Mission statement: Increased farmer access to information, knowledge and technology through an effective, efficient, sustainable and decentralised extension with increasing private sector involvement in line with government policy.

Defining the context

To realise the vision and mission for the agricultural extension, these had to be translated and be put in context. The main contextual issues eventually developed to address the strategy.

- Increasing the effectiveness, efficiency and sustainability (including financing, private sector participation, farmer responsiveness, deepening decentralisation, gender sensitivity) of the extension delivery service
- Increasing farmers' access to and sustaining knowledge (education), information and communication to the farmers
- Increased access to and sustaining effective and efficient productivity enhancing technologies
- Aligning extension to government policy particularly privatisation, liberalisation, decentralisation and democratisation
- Creating and strengthening linkages and co-ordination within the overall extension services.

Guiding safeguards and lessons for choice of options

In developing choices and options, reviews, evaluations and diagnostic studies were done, which indicated that past agricultural extension in Uganda had been unfocused, reached few farmers and, its messages and approaches were not effective and cost effective. It also showed that financing and delivery mechanism have not been efficient and sustainable and that for a long time extension has been inherently exogenous, donor driven and non-participatory. In addition, generally the extension system was characterised by too much bureaucracy and manned by civil servants with low responsiveness to the farmers' needs; and largely susceptible to diminished budgetary supports. The situation is further aggravated by lack of financial and performance accountability and client ownership. Therefore, the elements of the strategy critically focused on the above. In this respect the issues and safeguards that guided the process in the development of the strategy bore on characteristics of farmers in Uganda (Figure 1), financing and delivery of extension (Figure 2), evolution of the process and principles involved as well as the lessons from within and other countries.

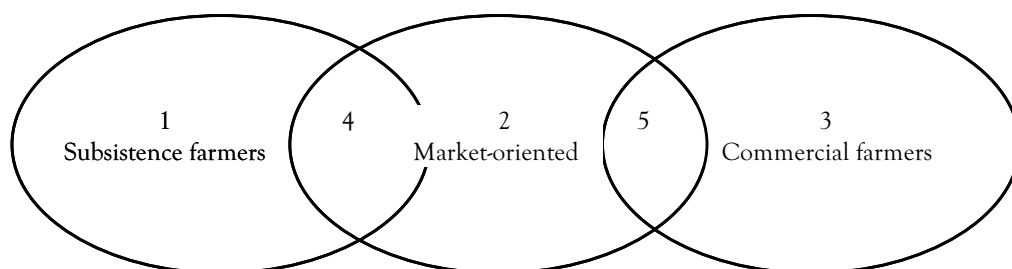


Figure 1. Farmer categories.

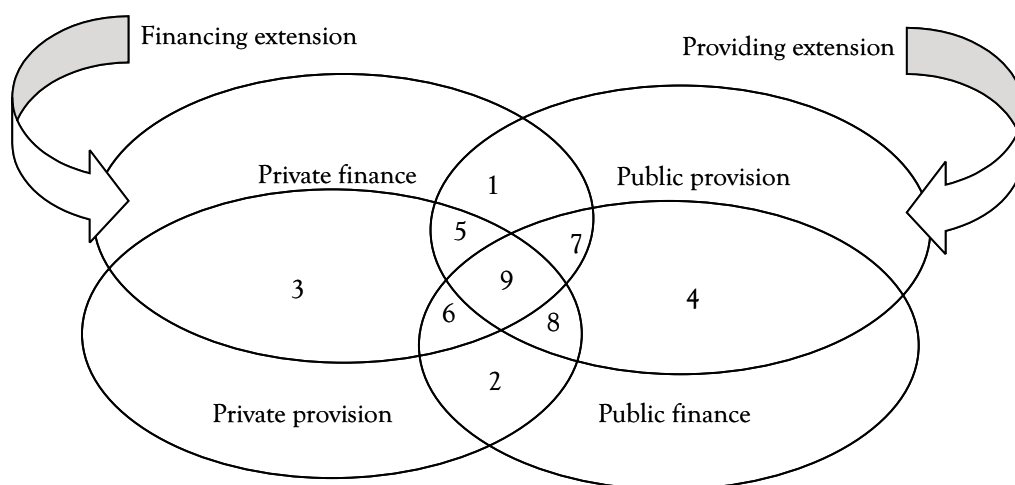


Figure 2. Alternatives for financing and provision of extension.

Characterising the Ugandan farmer

In search of a strategic framework for extension systems, clear analysis of farmer types in Uganda was made so as to bring them in context (Task Force on Agricultural Extension 1999). Farmers were categorised within the broad groupings presented in Figure 1 and the strategy designed to reflect farmer types, status and resource base.

The main categories of farmers from above were identified as follows:

1. Subsistence farmers
2. Market-oriented farmers
3. Commercial farmers
4. A mix of subsistence and market oriented farmers
5. A mix of market-oriented and commercial farmers.

The three main categories of farmers are described and defined in Table 1.

Table 1. Farmer definition matrix.

Characteristics	Subsistence farmers	Market-oriented smallholder farmers	Large-scale commercial farmers
Objective	Mainly for home consumption	Home consumption and market	Market
Technology	Indigenous/traditional low input/output	Some improved technology but still low output	Improved/advanced and high output
Activities	Grow crops/livestock (staples)	Grow crops/livestock food and cash	Specialised
Attitude	Risk averse	Cautious risk-takers	Risk takers

Table 2. *Distribution of rural households by farm size.*

Area of farm owned (ha)	Number of households ($\times 10^3$)	Percent of land
0–1	1513.68	62.2
1–2	556.68	22.9
2–4	253.18	10.4
4–6	56.08	2.3
6–8	17.13	0.7
8–10	7.93	0.3
10 and above	30.54	1.3
Total	2435.52	

The survey covered all districts of Uganda except Kumi and Soroti in the eastern region, and Gulu, Kitgum, Kotido, Lira and Moroto in the northern region.

In the conceptual shift of government responsibilities and roles in extension delivery, strategies that are evolutionary in nature, situation differentiated, gradual and multi-dimensional had to be developed otherwise resource poor farmers will remain poorly served. The strategy aimed at the gradual shifting of farmers from subsistence to market-oriented to commercial.

Alternative extension financing and delivery systems

In search of a strategic framework, a clear distinction was made between financing and delivery of extension as two distinct components in service provision. Four major models and several overlaps of service provision involving different combinations of public/private sector finance and delivery emerged (Figure 2). On the basis of these, a range of options emerged:

1. Private finance and public delivery
2. Public finance and private provision
3. Privately financed extension and private delivery of extension
4. Public finance and public extension delivery
5. Private finance and a mix of private and public extension delivery provision
6. A mix of both public and private finance but with private delivery
7. A mix of both public and private finance but with public delivery
8. Public finance and a mix of public and private extension delivery provision
9. Both public and private finance and with both public and private provision of extension.

Careful reflection of principles and country specific lessons

In recent years there has been a steady shift, in many countries, from public to private agricultural extension service and for users to take on more responsibility for extension. However, there has perhaps been insufficient critical reflection on the principles which

should guide the process. In search of a strategic framework to address the current shortcomings of the extension system in Uganda, critical examination of lessons and experiences from other countries were drawn. It was established that a number of innovative schemes have been tested in Latin America, Europe and Asia (Table 3) (Ameur 1994; World Bank 1994; Lopez 1995; FAO 1997; Baner et al. 1998; Kidd et al. 1998) from which practical lessons and application were drawn.

Table 3. Country example for extension delivery: A variety of experiences with privatisation and commercialisation extension.

Coutry	Case
New Zealand	Complete commercialisation of public extension
The Netherlands	Cost recovery from users
Germany	Many modes: Completely commercialised/privatised farmer associations and voucher system
Denmark	Extension services rendered by farmers' organisations
China	Contracting subject matter specialist by farmer groups
Ecuador	Share cropping between farmers and extension staff for a profit
Costa Rica	Voucher system targeted at small farmers and to contract private extension
Chile	Public financing and various modes of private delivery
Colombia	Public financing and various approaches of private delivery

Indeed these lesson and experiences guided the design of the NAADS in Uganda involving a clean policy shift from:

- farmers as beneficiaries to users and clients thus making them play a much larger role in controlling NAADS and own the system making it more demand driven including committing farmers to specific responsibilities
- a system operated by public poorly-paid employers to operate through contracting arrangements and by private institutions thus encouraging partial privatisation of advisory services
- the public sector as the provider of services to the role of stimulating the development of a private market for extension services
- direct government involvement in commercial aspects of agriculture to promoting the role of private sector. In this respect, the government will not:
 - supply or produce planting materials and other agricultural inputs (except for research and demonstration purposes)
 - supply artificial insemination or proven bulls
 - process or market agricultural outputs
 - construct large irrigation infrastructure
 - extension as a non-performer to extension as a results-oriented system.
 Thus specific consequences and outputs of NAADS are:
- deepening decentralisation of extension delivery to districts and sub-counties
- dispossession of the delivery of extension services to the private sector over a 25-year time span

- increasing the contribution of private sector financing of extension to 33% of total sector funding over 25 year period
- increasing over-all spending in agricultural extension services from just over 0.4% of agricultural GDP to 3.4% and specifically increasing public spending from 0.41% to at least 2% of agricultural GDP
- establishment of an agricultural development fund at district and sub-county level and
- establishment of agricultural development centres (ADCs) and technology development centres (TDCs) at districts and agricultural research development centres (ARDCs) at zonal level to enhance technology adoption.

Defining the strategy

Objectives and success indicators

Drawing from the above, the NAADS objective was defined as to increase use of appropriate and profitable technologies for sustainable commercially-oriented production through the pursuit of the extension mission. The measure of success of the strategy was also defined and these will bear on increase in gender and farmer types differentiated indices of:

- Agricultural transformation (Figure 3) is measured from rate of farmer commercialisation and proportion of farm output marketed, increased specialisation and use of more productive inputs, improved food security, to increase profitability, farmer attitude change and increased value adding. Specifically a decrease of subsistence farmers from current 82 to 40% within 25 years. At the same time an increase of commercial farmers from below 5 to at least 20% during the same period.
- Increased agricultural productivity: This implies increased total factor productivity from land, labour, capital input/output and organisational ability. This will focus on decreasing yield gap between those achieved from the research centres and the actual farmer situation from the current 80 to less than 30% within 25 years.

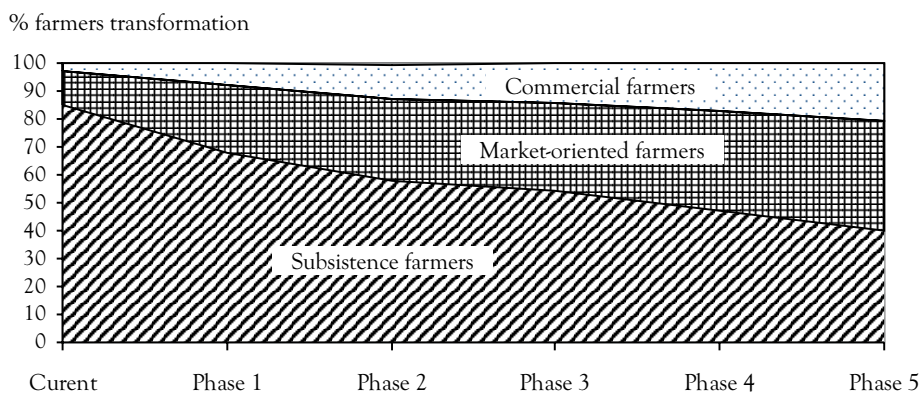


Figure 3. Farmer transformation in five five-year programmes.

- Sustainable natural resource productivity and institutional sustainability: This implies sustainable agricultural resource use and maintenance or improvement of the natural resource base despite increased productivity and farmer transformation. It will include institutional sustainability as reflected in increased participation and financing and improved standards.
- Increased agro-industrialisation: This implies export and domestic requirements for tradable commodities and products met.

Components of the strategy

From the above, areas which components of the extension strategy will bear on were identified as follows:

- i. Development of sub-county and district agricultural advisory strategic plan: A covert objective is to build consensus and ownership of the agricultural development process. Therefore all the activities in the process must involve all categories of stakeholders—particularly the women.
- ii. Development/improvement of operational capacity: This will centre on functional capacity as it relates to personnel, equipment, transport, supplies and operational funds. Whereas the Local Government Act (1997) transferred the mandate and responsibility of extension service implementation function to districts and sub-counties, their capacity is very limited and a considerable capacity building will be needed.
- iii. Improvement/development of management systems: This will focus on results oriented management (ROM) targeting value for money. At district and sub-county level, important areas of concern for improvement relate to programme development and management; financial management and accountability; administration and physical resources management; and human resource management.
- iv. Developing extension delivery and financing mechanisms: In developing the strategy, five financing/delivery (Figure 2) options are provided within the context of a continuum of farmer types (Figure 1) ranging from subsistence through market-oriented to commercial, as shown in Table 4.

Mechanisms for implementing the strategy embody the following principles:

- Empowering subsistence farmers to access private extension services.
- Developing private sector delivery capacity and systems.
- Developing sustainable financing institutions and mechanism.

The strategy developed will be in five phases each for five years with the following objectives:

Phase I: To shift from public to private delivery with mostly direct public financing while building the foundation for greater private sector financing. To achieve these, the following should be put in place:

- mechanisms for direct flow of funds to sub-counties and farmer groups
- mechanisms for sub-counties and farmer groups to source services.

Table 4. Extension service and farmer category matrix.

Farmer category	Options for financing and provision of extension services				
	Public finance and public delivery	Public finance with mix of public and private delivery	Public finance with private delivery	Public and private finance with private delivery	Private finance with private delivery
Commercial					
Mix of market-oriented and commercial					
Market-oriented					
Mix of subsistence and market-oriented					
Subsistence					

Phase 2: Consolidation of achievements in phase 1 and further reduce ratio of public to private finance to about 3:1. This will increase overall funding, without reducing public financing. In phase 2 and in subsequent phases, the rate of change from public to private will be dependent on the rate of farmer transformation from subsistence to commercial.

Subsequent phases (3–5): To get the ratio of public to private financing to about 2:1 by the end of phase 3, 1.5:1 by end of phase 4 and 1:1 by end of phase 5. The strategy is to greatly increase extension overall funding with additional funding from other sectors. The strategy in the last three phases is to accelerate the role of industry in financing extension.

- v. Strengthening technology systems and pathways: Since the transformation will, to a large extent, depend on innovative technological approaches, their uptake and application—fundamental steps to be taken in the strategy to stimulate increased technological development, uptake and application has to include interventions at levels of the technological flow. Key emphasis at farmer level will be farmer-based trials, demonstrations and basic farm skills and farm management training.
- vi. Strengthening knowledge information and communication: Physical, technical and social barriers have greatly limited access to knowledge and information on agriculture. One of the reasons for this is lack of well co-ordinated and integrated programmes at both national and local government levels. This will therefore be one of the areas of focus.
- vii. Stronger and effective linkages and co-ordination: The strategy recognises that stronger and effective linkages and co-ordination in the agricultural sector are important for modernisation. The linkage mechanism recognises the major players as farmer, district extension systems, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), agricultural training institutes, the national agricultural research systems (NARS), the private sector, the parliament/cabinet and the donor communities/external institutions.

The NAADS programme design

Principles of the NAADS

Before the development of the programme implementation arrangements, the principles through which the NAADS is anchored into the PMA were defined and stated as follows:

- empowering the farmers and building demand for both research and agricultural advisory services
- targeting agricultural services to the poor farmers who constitute the majority
- mainstreaming gender issues
- deepening decentralisation to bring the control of the services nearer to the farmers
- commercialisation—including intensification of productivity and specialisation
- participatory processes in planning, contracting, monitoring and evaluation
- managing natural resource productivity
- increasing institutional efficiency through contracting out services and better linkages and
- harmonisation of donor supported projects with PMA principles.

The NAADS programme components

From the above principles and taking into account the current shortcomings in the extension system, five NAADS components developed within which its anticipated outputs were defined. The philosophy underlying each component and the mechanisms that will be used to ensure that the basic principles outlined in are embedded within the approach used to generate the outputs, are described below.

Component 1: Advisory and information services to farmers

Here NAADS will support initiatives by farmers, working together in groups with their sub-county government, to contract agricultural advisors to deliver identified priority services. Matching grants would be made available from the district and national levels of government to help the farmers finance such contracts. Specific activities to be funded include orientation and group mobilisation, participatory planning, technical advisory service and information and communications.

Component 2: Technology development and linkages with markets

Support the multiplication of technologies at sub-county and district levels. Creation of linkages among farmers, advisers and researchers will be promoted. Farmers will be availed

funds to contract researchers to work with them on technology development and adaptation and also to link with markets.

Component 3: Quality assurance

Regulations and technical auditing of service providers. Support will be provided for the establishment of a regulatory framework for service providers by setting and enforcing standards for qualification and performance.

Component 4: Private sector institutional development

To accelerate the process of service provider transformation, a programme will be established and supported to assist private service providers to retrain and up-grade their skills. Leaders of farmers' organisations will be trained in managerial and leadership. Funds will be provided to facilitate the restructuring of the local government human resource structure consequent to the privatisation of the services.

Component 5: Programme management and monitoring

This component will establish and support public institutions at both the national and local government levels to play their statutory roles with respect to the NAADS. This will include monitoring and evaluation of programme activities and establishment of information management systems.

NAADS programme scope, target group and phasing

After the components were developed the programme scope, targets and phasing were set. It was determined that, to participate in NAADS, each district and sub-county will have to satisfy already laid down criteria and a few specific to NAADS.

The services to be provided would be solicited by and based on contracts arranged at the behest of the eligible beneficiary (farmers, farmers' groups, forums, local governments on behalf of farmer forums or groups, and the NAADS Board and Executive, for national or agreed thematic interventions). Potential service providers will need to meet a set of criteria of professional competence standards.

The two main ways in which individual farmers can participate in NAADS are:

- as members of a farmer's institution (group or fora) that can be a named party to a service contract
- as residents of a village, parish or sub-county where a service provider has a contract with the sub-county to provide advisory services

For a farmer's forum to be recognised as a representative body of farmers for NAADS purposes within the sub-county, it should be:

- made up of representatives of farmer's groups or institutions and
- have at least 30% of the groups represented being women's groups, 20% youth groups and 5% disabled groups.

NAADS resource allocation and targeting

NAADS central government programme funds will be allocated to districts, based on the consolidated farmer groups' plan and budget, submitted by each sub-county farmer forum. To participate in the programme, districts and sub-counties have to meet the NAADS minimum conditions, of which counterpart contributions of funds will follow the process established for government/PAF projects. Sharing of NAADS funding between the national, district and sub-county levels will utilise similar criteria of population and land area to those of other projects, but with an element of bias to the poorer areas.

Organisation and implementation

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) will have overall national responsibility for the programme, with oversight by MFPED, while sub-county and district local councils and administrations will be responsible for support and supervision at their levels. Primary responsibility at grassroots level will be vested in the farmer groups that will be the prime clients of the advisory services—and their elected farmer forums at sub-county, district and national levels. The overall institutional structure of NAADS is illustrated in Figure 1. There was recognition of the Ministry of Local Government (MOLG), which is responsible for administration of the Local Governments Act 1997, under which NAADS district, sub-county and parish and village level activities will take place.

It was determined that the NAADS Board will be constituted and charged with the role of advising and giving guidance on programme policy and strategy issues and facilitating, supervising and supporting the NAADS Executive. The NAADS Secretariat will form the programme management. Since the majority of decisions and functions in routine management will be the remit of the appropriate farmer forum, sub-county and district personnel, the major task of the secretariat will be in overall planning, technical guiding and oversight of operations; and performing a catalytic and promotional function in advancing programme coverage and impact.

