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Smallholder livestock production in India: Opportunities and challenges

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NCAP (National Centre for Agricultural Economics and Policy Research)—ICAR (Indian Council of Agricultural Research), New Delhi, India

ILRI (International Livestock Research Institute) Nairobi, Kenya

Smallholder livestock production in India: Opportunities and challenges

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Editors

Foreword

Livestock have remained an integral part of the socio-economic fabric of rural India since time immemorial, as a source of livelihood and a provider of draught energy, manure and fuel. These functions, however, are changing in importance with economic development. Sustained rise in income and urbanization are now fuelling rapid growth in demand for animal food products, and the livestock are coming under pressure to produce more. India's livestock responded well to these changes. Over the last three decades livestock production grew faster than crop sector as a whole and made significant contribution to agricultural growth, which is considered to be an important factor in poverty reduction in most developing countries. Therefore, in rural India a growing livestock sector augurs well for the low income households to augment their income and escape poverty.

Though the small farmers have more opportunities in demand-driven livestock production, they have a formidable challenge of improving scale of production, its efficiency and quality to face the competition from large commercial producers in the market place, which is likely. The extent to which the small-scale farmers will be benefited from livestock sector growth would depend on how the policies, technologies and institutions respond to their needs. This workshop on 'Smallholder livestock production in India: Opportunities and challenges' has provided opportunities for various stakeholders to delve deeply into such issues.

It was a pleasure for us to have the International Livestock Research Institute (ILRI) as a partner in this workshop. The global experience of ILRI will help us devise appropriate policies and programs for a more pro-poor livestock sector growth. The papers in this volume have identified several researchable issues. We look forward for fruitful partnership research between Indian Council of Agricultural Research (ICAR) and ILRI.

Mangala Rai
Secretary, Department of Agricultural Research and Education (DARE)
Director General, Indian Council of Agricultural Research (ICAR)

Foreword

It is an honour and pleasure for ILRI to co-host this international workshop on 'Smallholder livestock production in India: Opportunities and challenges'. As elsewhere in the developing world, animal agriculture—encompassing ruminant and non-ruminant livestock and poultry—is integral to the economy of India. Many hundreds of millions of Indian farmers, landless livestock keepers and market agents and their families depend for their livelihoods on animal agriculture. Improving through livestock research the livelihoods of these people, many of which are amongst the world's poorest, is both a major challenge and an excellent opportunity for achieving economic growth and poverty alleviation. The task demands teamwork and collaboration such as that being discussed in this workshop.

Today in India and elsewhere in the developing world, particularly in Asia and Latin America, many farming systems are changing rapidly. Human populations are growing and becoming more urbanized and richer, resulting in a rapid increase in demands for high value foods: vegetables, fruits, milk, meat and fish. Market requirements, particularly for product quality and safety, are also changing. These challenges of the Livestock Revolution are very different from those faced prior to India's Green Revolution. Yet if we are to exploit the opportunities they represent, then we will require the same vision, the quality of science, the interdisciplinary and multi-institutional approaches and the international partnerships that resulted in the Green Revolution.

Today's research will help us to understand how economies are changing, what are the factors driving these changes, and how will these influence household decision-making and private sector investments. Critical decisions will relate to how technological, policy and institutional innovations and equitable development can be achieved through animal agriculture. We in ILRI look forward to contributing through this workshop to charting the course for collaborative livestock research that will alleviate poverty and support economic growth and the sustainable use of natural resources.

Carlos Seré
Director General, International Livestock Research Institute (ILRI)

Smallholder livestock production: An overview of issues[1]

PS Birthal, W Thorpe and VK Taneja

As income rises, the share of high-value food products in the food basket increases. This is precisely what is happening in most of the developing countries where sustained rises in per capita income together with urbanization, are resulting in increased demand for animal food products. The rising demand has been accompanied by an increase in domestic supply, and this phenomenon is termed the 'Livestock Revolution'. The factors underlying demand growth have been quite robust in the recent past and are unlikely to subside in the near future giving a further push to the revolution.

Most developing countries continue to grapple with problems of nutritional insecurity and rural poverty. The Livestock Revolution is expected to make a significant contribution towards improving nutritional security and to reducing rural poverty. The rural poor have little access to land and thus there are limited opportunities for them in crop production. On the other hand, livestock wealth is more equitably distributed compared to land, and the expanding demand for animal food products generates significant opportunities for the poor to escape poverty through diversifying and intensifying livestock production. Besides, the increasingly integrated global markets under World Trade Organization (WTO) is also creating opportunities for exporting animal food products.

The route to poverty reduction through livestock, however, is not free from threats. Poor livestock producers face numerous constraints in production and marketing. They are constrained by a lack of access to capital, quality inputs, improved technology and support services. They have small marketable surpluses, while local rural markets are thin, and sales to distant urban markets result in very high transaction costs. What is more, poor livestock producers face increased competition from large commercial producers, which undermines their economic viability. Intensifying livestock production would also cause negative externalities to environment and public health.

Another danger to pro-poor livestock growth stems from the globalization of markets. Global trade in livestock products is dominated by a few developed countries and is heavily distorted. Some countries in the European Union and the United States provide a high level

1. This paper is a synthesis of the papers presented to and the discussions held during the workshop.

of protection to their livestock industry, making it more difficult for developing countries to compete in the global market. In fact, many developing countries face the threat of cheap imports. On the other hand, developing country exports are thwarted by stringent food safety and quality standards.

Whether smallholders will be able to take advantage of the opportunities resulting from the increased demand for livestock products will depend on how supportive public policy is to smallholder livestock production and the extent to which smallholders improve their scale and efficiency of production.

India is no exception to these observations. It has a dynamic and fast growing livestock sector, which is becoming increasingly important nationally, regionally and internationally, especially for its contribution to alleviating poverty and for its impacts on environmental sustainability. A two-day international workshop on 'Smallholder livestock production in India: Opportunities and challenges' was organized by the National Centre for Agricultural Economics and Policy Research—an offshoot of the Indian Council of Agricultural Research, and the International Livestock Research Institute from 31 January–1 February 2006 at New Delhi, India to:

- assess the development prospects of India's livestock in the context of changing global economic environment and its impact on the rural poor, and
- suggest politically feasible and practical strategies and approaches for pro-poor growth in livestock production. An additional aim of the workshop was to explore possibilities of enhanced research collaboration between the national agricultural research systems (NARS) and ILRI.

The workshop was inaugurated by Prof Abhijit Sen, Member, Planning Commission, Government of India, and attended by over 70 participants. They included animal scientists, economists, policymakers and development practitioners representing national and international public and civil society organizations. In the inaugural session of the workshop, summaries of the following two papers were presented to apprise the participants of the emerging trends in the livestock sector nationally and internationally, and to set the tone for the subsequent discussions. The papers were:

1. Livestock sector in India: Opportunities and challenges for smallholders (PS Birthal and VK Taneja)
2. Lessons from a changing world: Implications for livestock research and development (ILRI).

The India paper provides a comprehensive overview of the livestock sector and brings out explicitly the importance of livestock in improving the wellbeing of the rural poor. The main highlights of the paper are:

- Livestock production in India has been growing faster than crop production, and thus contributed towards sustaining agricultural growth. The growth in livestock production was driven by animal numbers and by higher productivity, but the effect of numbers outweighs that of productivity;
- Agricultural growth in general is poverty-reducing, but growth in livestock production is more pro-poor than a similar growth in crop production as livestock wealth is more equitably distributed than land;
- But, small-scale livestock producers are constrained by lack of access to markets, credit, inputs, technology and services which may deter them from taking advantage of the opportunities resulting from the expanding demand for animal food products in the domestic and global markets;
- Low level of public investment in the livestock sector is detrimental to the interests of millions of poor livestock producers;
- Value addition to livestock production is not encouraging and may constrain the growth of livestock production, especially amongst small-scale producers; and
- The paper argues for a conducive policy environment to enable poor households to secure livestock assets, inputs and technology and to improve their access to output markets.

The ILRI paper provides a synoptic view of the changing global environment and draws lessons for India and other developing countries to transform livestock production to the benefit of the poor. The main messages from the global review are:

- It is critical for livestock researchers to understand how livestock systems are changing, whether in the systems in more marginal areas where change is slow or in the rapidly changing systems which are responding to market demand for livestock and livestock products;
- To achieve sustainable and equitable livestock sector growth in the different systems, it is important that technology, policy and institutional innovations are combined; and
- Beyond broader livestock sector growth, specific attention will need to be paid to how the poor can benefit from the emerging opportunities, which will require targeted and intelligent public-sector research and development interventions.

Three parallel roundtable sessions were organized to discuss the issues raised in the two papers, and to suggest appropriate policies and actions for the pro-poor development of the livestock sector. The discussions theme and the main recommendations that resulted for each theme were:

Improving smallholder competitiveness: The role of markets, institutions and trade

- Identifying market failures (credit, insurance, inputs, technology and information) that prevent smallholders from participating in livestock production and marketing;
- Mapping supply chains for live animals and their products and sub-products and strengthening those chains that benefit most to the producers through public policy;

- Assessing future demand for animal food products in terms of their quantitative and qualitative requirements, price and other attributes;
- Evaluating and documenting benefits and costs of alternative institutional models such as contract farming, co-operatives and producers' organizations; and
- Assessing the impact of WTO and Sanitary and Phytosanitary (SPS) regulations on trading dairy products, and impact on smallholders.

Strengthening the role of livestock in poverty alleviation, food security and environmental protection: Policies and strategies

- Understanding and quantifying livestock's contribution to poverty reduction;
- Identifying policy, institutional and technology options to make livestock growth more pro-poor:
  - Risk mitigation, market access, credit, insurance, vulnerability and knowledge management to minimize vulnerability of the poor to risks; and
- Integrating smallholders in the process of industrializing livestock:
  - Equity and environmental impacts of industrialization;
  - Public policy support for participating smallholders.

Increasing livestock productivity: Challenges, opportunities and strategies for research and development (R&D)

- Improving feeding systems using local feed resources especially through food–feed crop improvement and low-cost feed formulations;
- Estimating and reducing the economic losses from animal diseases;
- Methods for the conservation and improvement of indigenous livestock; and
- Information and knowledge management, particularly for institutional capacity building.

The workshop format ensured that full advantage was taken of the complementary interests and experiences of the national and international participants. There was a consensus that ICAR–ILRI work plan be reviewed and revised to reflect the workshop recommendations.

Livestock sector in India: Opportunities and challenges for smallholders

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Introduction

Accelerating growth in agricultural sector remains a key policy concern in India despite a significant decline in its share in gross domestic product (GDP), from 48% in 1970/71 to 24% in 2003/04. And rightly so, as the importance of agriculture transcends beyond its economic contribution. Nearly 72% of India's population lives in rural areas, and 75% of it depends on agriculture and allied activities for livelihood. Further, of 261 million poor in the country 75% are rural poor, and 54% of these belong to farm households. Growth in agriculture is thus critical to the livelihood of millions of rural poor. Ravallion and Datt (1996) and Warr (2003) have shown that in India agricultural growth is more pro-poor than the growth in other sectors of the economy.

Over the last three decades, India made tremendous progress in food production. However, agricultural growth hardly ever exceeded 3% a year. Keeping in view the pro-poor nature of agricultural growth, the National Agricultural Policy (NAP 2000) targeted a 4% annual growth in agricultural sector by 2020, and emphasized livestock as an important driver of growth. The policy statement focused on the need to: (i) evolve a livestock breeding policy to increase livestock production and enhance use of draught animals as a source of energy, (ii) generate and disseminate livestock related technologies to improve animal productivity, (iii) improve marketing, processing and transportation facilities for value addition, (iv) manage grazing lands and rejuvenate pastures, (v) establish disease-free zones, and (vi) involve co-operatives and private sector in development efforts. Besides, the statement also emphasized bringing up incentives for livestock production at par with crop production.

With an enabling policy environment there is a considerable scope to diversify agricultural sector towards livestock activities. Increasing population, urbanization and sustained

rise in per capita income are fuelling rapid growth in demand for animal food products. By 2020 demand for animal food products is likely to be double of the current demand (Delgado et al. 1999; Parthasarathy Rao et al. 2004). Besides, increasing globalization of agricultural markets is too opening up significant opportunities to augment export of animal food products (Aksoy 2004).

Livestock contribute over 25% to the agricultural sector output, up from 16% in 1970/71. In absolute terms, their contribution increased from 256 billion Indian Rupees (INR)[1] in 1970/71 to INR 934 billion in 2002/03 (at 1993–94 prices) at an annual rate of 4.3%, higher than the growth in the agricultural sector as a whole (2.8%). Notable growth occurred in dairy and poultry production. Milk production, that had been hovering around 20 million tonnes in 1950s and 1960s, increased to 88 million tonnes in 2003/04. Between 1980/81 and 2003/04 production of eggs increased from 10 billion to 40.4 billion, and of poultry meat from 0.1 million tonnes to over one million tonnes. Besides food production, livestock make important contributions to crop production by supplying draught power and dung manure.

Rapid growth in livestock production is desirable not only to sustain agricultural growth, but also to reduce rural poverty especially when a majority of the land holdings are small. Fifty-eight percent of rural households have land holding of less than 2 ha and another 32% have no access to land. Number of these households is likely to increase due to further subdivision of land holdings. Livestock are thus an important source of income for smallholders and the landless. Products like milk and eggs are steady source of cash income, and live animals are important natural assets for the poor, which can be easily liquidated for cash during emergency. Smallholders and landless together control 75% of the country's livestock resources, and are capable of producing at a lower cost because of availability of sufficient labour with them. Evidence shows that smallholders obtain nearly half of their income from livestock (Shukla and Brahmankar 1999; Birthal et al. 2003). Growth in livestock sector is thus more pro-poor than growth in other subsectors of agricultural economy.