Local governments will cover most of the local administrative and regulatory aspects and support requirements for NAADS. Parish, sub-county and district councils will, at their respective levels, be responsible for policy, assessment of effectiveness and general oversight of the NAADS, and voting of counterpart financial contributions.

Farmer institutions will be the cardinal element of the programme and their effectiveness will be the principal determinant of NAADS and PMA success. The purpose of the formation of farmers groups is to create institutions for farmer empowerment.

Service providers may be individuals, small groups of advisers, consultancy and professional companies, parastatal agencies, academic institutions and commercial companies. It will be a major pre-occupation of NAADS to foster development of the service provider sector. The main role of these agencies will be to arrange and perform the advisory, research and development services in response to the demands of farmers, sub-counties, districts and the NAADS executive.

Legal framework

To implement NAADS three legal and regulatory issues need to be resolved: Establishment of the NAADS Board and Executive as a statutory parastatal organisation; recognition and registration of farmer institutions as a key step for farmers to be empowered; tendering and contracting in which under NAADS it is envisaged that contracting of service providers would be undertaken mainly at sub-county level with decisive involvement of farmer representatives. Rather than attempt piecemeal amendments of various existing laws and regulations, which would have implications for other sectors, a NAADS Organisation Bill has been drafted. Its enactment would resolve all three legal issues above.

Implementation mechanisms

The planning and operations structure (Figure 2) encompasses three main categories of activities, namely: the principal planning process from the grassroots up to national level; a liaison channel for consultation and dialogue between the different levels; and the co-ordination, oversight and service contract deployment channel. The programme intervention phases have been developed as follows; establishment of interim institutional arrangements; mobilisation, sensitisation and inventory taking; and tribalising in selected districts.

To support the overall NAADS programme, donors will pool all new resources coming on stream through 'NAADS earmarked' budget support. Under this arrangement, donors' funds will be merged with the government's own resources. Matching contributions from district and sub-county levels will be mandatory. NAADS programme funding will be used under government procedures, legislation and regulations. NAADS planning and budgeting process is founded on the government's annual budgeting cycle. NAADS planning will build on the government's planning and budgeting process.

Given the hard budget constraints, the main principle guiding expansion will be to ensure that resources are spent in a cost-efficient and cost-effective manner. This will be

guaranteed by a system of conditionality for participation of districts and sub-counties in NAADS programme.

Programme costs and financing; financial management and procurement

Programme fund disbursements will be predominantly to sub-county governments, which will account for approximately 77%, with district and national level disbursement accounting for 11 and 12%, respectively. The programme cost will be financed by the government through national, district and sub-county funding as well as donor support and farmer contributions.

NAADS financial management will follow the relevant government and local government legislation and regulations. NAADS funding will be channelled under conditional modalities. Procurement of goods and services will be in accordance with government guidelines, subject to donor group satisfaction with any amendments agreed that are necessary to meet NAADS requirements. The principal instruments for the provision of services and for most of eligible expenditures will be formal and legally binding, performance determined and time and value bound contracts. The entities that will be mandated to award contracts will be farmers forums in conjunction with sub-county or district administrations; sub-counties and districts themselves; and the NAADS executive.

Donor co-ordination and government/donors partnership

The channelling of donors' funds through the budget has implications in terms of donors co-ordination and joint government/donors monitoring of NAADS. Donors will have to plan, budget and mobilise their support in line with the government's planning and budgeting cycle.

Monitoring and evaluation

Monitoring will record the delivery of NAADS inputs and the achievement of outputs. A logical framework has been developed, and this, sets out the inputs, the expected outputs and the main monitoring and evaluation (ME) indicators that will be used; and it also summarises the monitoring and evaluation process. Monitoring will be concerned with programme performance in delivery of individual services and supplies; timing and co-ordination of activities; and impact, as set out in the logical framework and cost tables. Monitoring will take place at four levels: in the field, in community, village and farmer group activities; at sub-county; at the district; at the NAADS office.

Programme implementation manual

An operations manual will govern implementation of the programme. This manual will define administrative procedures; sanction requirements; delegation of authority; procurement procedures; fund flow systems; accounting and auditing requirements; disbursement procedures; operation of the special accounts; formats, terms, conditions and standards for contracts and memoranda of agreement between various participating agencies; and monitoring and evaluation arrangements.

Financial and economic cost–benefit analysis

The economic analyses undertaken using a sector programme approach and farm enterprise based analysis indicate that the NAADS programme is economically viable. The analysis is based on advisory services contact (direct and indirect) with 40% of farm households in target sub-county, and an adoption rate by these contacted households of 50%. This would result in over 15% of farm households in target sub-county adopting improved practices and increasing productivity and returns. By year 7 of phase 1 this will involve approximately 420 thousand farm households in 40 districts, with the vast majority of these beneficiaries being smallholder farmers. NAADS will generate a range of other benefits that have not been assessed quantitatively. Benefits will include the improved human resource skills developed with the programme training and the strengthening of the local institutional capacity.

Implications and lessons learnt

The formulation process of the NAADS programme was by the government's own appointed task force. The criteria used for the selection of the task force members reflected the width and depth of stakeholder interest and covered all key representation from these interest groups. Because of these the NAADS has had very wide acceptance at home at all levels. The task force received support from and worked very closely with over thirteen development partners. This helped in drawing expertise and experience from a wider international arena and reaching consensus in wide ranging and complex issues very quickly during the whole design process. The team consulted very widely, both internally and externally during every design stage, which greatly helped in reaching a common goal and consensus on objectives, outputs, implementation arrangements etc. Those consulted included policy makers, decentralised governments, NGOs, farmers, service providers, private sector, the developmental partners and several other relevant institutions.

The design process was guided by the right government policy environment and legal framework, as well as from wider government strategies and plans directed at poverty eradication and modernisation of agriculture. This allowed for a programme which is within the context of government strategy and plan and thus within a readily acceptable framework.

In the design of the programme, it drew lessons from past experiences in Uganda and international best practice on extension systems operations and delivery. This helped in

combining best options suited to our own situation. The programme also had the right timeframe (18 months) to complete the task and sufficient budget support, which allowed for intensive and extensive consultation and consensus building.

All the above are lessons to draw from the formulation process of a radical programme of this magnitude.

The NAADS programme has major implications on the current institutional arrangements, which will have to be transformed to reflect decentralisation and farmer empowerment concepts. It has implications on the service providers who will no longer be public servants, but will work on contract based on farmer-identified needs and priorities. The proposed financial flow mechanism to, and implementation arrangements at sub-counties, combined with acceptability of programme evolution, is also a departure from past arrangements, which will allow multiple evolution of the programme and refinement of lessons. In this respect process monitoring is very important.

The programme, in its empowerment mechanism, has drastically changed the roles of the farmers and advisers and this has implications not only in attitudinal aspects but also in skill base and capacity building programmes.

Questions for discussions

Some areas that may be included for discussions are as follows:

- Expected challenges and opportunities to the programme
- How will farmers and private service providers rise to the challenges in the programme?
- Because the programme is designed to evolve from lessons learnt, what tools, skills and experiences can we draw from process monitoring?
- Is there a wide forum to share experiences in this sector?
- What implications does the programme have on the diary sector?

References

- Ameur C. 1994. *Agricultural extension: A step beyond the next step*. World Bank Technical Paper 247. The World Bank, Washington, DC, USA. 15 pp.
- Baner E., Hoffmann V. and Keller P. 1998. Agricultural extension down the ages. *Agriculture and Rural Development* 1/98:3–23.
- FAO (Food and Agriculture Organization of the United Nations). 1997. *Strategic extension campaign: An FAO agricultural extension approach*. FAO, Rome, Italy.
- Kidd A., Lamers J. and Hoffmann V. 1998. Towards pluralism in agricultural extension: A growing challenge to the public and private sector. *Agriculture and Rural Development* 1/98:7–10.
- Lopez R. 1995. *Determinants of rural poverty: A qualitative analysis for Chile. Technical dependent, rural poverty and national resources, Latin America region*. The World Bank, Washington, DC, USA. 33 pp.
- NAADS (National Agricultural Advisory Services). 2000. Master document of the NAADS Task Force and Joint Donor Group—Ministry of Agriculture, Animal Industry and Fisheries, Entebbe, Uganda.

- PEAP (Poverty Eradication Action Plan). 1997. Available at <http://www.worldbank.org/participation/tn2.htm>
- PMA (Plan for the Modernisation of Agriculture). 2000. Government of the Republic of Uganda.
- Task Group on Agricultural Extension. 1999. Strategic Framework Final Report. Government of the Republic of Uganda.
- The Local Government Act. 1997. Republic of Uganda. Uganda Printing and Publishing Corporation, Kampala.
- World Bank. 1994. *Chile, strategy for rural areas, enhancing agricultural competitiveness and alleviating rural poverty, Report No. 12776-CH of the National Resources and Rural Poverty Division*. The World Bank, Washington, DC, USA. 54 pp.

Theme 5: Effective and efficient livestock services for smallholder dairy production

Plenary discussion

After the presentation of the four case-study papers on livestock services, the points raised in the plenary discussion related to the scarcity of resources that define smallholder systems, and the difficulty of ensuring responsive and demand-led research and extension services for those systems. The debate on how to organise responsive services was continued during the theme 5 group discussion (see below).

In the plenary discussion, the issues and concerns raised were:

1. A common problem in developing countries is land scarcity, with a significant proportion of land being owned by a wealthy minority.
2. A major constraint in many systems is lack of (financial) capital.
3. Extension should be problem-based and driven by farmers.
4. On-farm research is needed to develop technology.
5. Replication of the Amul model
 - The major problem with replication resulting from cultural, ecological and social differences was reported as resistance to change by bureaucrats who had vested interests in the *status quo*.
 - Labour costs in India are very low and therefore the cost of services (veterinary and artificial insemination; AI) could be maintained at their current low levels. Participants queried the possibility of maintaining these low service costs in areas where wages were higher.
6. There is the need to decentralise services and to deliver to the farmers' doorstep.

These issues and the related topics that emerged from the presentations in themes 4 and 6 were subsequently discussed in small groups of workshop participants.

The outcomes for theme 5 are given below.

Group discussion

As for the other groups, the theme 5 discussions were guided by a set of questions. The questions presented to the group addressed alternatives to the government supply of livestock services and sought information about important lessons from countries in the South.

The questions were:

1. What are the lessons from countries in the South for improving the coverage, accessibility and effectiveness of services to smallholder dairy farmers?

2. The governments of many developing countries have stopped or are considering withdrawing from, providing input (production extension; clinical and AI) services to smallholder farmers. Which are the key steps required to manage the transition from delivery by public organisations to delivery by other providers?
3. What alternative mechanisms for the delivery of livestock services have proven successful in the South and what conditions were required?
4. Many smallholder farmers depend upon traditional systems for accessing livestock services (e.g. animal treatments) and technical advice (e.g. farmer-to-farmer advice). How can these systems be better served to the benefit of smallholders?

The group's responses to these questions were outlined as follows.

Lessons from countries in the South for improving the coverage, accessibility and effectiveness of services

- Government's role should be to provide public goods.
- The delivery of services by governments has failed.
- For commodities that pay like tea and pyrethrum in Kenya, the private sector has taken up extension and service provision. Difficult for non-cash crops, especially in subsistence farming systems.
- Subsidies result in false adoption and do not serve the poor.
- In some cases government might be involved in the delivery of private goods.

Which are the key steps required to manage the transition from delivery by public organisations to delivery by other providers?

- Government must be committed to the change.
- The transition must be managed.
- The stakeholders must be informed of the decision in advance (publicity).
- Unfair competition with other service providers must be removed in order that the private sector can take root.
- Mechanisms must be put in place to ensure that even remote areas will be reached by the private service providers.
- Training not only of vets and para-vets, but of local people so that they can provide some of the services.
- Some form of supervision should be provided (government).

What alternative mechanisms for the delivery of livestock services have proven successful in the South and what conditions were required?

- Co-operatives.
- Government should use policy instruments to encourage co-operative development.

- For co-operatives to be successful, local leadership is vital.
- Government can help through: empowering the people; training.
- The co-operatives should address the technical, social and credit issues.
- Public-funded, private-sector delivered services, i.e. CBOs, NGOs.
- Services can be decentralised to local organisations and the staff should be answerable to the people he/she is serving.
- The local institution should be democratic.

How can traditional systems for accessing livestock services be better served to the benefit of smallholders?

- Work should be set up to help understand local delivery systems.
- Identify the points of entry or intervention.
- Train the local people in particular skills.
- Validate the practices.
- Learn from the human medical field where they have combined/linked the traditional birth attendants with the modern medical services.

Conclusions

The presentations, the supporting papers and the discussion relating to the delivery of livestock services emphasised the importance of decentralising public-funded services to local organisations so that the staff are answerable to the people they are serving. There was also the call for innovative thinking to build upon the examples from India and elsewhere of public-funded, private sector delivered services. The importance of these issues are reflected in the workshop recommendations where actions towards achieving the objectives were agreed and are presented.

Theme 6: Making the research and extension paradigm responsive to farmer needs

Forage legume technologies: Participatory experiences with farmers and community-based organisations in Central Kenya

D.M. Mwangi¹ and C. Wambugu²

1. Corresponding author, Kenya Agricultural Research Institute (KARI)

P.O. Box 30148, Nairobi, Kenya

2. International Centre for Research in Agroforestry (ICRAF)

P.O. Box 27, Embu, Kenya

Introduction

Central Kenya constitutes 18% of the land area of the country; it holds about 64% of the human population. The population density range is wide, ranging from about 100 persons/km² in the dry lowlands to over 1000 persons/km² in areas with high agricultural potential (CBS 1994). Agriculture is the main economic activity with coffee (medium to low altitude) and tea (high altitude) as the major cash crops. The farming system is predominately mixed with livestock, especially dairy production being important. In a recent farm survey (Staal et al. 1998), farmers ranked dairy production second only to cash crops in economic importance.

In Kenya, it is estimated that 80% of the marketed milk comes from smallholder mixed farms (DANIDA/MoLD 1991; Mbogoh 1984) which are mainly family farms with less than ten hectares (ha) of land (Gitau 1994; Mwangi 1994) and less than ten dairy animals (Anon 1985; Anon 1987). Due to the high human population pressure, farms are small with average holdings of 0.9–2.0 ha per household (Gitau et al. 1994; Mwangi 1994) and are rapidly decreasing in size due to subdivision. Animals are therefore confined in stalls and fed on Napier grass (*Pennisetum purpureum*) in a zero-grazing production system. Approximately 80% of the dairy animals in Central Kenya are kept in this system (Mwangi 1994; Staal et al. 1998). The importance of the dairy enterprise in smallholder farms has increased in recent years, due to liberalisation in the dairy subsector, which has resulted in the redistribution and increase of the overall social and economic benefits of market-oriented smallholder dairying (Omore et al. 1999). This coupled with low cash crop prices has made smallholder dairy production an important income earner in smallholder farms in Kenya.

Sources of livestock feeds in Central Kenya

Planted forages, the maize crop, cereal residues, natural pasture and grass harvested from public utilities (i.e. road reserves, school compounds etc.) are the major sources of livestock

feeds in Central Kenya. As the size of land holdings declined due to subdivision, the contribution of pasture to livestock production has declined. Therefore, most livestock feeds come from planted forages and the cropped land. Apart from the maize crop, which is discussed below, bean haulms, weeds and fodder crops planted on soil conservation terraces are a major source of livestock feeds on many farms. Even on farms where animals are grazed, fodder including crop residues gathered from the farm is usually the main source of feed rather than pasture (Staal et al. 1998).

Napier grass is the main fodder crop in Central Kenya and is grown by over 70% of smallholder farmers in the area (Stotz 1983; Potter 1987; Bayer 1990; Mwangi 1994; Staal et al. 1998). Stotz (1983) estimated that 240 thousand hectares or 4% of the total arable land on smallholder farms in Kenya was under Napier grass. A recent survey in Kiambu district in Central Kenya showed that on average 0.2 ha were planted with Napier grass in households keeping cattle (Staal et al. 1998). This represents approximately 15% of all arable land on these smallholdings. Data from longitudinal recording of 21 farms in Kiambu indicate that over 40% of the dry matter available to dairy cows in the area comes from Napier grass (Table 1).

Table 1. Sources of livestock feeds in Central Kenya.

Source of feed	Proportion of overall dry matter (DM) available (%)
Napier grass	40.9
Dry maize stover	17.1
Concentrate feeds	12.2
Grass	7.6
Weeds from cropped land	6.0
Maize thinnings	3.3
Green maize stover	3.0
Banana pseudostems	2.6
Poultry litter	1.7
Banana leaves	0.8
Banana thinnings	0.6

Source: Smallholder Dairy Project (longitudinal recording in Kiambu district) unpublished data.

Maize is a staple food crop in Central Kenya and has become increasingly important as source of fodder in smallholder farms. The maize crop supplies approximately 23% of the dry matter (DM) available to dairy animals in Central Kenya (Table 1). The fodder is in the form of dry maize stover, thinnings and green stover. Methu et al. (1996) estimated that farmers grow an average of 0.36 ha of maize per season, from which they harvest 0.9 t of maize stover. Therefore, with two growing seasons/year, approximately 1.8 t of maize stover is harvested. In Central Kenya, farmers keep on average two animals (Methu et al. 1996; Staal et al. 1998). Therefore, the maize stover produced can be fed for between three and six months but intake and utilisation is limited by the inherent characteristics of

maize stover. Currently, maize stover provides approximately 17% of the DM available to cows (Table 1).

Maize thinnings and green maize stover form about 6% of the DM available to cows. While green maize stover (harvested after the maize cob reaches physiological maturity) is feed when available, farmers go out of their way to plant seeds closely with the aim of thinning the extra plants for livestock feed. On-farm work on smallholder farms has shown that this practice could increase the DM yield by between 1.1 and 2.4 t DM/ha per season (Lukuyu, personal communication). As the crude protein (CP) content of the thinnings is higher than that of dry maize stover (Onim et al. 1991), high-density planting increases the quantity and quality of forage available.

Limitations to dairy production in Central Kenya

Good quality Napier grass can support the production of between 7 and 10 kg of milk/animal per day (Anindo and Potter 1986; NDDP 1990) but actual production on farms is only about 5 kg/cow per day (Gitau et al. 1994). The poor performance is attributed to an inadequate year round supply of feed. Napier grass is grown with little or no chemical or organic fertiliser and the DM yield is low. The digestibility and the nitrogen (N) content of Napier grass declines rapidly as the grass matures, especially during the dry season, curtailing milk production. The utilisation of maize stover, which is the main roughage during the dry season (Said and Wanyoike 1987; Mwangi 1994), is constrained by the low CP content (Nicholson 1984; Little and Said 1987; Methu 1998). This system seems to offer itself for the integration of both herbaceous and shrubby legumes. It is apparent, therefore, that milk production in Central Kenya is limited by both the quantity and quality of feed available. Therefore, any strategies aiming at increasing milk production must address both the quantity and quality issues. In this regard herbaceous and multipurpose/shrubby legumes can contribute and are discussed below.

Potential benefits of integrating forage legumes into smallholder fodder systems in Central Kenya

The benefits of integrating legumes into fodder systems have been demonstrated. A review by Saka et al. (1994) looks at the benefits in different farming systems in sub-Saharan Africa (SSA). This case study will, therefore, not attempt to review the benefits of forage legumes in animal production systems but will highlight some recent work in Kenya with forage legumes and their contribution to DM yield of fodder crops and animal performance. Experience with the participatory introduction of herbaceous and shrubby legumes into the farming systems will be discussed in detail.