During 1970s livestock were considered an important instrument to counteract adverse effects of land-based Green Revolution on rural income distribution. The poor were provided credit assistance to build up livestock assets under poverty alleviation programs such as Integrated Rural Development Programme (IRDP). Major support to livestock sector, however, came in the form of 'Operation Flood' program, which was launched in 1970 to link rural milk production with high-demand urban consumption centres through

1. In September 2006, USD 1 = INR 46.52.

the network of dairy co-operatives. Besides, the dairy industry was protected from cheap imports through licensing, quotas and tariffs.

Some important policy initiatives to improve growth and efficiency in livestock production and processing were taken after the initiation of the process of economic reforms in 1991. Entry of private sector into dairy industry was freed from regulations, and the import-substitution policy was given up removing quantitative restrictions on imports and reducing tariff rates. Processing of livestock products was encouraged by lowering excise duties and corporate taxes. The Agricultural Produce Market Committee Act, that prohibited sale/purchase of agricultural commodities outside state designated markets, has been amended recently to allow private sector to procure produce directly from producers through institutional arrangements like co-operatives, contract farming and producers' associations or by establishing their own markets. The Reserve Bank of India permitted financial institutions to finance contract farming schemes.

Nevertheless, there is an apprehension whether smallholder livestock producers can take advantage of the emerging opportunities. Productivity of livestock is low, and smallholders are constrained by a lack of access to markets, capital, inputs, technology and services. Failure to address these constraints may depress domestic production and lead to an import upsurge. There is also a possibility of emergence of large landholder commercial production systems especially around urban areas to cater to the increasing demand for animal food products there. Smallholders though are efficient even under low-input conditions; economies of scale in production and marketing in commercial production may erode their competitive advantage.

Increasing globalization of livestock products markets is an opportunity as well as a threat to India's livestock sector. Global demand for livestock products is increasing and thus offers an opportunity to increase exports. India has a competitive advantage in primary production of many products, but their exports are constrained by low level of processing, distortions in world trade and stringent food safety norms in the international trade. On the other hand, there is an imminent threat of cheap imports especially from the European Union and the United States that heavily protect their livestock industry through subsidies and market support measures.

Livestock production is therefore likely to be under significant adjustment pressure in the liberalized economic environment. Whether smallholder livestock producers would be able to expropriate emerging opportunities would depend on their ability to improve efficiency in production, and preparedness of the government and industry to facilitate the adjustment process through policies and investments. This paper examines opportunities and challenges to smallholder livestock production in India. Next we analyse trends in

consumption and demand for livestock food products. We then provide an overview of livestock production systems and their performance. Impact of livestock sector growth on poverty is also examined. Issues related to marketing, processing and trade and policy issues related to investment, infrastructure, services and institutions are discussed. The last section presents conclusions and policy issues.

Demand for livestock food products

Sustained economic and income growth, and urbanization[2] are causing significant changes in food consumption pattern in India. Consumers are including more of high-value commodities such as fruits, vegetables and animal products in their food baskets (Table 1). Trends in per capita consumption of different food commodities between 1983 and 1999/2000 show a decline in cereal consumption (12%) and notable increases in consumption of fruits, vegetables and animal products. Per capita milk consumption nearly doubled from 43 kg to 74 kg, and meat consumption increased from 2.4 kg to 3.1 kg/annum. Growth in consumption of animal products was more pronounced in 1990s as compared to 1980s. Increase in meat consumption was driven by significant increase in consumption of poultry and bovine meats. Egg consumption also increased substantially during this period. On the other hand, per capita consumption of small ruminant meat, the most preferred meat in India, has remained almost unchanged.

Table 1. *Per capita consumption of livestock products in India (kg/annum)*

Commodity	1983	1987–88	1993–94	1999–2000
Cereals	168.3	167.3	153.0	147.5
Pulses	11.5	11.8	9.8	12.5
Vegetables	47.6	52.4	61.5	76.1
Fresh fruits	3.2	11.7	19.3	18.1
Milk	43.0	54.4	58.6	73.5
Goat meat and mutton	1.1	1.1	1.0	1.0
Beef and buffalo meat	0.6	0.7	0.7	0.9
Poultry meat	0.3	0.4	0.4	0.7
Pig meat	0.2	0.2	0.3	0.2
Total meat	2.4	2.5	2.4	3.1
Eggs (no.)	9.2	12.1	13.0	19.5
Fish	2.5	2.8	2.9	3.5

Sources: Joshi et al. (2004); Kumar and Birthal (2004).

These changes in consumption are not confined to any specific group of consumers, but are widespread (Table 2). Although, per capita consumption of different animal food products is positively associated with consumers' income; proportionate increase in their

2. Between 1981 and 2001 per capita income and urban population in India grew by about 4% and 3% per year respectively.

consumption over the last two decades was higher among the households at lower end of income distribution. Between 1983 and 1999/2000 consumption of milk, meat and eggs among the very poor households increased by 49, 38 and 193% respectively. The corresponding increase in their consumption among rich households was 39, 5 and 35%. This is expected, as the demand for animal products is more income elastic compared to staple foods, and the poor, with rise in their income, spend more on high-value food products including animal products. Kumar and Birthal (2004) observed declining income elasticity of demand for animal food products with rise in per capita income.[3] The implication is that the demand for animal food products would grow faster as more people come out of poverty. The proportion of poor in total population in India has come down from 45% in 1983 to 26% in 1999/2000.

Table 2. *Per capita consumption of livestock products in different income classes*

	Milk (kg/annum)		Meat (kg/annum)		Eggs (No./annum)	
	1983	1999–2000	1983	1999–2000	1983	1999–2000
Income class						
Very poor	9.4	13.8	1.0	1.4	1.9	5.6
Poor	22.0	23.5	1.6	1.4	4.1	8.9
Non-poor	40.2	46.7	2.3	2.4	7.3	13.6
Rich	89.7	115.6	4.2	4.4	21.3	28.7
Location						
Rural	37.0	63.3	2.0	2.4	5.9	15.1
Urban	55.5	90.7	3.2	4.2	16.0	26.9

Note: Households falling below 75% of the poverty line are classified as very poor, between 75% and poverty line as poor, between poverty line and 150% of it as non-poor and above 150% of the poverty line as rich.
Source: Kumar and Birthal (2004).

Table 2 also shows changes in consumption of animal food products for rural and urban populations. Compared to rural, urban households consume more of animal food products. In 1999/2000 per capita consumption of different animal food products was 1.5–1.8 times higher in urban households than in rural households. The gap between urban and rural households, however, has narrowed down. Between 1983 and 1999/2000 per capita consumption of milk by rural households increased by 71% compared to 63% in urban households. The proportionate increase in egg consumption was also higher for rural households. This implies that though urbanization[4] would remain a key driver of growth in demand for animal food products, sustained rise in rural income would also fuel rapid growth in their demand.

3. Income elasticity of demand for milk, meat and eggs for the very poor households was estimated at 0.7, 0.85 and 0.86, respectively. The corresponding figures for the rich were 0.39, 0.22 and 0.5 respectively.

4. Between 1981 and 2001 urban population grew at an annual rate of 3% compared to 1.7% growth in rural population.

Apart from income growth and urbanization, prices are important determinants of demand growth. Real retail prices of different meats and eggs (except mutton and goat meat) declined in the range of –0.2 to –1.6% a year between 1983 and 1999/2000. Retail price of milk remained almost unchanged during this period. Kumar and Birthal (2004) estimated price elasticity of demand for livestock products in the range of –1.0 to –3.6, suggesting that with real prices going down, growth in demand for animal food products is expected to be robust.

Total consumption of animal food products almost doubled between 1983 and 1999/2000 (Table 3). Total milk consumption increased from 35 to 73 million tonnes and meat consumption from 1.7 to 3.1 million tonnes. The factors underlying demand growth were quite robust in the past, and are unlikely to subside in the near future, which implies that demand for animal food products will keep on increasing. Projections to 2020 indicate considerable increase in demand for livestock products (Table 3). Demand for milk is expected to be in the range of 132–140 million tonnes and for meat to 8–9 million tonnes (Delgado et al. 1999; Parthasarathy Rao et al. 2004). Demand for eggs would also increase considerably.

Table 3. *Demand for livestock products to 2020 (× 10^6 t)*

Commodity	1983	1999–2000	2020*
Milk	34.6	73.4	132.0–140.0
Total meat	1.7	3.1	8.0–9.0
Beef and buffalo meat	0.5	0.8	
Mutton and goat meat	0.8	1.0	
Pig meat	0.1	0.2	
Poultry meat	0.2	0.7	
Eggs (no. × 10^9)	6.6	19.3	49.7

Sources: Total consumption calculated using information in Table 1; *Delgado et al. (1999); Parthasarathy Rao et al. (2004).

Production systems and their performance

Livestock production systems

Livestock in India are raised as a part of mixed farming systems. Mixed farming systems are considered environmentally most benign and sustainable because of complementarities between crop and livestock production. Animals derive most of their feed–fodder requirement from agricultural residues and byproducts, and in turn provide draught power and dung manure for cropping activities.

Livestock production systems are broadly classified as mixed rainfed, mixed irrigated, grassland and landless/industrial (Thornton et al. 2003). In India mixed rainfed system is practised on 46% of land and mixed irrigated system on 37% land. Grassland and industrial systems are limited to 4 and 13% of land, respectively. However, mixed crop–livestock systems are characterized by considerable heterogeneity in terms of species, production efficiency, management practices and commercialization. This heterogeneity was captured by Parthasarathy Rao et al. (2004) who delineated 15 crop–livestock systems, and found cattle or buffalo as the second or third largest economic activity in most of these.

Mixed farming systems, however, are undergoing a steady transformation due to increasing pressure on livestock to produce more to meet the growing food demand. The non-food functions of livestock, that is draught services and manure production, are declining in importance because of increasing use of bio-mechanical inputs in crop production and declining size of land holding. Thus the interactions between crop and livestock production are likely to weaken, giving way to emergence of commercial production systems based on high-producing animals and external inputs. For instance, poultry production in India has largely been transformed from a backyard activity to a commercial activity. The commercialization trends are also visible in the case of dairy.

Livestock resources

Population

India has huge population of different livestock species (Table 4). In 2003 it had 185 million cattle, 98 million buffaloes, 124 million goats, 61 million sheep, 14 million pigs and 489 million poultry birds. The cattle have always dominated livestock production systems, because traditionally maintaining a sufficient number of draught animals for use in crop production and transportation remained the first priority of Indian farmers, and this led to dual-purpose breeds of cattle that could produce milk and quality draught males. Other species like buffaloes, sheep, goats, pigs and poultry are largely maintained for food production.

Structure of livestock production, however, is changing. Cattle number, which had been increasing until early 1990s, has started declining. Between 1992 and 2003 it declined by 9%. The decline is confined to indigenous stock that comprised 87% of total cattle in 2003. The population of indigenous cattle declined by 15%, while that of crossbred increased by 62%. Further, the decline was more in males (22%) mainly due to their increasing substitution by mechanical power, and low productivity of milch cows further added to it (Box 1).

Table 4. *Livestock population in India (× 10^6)*

	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
1972	178	57	40	68	7	139
1982	192	70	49	95	10	208
1992	205	84	51	115	13	307
1997	199	90	57	123	13	348
2003	185	98	61	124	14	489
			% annual growth			
1972–1982	0.8	2.0	2.0	3.5	3.9	4.1
1982–1992	0.6	1.9	0.4	1.9	2.4	4.0
1992–1997	–0.6	1.3	2.5	1.3	0.8	2.5
1997–2003	–1.0	1.2	1.2	0.2	0.3	7.0

Source: GOI (various years): Reports on the quinquennial livestock census.

Box 1. Cow at crossroad

The cow, which is considered sacred by the majority Hindu population in India, is at crossroad now, because of its declining utility as a source of draught power. In the quest of increasing food grain production, the central and state governments have indiscriminately promoted use of machines by providing subsidized credit facilities even to small landholders. The machines ensure timeliness in agricultural operations and are cheaper to use compared to maintaining a pair of bullocks throughout the year. Bullocks are used only for about 90 days a year. The number of tractors per 10 thousand hectares increased from 7 in 1971–72 to 109 in 1991–92, while the number of draught animals declined from 68 to 59/100 ha in 1991–92. In 2003 the number of tractors increased to 167 per 10 thousand hectares and the number of draught animals declined to 40/100 ha. While the bullocks, and thereby the cows are becoming redundant, policies do not permit their slaughtering and export.

Population of crossbred cattle and buffaloes, however, has been increasing. Proportion of crossbreds in total cattle population increased from 4.6% in 1982 to 13.3% in 2003. During this period, buffalo population increased from 70 million to 98 million. Growth in buffalo population, however, decelerated from around 2% during 1970s and 1980s to around 1.2% afterwards. The deceleration was on account of slow growth in male population; from 0.7% during 1970s and 1980s to 0.3% during 1990s.

Goat number increased from 68 million in 1972 to 124 million in 2003, but at a decelerating rate. During 1997–2003 goat population remained almost stagnant. Sheep population increased but with considerable variation in trend growth. The preference for sheep in relation to goat has weakened; ratio of sheep to goat that was 0.6 in 1972 fell to 0.5 in 2003. The main reason for this is that sheep is a grazing animal, and the grazing lands

in India have been deteriorating, quantitatively as well as qualitatively (Jodha 1992). In nutshell, grazing based small ruminant production systems are unlikely to sustain for long, unless supplemented by stall-feeding.

Monogastrics, mainly poultry, are gaining importance. Between 1972 and 2003 poultry population more than tripled, from 139 million to 489 million. Except during 1992–97 poultry number has maintained a steady growth of above 4% a year. Between 1997 and 2003 poultry witnessed an all time high growth of 7% a year. Pig population has almost doubled, from 7 million in 1972 to 14 million in 2003. But, growth in pig population has decelerated sharply since 1992, primarily because of a lack of widespread demand for pork.