Effect of herbaceous legumes on total (grass and legume) DM production

The DM yield achieved will depend on the production system and the legume species used. In cases where nitrogen does not limit grass growth, tropical grasses will always out-yield legumes grown in pure stands and the yield gap may be as high as 10 t. Therefore, in a situation where population pressure is high, as in Central Kenya, pure legume plots are not envisaged.

Many workers have reported higher grass DM yields when grass is grown in a mixture with legumes (Ibrahim 1994; et al. 1995; Shehu and Akinola 1995). Napier grass/legume work in Central Kenya did not give a higher grass DM yield (Mwangi 1999); however, when forage legumes were integrated into the forage system, the total (grass + legume) DM yield was higher than the sole Napier grass yield by between 20 and 38% (Table 2). Mureithi (1992) reported similar findings when Napier grass was grown together with *Clitoria ternatea* at the Kenyan coast. The higher DM yield was therefore the additive effect of the legume DM rather than its effect on grass performance. This would imply that the Napier grass/legume mixture was possibly utilising resources (soil, space etc.) more efficiently, resulting in a higher forage DM yield.

Table 2. The effect of growing Napier grass together with *Desmodium intortum* or *Macrotyloma axillare* on heifer carrying capacity of land and live weight gain by dairy heifers.

	Napier grass alone	Napier grass/ <i>D. intortum</i>	Napier grass/ <i>M. axillare</i>
DM yield (kg/ha per year) ^a	20,040	27,780	24,480
Intake (kg DM/day) ^b	6	7	7
Live weight gain (LWG) (actual) (kg/day) ^c	0.39	0.42	0.42
LWG (estimated) (kg/day) ^d	0.50	0.56	0.51
Carrying capacity (heifers/ha per year) ^e	9.1	9.8	8.6
Live weight gain (kg/ha per year) ^f	1295	1690	1530
Advantage (kg live weight/ha per year) ^g	–	395	235

a. Yield in work at Muguga.

b, c and e. Calculations based on a Napier grass/*D. intortum* mixture (85:15%) (Kariuki et al. 1998b).

d. Estimated live weight gain (LWG) made using the allocation of nitrogen in organic resources for animals and crops (ANORAC) model (Thorne and Cadisch 1998).

g. Advantage of mixture over Napier grass alone.

Effect of herbaceous legumes on animal performance

The potential effect of integrating forage legumes into a Napier grass mixture on animal performance is shown in Table 2. Kariuki (1998a) supplemented dairy heifers on Napier grass with *Desmodium intortum* and reported a higher live weight gain than with the Napier grass alone treatment. As the dairy enterprise in Central Kenya is characterised by low live weight gain in young stock, these results indicate the potential of legumes in the system. Calculations based on these results (Kariuki et al. 1998a) and on agronomic data collected

in Muguga (Mwangi 1999) indicate that integrating legumes into the Napier grass fodder system, would increase the carrying capacity from 8.2 to 9.8 heifers/ha per year and total live weight gain from 1280 to 1690 kg/ha per year (Table 2).

The above-cited cases demonstrate the potential role that forage legumes (herbaceous and shrubby) can play in the livestock system, not only in Kenya but also in SSA. Unfortunately, this potential has not been translated into tangible benefits in smallholder farms mainly because of poor adoption of forage legume technologies by smallholder farmers.

Several attempts have been made to introduce herbaceous legumes on smallholder farms in Central Kenya. *Desmodium intortum* and *D. uncinatum* were introduced to smallholder farms in Central Kenya by the National Dairy Development Project (NDDP) a decade ago. The project recommendation was that the legumes should be grown and harvested together with Napier grass with an aim of improving the N supply to dairy cattle. More recently, the Kenya Agricultural Research Institute (KARI) introduced both herbaceous and shrubby legumes into the same area. The legumes were to be intercropped with food crops and planted grasses (Wandera 1995). The Legume Research Network Project (LRNP) also introduced herbaceous legumes mainly as a green manure crop in areas of Embu in Central Kenya.

Despite these and many other attempts to introduce shrubby and herbaceous legumes on smallholder farms, adoption has been low (Paterson et al. 1996a). In 1994, the NDDP reported that out of 222 farms with a total of 536 ha surveyed in Eastern Kenya, only 42 farms were growing herbaceous legumes on approximately 7.2 ha of land. However, the report did not indicate the proportion of the legume in the DM and, therefore, the importance of the legume in the system could not be determined.

This case study will, therefore, deal with the recent activities to introduce *D. intortum* cv. Greenleaf through the National Agricultural Research Project phase II (NARP II) and *Calliandra calothyrsus* through the System-wide Livestock Project (SLP). Factors that affect the adoption of the legumes and methods used in attempts to overcome constraints are discussed.

Experience with *Desmodium intortum* cv. Greenleaf

As indicated earlier, Napier grass is the main planted forage in Central Kenya. Therefore, all attempts to integrate *D. intortum* into the farming system have focused on its role as a companion crop to Napier grass. In this work a participatory approach was used. A survey was conducted in Kandara division of Maragua District, one of the areas where the NDDP introduced *D. intortum* in Central Kenya with the objective of identifying constraints to adoption and documenting farmers' experiences with the legume. A total of 33 farmers and a total of 13 key informants (farmers involved with NDDP work) were interviewed. After the survey, on-farm studies involving 15 smallholder farmers in the area were established. The on-farm studies were looking at the effect of growing Napier grass with or without legumes

on DM yield. During these studies (a period of approximately 18 months) dialogue with the farmers was maintained. The experiences highlighted below were mainly from this period of constant interaction with the farmers.

The farmers identified the major constraints to adoption (Mwangi 1999) as:

- availability and cost of *D. intortum* seeds
- slow growth during the seedling stage
- failure to demonstrate clearly the benefits of herbaceous legumes, especially at the farm level
- poor persistence of the legumes when grown together with Napier grass.

Availability, cost and ease of handling of seeds

The main source of legume seeds so far in Kenya has been the small quantities supplied by researchers conducting on-farm experiments. The introduction of forage legumes has not been matched by the supply of seeds by commercial seed companies, as is the case for other crops like maize. When available, most of the seeds are imported and are expensive. *D. intortum* seed will cost approximately 2000 Kenya shillings (KSh) per kg (US\$ 1 = KSh 80 at March 2001). Farmers grow on average 0.2 ha of Napier grass (Staal et al. 1998) and; therefore, to grow *D. intortum* together with Napier grass they would require 500 g of seed at a seed rate of 2 kg/ha. This amount would cost KSh 1000 (US\$ 12.50). In an area where the monthly income is estimated at KSh 6664 (US\$ 83.3) (Staal et al. 1998) the seed cost would take approximately 15% of the total monthly farm income. This high cost of seed and the fact that the seeds are not readily available make the otherwise good technology unattractive to farmers.

The legume seeds are small; therefore, sowing requires extra care and extra labour is required at a time (planting season) when the demand for labour for planting food crops is high. The tiny seedlings that emerge make weeding difficult. Many farmers that we worked with indicated that this weeding problem would be a major issue if they had to adopt the legume. In several instances the farmers unintentionally uprooted the legumes together with weeds. The incidences of uprooting the legume were higher where labour was hired (personal observation).

The conclusions from the study were that if the issues of availability, cost and difficulty of handling the seed and seedling were not addressed then the technology was unlikely to be adopted. An alternative method of establishing the legume through stem cuttings (vines) was envisaged. Establishment from stem cuttings was successful and the survival rate was over 90% (Mwangi 1999). The farmers could easily relate to the planting of stem cuttings, as this was similar to planting sweet potato vines, which they do all the time.

When the farmers learnt that they could establish *D. intortum* from stem cuttings but that the number of stems that the research team could provide was limited they started small nurseries, mainly near shallow wells on the farm or under banana plants where water and shade was available. These nurseries have now become sources of planting material, thus ending the dependency on the research team. Farmers used the materials from the nurseries to experiment with the legume. When the experiments started the only niche for the legume

that was discussed with the farmers was the Napier grass stands. Farmers later planted the legume under coffee, banana and avocado trees and on soil conservation structures. This planting and experimentation by farmers would not have been possible if the legume had to be established from seed. Planting stem cuttings made weeding of the stands easier. Therefore, solving the propagation issue and putting the solution into farmers' hands increased the potential for adoption of the *D. intortum* technology. It must be emphasised that difficulties with propagation are a critical constraint to fodder adoption. The wide spread adoption of Napier grass is mainly attributed to the ease with which it can be propagated (Mwangi et al. 1995).

Anecdotal information indicates that farmers not involved in the study have received planting material from farmers with nurseries and in turn have started their own nurseries. The effectiveness of the nurseries as a source of *D. intortum* planting material will be assessed through a planned adoption study.

Initial slow growth

As stated previously, the main constraint to animal performance in Central Kenya is the inadequate year round supply of good quality forage. Therefore, any forage introduced to the area must be fast growing and high yielding. This explains the adoption of Napier grass by the majority of smallholder dairy farmers (Mwangi 1994; Mwangi et al. 1995; Staal et al. 1998), which is likely to be used as a model to assess other forage crops.

The initial growth of *D. intortum* is slow especially when established from seed and cannot be compared with that of Napier grass even when stem cuttings are used. When Napier grass is established from rooted splits, the farmers can take the first cut three to five months after planting depending on rainfall but *D. intortum* takes between eight and nine months before a cut can be taken. During this period, Napier grass will have produced 7.7 t of DM/ha compared with only 3.7 t from the legume (Mwangi 1999).

As the legume was relatively new to the farmers, the initial low growth rate made them decide that the potential was low and that the legume was a waste of time and resources. The main question asked by the farmers at this stage was 'will the legume ever get to a stage where we can harvest and have substantial amounts to feed the cow'? At this point the cause would have been lost if farmers were not given something to hold on to. Therefore, a decision was made to take the farmers to the research centre where they could see an already established Napier grass/*D. intortum* mixture. The farmers initially could not relate the established legume to the struggling seedlings on their farms and the visit had a major impact on farmer perception of the technology. As trips to the research centre might be costly and do not always reflect conditions on smallholder farms, the research team has emphasised farmer-to-farmer visits to enhance adoption of the legume technology. During these visits the farmers see the potential of the legume and always carry planting material back to their farms. Plans are underway to conduct an adoption study to determine how effective this approach has been, but anecdotal information indicates that it has been successful.

Failure to demonstrate clearly the benefits of herbaceous legumes, especially at the farm level

If farmers have to adopt a technology, they must be able to clearly see the benefits. Sometimes beneficial technologies are not adopted because the benefits cannot be clearly demonstrated or are long term. The major benefits of forage legumes include higher DM yields (Keya et al. 1971; Keya and Kalangi 1973; Reategui et al. 1995; Shehu and Akinola 1995; Mwangi 1999), biological nitrogen fixation (BNF) (Cadisch et al. 1989; Thomas and Sumberg 1995; Mwangi 1999), improved soil fertility and better animal performance due to the improved N supply in the diet (Kariuki et al. 1998a, b and c). Some of these benefits are difficult to demonstrate on-farm and others like soil fertility improvements are long term.

When the research team introduced *D. intortum* to farmers in Central Kenya, higher DM yields, higher N content yields and improved BNF were the benefits emphasised. These were the same benefits observed in on-station work (Mwangi 1999). A benefit that was observed on-station, but not emphasised by the research team when it discussed the benefits of the legume with farmers, was weed suppression by the legume when grown together with Napier grass. This turned out to be the most important benefit to the farmers, as they could easily observe and quantify it.

Napier grass is usually cut after 4–6 weeks of regrowth. After each cut the plot should be weeded. Therefore, with a minimum of four cuts per year the plot has to be weeded four times. It takes eight man-days to weed one hectare of Napier grass. At the current rate of KSh 150 (US\$ 1 = KSh 78.9) per day, it would cost at least KSh 4800 (US\$ 60) per year to weed a hectare of Napier grass. The saving incurred due to weed suppression by the legume is attractive to farmers and is the main benefit they see in the legume technology. Therefore, although the farmers have not realised the effect of the technology on livestock performance, which the research team emphasised, they are ready to adopt the technology because of other benefits, such as weed control.

Poor persistency of the legumes when grown together with Napier grass

Poor persistency of *D. intortum* when grown together with Napier grass was cited by the farmers as a major constraint in this technology. One farm had a substantial amount of *D. intortum* growing in a pure stand, but apart from this there was no trace of the legume in the Napier grass plots. It was suspected that Napier grass, which is a very competitive grass, had 'edged out' the legume through competition. This apparent lack of persistency could have been caused by one of several factors: (i) The management (i.e. spacing, harvesting frequency, manure application etc.) of Napier grass was not adjusted to accommodate the legume in the intercrop; (ii) The legume was planted in the same row with Napier grass, tending to maximise between species competition; (iii) The legume seed was drilled into an established stand of Napier grass, therefore, giving the young seedlings little chance to survive.

Experience with *Calliandra calothyrsus* in Central Kenya

Since the 1980s, *C. calothyrsus* has been seen as a potentially important N rich supplement for increased milk production. The focus has been on integrating calliandra into the existing cropping system on smallholder farms. In this regard, several niches have been identified into which calliandra can be cultivated (Paterson et al. 1996b) including:

- hedges around the farm compound
- along contours and soil conservation terraces
- intercropped with Napier grass
- between upper storey trees (mainly under *Grevillea robusta*).

As with the herbaceous legumes, the benefits of growing *C. calothyrsus* in different niches have been clearly demonstrated in research experiments. Napier grass DM yield in the rainy season was not affected by intercropping it with *C. calothyrsus* (NARP 1993) but dry season DM yield was reported to increase (Nyaata 1998). Feeding trials have considered *C. calothyrsus* as a supplement to the basal diet of Napier grass and as a substitute to dairy meal (Paterson et al. 1996a). Supplementing milking animals with one kg of fresh *C. calothyrsus* increased milk yield from 10 to 10.75 kg/cow per day (Paterson et al. 1996b). Despite these benefits, adoption of *C. calothyrsus* by smallholder farmers has been poor. Farm survey reports attribute poor adoption of *C. calothyrsus* to lack of seed/seedlings but personal observation and discussion with farmers indicate that objectives of introducing the trees were not discussed sufficiently with farmers.

Lack of planting material

Although fodder trees are currently gaining popularity in smallholder farming systems, most of the seeds come from international research centres, such as International Centre for Research in Agroforestry (ICRAF), non-governmental organisations (NGOs) and localised harvests in Western Kenya and Embu (Franzel et al. 1999; Wambugu 2000). This short supply of seeds has constrained the adoption of calliandra by smallholders (Gerrits 2000; Personal observation). Farmers rarely collect or use seeds from their own farms or from their neighbours, as they still expect the tree seedlings or seeds from projects, NGOs and international centres (Franzel et al. 1999). Currently, efforts are underway to overcome this constraint by training and encouraging farmers and farmer groups to produce and use their own seeds (Gerrits 2000; Wambugu, unpublished information). Unlike the case of *D. intortum*, vegetative propagation of calliandra is not an option. Therefore, the way forward is for the farmers, either in groups or as individuals, to produce seeds by having seed orchards or by not coppicing a number of trees so that they can produce seeds.

Lack of clear objectives

A farmer needs 500 calliandra trees to feed a cow throughout the year at a rate of two kg DM/day (Paterson et al. 1996b, c), whereas often farmers have less than a hundred trees. In

the Embu area, which is considered to have the highest adoption in the country, only one farmer out of 45 sampled, claimed to have enough calliandra trees to feed his cows throughout the year. It is currently not uncommon to find a farmer with less than 10 calliandra trees. Therefore, the amount available to feed to livestock is small.

The major introduction of multipurpose trees was spearheaded by the NDDP in many of the dairy areas in the country. It appears that the number of trees required to effectively feed a cow and the management of the trees to maximise biomass production was not discussed (personal observation). On farms where the NDDP operated, it is common to find two or three tall trees with no efforts having been made to increase the number planted or to manage the trees to form a hedge. In the case of dairy farmers in Central Kenya, there is need to expand the number of calliandra trees to reach the recommended 500 trees/cow or to recommend appropriate feeding practices to farmers which make best use of the limited quantity available.

Current approach for the introduction of forage legumes in Central Kenya

After evaluating forage legumes and validating the results on-farm, the main challenge is the scaling up and scaling out of the technology. If a technology is to have impact in an area, then many more farmers than those involved in the pilot/testing group must adopt the technology. In the past, introduction of both herbaceous and shrubby legumes has been through individual farmers. This approach has its limitations, especially where nurseries have to be established.

In the scaling up and scaling out stage, the group approach was adopted. The group approach means that the farmers can share the cost in terms of labour or inputs required for the nursery. The presence of many organised farmer groups (i.e. self-help groups, farmer co-operatives etc.) provides a favourable environment for awareness creation, training and distribution of planting materials. Participatory approaches are being used in training and working with farmers and partners from public extension services, community-based organisations and NGOs. This is aimed at developing and enhancing strategic partnerships with farmers, researchers, extension agents (both public and private) and farmers. In this approach, SLP is working with 150 farmer groups, 4 local NGOs, 1 international NGO and 10 community-based organisations (Wambugu 2000) to disseminate *C. Calothyrsus*.

D. intortum integration with Napier grass was a success story in a small area and with a few farmers. The challenge now is that of scaling up. The Smallholder Dairy Project (SDP) is a collaborative effort between the Ministry of Agriculture and Rural Development (MoARD), KARI and the International Livestock Research Institute (ILRI) with funds from the Department for International Development (DfID). The project goal is to improve access by poor dairy farmers to goods, services and favourable market conditions and of other farmers to knowledge services. The *D. intortum* technology has the potential to contribute to the project goal by improving the feed supply to dairy cattle and, therefore, SDP is involved in the scaling up and scaling out process.

Geographic information system (GIS) tools were used to determine areas in the country where the legume would grow based on biophysical conditions. Furthermore, areas where adoption of the technology was most likely were identified using market accessibility, production systems and levels of intensification. After the areas were identified, the group approach was adopted. In areas where SLP was working to promote *C. calothyrsus* a decision was made to link into the same farmer groups. This reduced costs in terms of the time and resources required to mobilise farmer groups and to characterise them. Moreover, it also gave the farmers a choice in terms of the forage legume they could plant.

Implications and lessons learnt

One of the lessons learnt from this work is that availability and cost can curtail the adoption of an otherwise excellent technology. In both cases presented here, availability of planting material and the ease of propagation have been shown to be critical issues that must be addressed if the technologies are to be adopted by farmers. Giving farmers free seedlings or seeds from international research centres, research projects or NGOs reduce the farmers' abilities to use other resources available at farm level, as they will expect more free planting material. This was and might still be the case with *C. calothyrsus* in Central Kenya. On the other hand, it will be futile to introduce the technology without making some planting material available. Therefore, the aim should be to move the farmers from the point where they are dependent on international centres and NGOs to a point where they can handle the technology with little or no intervention from outside their systems. Consequently, it would be wise to address the problems of germplasm availability and propagation early in the phase of forage technology development, otherwise adoption will be poor.

Adoption of any technology is enhanced when farmers can easily see the benefits. Therefore, short-term benefits should be emphasised although the long-term ones should also be mentioned. Visits to research centres or to other farmers will help farmers to visualise the potential the technology has. In situations where 'mother-baby' trials can be set up, they should be encouraged as the mother trials help the farmer to see the potential of the technology in their own environment rather than in research centres where the situation might be very different. In mother-baby trials an on-station type trial (mother trial) is established in the target area. Biological data are collected from this trial but farmers are encouraged to observe what is happening and to pick a few of the species/cultivars of forage planted in order to experiment with them further on their farms in the baby trials.