Animal husbandry in India is largely a rural activity. In 2003 rural households accounted for about 95% of ruminants, 92% of poultry and 84% of pigs (Table 5). Urban livestock production, though small in size, has been growing faster. Given the rising demand for animal food products, trends in urban/peri-urban livestock are likely to be stronger.

Table 5. *Size and growth in rural vs. urban livestock population in India*

		Cattle	Buffalo	Sheep	Goat	Pig	Poultry
				% share			
Rural	2003	94.9	93.9	94.3	94.5	84.4	91.8
Urban	2003	5.1	6.1	5.7	5.5	15.6	8.2
				% annual growth			
Rural	1982–1992	0.7	1.9	0.4	1.8	3.5	6.5
	1992–1997	–0.6	1.3	2.5	1.3	0.4	2.1
	1997–2003	–1.3	1.2	0.8	0.1	–0.1	6.4
Urban	1982–1992	2.7	2.8	4.2	5.1	4.6	–5.8
	1992–1997	1.1	2.5	1.7	0.2	3.4	2.1
	1997–2003	0.7	4.3	10.8	3.8	3.1	8.2

Source: GOI (various years): Reports on the quinquennial livestock census.

There is considerable variation in regional spread of different animal species (Annex 1). Cows have a wider spread, but have a higher concentration in eastern region of the country. Buffaloes have a larger concentration in the irrigated northern plains having sufficient supply of feeds and fodder. Small ruminants are spread throughout the country but with varying degree of concentration. Sheep are concentrated in the rainfed southern and western parts, while the concentration of goats is higher in the eastern region. Pigs have a larger concentration in the northeast and poultry in the south.

Technology adoption: Case of crossbreeding

An important development in India's livestock production systems has been the introduction of high-producing exotic germplasm to improve productivity of indigenous stock mainly

of cows, sheep, pigs and poultry. Efforts to introduce exotic breeds for crossbreeding date back to early part of twentieth century, but could not succeed due to non-adaptability of exotic/crossbred animals to the tropical climate, and farmers' poor economic conditions. Concerted efforts to promote crossbreeding technology, however, were made after independence. A number of crossbred strains of cow, sheep and pig are now available.

Table 6 shows share of crossbred animals in India. In cattle, crossbreds comprised 13.3% in 2003, up from 4.6% in 1982. During this period, proportion of improved poultry increased from 7.5 to about 48%. Share of crossbred sheep and pig too increased. In 2003, 9% sheep and 16% pigs were crossbreds.

Table 6. *Crossbred/improved animal population in India (%)*

	Rural		Urban		Total	
Species	1982	2003	1982	2003	1982	2003
Cattle	4.3	12.5	14.1	28.9	4.6	13.3
Sheep	3.0	9.6	8.1	4.9	3.1	9.3
Pig	8.8	15.5	15.7	19.6	9.2	16.1
Poultry	5.5	46.7	14.2	61.9	7.5	47.9

Source: GOI (various years): Reports on the quinquennial livestock census.

However, there exists a technological dualism between rural and urban livestock production. Adoption of crossbreeding technology is higher in urban livestock production systems. This is obvious, as compared to rural, urban production has a greater commercial orientation and is based on external inputs.

Regional differences in the spread of crossbreeds are glaring (Annex 1). Crossbreds account for over half of the total cattle in Punjab, Kerala, Tamilnadu, Sikkim and Nagaland, 25–50% in Haryana, Himachal Pradesh, Jammu and Kashmir and Mizoram and 10–25% in Maharashtra, Bihar, Goa, Karnataka and Manipur. In other states it is less than 10%. Adoption of crossbreeding technology in sheep is localized largely to Gujarat, Jammu and Kashmir, Punjab and Madhya Pradesh. Adoption of improved poultry is higher in Punjab, Haryana, Andhra Pradesh, Himachal Pradesh, Gujarat and Goa (>60%). Limited adoption of crossbreds in some states is largely due to their lack of adaptability to extreme climatic conditions (mainly temperature). High initial investment and operational costs (mainly cows), and greater susceptibility to diseases are other important reasons. Nevertheless, demand for high-producing animals would increase with growth of commercial livestock production systems. Declining size of land holding and increasing mechanization of agricultural operations would also act as catalysts.

Production performance

Production and productivity

Domestic supply of livestock products in India has increased parallel with increase in their demand (Table 7). Milk production increased from 22 million tonnes in 1970/73 to 33 million tonnes in 1980/83 and further to 88 million tonnes in 2001/03. Buffaloes and cows are main milch species and contribute 55 and 43% respectively to total milk output. Though the growth in milk production has been robust, yet it has started showing signs of deceleration since 1991. The deceleration is observed in case of both cow and buffalo milk production. However, sustained growth in milk heralded the country into an era of self-sufficiency towards late 1990s, and reduced dependence on imports. Such a tremendous progress was brought about by the technological change in dairy production and improvement in producers' access to markets through dairy co-operatives.

Table 7. *Production of livestock products in India*

	Production ($\times 10^6$ t)			% annual growth	
Commodity	1980/82	1990/92	2001/03	1981–90	1991–2003
Milk	33.9	54.7	86.7	5.3	4.5
Cow	14.2	23.2	36.9	5.3	4.4
Buffalo	18.6	29.1	48.2	5.1	4.9
Meat*	1.51	2.52	3.74	4.9	4.2
Large ruminant	0.52	0.72	1.13	4.0	5.5
Small ruminant	0.67	0.90	1.0	4.4	1.5
Poultry	0.29	0.56	0.95	6.5	4.7
Pork	0.08	0.14	0.34	6.9	8.8
Egg (no. $\times 10^9$)	10.1	21.1	39.6	8.5	5.3
Wool ($\times 10^6$ kg)	33.2	41.5	49.5	3.0	2.2

Sources: GOI (various years): Basic animal husbandry statistics; *Estimated by authors.

Meat production increased from 1.5 million tonnes in 1980/82 to 3.7 million tonnes in 2001/03. In early 1980s small ruminants were the major suppliers (44%) of meat, followed by large ruminants (35%), and poultry (19%). The meat production structure, however, changed drastically in recent years. Monogastrics especially poultry meat has emerged as the most important meat with a share of 35% in 2001/03.

Like milk, growth in meat production too has been robust. Meat output grew at an annual rate of 4.9% during 1980s and 4.2% since 1991. Marginal deceleration in growth was primarily due to significant drop in the growth of small ruminant meat production. Meat outputs of other species especially buffalo and monogastrics, however, grew faster during this period. Faster growth in monogastrics meat production is expected, as these have short-generation interval and higher prolificacy rate and require less of land resource. Although,

small ruminants have similar biological characteristics, their production has come under pressure of squeezing common grazing lands. Nevertheless, there are opportunities for commercialization of small ruminant production as the demand for sheep and goat meat continues to be high.

Indian livestock are low-producing (Table 8, Annex 2). Productivity of cattle, in terms of both milk and meat, is about half of the global average. Meat yield of small ruminants and monogastrics is also less; small ruminants yield 25%, pigs 45% and broilers 40% less than the global average. Average milk yield of cows and buffaloes taken together was 1200 kg/annum in 2002/04, but there are considerable differences in their yield rates. A buffalo yields 1.5 times than does a cow. Nevertheless, cow milk yield has grown faster than that of buffalo, mainly during 1980s. During this period, cow milk yield witnessed an annual growth of 3% and accounted for 57% of the output growth. The growth, however, decelerated subsequently, causing a marginal decline in its contribution to output growth. On the contrary, milk yield of buffalo grew faster during 1991–2003, increasing its contribution to 45% from 17% during 1980s.

Table 8. *Growth in livestock productivity in India*

	Yield (kg/animal per annum)	Productivity growth (%)	
	2002/04	1980s	1991–2003
Milk			
Cow	977	3.0	2.3
Buffalo	1452	0.9	2.2
Total*	1200	2.0	2.3
Meat			
Large ruminants	118	0.6	0.06
Small ruminants	10.6	–0.2	0.1
Poultry	0.9	–0.4	0.4
Pig	35	0.0	0.0
Layers	12	2.9	0.6

*Does not include goat milk.
Source: FAOSTAT (2005).

Growth in meat production occurred mainly from increase in numbers. Carcass weight of ruminants, large as well as small, has remained almost stagnant. Poultry productivity mainly of layers grew at an annual rate of 2.9% a year during 1990s, but fell to 0.6% subsequently.

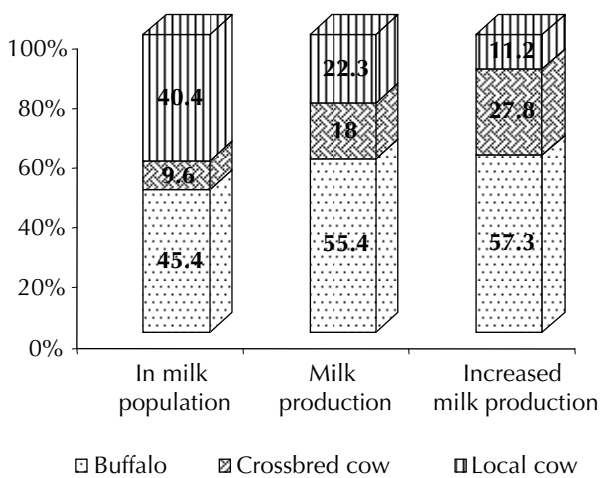
Sources of productivity growth

Rapid growth in production and productivity of dairy and poultry could be attributed to technological change, better feeding and improvements in animal health. Birthal et al. (1999) estimated total factor productivity growth (TFPG) in the livestock sector for the period 1950/51 to 1995/96 and found total factor productivity growing at an accelerated rate after 1970–71 (1.4% a year) compared to pre-1970–71 period growth of –0.4%. In the post-1970–71 period, TFPG accounted for nearly 40% of the output growth.

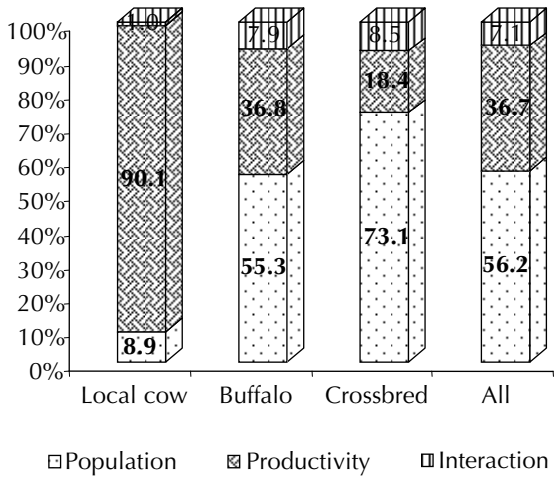
Breed improvement

Genetic enhancement is an important strategy to improve productivity, and in India considerable efforts have been made in this direction especially in dairy and poultry. In the following paragraphs we try to quantify the contribution of genetic enhancement to output growth focusing on dairy and poultry.

In 2002/04 crossbred cows comprised 10% of total in-milk animals (including dairy goats) and contributed 18% to total milk production (Figure 1 and Annex 3). Their share in in-milk bovines as well as in milk production almost doubled since 1992/93. During this period, total milk production increased by 26 million tonnes, and 37% of this was due to improvement in animal productivity. Crossbred cows accounted for 28% of the incremental production, and nearly 18% of this came from improvements in productivity (Figure 2). On the other hand, indigenous cows contributed 11% to the incremental output, and most of it came from enhanced productivity. Buffaloes accounted for 57% of the incremental production and yield improvements accounted for 37% of this.



Source: GOI (various years): Basic animal husbandry statistics.
Figure 1. *Contribution of different species to milk production growth, 1992/93 to 2003/04.*



Source: GOI (various years): Basic animal husbandry statistics.

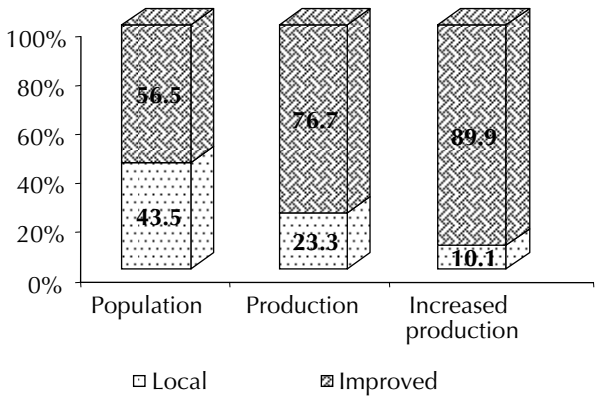
Figure 2. *Share of productivity to milk production growth by species, 1992–93 to 2003–04.*

These results imply that future growth in milk production should come largely from (i) replacement of low-yielding indigenous cows with crossbreds and buffaloes, (ii) improvements in their yields as their potential is yet to be fully exploited; the potential yield of a crossbred cow is about 3000 kg/annum and that of buffalo about 2000 kg/annum, and (iii) better management of higher milk yielding breeds of indigenous cows such as Sahiwal, Gir and Tharparkar. The improved indigenous breeds have yield potential of 1800–2000 kg/annum.

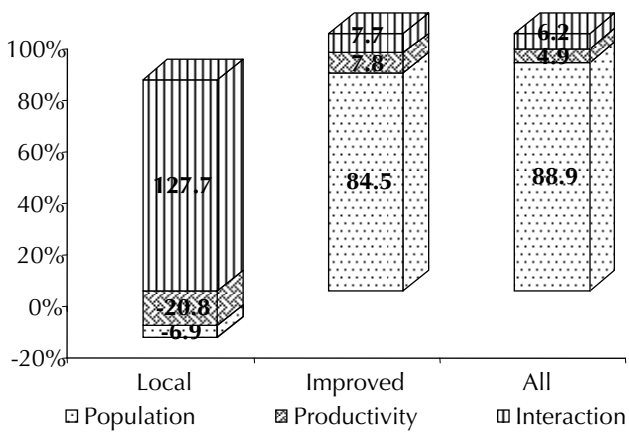
Over the last three decades, poultry production in India has transformed from a backyard to an industrial activity mainly due to (i) introduction of exotic germplasm, (ii) improvements in poultry nutrition and health, and (iii) increasing participation by the private sector. Between 1992–94 and 2002–04 proportion of improved layers in total layers increased from 46 to 57%, and in egg production from 66 to 77% (Figure 3 and Annex 4). There was also substantial increase in productivity of improved layers. Productivity of local layers, however, declined marginally. Improved layers accounted for 90% of the increased egg production during this period, and most of it occurred from increase in their population. Performance of local layers has been dismal, in terms of production as well as productivity (Figure 4). This suggests that future growth in egg production would result from increase in population as well as productivity of improved layers.

Contribution of productivity to output growth is a cumulative effect of technological change and improvements in nutrition, health and management. In case of a crossbred/improved animal, productivity is embodied as a genetic trait, and therefore the contribution of the crossbred/improved animals to incremental production represents their contribution. India has a low proportion of improved/crossbreds in total population of different species,

and there is considerable scope to increase livestock production through crossbreeding technology. This, however, would require considerable investment in research for evolving breeds that suit to varied climatic conditions and offer greater resistance to diseases.



Source: GOI (various years): Basic animal husbandry statistics.
Figure 3. *Contribution of different species to egg production growth, 1992–93 to 2003–04.*



Source: GOI (various years): Basic animal husbandry statistics.
Figure 4. *Share of productivity to egg production growth by species, 1992–93 to 2003–04.*

Feed and nutrition

Adequate supply of feed and fodders is crucial to improving livestock productivity. Livestock in India are maintained largely on crop residues, byproducts and grazing lands. India has remained chronically deficit in feed and fodders. The deficit is largely on account of huge livestock population in relation to available feed resources. The National Commission on Agriculture (1976) estimated deficit in dry fodder, green fodder and concentrates to the extent of 49, 53 and 43% respectively for the year 1972–73. Feed deficit, however, declined subsequently due to significant increases in production of food–feed crops. In 1991 the estimated deficit in dry fodder, concentrates and green fodder were 31, 47 and 23%, respectively (Singh and Muzumdar 1992). Recent estimates of demand, supply and

requirement of different feedstuffs by Birthal et al. (2005) show significant reduction in deficit in dry fodder (Table 9). Deficit in green fodder and concentrates, however, persists. In terms of Digestible Crude Protein (DCP) and Total Digestible Nutrients (TDN) the deficit is to the tune of 50 and 27%, respectively.

Table 9. *Feed and fodder demand and supply in India, 2002–03 (× 10^6 t)*

Feedstuff	Consumption	Requirement
Green fodder	491	648
Dry fodder	459	503
Total concentrates	62	87
DCP	257	351
TDN	18	36

Source: Birthal et al. (2005).

Cultivated fodders and gathered grasses are two important sources of green fodder and each account for about half of the green fodder consumption (Birthal et al. 2005). About 5% of the gross cropped area in the country is allocated to fodder crops. This, however, has not increased much over the last two decades (Table 10). Common grazing lands (permanent pastures and grazing lands, wastelands, fallows excluding current fallows) occupy 16% of the geographical area, marginally less than 18% in 1980–81. Area under permanent pastures and grazing lands comprises a mere 3.3% of the total area, and has been declining steadily. Jodha (1992) based on village land records showed considerable quantitative and qualitative deterioration in grazing lands.

Table 10. *Grazing resources in India (× 10^6 ha)*

Type of resource	1980–81	1990–91	2000–01
Geographical area	328.7	328.7	328.7
Forests	67.5	67.8	69.4
Permanent pastures and grazing lands	12.0	11.4	10.9
Culturable wastelands	16.7	15.0	13.6
Fallow other than current fallows	9.9	9.7	10.1
Barren and uncluturable wastelands	20.0	19.4	19.3
Total CPRs (excluding forests)	58.6	55.5	53.9
CPR as % of geographical area	17.8	16.9	16.4
Permanent pastures and grazing land as % of geographical area	3.6	3.5	3.3
% of gross cropped area under fodder crops	4.6	4.6	4.4
Livestock units (× 10^6)	295.0	327.0	328.0
Livestock units/ha of CPR	5.0	5.9	6.1

Source: GOI (various years): Indian agricultural statistics.

There are a number of technological and policy options to address the feed deficit. The deficit is largely due to huge number of low-producing animals. This suggests a need to optimize livestock population compatible with available feed resources or improve feed resources. Replacing the low-producing animals with high-producing animals is one option

to do this. This strategy, however, is feasible only in the long run. In short run, farmers should be encouraged to allocate more area to green fodder crops. Better management of common grazing lands would add to improved fodder supplies. Further, feed deficit is localized and seasonal (Singh and Muzumdar 1992). In such a situation there is a need to promote community fodder banks where surplus fodder can be stored as hays/silage for use during scarcity. Besides, there are a number of technologies (treatment of straws, urea molasses mineral blocks, bypass protein etc.) available that help better use of feed and fodder and contribute to increasing animal productivity (Singh and Schiere 1994). Their adoption, however, has remained limited.

Animal health

Growth in animal production cannot be sustained unless animals are protected against diseases. Over the years considerable progress has been made to keep diseases under control (Table 11). Rinderpest, a devastating disease of ruminants, has been eradicated. But, a number of other diseases like Foot and mouth disease (FMD), Black quarter (BQ), Hemorrhagic septicemia (HS) etc. continue to persist, and sometimes in severe forms. In recent years, incidence of almost every disease has increased in dairy animals. Similarly, in small ruminants diseases like Peste des petits ruminant (PPR) and blue tongue occur frequently. Poultry is highly susceptible to a number of diseases such as New Castle disease, Infectious bursal disease (IBD) and chronic respiratory disease.

Table 11. *Incidence of some important diseases in India (no./million population)*

Disease	1981	1985	1990	1995	2001	2003
			Bovine			
FMD	179.4	65.4	184.4	140.3	218.5	409.9
Rinderpest	5	1.2	0.9	0.2	0.0	0.0
Black quarter	3.8	2.8	3.5	17.1	10.2	15.6
Hemorrhagic septicemia	6.2	4.1	0.07	77.6	21.6	14.5
Anthrax	0.3	0.3	0.6	6.2	2.4	1.1
Fascioliasis				21.5	18.1	77.2
			Ovine			
FMD	24.5	0.01	5.6	2.9	69.3	30.2
Rinderpest	4.5	3.7	4.1	0.4	0.0	0.0
Hemorrhagic septicemia	0	0	0	0.4	8.0	0.0
Anthrax	0.02	0.10	0.3	1.2	2.5	2.9
Peste des petits ruminant				7.5	194.0	181.0
Blue tongue				20.1	99.4	110.1
			Avian			
New Castle disease				51.4	174.3	823.3
Infectious bursal disease				1817.2	84.3	236.2
Chronic respiratory disease				332.9	47.2	74.4

Sources: GOI (various years): Basic animal husbandry statistics; Singh et al. (1998).

Frequent occurrence of diseases is largely on account of a lack of emphasis on prophylactic measures. The need therefore is to emphasize prophylactic control measures rather than curative ones. Prophylactic measures assume greater significance in the context of emergence of exotic diseases like avian influenza, mad cow disease etc.

Livestock and poverty

With growing empirical literature on the relationship between agricultural growth and poverty in developing countries there is a consensus now that agricultural growth is necessary for poverty reduction (Ravallion and Datt 1996; Hasan and Quibria 2002; Thirtle et al. 2002; Warr 2003). For India, Ravallion and Datta (1996) and Warr (2003) have shown that growth in agriculture is more poverty reducing than growth in other economic sectors. It may be noted that the proportion of poor in rural population in India has come down from 56.4% in 1973–74 to 27.2% in 1999–2000.

In developing countries livestock are an important component of agriculture, and are considered central to the livelihood of a large number of the poor. There are a number of ways in which livestock contribute to their livelihood (LID 1999). First, they generate a continuous stream of income, which is often used to meet their daily food and other expenses. Second, they are important natural capital assets for the poor, which can be used to maintain livelihood in times of crisis. Third, livestock allow the poor to gain private benefits from common property resources (in terms of animal grazing and fodder collection). Fourth, livestock act as a cushion against income shocks of crop failure. Finally, livestock rearing empower women as they perform a number of activities related to livestock production. Empirical evidence on the relationship between livestock sector growth on poverty is anecdotal, yet scattered evidence on livestock's contribution to income indicates that growth in livestock production is pro-poor. In the following paragraphs by looking at the ownership distribution and income contribution of livestock we try to establish that growth in livestock sector is pro-poor.

Income and employment generation

Livestock are becoming an important source of income in India. Their share in agricultural income increased from about 17% in 1971–73 to 22% in 1991–93 and further to 25% in 2001–03 (Table 12). Their contribution, however, varies considerably across states. In states like Jammu and Kashmir, Haryana, Punjab, and some northeastern states livestock account for nearly one-third of their agricultural income (Annex 5).

Table 12. *Growth in the contribution of livestock to the gross value of output of agricultural sector*

	Crops	Livestock	Fishery	Forestry	Gross value output (INR × 10^9)
			% share		
TE 1972–73	71.4	16.7	2.4	9.5	1568
TE 1982–83	72.1	19.1	2.3	6.6	2035
TE 1992–93	70.0	22.2	3.1	4.9	2759
TE 2002–03	66.8	25.2	3.9	4.1	3562
			% annual growth		
1970–71 to 1979–80	1.8	3.9	2.9	–0.6	2.0
1980–81 to 1989–90	2.5	5.0	5.7	–0.7	2.9
1990–91 to 2002–03	2.2	3.8	4.7	1.3	2.4

Note: Growth rates were calculated using semi-log form of production function.
Source: GOI (various years): National accounts statistics.

It is interesting to note that growth in livestock income has always been higher than the growth in crop income, even during the heydays of Green Revolution (1970s and 1980s) when the policy emphasis was largely on crop production (Table 12). Over time, growth in the livestock sector, however, has taken an inverted-U shape; it increased from 3.9% during 1970s to 5% during 1980s and subsequently fell to 3.8%. Nevertheless, the observed growth patterns in different segments of agricultural sector imply that faster growth in livestock production sustains agricultural growth. Further, since livestock income has been growing faster than the crop income, it has considerable potential to contribute to poverty reduction. In this context, Mellor (2004) observed that 'rapidly rising income in low and middle-income countries results in demand growing at 6 to 8 percent per year. If the domestic industry meets that demand growth it will double in size every 10 years and its share in agricultural GDP will also grow rapidly, soon accounting for over half of agricultural GDP. That will make possible an overall growth rate in agriculture of 4 to 6 percent.'

Besides income, livestock are also an important source of employment for the rural people. In 1999–2000 primary livestock production engaged about 16 million rural persons, equivalent to 5.5% of total rural workers in the country (Table 13). However, there is considerable regional variation in the contribution of livestock to rural employment (Annex 5). Proportion of workers engaged in livestock production is much higher in Punjab (28.5%), Haryana (17%), Rajasthan (17%), Gujarat (12%), Himachal Pradesh (11%), Andhra Pradesh (8%) and Kerala (7%). In most of these states dairying has emerged as an important commercial activity necessitating the need for better animal care. In Andhra Pradesh industrialization of poultry production is responsible for higher employment.

Table 13. *Employment in animal husbandry in rural areas (usual status activity)*

Activity	1983		1999–2000		
	Persons ($\times 10^6$)	%	Persons ($\times 10^6$)	%	% change
Agriculture	167.5	72.4	201.1	70.2	20.1
Animal husbandry	19.7	8.5	15.7	5.5	–20.3
Fisheries	0.8	0.3	0.9	0.3	12.5
Forestry	0.7	0.3	0.9	0.3	28.6
Non-farm activities	42.8	18.5	67.9	23.7	58.6
Total	231.5	100.0	286.5	100.0	23.8

Source: Extracted from electronic database on 'Employment and unemployment situation in India', supplied by NSSO.

Benefits to the poor

Are the poor benefited from growth in livestock production? To a large extent, the answer lies in 'how livestock are distributed among rural households'. Table 14 presents ownership distribution of land and livestock suggesting that the poor have a higher stake in livestock income. In 1991–92 marginal landholders (<1.0 ha) who comprised 48% of the rural households controlled 44% in-milk bovines and 46% small ruminants. Their share in monogastrics was even higher. Share of marginal landholders in land was only 16%. Share of small landholders (1–2 ha) in land as well as livestock almost corresponded to their share in rural households. Together, marginal and small landholders possessed two-thirds of the large and small ruminants, 70% of the pigs and three-fourths of the poultry. However, the landless that comprised 22% of the rural households are deprived of land as well as livestock.

Table 14. *Distribution of land and livestock holdings in India, 1981–82 and 1991–92 (%)*

Item	Year	Landless (0 ha)	Marginal (<1 ha)	Small (1–2 ha)	Medium (2–4 ha)	Large (>4 ha)	All
Households	1981–82	26.1	41.2	14.5	10.6	7.8	100
	1991–92	21.8	48.3	14.2	9.7	6.0	100
Land	1981–82	0	11.7	16.7	23.5	48.1	100
	1991–92	0	15.5	18.6	24.2	41.7	100
In-milk bovines	1981–82	8.5	37.5	17.0	15.6	21.0	100
	1991–92	3.5	43.5	21.8	17.3	14.3	100
Small ruminants	1981–82	9.3	38.1	16.7	15.0	20.1	100
	1991–92	5.1	46.2	19.3	15	14.4	100
Poultry	1981–92	7.1	49.0	18.0	15.1	10.7	100
	1991–92	6.4	54.9	19	14.4	5.3	100
Pig	1981–82	10.1	56.0	20.4	7.5	6.1	100
	1991–92	7.7	49.9	20.4	13.9	8.1	100

Source: GOI (1997): Land and livestock holdings survey.