Working with farmer groups might enhance adoption of technologies, as the farmers share experiences, labour and other inputs required for the technology to succeed. It may enhance wider adoption even if the most proactive farmers are upset since they feel they are making effort for the weaker farmers who gain benefits they feel should remain with them. It is necessary to tell the farmers the minimum they would have to do to see any effects/benefits of the technology.

Germplasm evaluation should be carried out in the system where the forage will be grown. Currently, forage legumes are evaluated in small plots and in pure stands while may be the eventual aim is to grow them together with companion grass. In the current method

of evaluation, DM yield is the main factor considered while the ability to fit into a system (i.e. intercropping) might be a better issue to consider.

The participatory approach is expensive and time consuming but the benefits might outweigh the cost.

Questions

1. Germplasm availability was identified as a major constraint to farmers adopting forage legume technology. Two potential solutions were identified in this case study. What other options can be used to get forage legume germplasm into farmer's fields?
2. Should agronomist change the way they screen forage legumes and start screening them in the production systems that the legume will be grown in? What would be the implications of the approach on costs?
3. Participatory approaches and forging of partnerships are expensive and time consuming. How can the costs be reduced and what is the experience with this approach in other areas?
4. If farmers have to adopt a technology the benefits must be demonstrated. This is even more complicated when the benefits are long term, i.e. improving soil fertility or in the case of forage legumes where they have to be utilised through the animal. The mother-baby trial is an approach aimed at demonstrating the benefits of new technologies. What is the experience with mother-baby trials and what other approaches can be used? Would farmer field schools be a suitable alternative?

References

- Anindo D.O. and Potter H.L. 1986. Milk production from Napier grass (*Pennisetum purpureum*) in a zero-grazing feeding system. *East African Agricultural and Forestry Journal* 52:106–111.
- Anon. 1985. *Ministry of Livestock Development. Annual Report*. Ministry of Livestock Development, Nairobi, Kenya.
- Anon. 1987. *Fertiliser use recommendation project: Description of the first priority sites in the various districts (Murang'a District)*. Report 21. Ministry of Agriculture. National Agricultural Laboratories, Kenya.
- Bayer W. 1990. Napier grass—a promising fodder for smallholder livestock production in the tropics. *Plant Research and Development* 31:103–111.
- Cadisch G., Sylvester-Bradley R. and Nosberger J. 1989. ¹⁵N-based estimation of nitrogen fixation by eight tropical forage-legumes at two levels of P:K supply. *Field Crops Research* 22:181–194.
- CBS (Central Bureau of Statistics). 1994. *Kenya population census 1989. Volume 1*. Office of the Vice-President and Ministry of Planning and National Development, Nairobi, Kenya.
- DANIDA (Danish International Development Agency)/MoLD (Ministry of Livestock Development). 1991. *Kenya dairy master plan. Study report*. DANIDA and MoLD, Nairobi, Kenya.

- Franzel S., Arimi H., Murithi F. and Karanja J. 1999. *Calliandra calothyrsus: Assessing the early stages of adoption of a fodder tree in the highlands of Central Kenya*. AFRENA Report 127. ICRAF (International Centre for Research in Agro-forestry), Nairobi, Kenya. 19 pp.
- Gerrits A. 2000. Dissemination of fodder materials in the Central Highlands of Kenya. In: *Calliandra calothyrsus and other fodder trees: Moving forward in research and development*. Oxford Forestry Institute, Oxford, UK, and ICRAF (International Centre for Research in Agro-forestry), Nairobi, Kenya. pp. 12–14.
- Gitau G.K., O'Callaghan C.J., McDermott J., Omoro A., Odima P.A., Mulei C.M. and Kilungo J.K. 1994. Description of smallholder dairy farms in Kiambu district, Kenya. *Preventative Veterinary Medicine* 21:155–166.
- Ibrahim M.A. 1994. *Compatibility, persistence and productivity of grass-legume mixtures for sustainable animal production in the Atlantic zone of Costa Rica*. PhD thesis, Wageningen Agricultural University, Wageningen, The Netherlands.
- Kariuki J.N., Boer H., Tamminga S., Gitau G.K., Gachui C.K. and Muia J.M. 1998a. Rumen degradation and intestinal digestion of protein in Napier grass and other Kenyan forages. *Animal Feed Science and Technology* (in press).
- Kariuki J.N., Gitau G.K., Gachui C.K., Tamminga S. and Muia J.M.K. 1998b. Effect of supplementing Napier grass with desmodium and lucerne on intake and weight gains in dairy heifers. *Livestock Production Science* 60(1):81–88.
- Kariuki J.N., Tamminga S., Gachui C.K., Gitau G.K. and Muia J.M.K. 1998c. Intake, DM degradation and rumen fermentation as affected by varying levels of desmodium and sweet potato vines in Napier grass fed to cattle. *Animal Feed Science and Technology* (in press).
- Keya N.C.O. and Kalangi D.W. 1973. The seeding and superphosphate rates for the establishment of *Desmodium uncinatum* (Jacq) DC by oversowing in uncultivated grasslands of Western Kenya. *Tropical Grasslands* 7:319–325.
- Keya N.C.O., Olsen F.J. and Holliday R. 1971. The role of superphosphate in the establishment of oversown tropical legumes in natural grasslands of Western Kenya. *Tropical Grasslands* 5:109–116.
- Little D.A. and Said A.N. (eds). 1987. *Utilization of agricultural by-products as livestock feeds in Africa. Proceedings of a workshop held at Ryall's Hotel, Blantyre, Malawi, September 1986*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 179 pp.
- Mbogoh S.G. 1984. *Dairy development and internal marketing in sub-Saharan Africa: Some preliminary indicators of policy impacts*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.
- Methu J.N. 1998. *Strategies for utilisation of maize stover and thinnings as dry season feed for dairy cows in Kenya*. PhD thesis, University of Reading, Reading, UK.
- Methu J.N., Owen E., Abate A., Mwangi D.M. and Tanner J. 1996. Smallholder dairying in Central Kenya Highlands: Practices in the utilization of maize stover as a feed resource. In: Fungoh P.O. and Mbadi G.C.O. (eds), *Focus on agricultural research for sustainable development in a changing economic environment*. KARI (Kenya Agricultural Research Institute), Nairobi, Kenya. pp. 243–251.
- Mureithi J.G. 1992. *Alley cropping with leucaena for food and fodder production in smallholder farms in lowland Coastal Kenya*. PhD thesis, University of Reading, Reading, UK.
- Mureithi J.G., Tayler R.S. and Thorpe W. 1995. Productivity of alley farming with leucaena (*Leucaena leucecephala* Lam. de Wit) and Napier grass (*Pennisetum purpureum* K. Schum) in coastal lowland Kenya. *Agroforestry Systems* 31:59–78.

- Mwangi D.M. 1994. Survey on feeds, feeding and livestock management in Central Kenya. In: *Proceedings of the 2nd KARI scientific conference*. KARI (Kenya Agricultural Research Institute), Nairobi, Kenya.
- Mwangi D.M. 1999. *Integration of herbaceous legumes into Napier grass fodder systems in Central Kenya: Constraints and potential*. PhD thesis, University of London, London, UK.
- Mwangi D.M., Thorpe W., Methu J.N., G., M., Chui J.N., Musembi F.K., Lukuyu M., Chege L., Mutuota J. and Odongo N.E. 1995. Factors affecting the adoption of planted forages in the Nairobi milk shed: Report on participatory rural appraisals conducted in Kiambu, Kenya. Kenya Agricultural Research Institute (KARI), National Agricultural Research Centre, Muguga, Kenya.
- NARP (National Agro-forestry Research Project). 1993. National Agro-forestry Research Project. Kenya Agricultural Research Institute (KARI) Regional Research Centre—Embu. AFRENA. Report 69. Nairobi, Kenya.
- NDDP (National Dairy Development Project). 1990. Dairy Report: National Dairy Development Project. NDDP, Naivasha, Kenya.
- Nicholson J.W.G. 1984. Digestibility, nutritive value and feed intake. In: Sundtol F. and Owen E. (eds), *Straw and fibrous by-products as feed*. Elsevier, Amsterdam, The Netherlands. pp. 340–372.
- Nyaata O.Z. 1998. *Management of Calliandra calothyrsus in association with Pennisetum purpureum for increased dry season forage production on smallholder dairy farms in Central Kenya*. PhD thesis, University of Reading, Reading, UK.
- Omore A., Muriuki H., Kenyanjui M., Owango M. and Staal S. 1999. *The Kenya dairy subsector. A rapid appraisal*. MoA (Ministry of Agriculture)/KARI (Kenya Agricultural Research Institute)/ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Onim J.F.M., Otieno K. and Getz W. 1991. Development of Maseno double cobber maize cultivar for high forage and grain yield. In: *Proceedings of the ninth Small Ruminant CRSP scientific workshop held at Ketri-Mugaga, 27–28 February 1991*. KARI SR-CRSP (Kenya Agricultural Research Institute, Small Ruminant–Collaborative Research Support Programme), Nairobi, Kenya. pp. 108–116.
- Paterson R.T., Kiruiro E. and Arimi H.K. 1996a. *The use of Calliandra calothyrsus for milk production*. NARP (National Agro-forestry Research Project), Embu, Kenya.
- Paterson R.T., Roothaert R. and Kariuki I.W. 1996b. Fodder trees in agro-forestry: The Kenya approach.
- Paterson R.T., Roothaert R., Nyaata O.Z., Akyeampong E. and Hove L. 1996c. Experience with *Calliandra calothyrsus* as a feed for livestock in Africa. In: Evans D.O. (ed), *The genus Calliandra. Proceedings of an international workshop*. Winrock International Institute for Animal Agriculture, Bogor, Indonesia.
- Potter H.L. 1987. Inventory of feed resources for the smallholder farmer in Kenya. In: *Proceedings of the 2nd PANESA Workshop*. IDRC (International Development Research Centre), Nairobi, Kenya. pp. 2–22.
- Reategui K., Vera R.R., Loker W.L. and Vasquez M. 1995. On farm grass-legume pasture performance in the Peruvian rainforest. *Experimental Agriculture* 31:227–239.
- Said A.N. and Wanyoike M.M. 1987. The prospect of utilizing urea-treated maize stover by smallholders in Kenya. In: Little D.A. and Said A.N. (eds), *Utilization of agricultural by-products as livestock feeds in Africa. Proceedings of a workshop held at Ryall's Hotel, Blantyre, Malawi, September 1986*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 15–26.
- Saka A.R., Haque I., Said A.N., Lupwayi N.Z. and El-Wakeel A. 1994. *Forage legumes in crop–livestock systems of sub-Saharan Africa*. Environmental Sciences Working Document 24. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 82 pp.

- Shehu Y. and Akinola J.O. 1995. The productivity of pure and mixed grass-legume pastures in the northern Guinea savanna zone of Nigeria. *Tropical Grasslands* 29:115–121.
- Staal S., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M. 1998. A cross-sectional survey of Kiambu District for the identification of target groups of smallholder dairy producers. KARI/ILRI collaborative project research report, Nairobi, Kenya.
- Stotz D. 1983. *Production techniques and economics of smallholder livestock production systems in Kenya. Farm management handbook of Kenya.* Ministry of Livestock Development, Nairobi, Kenya.
- Thomas D. and Sumberg J.E. 1995. A review of the evaluation and use of tropical forage legumes in sub-Saharan Africa. *Agriculture, Ecosystems and Environment* 54:151–163.
- Thorne P.J. and Cadisch G. 1998. ANORAC. *Allocation of nitrogen in organic resources for animals and crops.* NRI (Natural Resources Institute), Chatham, UK.
- Wambugu C. 2000. Dissemination of fodder materials in the Central Highlands of Kenya. In: *Calliandra calothyrsus and other fodder trees: Moving forward in research and development.* Oxford Forestry Institute, Oxford, UK, and ICRAF (International Centre for Research in Agroforestry), Nairobi, Kenya. 9 pp.
- Wandera J.L. 1995. *Pasture/Fodder Research Program.* National Agricultural Research Centre, KARI (Kenya Agricultural Research Institute), Kitale, Kenya.

A case study on adoption of urea molasses mineral blocks

I. Patel

Professor, Institute of Rural Management, Anand 388001, India

Introduction

India is the largest milk producing country in the world. In 1997, total milk production in the country was 72 million tonnes, accounting for 13% of the world's total milk production. India also has 16% (960.18 million head) of the world's total bovine population (MoA 1999). During the last three decades, the progress made by the country in increasing milk production is remarkable. Annual milk production in India has made a quantum jump from 22 million tonnes in 1970 to 74 million tonnes in 1998–99. The Indian dairy sector consists predominantly of small-scale milk producers who generally keep on an average two milch animals. The households of marginal and small farmers, and landless labourers constitute about 76% of the total milch animal owning households and include approximately 65% of the total number of milch animals. They contribute about 65% of the total milk production of the country (NCAER 1999). In India, the co-operative dairy sector, based on the famous Anand Pattern with a three-tier structure (village, district and state levels), has played an important role in bringing the benefits of dairying to the small-scale milk producers.

Despite India's large volume of milk production, the average productivity of milch animals is quite low. This is attributed to low genetic potential for milk production, poor nutrition and poor management and care of the milch animals (Jain et al. 1996). Proper feeding of the animals is essential for improving their productive potential. Most of the small-scale dairy farmers' animals, however, survive on crop residues and natural herbage (grass, tree leaves etc.) which do not provide adequate nutrients to the animals for improving their growth and exploiting their productive potential. In general, low quality crop residues are deficient in fermentable nitrogen, carbohydrates and important minerals.

For supplementing the crop residue-based diet of large and small ruminants, the use of urea–molasses mineral block (UMMB) licks has been recommended by many livestock researchers. In India, the National Dairy Development Board (NDDB) and a few other research institutes have engaged in research for development of new types of low-cost urea molasses products. Such products include urea treated straw, UMMBs and molasses-urea enriched straw, all of which aim to improve the nutritive value of the traditional straw-based diet thus promoting healthy growth and milk productivity of dairy animals.

Benefits of using UMMB are well documented by researchers in developed and developing countries (Garg et al. 1998). However, research on adoption of UMMB licks among milk producers, particularly among dairy farmers in developing countries is very limited. Even in India, where UMMB production technology and the product were introduced in the co-operative dairy sector in 1984, systematic research on the adoption of UMMB technology by co-operative milk unions and milk producers is very limited. A few studies have focused on understanding the marketing of UMMBs (Sethi 1990; Singh and Mukherjee 1996). However, seldom are efforts made to examine the diffusion and adoption of UMMB among small-scale dairy farmers. In light of the limited research on the adoption of UMMB by milk producers in India, a systematic and large-scale study in this area could be very useful.

This case study focuses on understanding salient issues in the diffusion and adoption of UMMB among dairy farmers. The scope of the study is limited to Gujarat, a state with a successful co-operative movement, based on the Anand Pattern. Specifically, an attempt is made to understand the differential adoption of UMMB by different categories of farmers in order to find out whether there is a need to change/modify the technology, extension and popularisation methods and also the approach to developing such technologies.

Methodology

As a result of time constraints, the case study was focused on two leading milk unions of Gujarat, namely the Kaira District Co-operative Milk Producers' Union (known as Amul) and the Mehsana District Co-operative Milk Producers' Union Limited. The NDDDB worked closely with these unions in the initial stages of demonstrating and popularising the use of UMMB among dairy farmers.

Discussion is based on primary and secondary sources of information. To understand the diffusion and adoption of UMMB, focus group discussions and structured interviews were conducted with key informants (such as research scientists, NDDDB officers, extension staff and officers of the selected unions and dairy farmers) in the selected villages, namely Haijarabad and Chikhodara in Amul's milk shed and Parsa, Bhesana, Indrapura and Bhimapura in the Mehsana milk shed. These villages were selected, in consultation with the staff of the co-operative unions, because some efforts had been made in these villages to demonstrate and popularise UMMB licks. In addition, secondary sources of information, such as annual reports of the milk unions and annual reports of village milk co-operative societies etc. were also reviewed. Given the time constraints, the case study is based on limited field research; hence, the findings of the case study indicate trends, which need to be examined in detail with systematic and large-scale research.

Discussion is organised in three major sections. First, development of the technological innovation and its diffusion among the selected co-operative milk unions is reviewed. Secondly, adoption of UMMB among smallholders in the Amul and Mehsana milk sheds is examined on the basis of the limited field research. Finally, the trends emerging from the case study are discussed.

Development and diffusion of UMMB technology

In the 1970s, when Operation Flood was launched by the NDDB in India, overall milk production was far below the national requirements. To enhance the nutrition and productivity of animals, and bring widespread economic benefits to milk producers, the NDDB under the Operation Flood Programme established cattle feed plants throughout the country to make reasonably priced compounded cattle feed and bypass protein feed available to farmers.

Research and development

For efficient digestion of crop residues in the rumen, it is essential that a certain concentration of ammonia-nitrogen be maintained in the rumen. This level is difficult to achieve on a crop residues-based basal diet. Several researchers have shown that this level can be achieved by supplementing UMMB in the ration of animals. In this regard, the technological innovation of the UMMB has been an important breakthrough for enhancing the productivity and nutrition of dairy animals. The UMMB is essentially a feed supplement that provides soluble nitrogen, fermentable energy and minerals to micro-organisms in the rumen. It consists of urea, molasses, some proteins, minerals and gelling agents.

On the basis of a series of experiments and trials at the laboratory, farm and village levels, the NDDB developed UMMB licks in the early 1980s and standardised the formulation for commercial production. Laboratory trials were carried out with nearly 200 formulations. For production of UMMB, the NDDB experimented with a hot process (Kunju 1986). Furthermore, the NDDB also designed and fabricated the first UMMB manufacturing plant for commercial production and, in 1984, commissioned it at the Amul cattle feed plant. This was followed in 1985 by the commissioning of a second plant at the Boriavi cattle feed plant of Mehsana Milk Union.

The 'hot process' of manufacturing UMMB was found to be labour and energy intensive. There was also a serious problem of melting and de-shaping blocks from the 'hot process'. Therefore, between 1984 and 1993, NDDB made earnest research efforts and succeeded in producing UMMB by a 'cold process' (Garg et al. 1998). In collaboration with an equipment fabricator, the NDDB also developed a device for manufacturing rectangular UMMB licks weighing 3 kg each, through the 'cold process'. Thus, technological innovation of UMMB licks consisted of the formulation (ingredients), the process of mixing the ingredients and the cost-effective device for manufacturing UMMBs.

Research and field trials of UMMB in the villages have shown encouraging results (Box 1). However, it is important to emphasise here that after adoption of UMMB licks, the benefits are not visible immediately. It takes at least two weeks and is dependent upon regular licking of the blocks by the animals and on livestock feeding patterns.

Diffusion of UMMB technology by NDDB

First, the NDDB conducted a demonstration-cum-popularisation programme in Gujarat to demonstrate the benefits of UMMB; this was then revised and expanded to other states, such as Rajasthan, Orissa and Kerala. In the initial stage, the NDDB focused on feeding trials and a popularisation programme in selected villages of the Kheda and Mehsana milk sheds. During the trial phase, NDDB conducted a series of meetings, seminars, workshops and training programmes. Moreover, they carried out extension activities with all the concerned persons from the village level upward to the union level (i.e. farmers, promoters, union officials and extension staff etc.) in order to demonstrate the benefits of UMMB and popularise it among the milk producers. NDDB also developed extension materials on UMMB for the demonstration-cum-popularisation programme, such as a video film, folders, posters, flip charts and slides, and an artwork for wall paintings in public places.

Box 1. Benefits of using urea molasses mineral blocks

The major advantage of using UMMB is improvement in the digestive efficiency of ruminants, which brings many direct and indirect benefits:

- improvement in the utilisation of dry fodder and low wastage of fodder by the animals
- improvement in milk production and milk fat content
- better physical growth
- improvement in reproductive efficiency etc.

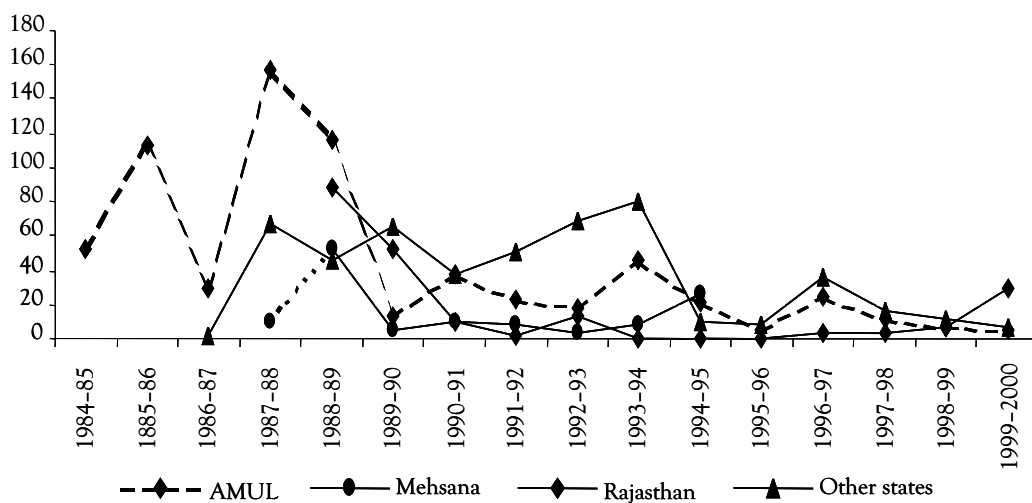
In the past, a series of on-station and field trials by NDDB have been conducted on the animal response and economic benefits of using UMMB. Results summarised in the technical bulletins on animal licks indicate improvement in straw utilisation, savings in the use of concentrates and improvements in growth rate and milk production. Leng et al. (1991) reported results of a study on Surati buffalo that examined milk production response and level of income. Conventionally fed animals were compared with those fed UMMB and bypass protein along with decreasing quantities of concentrate. Results showed that after reducing the amount of concentrates by 40%, introduction of UMMB and bypass protein maintained milk yield and increased income over feed cost by 2.50 Indian rupees (Rs)/day per animal (US\$ 1 = Rs 45.5).

Based on the encouraging response of the field trials in Gujarat, in 1989, NDDB set up eight UMMB plants (hot process) across the country under Operation Flood. Subsequently, based on experiences in the Mehsana milk shed, a trial demonstration-cum-popularisation programme was conducted in seven milk sheds of Rajasthan, namely Ajmer, Jaipur, Jodhpur, Bhilwara, Bikaner, Pali and Ganganagar. The trial programme was pursued in phases between November 1992 and March 1993. It was also introduced in one milk shed in Orissa (Keonjhar) in April 1993 and two milk sheds (Eranakulam and Trivendrum) in Kerala during September 1993. UMMB trials and popularisation programmes in the selected milk sheds were conducted by NDDB and met all the requirements for training, extension, feeding, recording, supervision, monitoring and review of progress etc. The

programmes placed the greatest emphasis on popularisation (training and extension support) and marketing of UMMBs.

After completion of almost all the trials and popularisation programmes by the end of 1993, NDDDB concluded that the 'hot process' blocks had inherent problems, not only in non-licking by the animals but also in their production. Therefore, NDDDB decided to replace UMMB production by the 'hot process' with production by a 'cold process', which was cheaper and more convenient to handle. The trial was concluded pending development of the cold process. Throughout the trial phase, NDDDB's efforts were directed towards addressing product-related problems. During 1984-90, 11 milk unions had adopted 11 hot process plants. With the improvement in UMMB production through the cold process, 8 of the 11 hot process plants were replaced with cold process plants and 3 new cold process plants were installed, 2 in Gujarat and 1 in Uttar Pradesh. Since 1984, a total of 22 UMMB production plants (11 hot process and 11 cold process) were in the states of Gujarat, Karnataka, Punjab, Rajasthan, Uttar Pradesh, Bihar and Pondichery (Union Territory). A cursory look at the production of UMMBs by Amul, Mehsana and the unions of Rajasthan and other states between 1984 and 2000 suggests that there has been a considerable decline in UMMB production since 1993-94 (Figure 1). Thus, indicating that diffusion of UMMB production technology among the co-operative milk unions across the country has remained limited despite intensive extension efforts by NDDDB.

No. of block ($\times 10^3$)



Source: UMMB production data for AMUL and Mehsana Milk Union were provided by the cattle feed plants of the respective unions. While the National Dairy Development Board (NDDDB) provided data for Rajasthan and other states.

Figure 1. Urea-molasses mineral block (UMMB) production in various co-operative union states.

During November 1995, NDDDB signed a project agreement with Appropriate Technology International (ATI)-India, a non-governmental organisation, for diffusion of the UMMB technology, initially in the Ahmedabad, Mehsana and Banaskantha districts of

Gujarat. Initially, the project was for five years. ATI promoted UMMB licks in the selected districts with intensive extension and marketing efforts. During this period, ATI faced several problems with the blocks including non-licking by the animals, melting and de-shaping etc. Similar problems had been seen previously by the NDDDB. ATI changed the shape of the blocks from rectangular to hemispherical. However, the problem related to licking persisted. The farmers often reported that animals were biting the blocks rather than licking them. Use of inappropriate dispensers was another problem faced by ATI. Due to product-related problems and rejection of UMMB by the dairy farmers, in 1998, ATI switched over from UMMB to urea molasses granules (UMG) in the Mehsana milk shed.

Experiences with UMMB production technology

To develop the UMMB production process (hot and cold) and production plant technology, the NDDDB worked closely with Amul and the Mehsana Milk Union. However, the cattle feed factory at Boriavi could not maintain the quality of UMMBs, even through the cold process, because of inconsistencies in the quality of locally available raw materials and unskilled contractual labour. Hence, there was no substantial improvement in the adoption of UMMBs by the dairy farmers after introduction of the cold process in the Mehsana milk shed. Amul started production of UMMBs (cold process) by involving the professional staff and ensuring the quality of ingredients (raw materials). Nonetheless, even with quality assured, UMMB production did not increase because demand remained low (Figure 1). The experiences of Amul and the Mehsana Milk Union with UMMB production suggest that, in practice, the process of UMMB production is complex and requires professional inputs. Unless proper attention is paid to operating the plant, UMMB quality cannot be maintained.

The extension approach of Amul and Mehsana Milk Union

Amul and the Mehsana Milk Union promoted UMMB among dairy co-operative society (DCS) staff and dairy farmers through concerted extension efforts. Focus group discussions were carried out with the concerned officials and field staff of Amul and structured interviews with the officials engaged in UMMB promotion in Mehsana milk shed. These revealed that both unions used multi-pronged extension strategies to diffuse information about UMMB at the village level and to encourage dairy farmers to use UMMB licks for their animals. However, the extension approach differed between the unions.

Amul introduced UMMB to the dairy farmers for the first time in the mid-1980s through the extension staff of the Department of Animal Husbandry, and the Department of Procurement and Inputs. The selected individuals were released from their routine work so that they could concentrate exclusively on diffusion of UMMB in the villages. Promotion of UMMB was undertaken in the form of a campaign, known as *chatan dan zumbesh*. The key extension strategy used for generation of awareness about UMMB was an intensive contact programme in each village with the DCS staff, management committee members, members of the village co-operative societies and other villagers. In general, efforts were made to first

convince the DCS Chairman and some of the influential and educated members of the management committee, who were interested in increasing milk production of their dairy. The extension staff also demonstrated the use of UMMB licks. The Amul *patrika*, a fortnightly newsletter written in simple language and containing short articles, small posters and stripson UMMB, posters and flyers were used for disseminating information among the DCS members.

The extension approach of the Mehsana Milk Union for popularisation of UMMB was somewhat different. Unlike Amul, extension work was taken up primarily by small teams of extension staff, who were provided with all their prerequisites for field trials and extension activities, including vehicles for mobility, salaries for the union staff/supervisors, extension materials etc. Initially, the focus of extension efforts was on five to six experimental villages. However, later on, two to three extension teams visited more than 400 DCSs to popularise the UMMB. Extension was undertaken primarily through intensive contact programmes at the village level. Discussions and meetings were held with milk producers, DCS staff and management committee members, women dairy farmers and the villagers. Posters, film shows and other educational materials, developed by NDDB, were also used to generate awareness about UMMB licks and motivate dairy farmers to use them. During the annual audit of DCS accounts, efforts were also made to persuade DCS staff to purchase UMMB on a trial basis.

Given the high credibility of both unions, DCS staff and dairy farmers were receptive to the use of UMMB to improve productivity of their animals. Extensive extension efforts during the field trials in Amul and the Mehsana milk sheds succeeded in generating awareness about UMMB among DCS staff and milk producers. On the basis of negative feedback from the users of UMMB licks, several changes were made in the UMMB production process and product. These included the shift from the hot to the cold process, modification of the shape of blocks (from rectangular to round) and improvement in the palatability of the blocks (by reducing the highly alkaline pH) etc. However, the intensive extension efforts of both unions failed to persuade the dairy farmers to use UMMB licks on a regular basis beyond the trial stage.

Adoption of UMMB among small dairy farmers

Who were the adopters of UMMB in the Amul and Mehsana milk sheds? What were their experiences in using UMMB licks? Discussions with the concerned extension staff of both unions, DCS staff and milk producers in the selected villages threw light on the limited adoption of UMMBs among the milk producers.

The early adopters of UMMBs

In Mehsana Milk Union, UMMB licks were first promoted free of charge in a few experimental villages and then introduced for sale in additional villages through the village dairy co-operatives. The officials of Mehsana Milk Union consider UMMB a very

useful product for milk producers in dry areas where animals' diets are deficient in nitrogen due to shortages of green fodder. Despite concerted extension efforts in Mehsana milk shed, only a few large-scale milk producers from the dry areas adopted UMMBs. Most of the early adopters of UMMB licks in Mehsana milk shed were primarily concentrated in the green areas. Many of them had more than four animals. However, most of them discontinued the use of UMMB after the trial phase. As a result, the demand for UMMB declined.

Although Amul tried to popularise UMMB among all milk producers (including smallholders), the early adopters of UMMB were primarily those who had taken up dairying as an important income generating activity. They were educated and belonged to the upper castes of the *patels*, *brahmins* and *baniyas*. They, particularly the *patels*, were ready to adopt anything that would increase their income from dairying. They were progressive farmers who were receptive to new ideas and strove to improve milk productivity. In the words of the extension staff 'their mindset was very different. Therefore, they adopted UMMB licks and used them. Similar receptivity to new ideas is not found among other communities who are in the dairy business now'.

For effective use of UMMB, it is essential that the block be put in a place that is accessible to the animals so that they could easily lick the block as and when necessary. In the reality of the field, however, this was not easy to achieve. Only a few large-scale milk producers had a properly constructed and spacious cattle shed in which the UMMBs could be properly placed. The availability of cattle sheds differed from place to place. In the villages of Kheda District, the land available for cattle sheds was very limited. Generally, the animals were kept in the courtyard in front of the house in a limited area. Often the animals were tied to a pole/batten by a rope so that they could move around. In the green belt of the Mehsana milk shed, cattle were kept in agricultural fields or tied to the trees in front of the *vada* (courtyard) near the house. Some farmers kept their animals in fields during the day and brought them home only in the evening for milking. Other milk producers took their animals to graze instead of keeping them in one place for stall-feeding. In such situations, it was difficult for the farmers to find an appropriate place for UMMBs.

Considerable efforts were made by NDDB to find an appropriate dispenser for holding the UMMBs. However, none of the options offered an acceptable solution. For example, initially the farmers used *tagaras* (small round metal vessels) for UMMB. As *tagaras* were lightweight, the animals used to tip them over and the blocks became soiled. To solve this problem, heavy cement blocks were introduced in the Mehsana milk shed for holding the UMMBs. However, neither *tagaras* nor cement blocks offered the right solution; as these dispensers were placed on the ground in front of the animals, cow dung, urine, dust, water, straw etc. spoiled the UMMBs. Once the blocks were spoiled, the animals would not eat them. NDDB further designed plastic dispensers for holding UMMBs. These plastic dispensers could be hung where they were accessible to the animals; however, the animals easily broke them, even when they were hung or placed above ground level. Similarly, metal boxes were designed in such a way that the animals could not chew the UMMB, but could easily lick them. Nevertheless, their use was also limited, as most farmers did not have a proper place in their cattle shed to hang them.

Irrespective of the type of dispenser used, a common problem reported by the early adopters was melting of the blocks. The blocks prepared through the hot process were sensitive to humidity and temperature, and melted easily. This made the blocks very messy and unhygienic. The blocks also attracted flies and other insects due to their molasses content. Instead of licking the blocks over a period of time, some of the animals chewed them. Unlike hot process blocks, the cold process blocks did not melt easily. However, some of the animals did not lick the blocks, presumably because of problems in palatability. The farmers sometimes used to sprinkle flour on the blocks to induce licking. Unused hard blocks were wasted, dissolved in water or cut into small pieces and mixed with cattle feed. The benefits of using UMMBs were not easily visible to the farmers when the animals did not consume an adequate quantity of the blocks. Inability to maintain quality of the UMMB was one of the major factors that adversely affected its use.

In summary, beyond the trial phase only a few small-scale milk producers used UMMB licks on a continuous basis. In Mehsana Milk Union, from about 1998, some of the users of UMMB from the green areas switched over from UMMB licks to urea molasses granules. Unfortunately, the use of granules does not have adequate scientific support. Due to once-a-day feeding practices, the granules release a short-lived high concentration of ammonia in the rumen, much of which is wasted. In a few villages (Chikodara, Gopalpura, Sarsa, Narsanda etc.) in Amul's milk shed, however, some large-scale dairy farmers, who have undertaken animal husbandry as a primary occupation, have continued to use UMMBs.

Adoption of UMMB in Haijarabad village

Haijarabad, a small village with 400 households, and with a total area of 507 ha, is in Matar Taluka of Kheda District. It is a multi-caste village inhabited by *patels*, *pandya*, *brahmins*, *baraiyas*, *ravals*, *harijans* and Muslims. Agriculture is the main occupation and source of income for most of the households of Haijarabad while animal production is a secondary occupation for some of the villagers. Irrigation is available through canal and boreholes and most farmers produce crops twice a year.

Haijarabad Dairy Co-operative Society (HDCS)

The Haijarabad DCS was established in 1959 and in the last two decades, membership and milk procurement of the HDCS has increased substantially. Membership of HDCS more than doubled between 1981 and 2000, from 295 to 610 members, whilst milk procurement increased at the compound rate of about 3%. Of the 610 members of HDCS in 1999–2000, about 600 members were smallholders, who owned one or two milch animals. Thus, small-scale dairy farmers supply most of the milk for the HDCS.

Livestock censuses conducted by HDCS in 1990–91 and 1997–98 revealed that the animal population of Haijarabad had declined by about 9% within this seven-year period. The major reductions were in the populations of bullocks and buffalo.

Adoption study of UMMB among milk producers

UMMB, known locally as *chatan dan* or *kala int*, was first introduced in Haijarabad in 1984–85 by Amul. Haijarabad was selected by Amul as an experimental village to promote UMMBs among small-scale milk producers. UMMBs were supplied free to DCS members for trial. A quick review of UMMBs supplied to its members during 1984–91 shows that adoption of UMMBs in Haijarabad was very limited. It was difficult to examine the level of adoption among HDSCS members as several years had passed since UMMB licks were introduced in Haijarabad. However, 15 users of UMMB (14 men and 1 woman) were identified with the help of DCS secretary and were interviewed with the help of a short structured questionnaire. As it was a long time since people had used UMMB licks, they could not provide precise and detailed information. Nonetheless, their responses shed some light on the adoption of UMMB in Haijarabad.

Socio-economic background of the users of UMMB

The selected 15 respondents were from diverse social backgrounds; the 12 belonged to the subcastes of *patel*, *pandya*, *sisodiya* and *raval*, and three of them were *pathans* (Muslims). Educational level of the respondents was low; four were illiterate, six had some primary education (up to 3–7 grades) and five had secondary education (up to 10th grade). The average family size of the respondents was 6.6. Except for three landless labourers, agriculture was the main occupation of the respondents. Only two respondents were engaged in service as a secondary occupation. Only one of the respondents, a woman from the family of a small-scale farmer, mentioned animal husbandry as a secondary income-generation activity. Most of the respondents (10 of 15) were marginal farmers with less than 1 ha of land; only two respondents owned more than 2 ha of land.

All the respondents owned livestock, consisting of cattle and buffalo. There were seven dairy farmers with 1–2 milch animals each and eight milk producers with 3–4 milch animals each. Except for one respondent who had a *pucca* (properly constructed) cattle shed with a proper roof and flooring, all other respondents kept their animals in thatched cattle sheds near their houses. In general, the space for keeping the animals was very limited. None of the respondents had undertaken dairy as an important income-generation activity. For most of them, dairy was a source of supplementary income. All the respondents used paddy straw as the main dry fodder; a few respondents also used *bajra* (pearl millet) and *jowar* (sorghum) straws. Alfalfa was used as green fodder by 12 of 15 respondents. Only one-third of respondents used grass, while use of maize and *bajra* as green fodder was very limited. Amul *dan* was the most popular concentrate. While cottonseed cake was used by one-third of the respondents, only a few respondents used rice bran, wheat grain or maize cake.

It is against this socio-economic background of the responders that we will examine their adoption behaviour.

Awareness about UMMB

How much information about UMMB had reached the villagers in Haijarabad? The users received information about UMMB from various sources. Amul extension staff members were the most important sources of information for the respondents. During their visit to the HDCS, they had discussed the new product and its benefits with the DCS staff and members of the management committee. All the respondents reported that members of the HDCS management committee informed them about UMMB. Thus, the management committee had played an important role in disseminating information about UMMB among the members. Nine of 15 respondents came to know about UMMB through a veterinary staff, who visited the village for pregnancy diagnosis or artificial insemination and advised them to use UMMBs for pregnancy-related problems. Though HDCS received material (posters, brochures, Amul *patrika* etc.), only two respondents learned about UMMB from Amul *patrika*. In summary, Amul's extension approach appeared to have succeeded in disseminating information about UMMB among milk producers in Haijarabad.

Except for one individual, all respondent were aware of UMMB as a feed supplement with essential nutrients and were aware of its key benefits, such as an increase in milk production, and improvement in the health and reproductive efficiency of the animals. The respondents also knew about the procedure for using UMMBs. Most respondents used to put the UMMB in a *tagara* (a metal utensil) in front of the animals. Initially, they used to sprinkle wheat or *bajra* (pearl millet) flour on to the UMMB to induce the licking habit among the animals. Except for three respondents, who used UMMBs for in-milk, dry and pregnant animals, the rest used UMMBs for all their animals. It was not clear whether such practice was followed because of free availability of UMMBs or because of perceived benefits.