Further, a comparison of livestock ownership pattern in 1991–92 with that in 1981–82 shows an improvement in distribution of land and livestock holdings. Share of marginal and small landholders improved both in land and livestock, although their number too increased simultaneously. Share of landless in livestock holdings, however, declined during this period.

Livestock producers in India operate on a small scale. On an average, there were 46 in-milk bovines, 85 small ruminants, 167 poultry birds and 6 pigs per 100 households in 1991–92 (Table 15). Scale of production, however, is positively associated with land holding. The difference in the scale is huge between marginal and large landholders. This is expected, as the latter are better economically, have higher investment capacity and sufficient supply of feed and fodder.

Table 15. *Average size of land and livestock holdings by farm size in 1981–82 and 1991–92*

Year	Landless	Marginal	Small	Medium	Large	All
			Land holdings (ha/household)			
1981–82	0	0.36	1.46	2.81	7.84	1.26
1991–92	0	0.35	1.41	2.69	7.50	1.07
% change		–2.8	–3.4	–4.3	–4.3	–15.1
			In-milk bovines (no./100 households)			
1981–82	7	28	48	74	115	37
1991–92	6	41	69	80	107	46
% change	–14.3	46.4	43.8	8.1	–7.0	24.3
			Small ruminants (no./100 households)			
1981–82	37	98	120	147	289	105
1991–92	20	81	115	131	203	85
% change	–45.9	–17.3	–4.2	–10.9	–29.8	–19.0
			Poultry (no./100 households)			
1981–82	39	171	179	206	204	144
1991–92	49	190	223	247	147	167
% change	25.6	11.1	24.6	19.9	–27.9	16.0
			Pigs (no./100 households)			
1981–82	2.2	7.7	8.0	4.0	4.4	5.7
1991–92	2.0	4.3	6.0	6.0	5.3	4.0
% change	–9.1	–44.2	–25.0	50.0	20.4	–29.8

Source: GOI (1997): Land and livestock holdings survey.

Scale of livestock production of smallholders has been improving. Between 1981–82 and 1991–92 average number of dairy animals owned by marginal and small landholders increased by 45%. Similarly, size of poultry flock increased by 11% for marginal and 26% for small landholders. Increase in scale was much less for medium and large landholders. In fact, scale of production (except pigs) on large farms declined over this period. Scale of small ruminant production witnessed a general decline. This was largely due to quantitative

and qualitative deterioration in common grazing lands, which are important sources of fodder for small ruminants. Relatively faster increase in the scale of smallholders implies that smallholders respond better to demand signals than do the large landholders.

The distribution pattern of land and livestock holdings suggests that the poor have more income and employment opportunities in livestock production than in crop production. In a survey of dairy producers in the milksheds of dairy co-operatives, Shukla and Brahmankar (1999) observed smallholder households deriving 30 to 53% of their income from dairying compared to 19 to 25% by larger landholders. Birthal et al. (2003) found small ruminants contributing between 25 to 75% to the income of the smallholders who possessed them.

Livestock production also is an important source of employment for smallholders. Share of livestock in rural employment by size group of land holding presented in Table 16 shows that animal husbandry engaged nearly 6% of smallholders. This proportion is less compared to large holders. This is obvious as the scale of production of smallholders is much smaller compared to large landholders.

Table 16. *Share of animal husbandry in rural employment by land holding class, 1999–2000 (%)*

Activity	Landless	Marginal	Small	Medium	Large
Agriculture	67.1	66.3	82.8	84.4	83.1
Livestock	5.1	5.3	5.7	6.4	8.8
Fisheries	0.3	0.5	0.1	0	0.3
Forestry	0.3	0.4	0.2	0.2	0.1
Non-farm activities	27.2	27.6	11.2	9	7.7
Total	100	100.1	100	100	100

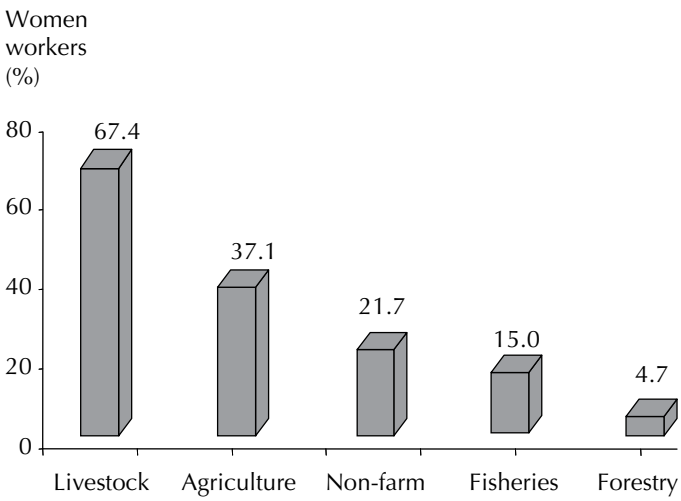
Source: Extracted from electronic database on 'Employment and unemployment situation in India', supplied by NSSO.

An interesting feature of livestock production is that it promotes gender equity. Sixty-seven percent of the total workers engaged in the livestock production are women (Figure 5). Participation of women in other agricultural activities is lower compared to animal husbandry.

These results suggest that compared to crop production, livestock production tends to be more important among smallholders, and growth in livestock production is expected to have a more beneficial effect on poverty reduction than a similar increase in crop production. Figure 6 plots growth in head count rural poverty ratio[5] *vis-à-vis* growth in livestock and crop subsectors for major Indian states for the period 1983–84 to 1997–98. The fitted lines clearly show a faster reduction in rural poverty where growth in livestock sector had been robust. States like West Bengal, Tamilnadu, Kerala, Karnataka Haryana, Punjab

5 . Poverty ratios were taken from Jha (2003).

and Maharashtra performed better in livestock production as well as in poverty reduction. Andhra Pradesh too witnessed high growth in livestock production but its impact on poverty reduction was not as high. This is because industrialization of poultry production accounts for nearly half of the livestock income in the state. On the other hand, Assam, Madhya Pradesh, Rajasthan and Uttar Pradesh experienced low growth in livestock production as well as in poverty reduction.



Source: Extracted from electronic database on 'Employment and unemployment situation in India', supplied by NSSO.

Figure 5. *Female participation in agricultural works.*

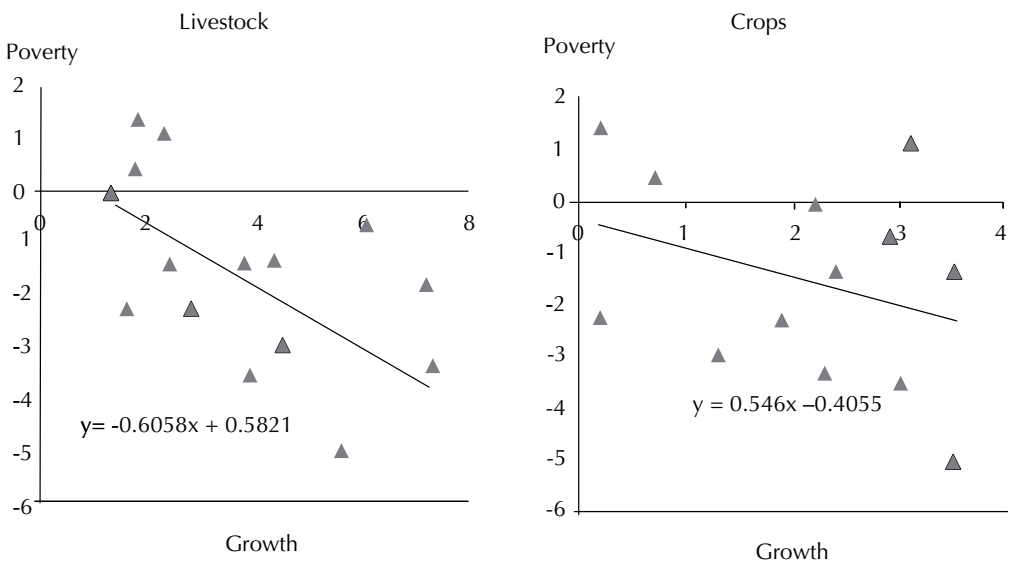


Figure 6. *Relationship between livestock sector growth and rural poverty in India.*

Markets, value addition and trade

Markets, value addition and trade facilitate growth. Their role is more important in perishables like milk, meat and eggs, which require immediate transportation from farm to consumption centres or storage or conversion into less perishable forms.

Marketing of livestock products

There are nearly 2000 markets in India for live animals and their products. These fall in the jurisdiction of state governments, and are managed by the local bodies such as Municipal Corporations and Village Panchayats. Livestock markets are regulated under the Agricultural Produce Market Acts.

Live animals

Markets for live animals are not well developed. A considerable proportion of live animals, mainly ruminants, are exchanged amongst livestock producers themselves and between producers and itinerary traders. Itinerary traders assemble animals from producers for sale in the regulated markets to larger traders as well as to other buyers. Bulk of the trade in small ruminants takes place between producers and itinerary traders. Large producers generally sell directly in the markets. Another important marketing channel for small ruminants is their direct sale to slaughterhouses and butchers. Sometimes, small producers assemble their produce and sell collectively to the slaughterhouses. Butchers-cum-retailers in small towns too procure live animals directly from producers. Direct sales between producers and consumers are rare.

There are a number of reasons for low participation of livestock producers in markets. Marketed surplus is often small, while markets for live animals are thin, irregular and often at far distance from the production centres. These escalate cost of transportation and associated activities like housing for animals, and the opportunity cost of time. Further, lack of basic facilities in markets, for producers as well as animals also discourages producers to bring their animals to the markets.

Prices of live animals, especially ruminants, are negotiated by buyers and sellers, taking into consideration the animal characteristics, such as age, body weight and structure, appearance, breed, yield and health status.

Markets for poultry are well developed and organized. Bulk of trade in broilers and eggs takes place between producers and traders directly or indirectly through commission agents in the designated markets or at the farm gates. Retail traders procure broilers either directly

from producers or from wholesale traders. Direct sale between producers and consumers/ retail traders is limited. In some states poultry co-operatives also facilitate marketing, but on a limited scale.

Prices of broilers and eggs are largely determined by market forces. There is considerable seasonality in demand for poultry products, and their prices fluctuate accordingly. Prices of poultry products are lowest during summers when their demand is low. The National Agriculture Cooperative Marketing Federation (NAFED) undertakes price stabilization programs. It buys eggs during flush season, store these and sell in the lean season. The presence of NAFED, however, is limited.

Poultry marketing in major producing regions, however, has undergone a significant transformation. Here, contract farming has emerged in a big way, providing an assured market and returns to the producers. Producers associations like National Egg Coordination Committee (NECC) and Broiler Producers Marketing Association (BROMARK) set the daily harvest prices depending on the market situation.

Meat

There are over 4000 registered and 30 thousand unregistered slaughterhouses in India, producing almost an equal amount of meat. Most of the slaughterhouses are overcrowded, unhygienic and lack essential services like water, drainage, waste disposal and effluent treatment (World Bank 1999). Slaughtering practices are traditional, resulting into low recovery rate, and wastage of byproducts like blood, skins, tallow etc.

About 40% of sheep, 46% of goats and 80% of pigs are slaughtered every year. Slaughter rate for cattle and buffalo is about 2%. Cow is sacred to the majority Hindu population, and its slaughtering therefore is banned in most Indian states except Kerala, Tamilnadu, West Bengal and some northeastern states. Buffalo is not subjected to a similar sentiment, yet its slaughter rate is low. It is only the young male calves and unproductive females and males that are slaughtered. The sex ratio in buffaloes is highly adverse to male, indicating high mortality in young calves in want of proper care. In other words, this is a waste of potential meat production. Taneja and Birthal (2004) estimated that about 1.5 million tonnes of meat can be produced annually if young buffalo males are properly cared.

Milk

Nearly 45% of the milk produced in the country is marketed, and the producer households consume the rest (Kurup 2002). Milk markets are largely informal. About two-thirds of the marketed surplus is sold in informal markets. Organized markets comprising of co-operatives and private sector share the rest, and almost in equal proportion.

Vendors and milk dealers dominate the informal market. Vendors operate on a small scale. They collect milk from the producers and sell to urban consumers, creameries and confectioners. Milk dealers supply milk to bigger milk dealers and private processing factories. Informal markets, however, are unstable and often exploitative particularly during the flush production season. Prices are determined arbitrarily, and under-pricing is common during this season. Producers also sell milk directly to urban consumers, creameries and confectionaries, but their share in the informal market is low.

There are about 750 dairy processing units in the organized segment and they procure nearly 20% of the milk produced or one-third of the marketed surplus. Since 1980–81 number of dairy processing units has grown almost threefold, and the raw material procured increased about sevenfold.

The organized sector follows a two-axis pricing formula, that is price is determined based on fat and solid-non-fat (SNF) contents in the milk. Buffalo milk contains a higher fat percentage and is generally priced on fat content basis, while cow milk has a lower fat percentage and thus both fat and SNF are considered in its pricing.

Dairy co-operatives are an important component of organized milk markets and their network has expanded considerably since the launch of Operation Flood program in 1970. Important indicators of growth of dairy co-operative presented in Table 17 show an eightfold increase in their number and a sevenfold increase in their membership since 1980–81. During this period, milk procured by co-operatives increased from 935 thousand tonnes to 6.381 million tonnes. As proportion of total milk produced, it increased from 3% in 1980–81 to 7.2% in 2003–04.