Experiences in using UMMBs

In general, any product for animals launched by Amul was viewed favourably by the members, because of Amul's high credibility among the members. The respondents used the UMMBs during the trial stage; six of them used UMMBs during 1987-88 and the remaining nine respondents tried them during 1988-89. It was difficult to assess the quantity of UMMBs used per month per animal. The experiences of the farmers are summarised below:

1. Seven of 15 respondents mentioned that UMMBs were good for the animals, but they could not explain why.
2. One landless labourer reported that UMMBs were useful for improving reproductive efficiency of the animals.
3. One marginal farmer thought that UMMBs were good for crossbred cows.
4. Common problems in using the UMMBs included melting of the blocks and spoiling of the blocks by houseflies, ants, dust, dung, urine etc.
5. A few respondents reported shortages of utensils (*tagara*) for dispensing UMMBs.

In practice, benefits of UMMB were not visible to the respondents, as their animals did not lick an adequate quantity of the blocks. The milk producers were not greatly concerned about the long-term benefits of using UMMBs, for example the maintenance of a constant level of milk production, reduction in inter-calving period, maturity of calves, increase in food intake and improvement in animal health etc. As most of the milk producers were not engaged in systematic livestock care, they did not notice some of these benefits. Hence, most of them primarily used UMMBs while the blocks were provided free of charge.

Adoption of UMMB: The perspective of women dairy farmers

As women dairy farmers are primarily responsible for animal husbandry, we tried to question one successful woman dairy farmer and a few resource-poor women smallholders about their perspective on the use of UMMB and the constraints to using them on a regular basis.

The perspective of resource-poor woman dairy farmers

Focused group discussion was held with four poor Muslim women who had one to two milch animals. Agricultural wage labour was their primary source of income. However, full-time wage labour was available to them for only 120 days in a year. For them, animal husbandry was a supplementary income generation activity. Most of the smallholders, however, kept their milch animals in a subsistence manner. Rice and *bajra* (pearl millet) straws were the major dry fodders and were usually available at affordable prices in the village; however, due to drought this year, the smallholders had to buy dry fodder from the market at a higher price. In the monsoon season, grass was usually available free of charge, from agricultural fields where the smallholders worked. At times, they had to buy alfalfa from other farmers for the lactating animals. All of the smallholders regularly used Amul *dan*, the concentrate that they purchased from HDCS to maintain milk fat content. According to them 'without fat in the milk, there is no return for the money spent on the animal'. Other concentrates, such as wheat grains, barley, maize etc. were given to the milch animals only if money was available.

Thus, the resource-poor smallholders spent judiciously on fodder and feed. One in-milk cow/buffalo normally gave two litres of milk/day for which the smallholders were paid 20 Indian rupees (Rs)/day (US\$ 1 = Rs 45.5). About Rs 15/day was spent on Amul *dan* and fodder. The net income of Rs 5/day from dairy was used for meeting household expenses. Thus, they hardly had any surplus income to spend on a new feed supplement, such as UMMB. Some of the resource-poor women dairy farmers had used UMMBs for a few days when they were available free of charge from the HDCS, but they used each block judiciously, only giving it to the animal at the time of feeding in the morning and evening. Two women discontinued the use of UMMBs, as the animals that licked UMMBs were eating more fodder, but not giving more milk and milk fat to compensate for the increased expenses on fodder. Others found it inconvenient to use the blocks.

The perspective of a successful woman dairy farmer

Sumitraben Amratbhai Patel is a 33-year old marginal farmer with 0.46 ha of irrigated land. She belongs to a nuclear family, consisting of her husband and two school-going children (a son and a daughter). She is educated up to 10th grade. Sumitraben has taken up animal husbandry as a primary occupation. Her husband also helps her to take care of their animals. Her family grows three crops a year, such as tobacco, wheat, *bajra* (pearl millet), *jowar* (sorghum) and *rachaco* (alfalfa). The gross annual family income is about 19 thousand Indian rupees of which about 58% are from animal husbandry. According to Sumitraben, 50% of the dairy income goes towards maintenance of the animals.

After her marriage in 1984, Sumitraben started with two buffalo and later purchased one cow with a loan from the bank. She used the income from cow milk to repay her loan and to maintain her animals (for fodder, purchase of concentrates etc). She regularly saves from her dairy income and has used the money to improve her assets (renovating her house, purchasing land for building a new house and improving farmland). Sumitraben keeps only two to three milch animals and maintains only those, which are regular milkers. She finds that cows are more profitable than buffalo because they are less expensive and give milk for a long duration.

She feeds all her animals on dry fodder, such as crop residues of rice, *bajra* (pearl millet) and *jowar* (sorghum) that are available from her farm. Only in-milk animals are fed on green alfalfa fodder, also grown in her fields. Concentrates are purchased from the market and only given to the in-milk animals. Amul *dan* is used regularly and only when it is not available does Sumitraben use cottonseed cake or sometimes rice bran and wheat. Recently, she has started giving a mineral mixture to the milch animals and calves.

Sumitraben came to know about UMMBs in a village meeting and used them several years ago, after purchasing blocks from the DCS. She was aware of UMMBs as a feed supplement with nutrients. In her opinion, the benefits of UMMBs are (1) to increase feed intake and (2) to improve health and reproductivity of the animals. However, she discontinued the use of UMMB after a period of time because of inconvenience in using UMMBs, wastage due to spoilage and the nuisance of flies and insects.

In summary, adoption of UMMBs in Haijarabad was limited. Most of the milk producers did not use the blocks beyond the trial stage due to inconvenience in using the blocks or due to invisibility of immediate and direct benefits in terms of increased milk production and milk fat content. As there was very low demand for UMMBs in the village, HDCS also did not purchase them.

Thus, the case study of UMMB diffusion and adoption among small-scale dairy farmers shows that even an intensive extension approach is unlikely to be effective unless the innovation that it promotes is perceived as relevant by the potential adopters and meets their needs or solves their problems. Benefits of UMMB were not visible to the milk producers, as for various reasons the animals did not lick adequate quantities of blocks. The milk producers were not greatly concerned about the long-term benefits of using UMMBs, as most of them were not engaged in systematic livestock care and consequently they did not notice these benefits.

Lessons learned

The NDDDB has developed the UMMB technology to improve the milk productivity of dairy farmers, particularly smallholders. This descriptive case study highlights the limited nature of diffusion and adoption of UMMB technology among small-scale dairy farmers of Amul and the Mehsana Milk Union in Gujarat. What are the lessons that can be learnt from this case study?

Research and development of UMMB

- a. Before even developing UMMB or any such product there is a need to understand livestock feeding patterns, changing farming systems and livestock practices of milk producers in general and of smallholders in particular.
- b. Field trials should be based on the 'on-farm participatory approach' that takes into consideration the farmers' evaluation of the product for development and modification of the form of the product.

Thus, the key issue is as follows:

What should be the appropriate approach for developing innovations for small-scale dairy farmers? Should it be from laboratory to farm, from farm to laboratory or a combination of approaches?

Diffusion of UMMB through extension

- a. The extension support or lack of it, for any innovation, can speed up or retard its rate of adoption.
- b. Institutional aspects of transferring research results are very important for commercialisation and diffusion of new products.

What kind of extension approach is required for the persuasion and trial stages of the adoption process?

Adoption of UMMB by small-scale dairy farmers

- a. Livestock feeding patterns of smallholders, including the use of UMMBs, are shaped by the existing farming systems and livestock care practices.
- b. Adoption of UMMBs by milk producers is influenced by the perceived direct benefits of UMMB.

In summary, the major emphasis of development and diffusion of UMMB has been to try to fit the innovative product within the existing system. Improving milk production of the animals of small-scale dairy farmers from divergent livestock and farming systems needs to move away from such a top-down approach for 'transfer of technology' to a farmer-centred approach that is based on people's felt needs and problems?

The case study is based on limited field research, however, the findings and the trends discussed need to be examined further through in-depth and rigorous research, for a clearer understanding of adoption processes and in order to develop an appropriate approach.

References

- Garg M.R., Mehta A.K. and Singh D.K. 1998. Advances in the production and use of urea molasses mineral blocks in India. *World Animal Review* 90(1):22–27.
- Jain D.K., Sharma K.N.S., Walli T.K. and Rai S.N. 1996. *Estimates of nutrient requirement and availability for bovine population across major states in India*. Dairy Economics, Statistics and Management Division, National Dairy Research Institute (ICAR), Karnal, India. 50 pp.
- Kunju G.P.J. 1986. Urea molasses block: A feed supplement for ruminants. A paper presented at the international workshop on rice straw and related feeds in ruminant rations held at Anand, Kandy, Sri Lanka, 24–28 March 1986. National Dairy Development Board, Anand, India. 17 pp. (mimeo).
- Leng R.A., Preston T.R., Sansoucy R. and Kunju P.J.G. 1991. Multinutrient block as a strategic supplement for ruminants. *World Animal Review* 67(1):11–19.
- MoA (Ministry of Agriculture). 1999. *Basis animal husbandry statistics 1999*. Department of Animal Husbandry and Dairying, MoA, New Delhi, India. 148 pp.
- NCAER (National Council of Applied Economic Research). 1999. *Impact evaluation of Operation Flood on rural dairy sector*. NCAER, New Delhi, India. 167 pp.
- Sethi S. 1990. Study of the present sale profile of balanced cattle feed, urea molasses lick blocks, by-pass protein feeds and a strategy to market these products effectively (an NDDB New Delhi Project). Report of the Management Traineeship Segment-I, No. MTS-646, PRM 1989–91. Institute of Rural Management, Anand, India.
- Singh A.K. and Mukherjee S. 1996. *Monitor and analyse the findings of focus group trials aimed at test marketing molasses urea block in the district of Ahmedabad*. Report of the Management Traineeship Segment-I, submitted to Appropriate Technology India (Ahmedabad), MTS-1149. Institute of Rural Management, Anand, India.

Farmers' perceptions of service delivery and policy support from smallholder dairy in Nepal: Nepal case study

D.D. Joshi

Director, National Zoonoses and Food Hygiene Research Centre (NZFHRC)
Chairperson, Nepal Veterinary Council (NVC)

Introduction

In a land area of 54.4 thousand square miles, Nepal has a population of 23 million people. The total number of livestock is 9.71 million cattle and buffalo, 4.3 million sheep and goats, 4.9 million poultry, a small number of pigs, horses, mules, yak and chauries. The number of people engaged in the agricultural sector is about 9.7 million, whereas the total number of cattle and buffalo population is 9.71 million head. This shows that each farm household in Nepal with 5.8 persons on the average keeps 5.8 livestock. Nepal ranks as one of the highest amongst the developed countries in terms of population density of cattle and buffalo (CBS 1998).

Farmer

This is a case study of a 45 years old smallholder dairy farmer Mr Ram Prasad Bastola, from Fical village of Ilam District, Mechi zone, Eastern Development region of Nepal. This case study represents over 75 thousand such farmers of Nepal who are currently producing and selling milk to the formal and informal dairy market channel of the country (DDC 1999). Farmer's selection was done on the basis of his involvement in dairy farming and milk selling to the Milk Producing Co-operative Society (MPCS), member of this MPCS, member of local farmers organisation and participation in different training programmes organised locally by Fical Milk Chilling Centre (MCC), Department of Livestock Services (DLS) and credit agencies. The interview was based on the structured questionnaire and personal observation.

Mr Bastola has a small two story Pakka house made from stone with 1.5 ha of cultivated land. He lives with his 60 years old mother, his 40 years old wife, one 15 years old son named Shyam, two daughters Rita and Gita of 10 and 13 years old, respectively. He has secondary education and can read and write Nepali very well. His son is in the 8th grade and goes to school in Fical. His wife and two daughters are literate although never have been to high school. His mother is illiterate.

Milk production in Nepal is an integrated part of the traditional production system with small non-commercial holdings. Many of these small farmers market milk directly to urban areas and the surplus through the DDC or private dairies. Milk and milk products provide an important contribution to the nutrition of the many people living in rural areas as well as urban Nepalese families. Farmers own about 40% of Nepal's dairy livestock with less than 0.5 ha per family (Ministry of Finance 1998). These farmers have few sources of generating cash income. Their small plots of land are insufficient to feed their livestock so they have to depend on communal pastures and forests that are over-utilised. It will require major efforts and investments to introduce and motivate the large groups of small farmers to apply productive technologies that are environmentally sustainable. However it seems the only option available.

Methodology

In this case study I have used participatory rural appraisal (PRA) approach method to interview an individual smallholder, Mr Ram Prasad Bastola, from Fical village of Ilam District with cow milk pockets. This case study has used both the primary and secondary level information. The case study is based on a review related documents, supplementary primary field survey, discussion and interview with specialists and interactive meetings with observations.

In this PRA approach method I asked the farmer some questions and discussed with his family members on the following topics:

- agricultural farming practices
- farming responsibilities by family members
- milk production and marketing
- milk consumption at home
- milk price
- animal feed, pasture and management
- livestock extension and research
- Milk Producers Co-operative Society and linkages with DDC Co-operative in milk marketing
- farmers training on dairying by the Department of Livestock Services (DLS) or DDC or National Dairy Development Board (NDDB) inside and outside country
- bank loan for animal purchase
- animal insurance
- world trade information
- government livestock development policy and
- dairy development issues and constraints.

Results

Mr and Mrs Bastola produce crops, livestock and mixed farming as an integrated approach. They grow mostly paddy maize, beans, millets and little potatoes with green vegetables for

their own home consumption. Mr Bastola has two milking cows, one local breed called 'Siri' and other Jersey crossbred, with one calf and one heifer along with two goats and one dog.

Mrs Bastola has a major responsibility to look after cow feeding, milking and cleaning the cowshed. Sometimes she also goes to sell milk to the MPCS. In Nepal wife and husband have equal share of work at the farms but cash income goes to the husband. Husband and wife share benefit.

He was asked how much milk his cows produce and he replied that he gets 6.5 litres of milk from Jersey crossbred and 3.5 litres from Siri cow in one milking period. He sells 10 litres of milk to the MPCS. He said that he is a member of this society. He cannot sell evening milk because there is no provision for selling milk in the evening markets. He consumes the rest of the unsold milk at home in the form of curd, whey, butter ghee and hard cheese. Milk price is paid by MPCS to him every 15 days on the basis of the quality of milk. Fats and solids not fat (SNF) are not allowed in the content of the milk. He said the price of one litre of milk that is Rs. 15 is not enough because the production cost is higher than that. He also said the price is controlled by His Majesty's Government (HMG) of Nepal. At present cost of production in Nepal is Rs. 19.75 per litre. He further explained that the MPCS has no control on pricing system. He further stated that this pricing system established by HMG/Nepal is based on fat, solids-not-fat (SNF) and total solids (TS) in the milk (NDDB/DSP Report 1999). Regarding the question of animal feed, he said he has to buy concentrate feed from a local market. He also mentioned that he feeds his milking cows at the rate of 1 kg/day per cow along with crop residues, salt, fodder grass called Amaliso, and some time *khole* (locally home made ration). He also mentioned that about 90% farmers in Ilam have crossbred cows for milking purposes and they feed their cows just like him.

He further said that DDC, the only public sector institution of the country was established. He said that there are about 1000 MPCs in the country and they have union at districts, regional, and central level and have not done well to the farmers. Mr Bastola is also a member of the farmers' organisation, where he discusses about the different aspects of livestock development, research, credit insurance of animals, veterinary services, extension and marketing system in the district.

Asked whether he has been to any farmers training organised by Department of Livestock Services and farmers visit programme, Mr Bastola replied that he had been to Biratnagar to participate in farmer's group training for 15 days and visited the Biratnagar, Hetauda and Kathmandu milk supply schemes of DDC. During the training he learned that the HMG/Nepal had approved ten years dairy development plan, livestock master plan and Agriculture Perspective Plan (APP) and ninth five-year plan. He was also taught that in the livestock sector, HMG/Nepal had implemented Livestock Sector Master Plan (LSMP) since 1993. The plan had the coverage for 10 years. In the mean time, a twenty-year Agriculture Perspective Plan (APP) was designed in 1995 with the strategy of agriculture led growth for the rapid economic growth and poverty alleviation in the country. He was also told that the livestock sector strategy under APP emphasised meat and milk production, animal nutrition (specifically nutritional fodder supply), health and marketing (APP 1998).

He was asked about the future potentiality of more milk supply from farmers to the market. He replied that the future of milk production level depends on the potential from producing additional milk through modern technology, better extension efforts and, open

policy for milk price paid to the farmers to convert the potential to the reality. He also pointed out that it would depend on two aspects: production increase in already collected area, and the effect of additional road network in the milk shed areas.

Regarding the role of DLS and National Agriculture Research Council (NARC) in development of technology, animal health, livestock research and extension services, he commented that on the production side, DLS is involved in the development of technology, animal health and extension services. NARC is involved in agricultural research and has almost no involvement in livestock research. At present extension services at the rural level are carried out by DLS through JT/JTA and some village animal health workers who are good and effective. He further explained that recently private sectors have also started playing a significant role, basically in animal health. He did not like the private veterinary services because it is not good for the poor farmers like him to pay the additional fees. There is no artificial insemination (AI) service in the district so the farmers have to depend on natural cross breeding with local bulls.

Regarding the question of live animals purchasing and selling at bazaars/markets, he replied that the marketing system for live animals particularly dairy cattle and buffalo is fragmented. There is no orderly system that exists in the distribution of improved dairy livestock and the volume of trade is also not known but seems to be growing. There are no nucleus dairy animal breeder farms in the country so far developed either in the government or in the private level. He said he had difficulties last year buying his Jersey cow from Darjeeling India.

With regard to the question of cow milk cheese making in Ilam, he said that there are eight cheese factories located in Ilam out of which four factories are run by DDC and the rest four by private sectors. He pointed out that these plants are going to close soon because of bad location, poor quality of milk, high temperature and cow milk mixed with buffalo milk that created problems in the quality of Kanchan Cheese manufacturing. He said he tried selling milk during the holiday but none of them agreed.

With regard to the question on whether co-operative movement in dairy is successful or not he answered that, since he is also a member of MPCS, the co-operative movement is successful only when the members know the details of the co-operative functions. He said that many farmers of his society are not aware on co-operative principles, so appropriate mechanisms should be developed for creating awareness and to make the movement successful.

Last year, Mr Bastola and his neighbour went to the Ilam District Agriculture Development Bank for credit to buy a Jersey crossbred milking cow along with a calf. Mr Bastola took a loan of Rs. 20 thousand and also animal insurance, which he has been paying the premium of 6% and 15% interest rate to the DAB/N. His neighbour's cow died six months ago and he has not had insurance compensation yet. This is a big economic burden to this farmer.

On the question of World Trade Organization (WTO) impact on the Nepal dairy industry, he said that the importance of the WTO for Nepal will not affect trade with other countries because Nepal is a small country with no impact on the world market and has low barriers to entry. He also emphasised that WTO will have the effect of potentially opening markets in the South Asia region. Nepal will have to aggressively compete with prices in the

region. He further pointed out that as far as Nepal's market is concerned, the HMG/Nepal has already opened border policy with India (World Bank 1998). He further said that DDC is presently exporting milk to India but on subsidised prices, which is not good for the farmers in the long run to sell at the present price paid to the farmers in Nepal.

Asked about the role of private sector dairy companies emerging in Nepal, he replied that their levels of management, technical knowledge, and marketing expertise are weak and are only beginning to develop. He pointed that the country has to focus on the market segments that they can supply to meet the needs of consumers. The range of potential products is increasing, and Nepal dairies need to focus on product development and diversification. He also stressed that Nepal's borders are open to imports that places pressure on producers and processors to be efficient and competitive.

Regarding the milk holiday question, he replied that he had been facing this problem since 1991/92. He further said that all these created a mismatch between milk offer, milk collection, and serious market search by the producers for selling additional milk and milk products. The result is that there has been a milk holiday since 1991/92. He also criticised the HMG/Nepal policy for the rapid expansion of roads and liberalising the market in the last decade. Sufficient adjustment has not yet been made between road expansions and there is no additional milk processing operation at the public and private sector. Road expansion doubled in 1990's compared to 1980 leading to faster increase in milk offered by farmers. He also expressed that HMG/Nepal did not go for parallel increase in the capacity in DDC, although some capacity were increased through rehabilitation of old DDC plants between 1988–89. A milk powder plant with the milk consumption capacity of 35 thousand litres/day was established in 1991. These capacities got occupied quickly. In the mean time, HMG/Nepal laid additional emphasis on economic liberalisation with the start of 8th plan (1992–97) and up to 9th plan period. No processing capacity has been added to the public sector to date (National Planning Commission 1992, 1998).

Furthermore, he suggested that introducing new varieties are other options for increasing milk demand. There is very high scope for introducing school milk by targeting at least the boarding school. Similarly, condensed milk option also exists, if we want to tap the potential supply to the military. Whole and skim milk powder, flavoured milk and yoghurt (stirred), ice cream and other various products also have prospects in view of growing exposure to the urban people with the modern life style. He further suggested that milk supply in the office complex is also a possibility to reduce the milk holiday.

Conclusion

At the end of the interview with Mr Bastola I asked him what sort of implications, issues, lack of process in livestock development and future strategy and lessons learned can be told in this case study from his side on priority basis. He concluded by ranking the issues and problems below:

Detriment milk pricing policy of the government

The government policy on fixing the producer and retail prices is a major detriment to the development of the dairy industry because prices are set under a climate of political influence with no relevance to general market conditions inside Nepal or to border prices. The policy has set both the producer and retail price effectively constraining the dairy processing industry with margins that do not reflect general business cycles and the impact of rising costs, wages, utilities, taxes etc. The classified pricing system that is based on differentiation of markets and the demand characteristics of the products will provide a better return, a larger market, or both rather than a single price for milk for all uses. The National Dairy Development Board (NDDDB) should look into this pricing system to account for quality of the milk being delivered to the collection and processors.

Livestock breeds

He indicated that they had poor indigenous breed of livestock and lack of exotic livestock breed stock in the country. As a result every year farmers have to spend lots of money in India to buy animals. Most of the time they do not get true breeds of dairy animals from Indian markets.

Inadequate delivery of animal health services

Livestock extension and animal health services in dairy sector are subsidised to the farmers but are inadequate and not available at the time when needed. Mr Bastola pays for the medicine and veterinary service fee arranged privately. It does not mean that he does not like to pay fee to private practitioners.

Dairy animal marketing

There are poor marketing facilities for live animals and animal products within the country. Animals hat-bazaar system should be organised and developed in all five developing region of the country.

Milk co-operatives

Regarding the milk co-operative movements he said that there are critical issues and lots of confusion in operating the co-operatives at grassroots levels because many farmers or the members of the co-operatives are not well informed on the principles and functions of the co-operatives. The co-operative movement has been more or less a forced phenomenon. MCC are established with political colours and cannot fulfil their actual co-operative based objectives. There is lack of co-ordination between Department of Co-operatives (DOC) that

has regulatory functions and the National Co-operative Development Board (NCDB) that has promotional functions.

Mass education programmes

There is a great need to educate consumers on how to launch new dairy products, otherwise the new market penetration would be tough.

Milk marketing

There is lack of infrastructure for collecting, processing and marketing milk and milk products at village levels. Village road development programmes should be started as early as possible.

Poor livestock farm management

There is poor livestock farm management system at farming levels as can be seen in Mr Bastola's farm. There is no research attention given to this aspect either from DLS or from NARC.

Lack of long-term appropriate livestock policy

A livestock policy concentrating on pocket developments for specific products such as milk pockets with identified potentials is important for optimising the use of investment, extension staff and other support resources. This will also help to develop markets through the commercialisation of the products. The present policy where the government does everything is not effective. The system has to be decentralised and liberty and legal rights should be given to the MPCS.

Livestock supporting services

There is lack of supporting services like research activities on farmer's problems. These problems in livestock sector are related basically to inadequate extension, lack of research facilities, less focus on market orientation and commercialisation.

Questions raised in the case study

There are a number of questions raised in this case study and some of the most important questions are mentioned here.

1. What should be the organisational-administrative system of DDC?

Options:

- remain as it is in the government hands
- be co-operated in the hand of MPCs
- be privatised in the hand of business people.

2. Should government veterinary services be privatised?

3. Is it economical for farmers to go to India every time for animal purchase?

What should be the solution for this?

4. Who and how can we solve the livestock credit facility and insurance compensation?

5. Who should regulate milk and milk product pricing policy in the country?

Options are:

- government
- market (open)
- dairy industry union
- DDC

6. How can we re-organise the livestock research and development approach method for the up-lifting of smallholder dairy farmers?

Options are:

- participatory rural appraisal (PRA) approach method
- bottom up approach under decentralisation system
- conventional development approach.

Acknowledgments

I am most grateful to National Dairy Development Board (NDDB), India, and to International Livestock Research Institute (ILRI). My gratitude goes particularly to Dr Amrita Patel, Chairman, NDDB, and Dr Hank Fitzhugh, Director General, ILRI, for their kind invitation and support to me to participate in this workshop. I must thank my staff of NZFHRC particularly Ms Meena Dahal for the computer support.

References

- Agriculture Perspective Plan. 1997/98. Ministry of Agriculture, His Majesty's Government, Kathmandu, Nepal.
- CBS (Central Bureau of Statistics). 1998. Statistical Pocket Book 1998. CBS/NPC Kathmandu, Nepal.
- DDC (Dairy Development Co-operation). 1999. *Annual Report 1999*. Lainchaur, Kathmandu, Nepal.
- Ministry of Finance. 1998. Economic survey fiscal year 1997-98, His Majesty's Government, Kathmandu, Nepal.
- NDDB (National Dairy Development Board)/DSP Report. 1999. Hariharbhavan, Lalitpur, Nepal.

- NPC (National Planning Commission). 1992. Eighth five-year plan (1992–1997), NPC, His Majesty's Government, Kathmandu, Nepal.
- NPC (National Planning Commission). 1998. Ninth five-year plan (1998–2003), (1992–1997), NPC, His Majesty's Government, Kathmandu, Nepal.
- World Bank. 1998. *World Bank Development Report 1998. Knowledge for development*. World Bank, Washington, DC, USA.

Participatory research and extension for dairy technology development and transfer in Vietnam: A case study

D.D. Vu and D.V. Cai

Dairy Research and Training Centre, Institute of Agricultural Science of South Vietnam
121 Nguyen Binh Khiem, District I, Ho Chi Minh City, Vietnam

Vietnam is a tropical country with a hot and humid climate. The total area of the country is 332 thousand square kilo metre. It is densely populated by about 76 million inhabitants. Around 80% of the population lives in rural areas; among this group, approximately 70% rely almost exclusively on agriculture for their livelihoods. Agriculture is based mainly on rice production, supported by other crops such as maize, potato, sweet potato, cassava, groundnut, sugar cane and perennial commercial trees, such as coffee, rubber, tea and coconut. Vietnamese agriculture has been divided into the following seven agro-ecological zones according to ecological and economic conditions.

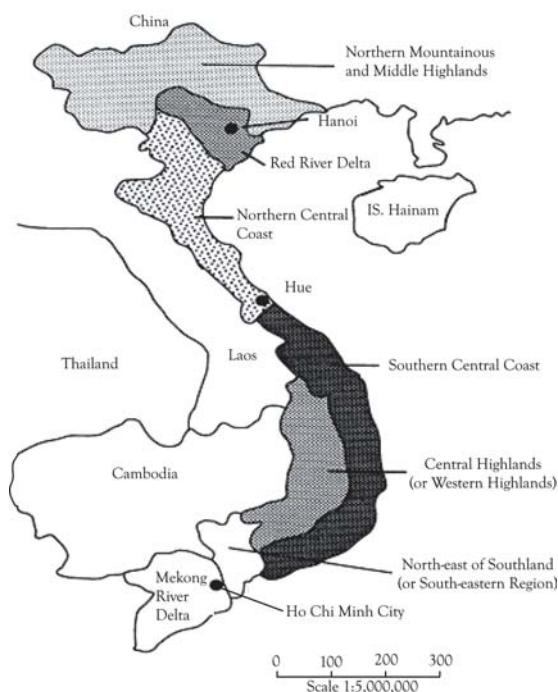
1. Northern Mountainous and Middle Highlands
2. Red River Delta
3. Northern Central Coast
4. Southern Central Coast
5. Central Highlands
6. North-East of Southland and
7. Mekong River Delta.

Dairy development: Advantages and constraints

After the success of the rice production programme, development of domestic milk production to meet the demand is a priority strategy of the National Food Programme in Vietnam. Before 1980, dairy cattle production in Vietnam was concentrated mainly in some state farms in southern highland and north-western areas, where the climate is reasonable for dairy cows (ambient temperature is around 18–23°C). However, the lack of management experience in big state farms has not encouraged dairy production to develop in either quantity or quality. Therefore, the size of the dairy cattle population and level of domestic milk production in Vietnam were low.

From 1980, some smallholder farms in Ho Chi Minh City started to raise dairy cows in small numbers (2–3 cows/farm). After several years, this dairy production model has provided a high and stable economic efficiency for the farmers. Therefore, smallholder

dairy production developed rapidly in the Ho Chi Minh City area and subsequently in other surrounding provinces.



Map 1. Map showing the seven agro-ecological zones of Vietnam.

According to statistical data, the dairy cattle population has increased in size since 1980; increases were especially rapid in the period between 1990 and 2000. In 1990, the dairy cattle population of the Ho Chi Minh City area was only 5000 head but it had increased to about 14 thousand by 1995. At present, the dairy cattle population of the whole country is about 35 thousand head, out of which about 23 thousand are in suburban areas of Ho Chi Minh City. In these areas, level of milk production is around 110–120 t/day; this level can meet only 10% of the raw material demands of the processing factories of VINAMILK and FOREMOST, the only two factories in this area.

Dairy production could be developed in suburban areas of Ho Chi Minh City and surrounding provinces because:

- (i) Fresh milk could be sold easily to the processing factories, which are located in Ho Chi Minh City and Binh Duong Province (40 km away from Ho Chi Minh City)
- (ii) There are abundant industrial by-products (such as brewery wastes, cassava wastes, soybean residues and molasses) which can be used for feeding dairy cows and
- (iii) There are research and extension organisations in each district, which could train and transfer the new technologies to the dairy farmers.

However, the most important constraint for smallholder farmers in practising and enhancing their economic efficiency is the feeding system. As mentioned above, dairy production has developed around the cities; consequently, most of the dairy farmers use a housed feeding system in which dairy cows are kept in their cattle sheds at all times. Cut grasses and agro-industrial by-products plus concentrates are given twice or three times per day after bathing and milking. Green forage has been supplied from two major sources: planted and natural grasses. Due to the limited area of cultivated land, only about 10% of farmer households plant grasses for dairy cows. The most popular improved grass variety is *Pennisetum purpurium* with a green matter yield from 200–250 t/year. Cut natural grass is the main green forage source for dairy cattle, in both grass planting and non-planting households. The natural grasses can withstand long periods of hot and poor nutrient conditions during the dry season. In the dairy cattle raising areas, new employment opportunities have arisen in the cutting and selling of natural grass to the farmers at a price of 150–200 Dong per kg (US\$ 1 = 14,030 Dong on 1st January 2000).

Because of the shortage of grasses, the farmers use many agro-industrial by-products as feeds. Rice straw is used as a source of roughage for dairy cows in the dry and even the rainy seasons. This straw is supplied from adjacent rice growing areas in various forms: green or dry form and whole rice plant or only the top part. The farmers use untreated rice straw, which has a low nutritive value. Industrial by-products from processing factories are popular as major ingredients in dairy cattle rations. These important by-products include: beverage residues, soybean grain waste, cassava root waste and molasses. Nutritionally, these feedstuffs are imbalanced, especially in terms of their energy and protein contents. Therefore, dairy cattle rations are usually inadequate nutritionally, especially for cows with high milk yields (>15 kg of milk/cow per day). Use of these rations results in poor body condition, short lactation periods, low reproductive performances, early culling and eventually low economic efficiency.

In the last few years, implementation of participatory research and extension programmes for improvement of dairy cattle feeding has been considered. These included on-farm trials on cultivation and use of improved grasses, utilisation of agro-industrial by-products and improvement of dairy cattle rations based on locally available feedstuffs.

This paper provides an overview of participatory research and extension on the utilisation of urea treated rice straw as the main roughage component of dairy cattle rations in the Ho Chi Minh City area.

Participatory research and extension on improved utilisation of rice straw for dairy cows

Annual rice production increased from 11.8 million tonnes in 1976 (after country reunification) to 16 million tonnes in 1986 (agricultural reform) to 26.3 million tonnes in 1996 and to even higher levels in recent years. Since 1990, Vietnam has become one of the biggest rice exporters in the world.

In Vietnam, the dominant integrated buffalo/cattle–rice production system has existed for a long time. Buffalo and cattle contribute significantly to crop production by providing

draft power and manure whilst, in turn, they rely greatly on crop production, which provides residues for their feeds. Generally, it is estimated that about 1 kg of straw is produced for each kilogram of grain harvested. Thus, at the current level of rice production in Vietnam, about 25–30 million tonnes of straw could be produced each year.

Nevertheless, as yet, rice straw has not been utilised maximally as a feed for ruminants because of low daily feed intakes by animals and the poor nutritional value of straw, especially in dairy cattle diets. The key to improving the use of rice straw by ruminants is to overcome the barriers to rumen microbial fermentation of lignocelluloses. The two well-known characteristics of rice straw that limit bacterial digestion in the rumen are its high level of lignification and low contents of nitrogen, vitamins and minerals. Therefore, in principle, two approaches should be combined, namely, straw delignification treatment and nutrient supplementation.

Many methods for treatment of straw have been developed and recommended. Among these, treatment of rice straw with urea was introduced as a suitable method for use in developing countries like Vietnam. However, extension of this technique to a wide number of farmers was limited. The reasons for the poor uptake of this technique may be:

- First, in addition to their poor understanding of ruminant nutrition and feeding, especially relating to dairy cows, farmers have not been well informed or trained in use of the technique. This is because there are poor linkages between agricultural educators, researchers, extension workers and target farmers.
- Second, priority is generally given to crop production in terms of labour use and cash investment.
- Third, the methods for development of new technologies are not technically and socio-economically suited to the local conditions under which smallholder poor farmers are dominant.
- Fourth, the farmers have no available cash to pay for the necessary inputs.

From 1990, some organisations such as the Centre for Agricultural Research Gembloux (Belgium), the International Development Research Centre (Canada), and the International Atomic Energy Agency (IAEA) have supported the Institute of Agricultural Science (IAS) of South Vietnam in implementing a programme on improvement of feeding conditions for dairy cows, especially improved utilisation of rice straw as the main roughage component of the diets.

Research and development

Survey

An initial survey carried out in 1990 determined that most dairy farmers (about 80%) have used rice straw for feeding dairy cows in both the dry and rainy seasons. Results of the survey also showed that because of its poor nutritional value, the dairy cows could intake only 3–4 kg of dry matter/day from rice straw. This low feed intake led to low productivity and poor reproductive performance of the dairy cows. Results of the survey also indicated that the farmers were willing to apply new technologies to improve utilisation of rice straw, especially if methods were highly practical.

Trials at laboratory level

Following the survey, some small laboratory trials were carried out in order to determine the appropriate level of urea application needed for treatment of rice straw. Although various levels of urea application have been recommended in the literature (ranging from 3 to 8%) the level of 4% was chosen for field application.

On-station trials

Before conducting on-farm trials, on-station trials were carried out in order to assess the effects of this technology on the productivity of dairy cows. This step was implemented to ensure that there would be no risk associated with application of this technology.

On-farm trials

After the on-station trials, on-farm trials were carried out with farmer participation. Initially, a part of the cost of building the treatment pools and purchase of plastic and urea were supported by the project. The farmers' animals were used for testing and the farmers monitored and assessed the effects of urea treated rice straw on the productivity of their cows.

Diffusion of technology

Several pilot farms were established in order to disseminate the technology to a wider number of farmers. Every two to three months, small training workshops were organised at these farms for training of the farmers and discussion and development of the technology. These training courses used farmer to farmer transfer of information. With this method, the farmers completely understood and believed the new technology because: (i) farmer's language is usually suited to the level of farmer's knowledge; (ii) the farmers usually believe what other farmers say more than what extension workers or researchers say; and (iii) they observe directly the characteristics and efficiency of the technology.

Lessons learned

Research and development

1. Before application of a new technology, it is necessary to conduct a survey in order to determine the practical conditions, farming systems, and farmers' willingness and ability to develop the technology under the field conditions.
2. The study should be based on the 'on-farm participatory approach' that takes into consideration the farmers' evaluation of the technology.

3. To be sustainable, an acceptable feeding system for the improved utilisation of rice straw should be simple and machinery-independent; it should also use cheap and freely available inputs, and fit easily into the farmers' normal routines.

Diffusion of the technique

1. For dissemination of new technology, it is necessary to establish demonstration units (farms). These farms will be used for farmer visits and training, and development of the technology.
2. Training of the farmers in application of a new technology should be carried out using the 'farmer to farmer' principle; thereby, making it is easier for the farmers to understand, believe and apply the technology.

Questions for discussion

1. The dairy cattle population is concentrated mainly around cities. Is it possible to develop dairy production to more distant areas where there is sufficient land for planting grasses and grazing, especially to rice production areas? What are the existing experiences of such attempts?
2. What is the role of the government and private organisations in the development of new technologies, such as the improved utilisation of rice straw in dairy production?
3. What are the functions and activities of dairy farming associations in the application of new technologies?
4. What is the best way to carry out training activities to increase farmers knowledge relating to the application of new technologies?

Theme 6: Making the research and extension paradigm responsive to farmers' needs

Plenary discussion

Under this theme, the four case-study papers presented contrasting organisational structures and technological foci drawing on experiences from sub-Saharan Africa, South and South-East Asia. During the plenary discussion the points raised related to technicians' perceptions of farmers, their needs and the approaches to meeting those needs, as well as the role of public-funded organisations. The debate was continued during the theme 6 group discussion (see below).

In the plenary discussion, the issues and concerns raised were:

1. Government's role is important in policy-making at the macro-level and needs input from research and development (R&D); however, its role at the micro-level, e.g. marketing, is questionable.
2. Involve farmers at all stages of the research process to determine their needs. Classic examples of R&D not involving farmers were presented.
3. Scientists look at smallholders as a homogenous group with similar ideas and therefore do not assess the appropriateness of a technology across a group (and from farmers' perspectives). Even within one village there is variability amongst farmers.
4. Adoption is a behavioural issue and the apparent physical parameters (education, human resources on farm, size of land holding) often used to determine whether adoption will take place or not, tend to end up being relatively irrelevant.

These issues and the related topics that emerged from the presentations in themes 4 and 5 were subsequently discussed in small groups of workshop participants.

The outcomes for theme 6 are given below.

Group discussion

In common with the other group discussions, a set of questions guided the theme 6 discussions. The questions presented to the group asked about the need for an information exchange network for R&D specialists, and how to ensure accessible, demand-led services for smallholders.

The questions were:

1. Should there be a collaborative South-South network on smallholder dairy R&E (amongst national research and extension services (NARES), IARCs, NGOs and farmer

organisations)? If so, what are the preferred options for implementing a network (an electronic network; regular international workshops and conferences etc), and how could they be resourced?