Table 17. *Selected indicators of growth of dairy co-operatives in India*

	1980–81	1990–91	2003–04
Number of dairy co-operative societies (DCS)	13,284	63,415	108,574
Farmer members ($\times 10^3$)	1747	7482	11,994
Members/DCS	118	132	110
Milk procured ($\times 10^3$ t)	935	3541	6381
Milk procured as % of total production	3.0	6.6	7.2
Milk procured/DCS (t/year)	70.4	55.8	58.8
Milk procured/member (t/year)	0.54	0.47	0.53
Liquid milk marketed (% of procured)	108.6	82.9	85.1

Source: NDDB (2004).

Despite a considerable horizontal expansion of dairy co-operative societies (DCS), no significant changes have occurred in the average size and scale of a village level dairy co-operative. Between 1980–81 and 2003–04, number of members/DCS varied between 110 and 132, and milk procured between 59 and 70 t/DCS per year. Similarly, milk

procurement/member has hardly ever exceeded 550 kg/year. This could perhaps be due to the policy of the dairy co-operatives to keep the size and scale within manageable limits.

Yet, performance of dairy co-operatives has been variable across states (Annex 6). About two-thirds of the milk procured comes from four states, i.e. Gujarat (29%), Maharashtra (15%), Karnataka (13%) and Tamilnadu (10%), while the share of these states in total milk production in the country is about 25%. In other words, producers' in these states have better access to co-operative milk markets. For instance, co-operatives could procure 29% of the milk output in Gujarat, 21% in Karnataka, 15% in Maharashtra and 13% in Tamilnadu. In most other states, co-operatives procure less than 5% of the milk output. In some states like Uttar Pradesh, Punjab and Haryana, which make considerable contribution to total milk output, private sector has a sizeable presence in milk market. Uttar Pradesh has 38% of total private milk processing plants in the country, and Punjab and Haryana have 7% each.

Growth in dairy co-operative occurred in a protective environment. They were protected from both internal and external competition. The external competition was restricted through high import tariffs and quantitative restrictions. Until 1994 dairy imports were canalized through National Dairy Development Board (NDDB). Internal competition was regulated by restrictions on the entry of private sector in dairy business under the Industries Development and Regulation Act 1951. The program of economic reforms initiated in 1991, however, exempted dairy sector from the Act and opened entry for private sector companies including multinationals primarily with an aim to improving efficiency in production, marketing and processing.

Delicensing attracted considerable private investment. A number of new processing plants were established. New entrants, however, started encroaching on the milk shed areas of the co-operatives. This prompted reintroduction of market controls. The Government of India promulgated the Milk and Milk Products Order (MMPO) in 1992 under which plants handling 10 thousand litres of milk a day were required to obtain a license and new processors were mandated to develop their own milk sheds. In 1993 the MMPO was amended and licensing requirement for firms handling less than 75 thousand litres/day was abolished. In 2002 the government again amended MMPO and removed restrictions on setting up the new capacity and done away with the concept of milk shed. Additionally, the amended order emphasized sanitary, hygiene, quality and food safety.

Wool, hides and skins

There are two important marketing channels for wool. Small herders often sell wool to itinerary traders who shear the wool and sell in the terminal markets. Large herders sell in

the terminal markets directly or indirectly through commission agents. The price of wool is determined by the wool quality.

The government also intervenes in wool marketing through the Wool Marketing Federations/ Boards. The government procures about 10–15% of the marketed wool. There are 61 wool markets in the country concentrated mainly in major producing states (Rajasthan, Tamilnadu, Gujarat, Karnataka and Uttar Pradesh). Indian wool is coarse and used mainly to produce carpets, furnishing items and industrial fibres. Only 8–12% of the wool is suited for apparel. For apparel wool India relies on imports mainly from Australia.

Traditionally, hides and skins were removed from fallen animals by the low-caste people, without any payment to the owner of the animal, but were required to bury the animal after removal of skin/hide. They locally treated hides and skins, and used for manufacturing shoes and other leather goods to meet the local requirement. With modernization of leather industry, cottage leather industry has almost collapsed, and now they sell hides and skins either to itinerary traders or in terminal markets. Hides and skins retrieved from slaughterhouses find way to terminal markets. Major markets for hides and skins are in Chennai, Kolkatta, Kanpur, Delhi, Mumbai and Hyderabad.

The changing face of markets: Emergence of contract farming

Economic reforms have paved way for participation by private sector in livestock products markets. Livestock products markets are now transforming from an open to vertically co-ordinated structures, like co-operatives, producers' associations and contract farming. Although co-operatives have existed in dairy since long, these are criticized for their inefficiency and excessive state controls. The private sector has adopted contract farming as a tool to ensure a sustained supply of raw material from producers. Much of the poultry production in major producing states is now produced under contract. Most of the private dairy processing firms also source milk from the producers using one or another variant of contract farming.

Main advantage of contract farming for producers is an assured access to market. Also, many firms provide quality inputs, technology, extension services and credit to producers and thus contribute to improving production efficiency. Benefits of contract farming, however, are questioned on grounds of monopsonistic exploitation by the firm and exclusion of the smallholders (Singh 2002). These apprehensions are largely theoretical and generalized based on a few such instances. Not much empirical evidence exists to prove these contentions. Birthal et al. (2005) in a study of contract farming in dairy and poultry found that contract farming by providing an assured market for produce helps improve farm profitability, reduce transaction costs and absorb price risk (Box 2).

Box 2: Contract farming in milk and poultry in India

The Nestle India Limited—one of the largest and oldest firms in dairy business in India sources nearly 250 million kg milk annually through contract farming from over 85 thousand producers spread over more than 1500 villages in Punjab. With an assured market at their doorsteps the producers could save transaction costs to the extent of 90% and reaped double the profits than the non-contract producers selling directly in the market. The price received by the contract producers was no less than the market price. Besides, they also received feed, medicines, fodder seed etc., and veterinary and agronomic services. Nearly 60% of the producers had 5 or less dairy animals.

The case of contract farming in broiler production relates to Venkateshawara Hatcheries Limited in Andhra Pradesh. The firm shares nearly 80% of the cost of production (chicks, feed and medicine) and provides veterinary services to the contract producers with buyback of entire production. The producers receive fixed remuneration on per bird basis for their contribution to production costs. The transaction costs to the producers are not much as the entire costs related to supply of chicks, feed and medicine is borne by the firm. The major benefits for the contract producers were assured returns, and transfer of production and market risks to the firm. On an average, contract producers received 13% higher profits compared to non-contract producers. About one-third of the producers were small (<5000 birds).

Source: Birthal et al. (2005).

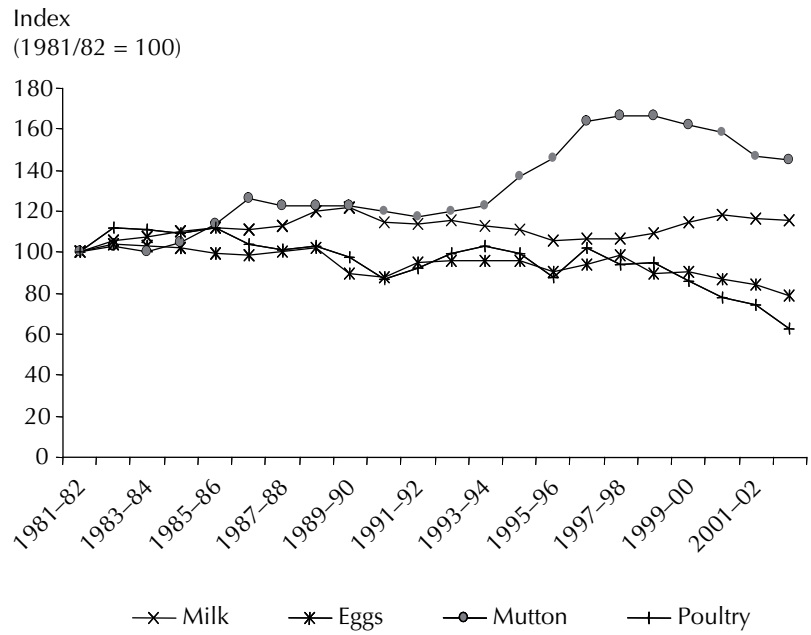
Realizing the potential of contract farming in improving backward and forward linkages, the government has taken some important policy initiatives. These are: amendment of the Agricultural Produce Market Committee Act to facilitate direct transactions between producers and firm through contract farming; permission to financial institutions to finance contract farming schemes; reimbursement of 10% of the funds invested (up to INR one million) by a processor in strengthening the backward linkages; reduction in excise duties on processed foods; and reduction in corporate taxes.

With an enabling policy environment, institutional linkages between production and consumption are likely to strengthen. Rising demand for processed quality products and growing culture of supermarkets would reinforce processors to enter into contractual arrangements as to ensure an adequate supply of quality final products to the consumers. Further, sanitary and phytosanitary standards for food products are becoming stringent in international trade, which can be adhered to if production and processing are integrated.

Behaviour of livestock product prices

Prices give signals to producers as what to produce and how much to produce. Livestock production is flexible and can be adjusted depending on prices of inputs and outputs. Livestock product markets in India are considered to be the most competitive as there is little, if any, government interference in livestock products marketing.

Figure 7 shows trend in real wholesale prices of animal food products. Milk price that was rising during 1980s, started declining during 1990s, but again showed a rising tendency from 1999–2000 onwards. The price of poultry meat and eggs remained somewhat stable during 1980s, but has fallen drastically especially after mid 1990s. Mutton price, however, kept on increasing until 1999–2000.

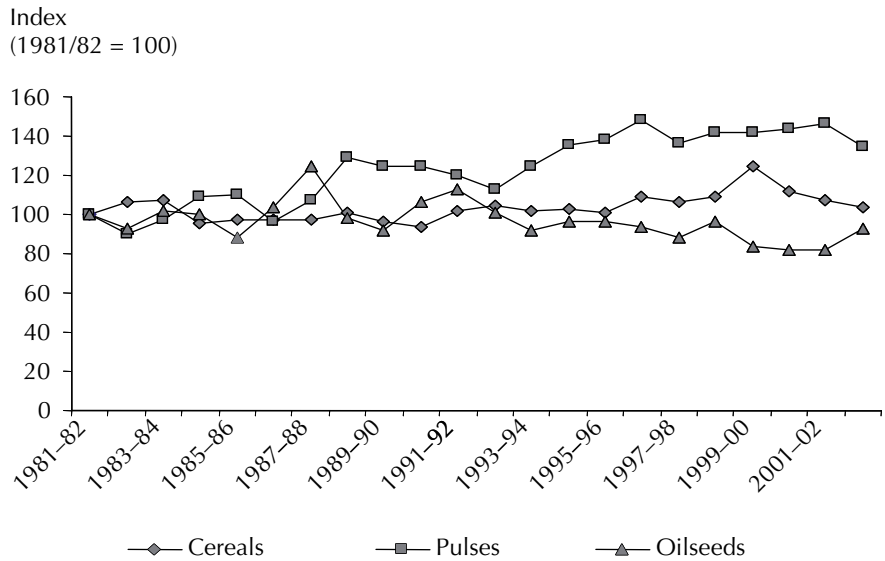


Source: GOI (various years): Index numbers of wholesale prices in India.
Figure 7. *Trend in real wholesale prices of livestock food products in India.*

Fall in prices, if not accompanied by a reduction in cost of production or input prices, may adversely affect farm profits. Cereals, pulses and oilcakes are important concentrate feeds for livestock. Trend in real wholesale prices of cereals was negative during 1980s, but started showing a rising tendency during 1990s (Figure 8). Prices of pulses remained upbeat throughout. Prices of oilseeds, however, declined during 1990s.

Effects of prices are reflected in the growth of livestock outputs. As noticed previously, growth in production of most of the livestock products decelerated during 1990s and this could partly be on account of fall in output prices and rise in input prices. Decline

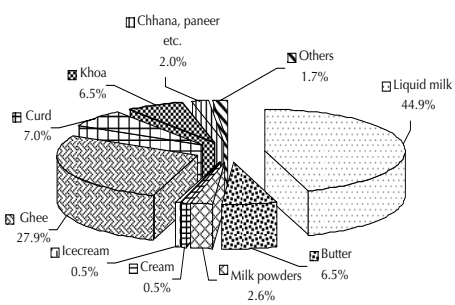
in output prices are considered favourable to demand growth, this, however, should be accompanied by a reduction in cost of production as to sustain farm profits. Reduction in cost of production can be brought about by wider adoption of production technologies and better management and feeding.



Source: GOI (various years): Index numbers of wholesale prices in India.
Figure 8. *Trend in real wholesale prices of grains and oilseeds in India.*

Processing of livestock products

Forty-five percent of the total milk produced in the country is consumed as raw, and the rest is converted into value added products (Figure 9). Ghee and curd are important milk products; about 28% of the milk is converted into ghee and 7% as curd. The rest is processed as butter, khoa, milk powder, cheese etc. However, processing is by and large a household activity. Producers unable to market milk convert it into ghee, curd and khoa for home consumption as well as for market. A part of milk production is also used in sweet manufacturing.



Source: Kurup (2002).
Figure 9. *End uses of milk in India, 2002.*

The organized sector procures nearly 20% of the milk produced in the country. About 25% of it is processed into value added products, and the rest is sold as liquid after pasteurization and packaging. The level of processing differs between co-operatives and private firms. Co-operatives convert 15% of the milk procured into value added products, while private sector processes a higher proportion of it into value added products. Value addition to meat is extremely low. Most of the meat and eggs produced in the country are consumed fresh, and hardly about 2% of the meat output undergoes value addition.

Processing industry, however, has been expanding especially since 1991 (Table 18). Number of dairy processing plants increased from 432 in 1990–91 to 770 in 1999–2000, with a corresponding increase in investment from INR 6.996 billion to INR 15.411 billion. During this period, gross value added increased from INR 1.903 billion to INR 3.999 billion. The investment and value addition in meat industry too has increased during this period.

Table 18. *Investment and value addition in livestock industry (INR × 10^6 at 1980–81 prices)*

Industry	No. of processing units	Fixed capital	Gross value added
Dairy			
1980–81	258	3661	473
1990–91	432	6996	1903
1999–2000	770	15,411	3999
Meat			
1980–81	22	256	59
1990–91	33	338	95
1999–2000	37	1877	322

Source: GOI (various years): Annual surveys of industries.

Food quality and safety

Food quality and safety issues are governed by a number of regulations and agencies. The Ministry of Food and Consumer Affairs is the main agency dealing with issues of food safety. There are other ministries/departments that have their own systems of food regulations. The Prevention of Food Adulteration Act is the main food safety act enforced by the Ministry of Health and Family Welfare, Government of India. It primarily focuses on establishing regulatory standards for food safety and applies equally to domestic and imported foods including livestock products. It covers various aspects of processing and distribution such as colour, preservatives, and pesticide residues, packaging, labelling and sales regulations. The Bureau of Indian Standards creates standards for food products. The Standards of Weights and Measures Act establishes fair trade practices with respect to packaged commodities, and makes it essential for the manufacturers to display information about the nature of the commodity, date of manufacture and retail price on the label.

Besides, there are a number of commodity specific quality control orders issued under the Essential Commodities Act. Milk and Milk Products Order (MMPO) and Meat Food Products Order (MFPO) are two such orders. These are applicable to both the domestic and imported foods. The MMPO regulates the production, distribution and supply of milk products. It establishes sanitary requirements for dairy products, machinery, premises, and establishes quality standards for milk and milk products. The MFPO provides for sanitary requirements and sets limits for heavy metals, preservatives and pesticide residues in meat products.

The food safety regulations are enforced by multiple agencies. This is considered to be restrictive to the growth of food processing industry. Recognizing the growth potential of food processing and to create an enabling environment for value addition to agricultural products the government has taken an initiative to create a Unified Food Law by merging/ amending all the existing food laws taking into consideration the global food quality standards. The Unified Food Law will be implemented/co-ordinated by a single agency.

Trade in livestock products

Livestock products account for 18% of the world trade in agricultural products (FAOSTAT 2005). However, India' share is negligible in it; 0.3% in exports and 0.4% in imports. Though, India is not a significant player in international trade in livestock products, integration of global markets under World Trade Organization (WTO) is creating opportunities for increased livestock exports. Global market for animal based foods has been expanding rapidly; between 1991 and 2003 world trade in dairy products (in quantity) increased by 1.5 times and of meat almost doubled. Trends in India's exports and imports of livestock products for the last two decades are shown in Figure 10 and Table 19. In 2001–03 livestock products accounted for 6.6% of exports and 5.8% of imports of agricultural products. Interestingly, share of livestock products in agricultural exports almost doubled since 1989–91, while that in imports fell drastically, from 16%. Livestock trade balance that had always been negative started taking a positive turn during 1990s and increased to USD 132 million in 2001–03.

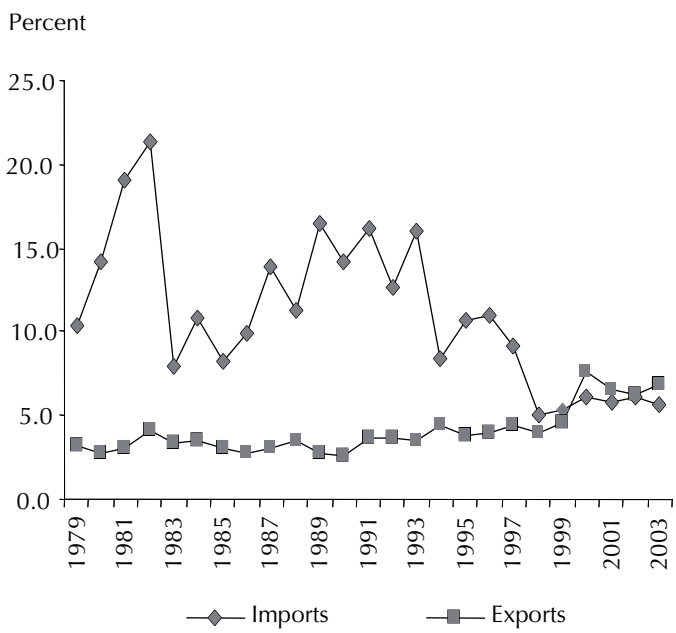
Exports

India's two major livestock products exports are buffalo meat and dairy products. In 2001–03 these accounted for 71 and 12% of total livestock exports, respectively. Exports of buffalo meat showed tremendous growth over the last two decades, especially since 1991 (Figure 11). These increased from USD 71 million in 1979–81 to USD 260 million in 2001–03. Major destinations for buffalo meat are: Malaysia, the Philippines, Jordan and United Arab Emirates (UAE).

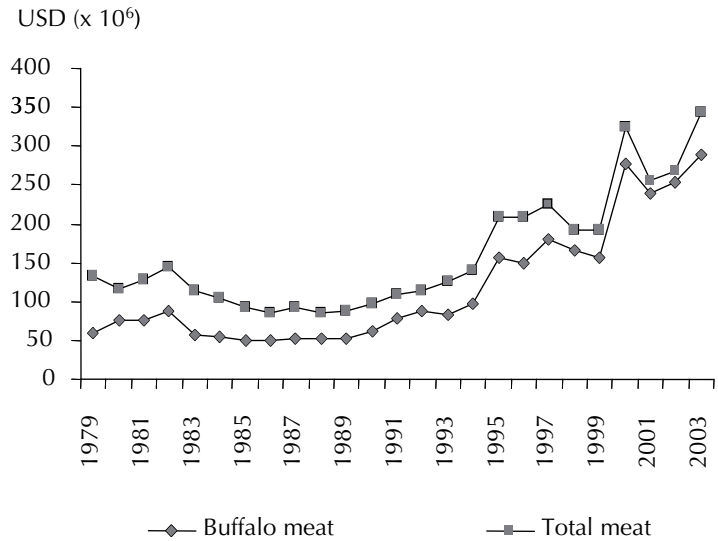
Table 19. *Exports and imports of livestock products of India (USD × 10^6 at 2000 prices)*

Item	Exports			Imports		
	TE 1981	TE 1991	TE 2003	TE 1981	TE 1991	TE 2003
Total agricultural products (USD × 10^6)	4586	3498	5520	2537	1191	4109
Livestock products (USD × 10^6)*	151	115	366	370	191	240
% of agricultural products	3.3	3.3	6.6	14.6	16.0	5.8
Composition of livestock trade (%)						
Live animals	9.6	8.0	0.7	0.4	2.7	0.3
Dairy products	1.5	2.7	11.8	61.7	10.2	6.5
Buffalo meat	47.1	55.8	71.0	0.0	0.0	0.0
Ovine meat	12.9	17.3	3.4	0.0	0.0	0.0
Poultry meat	0.0	0.3	0.7	0.0	0.0	0.0
Other meats	22.3	11.9	3.9	0.2	0.0	0.2
Total meat	82.3	85.2	79.0	0.2	0.0	0.2
Eggs	3.3	1.9	6.5	0.0	0.0	0.0
Animal fats	0.0	0.0	0.2	12.4	0.1	0.4
Hides and skins	0.6	0.4	0.6	0.2	17.0	24.1
Wool and hair	2.1	1.7	1.1	25.1	70.0	68.5
Others	0.7	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

* Excludes leather products.
Source: FAOSTAT (2005).



Source: FAOSTAT (2005).
Figure 10. *Trend in the share of livestock products in agricultural trade in India.*



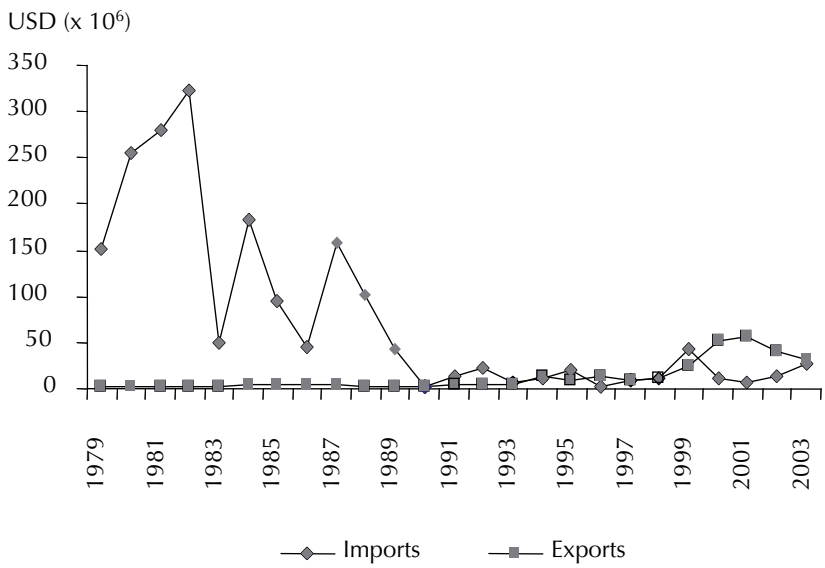
Source: FAOSTAT (2005).
Figure 11. *Trend in exports of meat from India.*

A number of factors contributed to the growth of buffalo meat exports. The minimum export price condition was eliminated in 1993. The government provided fiscal incentives to the export oriented units. Export oriented units exporting 50% of the output are eligible for tax breaks and for licenses to import processing equipment and machinery. These lead to establishment of some modern export oriented processing units by the private sector in collaboration or technical assistance from foreign firms. There is considerable scope to increase buffalo meat exports due to its price competitiveness and huge production potential. At present, a considerable proportion of male buffaloes die at a very young age due to lack of a remunerative market, which is potential waste of meat production (Taneja and Birthal 2004).

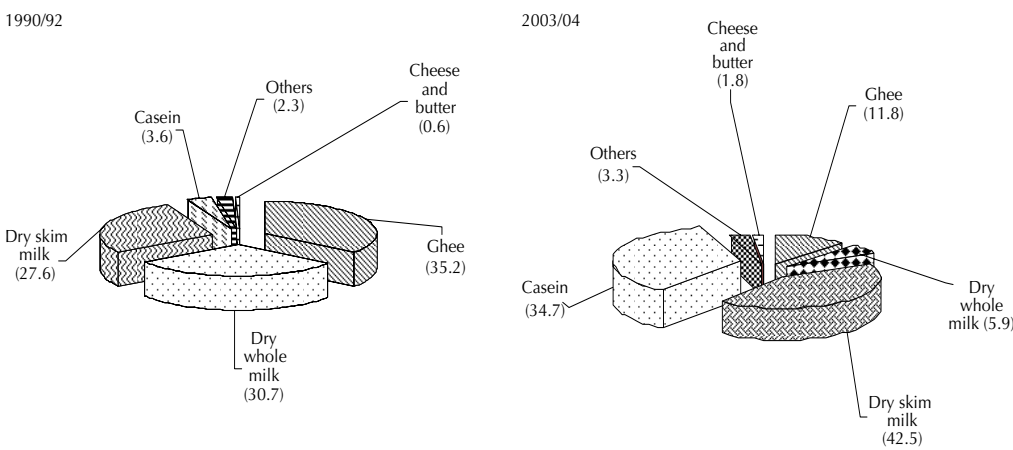
Removal of minimum export price conditions and provision of fiscal incentives did not lead to much increase in exports of small ruminant meat, mainly because of its high domestic demand. India exported small ruminant meat worth USD 12 million in 2001–03, with a share of 3.4% in total livestock exports. Share of small ruminant meat, however, has fallen drastically since early 1990s, though with sharp annual fluctuations. Major markets for small ruminant meat are UAE, Oman, Qatar, Bahrain and Saudi Arabia.

Poultry products, mainly eggs accounted for nearly 7% of total livestock exports in 2001–03. Exports of poultry meat increased from almost nil in early 1980s to USD 2.4 million in 2001–03. Major markets for eggs are UAE, Japan, Oman, Belgium, Saudi Arabia and Kuwait. Poultry meat is not competitive in the world market.

India emerged as the largest producer of milk in 1999, and since then exports of dairy products have started increasing (Figure 12). In 1999 India exported dairy products worth USD 25 million. Prior to 1999 exports of dairy products were meagre. Further it is interesting to note that composition of dairy products exports has changed drastically. In 1990–92 ghee, dry whole milk and dry skim milk were the main dairy products exports (Figure 13). In 2001–03 while the share of dry skim milk increased the share of dry whole milk and ghee fell drastically. Export of casein that was almost non-existent in early 1990s witnessed substantial growth with a share of about 35% in 2001–03.