2. What processes need to be put in place by NARES in the South to ensure that their services are demand-driven by their major clients: the smallholders and their market agents? If possible, give examples of R&E programmes that are responsive to the needs of smallholders and their market agents
3. In many developing countries public funding is declining for livestock research and extension. Based on experiences in developing countries, what options are worth exploring (or should be avoided) to give smallholders better access to R&E services?

The group's responses were as follows.

Should there be a collaborative South–South network?

It was agreed that an electronic network should be established. Networks that focus only on meetings were considered not valuable because transaction costs were high, especially when carried out at a national level.

FAO is already discussing a dairy research–extension network. This may be one vehicle for South–South linkages, although it is intended to focus on eastern and southern Africa. It was suggested that a co-ordinator institution would be required and that ILRI may be a candidate. It was recommended that the person recruited to establish and run the network should be carefully selected. Strict moderation and editing of posted material should be exercised to avoid network members being swamped with irrelevant material as often happens in electronic conferences. It was also suggested that a research scientist may not be the most appropriate person and that somebody without a research or other bias should be contracted who could bridge the gap between research and extension.

It was considered that an electronic network between South–South countries would be of value to share experiences of methodologies and successful case studies. Although many scientists were now prepared to talk about participatory techniques, the perception of what is participatory is often not clear. Working on-farm and using farmers' land, animals and labour should not, by itself, be considered participatory.

The network would allow contact between parties to facilitate capacity building in the countries of the South.

What processes need to be put in place by NARES in the South to ensure that their services are demand-driven by clients?

It was felt that there were few instances where NGOs, often with good farmer links, worked directly with research, although BAIF in India was one example.

It was made clear that not only was it important to adopt a more demand-led approach, but also to work in an inter-disciplinary manner, taking a farming systems approach. The farming system has also to be considered in its context of infrastructure, access to markets etc.

To ensure success it was suggested that capacity building start early in professional careers, before more traditional and ineffective approaches became engrained. The farming systems approach, participatory methodologies etc. should be taught at university level; for example the Institute of Rural Management, Anand (IRMA) is developing a course on gender analysis. It was felt that often courses on participatory research are a token gesture and not taken seriously. For example, in research institutions, current reward systems tend to focus on the products of on-station and top-down research, i.e. papers and articles in scientific journals, and should be changed to an outcome focus.

Examples of client responsive R&E

Some examples of R&E programmes that are responsive to client needs included:

- R-E network Ethiopia: Extension workers sit on annual EARO (Ethiopian Agricultural Research Organization) research reviews and have the opportunity to evaluate and suggest modifications for completed and proposed research and to propose research issues themselves.
- Dairy project Thailand: A dairy project in Thailand was described in which there were direct linkages between farmers and research scientists via extension workers.
- Amul co-operative India widely discussed during the meeting.
- NAADS as described in the presentation from Uganda.
- ATIRI Kenya where farmer groups request research scientists to work on issues in which they are interested.
- Schemes (listed by the participant from Uganda) in Costa Rica, Chile, Bolivia etc. which were taking new approaches to ensure that extension delivery was client-led.
- Bangladesh University is working with 2-3 NGOs which interact with university staff to feed back information from the field and who are involved in applied research at the field level.

Options to improve smallholder access to service

In the example of Amul, the Union instigates farmer study visits. Development of information centres may be an option.

Information delivery through co-operatives was one measure discussed and good examples were Amul, and co-operatives of coffee and sugar growers.

Most of the farmers outside co-operatives are fragmented and not unified making effective delivery more difficult. However, it was considered that there may be potential to work with existing social groups—for example religious or community based groups, women's groups etc. which, although established for different purposes, already are a cohesive and motivated group.

It was suggested that there should be more focus at the (output) market level rather than the input level, which has occurred in the past. Technologies being presented through extension services almost always involve increased inputs and it is important that the farmer

can recoup this expenditure. The only way this can occur is through marketing of the product.

Conclusions

As in the related themes, the presentations, the supporting papers and the discussion on the research and extension paradigm highlighted the importance of participatory approaches to ensure that research and extension technicians are answerable to the people they are serving. The decentralisation of public-funded services to community-based groups within organisational structures, which facilitate access to technical information and expertise yet assure accountability to the landless, the marginalised and smallholders and their market agents, were required. The actions agreed by participants to contribute towards achieving those aims are presented in the workshop recommendations.

Recommendations of the workshop

Based upon the issues raised by the workshop papers and during the discussions in the group and plenary sessions, five major areas of importance to ensuring the development of smallholder dairying and its competitiveness were identified and specific actions were recommended.

South–South information exchange and networking

The major recommendation of the workshop was the need for continued co-operation on the sharing of information, experiences and research findings related to smallholder dairy development with emphasis on networking among the countries of the South.

It was agreed that the beginnings made in establishing the electronic linkages among the participants and their organisations while organising the workshop, should be strengthened to facilitate the exchange of information. ILRI (www.cgiar.org/ilri) offered to assist in establishing a network through exploring opportunities with, for example, FAO (www.fao.org).

Participants agreed that the need for information exchange and networking was particularly relevant for issues related to:

- Collective-action groups: The collective action of smallholders (such as that practised in the Anand model in India) was seen by workshop participants as an important mechanism for successful dairy development.

Information exchange on the strengths and weaknesses of the approach was needed with emphasis on identifying the principles and best practices that determine the successful adoption and adaptation of the approach (see below).

- Participatory research and extension: The lessons from participatory research and extension approaches and methodologies presented to the workshop particularly interested the participants. They wanted more information about and contact with programmes in developing countries practicing participatory approaches to the development, testing and transfer of productivity-enhancing technologies. The workshop participants were particularly interested in testing the approaches, methods and tools to crop–dairy systems and to improving integrated nutrient management.

It was suggested that a link be established with the Consultative Group on International Agricultural Research (CGIAR's) System-wide Programme on Participatory Research and Gender Analysis (PRGA) led by Centro Internacional de Agricultura Tropical (CIAT). The PRGA website (www.prgaprogram.org/prga/) provides access to information on participatory research and extension approaches, methodologies and tools, and to current examples of their application to livestock-related constraints and opportunities.

- Milk marketing research: The over-riding importance to smallholder dairy development of effective milk collection and marketing strategies was highlighted in the workshop presentations and in the discussion sessions. Information exchange and networking on the lessons learnt on appropriate marketing strategies was therefore a key topic to be addressed through the continuing interactions amongst the countries of the South.
- Policy research: In the same way, the workshop participants agreed on the importance of sharing the lessons learnt from policy studies as related to dairy development, role of governments etc. Participants stressed the need for exchanging information on approaches and methods for carrying out policy research, for the presentation of the research outcomes to policy makers and their advisers and for advocating policy reforms related to smallholder dairy production and marketing.

Championing the collective action (co-operative) approach

An important conclusion of the workshop was that the time-tested Anand model of dairy co-operatives, with changes as may be necessary to suit local environments, was a good model for smallholder dairy development among the countries of the South.

The National Dairy Development Board (NDDB) (www.nddb.org) agreed to play the lead role in information dissemination and supporting the development of farmer organisations. It would use its bilateral linkages already established with Ethiopia, Nepal and Uganda, as a springboard to develop farmer-led programmes.

Enhancing the understanding of WTO regulations and their implications for smallholder dairy development

The representatives from most of the participating countries wanted to be kept well informed and updated on the implications for smallholder dairy production and marketing of the World Trade Organization (WTO) regulations. This should be done on a continuing basis by establishing a small group of countries in the South to help draw up plans of action.

The Institute of Rural Management (IRMA; www.irm.ernet.in), Anand, and NDDB offered to facilitate the process and to provide a forum for articulating the issues affecting smallholder dairy development in countries of the South.

Improving research and extension (R&E) systems to serve smallholder dairying

A major issue highlighted by the workshop participants was the need for more effective R&E systems, including the delivery of livestock services (e.g. veterinary and artificial

insemination; AI), to support smallholder dairy development. It was proposed that one way forward was to study and understand the successes and failures of the different approaches tried in various countries and to share those lessons through the proposed South–South information exchange and networking (see above).

It was agreed that NDDB and IRMA would collate information from South Asian countries, while ILRI (subject to identifying funding), would mount a parallel effort elsewhere, e.g. in the sub-regions of sub-Saharan Africa.

The workshop consensus was that organisational and institutional reforms (see, e.g. the Uganda case study), and particularly the efforts to privatise services and to form public–private partnerships were important. Therefore it was essential that efforts related to dairy were linked to national initiatives on the reform of agricultural services generally and to their re-organisation.

Conclusions

In conclusion, therefore, the workshop demonstrated:

- the commonality of many of the issues related to smallholder dairy production and marketing in the countries of the South
- the richness of the experiences in the South applicable to addressing dairy development for the improvement of the livelihoods of the landless, the marginalised and smallholders
- the key role that market-orientation and participatory approaches play in fostering effective efforts in support of dairy development
- the large benefits, actual and potential, of exchanging experiences amongst the countries of the South
- the importance of taking advantage of the new generation of information technologies to ensure more effective exchange of information within the South and
- the willingness and enthusiasm of the participants to work together to plan the agreed actions and to mobilise the resources required for their implementation.

List of participants

M.S. Ashok

Catalyst Management Services Pvt. Ltd.
179 VI Main KEB Layout, Geddalahally
Bangalore 560 094, India
Tel: 91-080-341 9616
91-080-341 7714
E-mail: ashokms/vsn1.net; cats@vsn1.com

B.H.W.M.U.S. Bandara (Dr)*

Director, Animal Breeding (Development)
Division
Department of Animal Production and Health
P.O. Box 13
Peradeniya, Sri Lanka
Tel: 94-0-8 388031
Fax: 94-0-8 388031
E-mail: daphdev@slt.net.lk

C. Chantalakhana (Prof)

Kasetsart University
Bangkok 10903, Thailand
P.O. Box 1014, Kasetsart P.O.
Tel: 66-2-579-4214
Fax: 66-2-579-8555/66-2-552-8171
E-mail: swkcrc@ku.ac.th

C. Devendra (Dr)

ILRI-Philippines
130A Jalan awna Jawa
58200 Kuala Lumpur, Malaysia
Tel: 603-783 9307
Fax: 603-783 7935
E-mail: cedv@pc.jaring.my

A.K. Joseph (Dr)

National Dairy Development Board (NDDB)
Anand-388 001, India
Tel: 091-269-2-40148/40149 or 40146
Fax: 091-269-2-40156 or 091-269-2-47102
E-mail: akj@anand.nddb.ernet.in

Durga Dutt Joshi (Dr)

Director, National Zoonoses and Food Hygiene
Research Centre
Tahachal, GPO Box 1885
Kathmandu, Nepal
Tel: 0977-1-270667
Fax: 0977-1-272694
E-mail: ddjoshi@health.org.np

M.P.G. Kurup (Dr)

16/2A, Borsad Road, Jitodia, 388 345,
Gujarat, India
Tel: 91-2692 36610/35549
E-mail: mpgkurup@wilnwtonline.net
mpgkurup@yahoo.com

Lusato Revocatus Kurwijila (Dr)

Sokoine University of Agriculture
Department of Animal Science and Production
P.O. Box 3004, Morogoro, Tanzania
Tel: 007-23-2604617
Fax: 007-23-2604562
E-mail: kurwiji@suanet.ac.tz

Jian-Xin Liu (Dr)*

Professor, College of Animal Sciences,
Zhejiang University Huajiachi Campus,
Hangzhou 310029
P.R. China
E-mail: jxliu@dia1.zju.edu.cn

Lucy M. Maarse

Head of Natural Resource Management Sphere
(Swiss Agency for Development and Cooperation)
and Delegate of Inter-cooperation (/IC) in India
E-mail: lucy.maarse@sdc.net

Bhupendra Nath Mathur (Dr)

Director, National Dairy Research Institute,
Karnal-132001 Haryana, India
E-mail: dir@ndri.hry.nic.in
bnm@ndri.hry.nic.in

* Invited but unable to attend. Papers are included in the proceedings.

H.G. Muriuki (Dr)

Assistant Director, Livestock Production
Ministry of Agriculture and Rural Development
P.O. Box 30028
Nairobi, Kenya
Tel: 254-2-718528
Fax: 254-2-721983
E-mail: ilri-ma@africaonline.co.ke_

David Miano Mwangi (Dr)

Head, Regional Research Programme
Kenya Agricultural Research Institute (KARI)
P.O. Box 30148
Nairobi, Kenya
Tel: 254-154-32404
Fax: 254-154-33091
E-mail: david.kari@2000ke.com

Reuben Njwe (Dr)*

Country Director
Heifer Project International
B.P. 633
Bouake 01, Cameroon
Tel: 237-36-3822
Fax: 237-26-3921
E-mail: hpicam@doualal.com

Joseph Nsereko

P.O. Box 21472, Kampala (Private) or
Mpigi District Administration
P.O. Box 172, Mpigi, Uganda
Tel./Fax: 256-41-345440
E-mail: ascim04@infocom.co.ug
Karidir@imul.com

A.M. Nyamu

Head of Publications
ILRI-Ethiopia
P.O. Box 5689
Addis Ababa, Ethiopia
Tel: 251-1-463215
Fax: 251-1-461252 or 464645
E-mail: a.m.nyamu@cgiar.org

J.M. Omiti (Dr)

Agricultural Economist
Institute of Policy Analysis and Research (IPAR)
P.O. Box 45843
Nairobi, Kenya
Tel: 254-2-251179
Fax: 254-2-251162
E-mail: jmomiti@par.or.ke

E.O. Otchere (Prof)

Director, Animal Research Institute
P.O. Box AH20, Achimota, Ghana
E-mail: ari@africaonline.com.gh

S. Parthasarathy

Assistant Director General
International Crops Research Institute for the
Semi-Arid Tropics (ICRISAT)
Patancheru 502 324
Andhra Pradesh, India
Tel: 040-3296161
Fax: 040-3296182
E-mail: icrisat@cgiar.org

A. Patel (Dr)

Chairman and Chief Executive
National Dairy Development Board (NDDB)
Anand 388 001, India
Tel: 091-269-2-40148/40149 or 40146
Fax: 091-269-2-40156 or 091-269-2- 47102
E-mail: amrita@anand.nddb.ernet.in

I. Patel (Prof)

Institute of Rural Management
P.O. Box 60, Anand 388 001
Gujarat, India
Tel: 02692-60177, 60181, 60391
Fax: 02692-60188
E-mail: ila@fac.irm.emnet.in

R. Rafaqat*

Animal Husbandry Commissioner
Government of Pakistan, Islamabad
Tel: 92-42-92-5092
Fax: 92-42-9221357

* Invited but unable to attend. Papers are included in the proceedings.

Datta V. Ranganekar (Dr)

National Dairy Development Board ()
Anand 388 001, India
Tel: 091-269-2-40148/40149 or 40146
Fax: 091-269-2-40156 or 47102
E-mail: dvr@anand.nddb.ernet.in

Dannie L. Romney (Dr)

ILRI-Nairobi
P.O. Box 30709
Nairobi, Kenya
Tel: +254-2-630743
Fax: +254-2-631499
Telex: 22040 ILRI/Nairobi/Kenya
Cable: ILRI/Nairobi/Kenya
E-mail: d.romney@cgiar.org

M. Saadullah (Prof)

Department of Animal Science
Bangladesh Agricultural University
Mymensingh 2202, Bangladesh
Tel: 880-91-55816
880-17-336 510
Fax: 880-91-55810
E-mail: msaad@royalten.net

Gobinda Chandra Saha

General Manager, Bangladesh Milk Producers'
Cooperative Union Ltd. (Milk Vita)
Dugdha Bhaban
139-140, Tejgaon Industrial Area
Dhaka-1208, Bangladesh
Tel: 00-880-2-882 6888
Fax: 00-880-2-882 68800
E-mail: milkvita@bangla.net

Rakesh Saxena (Prof)

Professor, Institute of Rural Management
P.O. Box 60
Anand 388 001, India
Tel: 0091-2692-60391, 60177, 60181, 60186
Fax: 0091-2692-60188
E-mail: rakesh@fac.irm.ernet.in

Vijay Paul Sharma (Prof)

Centre for Management in Agriculture
India Institute of Management
Vastrapur, Ahmedabad, India 380 015
Tel: 079-6307241
Fax: 079-6306896
E-mail: vijays@iimahd.ernet.in

K. Singh (Singh)

Director, Institute of Rural Management
Anand 388001, India
Tel: 02692-61230
Fax: 02692-60188
E-mail: ks@fac.irm.ernet.in

P. Skunmun

Buffalo and Beef Production R&D Center
(BPRADDEC)
Suwanvajokkasikit Animal R&D Institute,
Kasetsart University
P.O. Box 1014, Kasetsart P.O.
Bangkok 10903, Thailand
Tel: 662-5794214
Fax: 662-5798555
E-mail: swkppb@ku.ac.th

M. Smalley (Dr)

Programme Co-ordinator
Strengthening Partnerships for Livestock
Research (SPAN)
ILRI-Ethiopia
P.O. Box 5689
Addis Ababa, Ethiopia
Tel: 251-1-46 32 15
Fax: 251-1-46 12 52 or 46 46 45
E-mail: m.smalley@cgiar.org

S. Staal (Dr)

Agricultural Economist
ILRI-Kenya
P.O. Box 30709
Nairobi, Kenya
Tel: 254-2-630743
Fax: 254-2-631499/632013
E-mail: s.staal@cgiar.org

Nguyen Quang Suc (Dr)

National Institute of Animal Husbandry
Hanoi, Vietnam
Tel: 084-4-8387236
Fax: 084-4-8389775
E-mail: tcvcn@hn.vnn.vn

D. Taylor (Dr)

Deputy Director General
ILRI-Kenya
P.O. Box 30709
Nairobi, Kenya
Tel: 254-2-630743
Fax: 254-2-631499
E-mail: d.taylor@cgiar.org

W. Thorpe (Dr)

ILRI-Kenya
P.O. Box 30709
Nairobi, Kenya
Tel: +254-2-630743
Telex: 22040 ILRI/Nairobi/Kenya/
Cable: ILRI/Nairobi/Kenya
E-mail: w.thorpe@cgiar.org

Deepak Tikku

Managing Director
National Dairy Development Board (NDDB)
Anand 388 001, India
Tel: 091-269-2-40148/40149 or 40146
Fax: 091-269-2-40156 or 47102

Tsehay Redda

Animal and Fisheries Resources Development
and Regulatory Department
Ministry of Agriculture
P.O. Box 62347
Addis Ababa, Ethiopia
Tel: 251-1-155871
E-mail: mmoa4@telecom.net.et

Doan Duc Vu (Dr)

Deputy, Ruminant Research Department
Institute of Agricultural Science of South
Vietnam
121 Nguyen Binh Khiem, District I, Ho Chi
Minh City, Vietnam
E-mail: ttbs@hcm.vnn.vn

B.M. Vyas*

Managing Director
Gujarat Cooperative Milk
Marketing Federation Ltd.
Anand 388 001, India
Tel: 02692-40180
Fax: 02692-40208
E-mail: bmv.mdo@gcmmfho.guj.nic.in

William H. Winter (Dr)

Research Programme Manager
Australian Centre for International Agricultural
Research (ACIAR)
GPO Box 1571, Canberra ACT 2601
Australia
Tel: 61-2-6217 0545
Fax: 61-2-6217 0501
E-mail: winter@aciarc.gov.au

M.L. Yahuza (Dr)

Project Manager
National Livestock Projects Division (NLPD)
PMB 2222
Kaduna, Nigeria
Fax: 234-62 244421
E-mail: nlpd2000@yahoo.com

* Invited but unable to attend. Papers are included in the proceedings.