Source: FAOSTAT (2005).
Figure 12. *Trend in exports and imports of dairy products from India.*



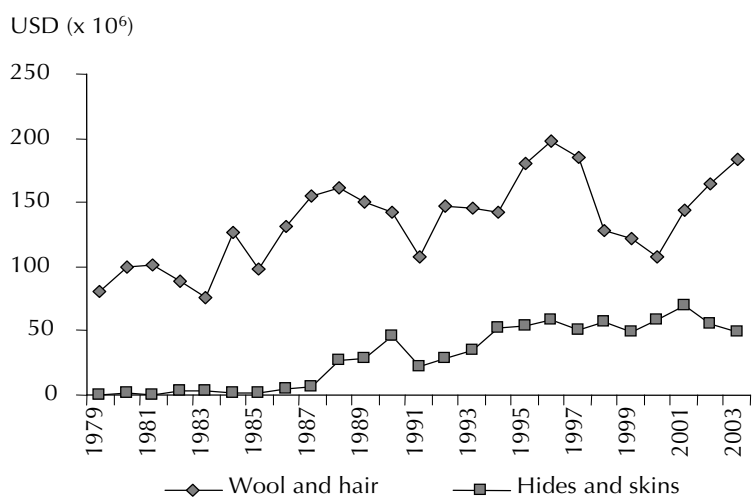
Source: FAOSTAT (2005).
Figure 13. *Changes in the composition of dairy exports of India (%).*

Growth in dairy products exports happened because of freeing of exports from licensing and quota requirements. Until 1993 the National Dairy Development Board (NDDB) had the monopoly on dairy exports. In September 1993 private exports were allowed with Agricultural and Processed Food Products Export Development Authority as the monitoring agency. Major destinations for dairy products are UAE, Bangladesh, Oman, Japan, Saudi Arabia and Germany.

Exports of hides and skins are negligible. Exports of raw hides and skins are banned primarily to improve the raw material availability for domestic industry. This policy has been quite successful in promoting exports of finished and semi-finished leather products. Exports of wool and hair are also limited.

Imports

Until recently India imported substantial amounts of dairy products. In 1979–81 dairy products worth USD 229 million were imported. This comprised 62% of total livestock imports (Table 19). Most imports, however, were in the form of food aids, and were canalized through NDDB. Imports fell sharply to USD 20 million in 1989–91, and since then these have almost remained stable. Sharp decline in milk imports was due to sustained growth in milk production in the country. During 1990s wool and hair emerged as main livestock imports. Their share in total imports of livestock products increased to around 70% from 25% in early 1980s. In absolute terms these increased from USD 94 million in 1979–81 to USD 164 million in 2001–03 (Figure 14). India imports mainly apparel wool, as domestically produced wool is unsuited for apparel manufacturing. Imports of hides and skins increased substantially to meet the growing demand of domestic industry.



Source: FAOSTAT (2005).
Figure 14. *Trend in imports of wool and hair, and hides and skins from India.*

Trade policy

Until 1991 trade in livestock products was heavily regulated through licensing, quota, tariffs etc. primarily to promote domestic industry. The government embarked on the policy of economic reforms in 1991 and introduced a number of trade reforms like reduction in tariffs, removal of quantitative restrictions and demonopolization of imports. Exports were also liberalized and many schemes were initiated to encourage exports.

Most consumer goods of agriculture and animal origin were in the negative list of imports and were not allowed without special licenses. The negative list, however, has been pruned considerably since 1991. Imports of many livestock products were restricted/canalized until 1997. Dairy imports that were canalized through NDDB have been opened up for the private sector. As of now, import restrictions remain only on live animals, buffalo meat, eggs, frozen semen/embryo, commercial chicks, pureline poultry and tallow/fat oils.

Import tariffs were reduced significantly in 1995. Tariff rate was 40% for dairy products (80% for icecream), 10% for fresh, chilled or frozen meat, 50% for processed meat, 40% for eggs and 50% for live animals. Tariffs on powdered milk and pureline poultry stock were completely eliminated. Subsequently, in view of non-reduction in support to livestock production in EU and USA, tariffs were raised on some products to counteract cheap import threat. In 2004–05 tariff rate was 60% for milk, cream and powdered milk, 40% for butter and butter oil , 30% for cheese and yogurt and 52% for icecream. Tariff rate for all meat products was uniform at 30%. Tariff for poultry grandparent stock was raised from 20 to 25% and for bovine semen from 10 to 30%. Tariff for live animals was reduced from 50 to 30% and on breeding bulls from 10 to 5%. Tariff on pureline poultry stock was 5%.

The government took a number of policy initiatives to boost exports of livestock products especially buffalo meat. Minimum export price condition on meat was abolished in 1993, and exports of milk, cream and butter that were canalized through NDDB were freed but subject to quota. Products like beef and tallow and fats and oils of livestock species are prohibited on moral/religious ground. Exports of cattle, camel, horses and hides and skins (except lamb fur skin) are restricted through licensing. The government also provides many other incentives to promote exports. The export oriented units (EOUs) and the firms in the export processing zones (EPZs) are allowed duty free imports of goods for manufacturing and processing. They are also permitted to sell half of their outputs in the domestic market. They also enjoy tax holidays and other benefits like concessional rent, sales tax, excise duty, corporate taxes etc. Foreign equity up to 100% for firms classified as EOUs and in EPZs and 51% for others is allowed. Besides, the Agricultural and Processed Food Products Export Development Authority (APEDA) provides subsidies to producers,

traders and exporters for export promotion, market development, market intelligence and infrastructure development.

International competitiveness

India has a competitive advantage in production of many livestock products. For example, producer price of milk in India has always remained lower than in USA (Table 20). However, prices of processed dairy products in India are much higher than the world prices. This is largely on account of (i) inefficiencies in processing, and (ii) distortions in world trade. India has a competitive advantage in export of mutton and beef. Chicken price in India, however, are significantly higher than the world price.

Table 20. *Wholesale prices of livestock products in India in relation to international prices (USD/t)*

Product	1995–96	2000–01	2001–02	2002–03
Cow milk: Producer price				
India	210	213	206	203
USA	300	343	384	267
Whole milk powder				
India	2186	3034	3006	2989
World	2120	1822	1973	1391
Skim milk powder				
India	3142	1911	1871	1847
World	2143	1896	1975	1326
Butter				
India	4341	4863	2875	2857
World	2251	1367	1336	1145
Beef				
India	952	848	893	827
World	2355	2477	2585	2384
Mutton				
India	2536	2456	2247	2229
World	2203	2995	3850	4215
Chicken*				
India	857	1095	1000	904
World	927	600	650	582

Sources: International prices from: http://www.oecd.org. Indian prices: GOI (various years): Agricultural prices in India. Producer price: FAOSTAT (2005); *Chicken meat: FAOSTAT (2005), export unit value.

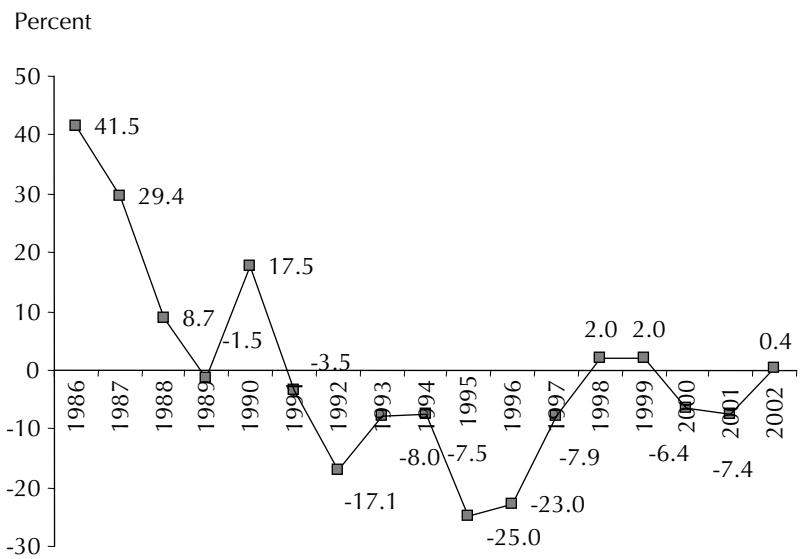
World trade in livestock products is heavily distorted. Table 21 shows estimates of producer support estimates (PSE) to various livestock products in major producing countries. In 2003 support to dairy sector was 77% in Japan, 55% in Canada, and 45% in USA. Support to beef and pork is considerable in Japan and Mexico. Poultry meat production receives considerable support in New Zealand, Mexico and Japan, and egg production receives considerable support in Canada, New Zealand and Japan. On the other hand, support to

livestock production in India is almost negligible. For instance, PSE for dairy in India has declined drastically (Figure 15). In other words, dairy producers in India are being net taxed.

Table 21. *Producer support estimates to livestock production in selected countries, 2002 (% of value of output)*

	Milk	Beef	Pork	Poultry meat	Eggs
Australia	15.5	3.8	3.6	3.4	4.1
Canada	55.4	11.5	6.1	3.3	31.6
New Zealand	0.6	0.6	0.1	42.4	29.8
European Union	48.6	74.5	21.2	38.0	3.3
Mexico	43.3	12.0	22.0	34.2	0.0
Japan	77.4	32.4	57.3	11.3	15.9
USA	45.5	4.4	4.2	4.2	4.2
India*	0.4	NA	NA	NA	NA

Sources: http://www.oecd.org; * Elumalai et al. (2004).



Source: Elumalai et al. (2004).
Figure 15. *Percentage PSE for milk in India.*

Distortions in world trade, if continue, might have a negative impact on domestic production unless protected against cheap imports. India therefore has a strong case to argue in WTO for reducing such distortions. Further, India is not under commitment to reduce domestic support, as the current level of domestic support to livestock sector is less than 2%, much below the WTO limit of 10%. India should also take advantage of green box clause that exempts general services and poverty-oriented developmental programs from reduction commitment, and support livestock production for the benefit of the poor.

Public spending and institutional support

Agriculture, including livestock, is a state subject and the issues related to livestock are largely handled by the state governments. The central government, however, intervenes in the issues of national importance. At the central government level, Ministry of Agriculture through its Department of Animal Husbandry and Dairy Development, Department of Agricultural Research and Education, Department of Agriculture and Cooperation and Directorate of Agricultural Extension deals in livestock issues. Major responsibility, however, is of the Department of Animal Husbandry and Dairy Development. The Department of Animal Husbandry and Dairy Development handles issues related to livestock production and health, dairy development, feed and fodder etc. The Department of Agricultural Research and Education is responsible for animal science research and education through the Indian Council of Agricultural Research. At state level, there are Departments of Animal Husbandry and Dairy Development. These departments provide support services related to animal breeding, feed and fodder development, disease control, and dissemination of technologies and information.

Public spending

Both the central and the state governments fund livestock development. Table 22 shows public spending on livestock by the central and state governments. Expenditure on animal husbandry and dairy development nearly doubled from INR 12.8 billion in 1981–83 to INR 21.9 billion in 2001–03. This comprised 8% of total expenditure on agricultural and allied activities in 2001–03, down from 14% in 1981–83. As proportion of value of livestock output, it declined to 2.4% in 2001–03 from 3.3% in 1981–83.

Table 22. *Expenditure on animal husbandry and dairy development in India (at 1993–94 prices)*

	TE 1982–83	TE 1992–93	TE 2002–03
Agricultural sector (INR × 10^9)	93.2	171.3	276.6
% share of central government		43.9	57.0
Livestock (INR × 10^9)	12.8	19.5	21.9
% share of central government		14.8	5.0
% of livestock in total agricultural expenditure	13.6	11.4	7.9
Value of livestock output (INR × 10^9)	387.9	612.3	896.2
Livestock expenditure as % of livestock output	3.3	3.2	2.4
Livestock expenditure/cattle equivalent unit (INR)	41.3	62.7	71.1

Source: GOI: Reports of the Auditor General and Comptroller of India.

Most expenses towards animal husbandry and dairy development come from state governments. Contribution of the central government in total expenditure was only 5% in 2001–03, down from 15% in 1991–93. On the other hand, the central government

contributed as much as 57% of total expenditure on agriculture and allied activities in 2001–03, up from 44% in 1991–93.

Activity-wise allocation of livestock sector expenditure is shown in Table 23. Dairy development has remained preferred public spending activity. It accounted for 58% of total expenditure in 1981–83 and 41% in 2001–03. Larger share of dairy development is on account of support provided to co-operatives and city milk schemes. Animal health and veterinary services also account for a considerable share in public spending for livestock development. Between 1980–81 and 2002–03 their share in total expenditure almost doubled from 13 to 23%. During this period, share of large and small ruminants remained almost unchanged at 12 and 2.5% respectively, while share of monogastrics declined marginally from 3.6 to 2.5%. Support to feed and fodder development activities is meagre (1.0%).

Table 23. *Distribution of livestock sector expenditure by activity (%)*

	TE 1982–83	TE 1992–93	TE 2002–03
Cattle and buffalo	11.9	13.0	11.7
Sheep and goat	2.3	2.4	2.5
Poultry	3	2.9	2.1
Pig	0.6	1.6	0.4
Other livestock	0.7	0.6	0.4
Veterinary services and animal health	13.3	21.1	23.3
Feed and fodder	1.0	0.9	1.1
Veterinary education and research	1.9	2.0	2.7
Dairy development	57.8	44.8	41.2
Investigation and statistics	0.3	0.5	0.7
Direction and administration	2.5	3.9	7.2
Other expenditures	4.7	6.3	6.7
Total	100	100	100

Source: GOI: Reports of the Auditor General and Comptroller of India.

Veterinary research and education received about 2.7% of the total expenditure on livestock sector in 2001–03, and has been increasing. Compared to share of agricultural research in agricultural GDP (0.5%), share of livestock GDP is much less (about 0.1%).

Livestock statistics has remained a neglected area. Except for livestock numbers, hardly there is any systematic and reliable compilation of information. Although share of livestock statistics and investigation has been increasing, it has hardly ever exceeded 1% of total livestock expenditure.

Some important policy issues emerge from the analysis of public spending. First, while prospects for livestock sector growth are bright, public spending on livestock remains

meagre. This may constrict growth of the sector and may have adverse effect on livelihood of millions of rural poor depending on livestock. Public spending on livestock development therefore needs to be stepped up. Second, public spending is heavily biased towards dairy development and veterinary services, ignoring other aspects like feed and fodder development and information services that are equally crucial to sustain growth of livestock sector. Priorities for livestock development need to be relooked considering resource availability and social and private benefits associated with different development activities. Third, there is a need to strengthen livestock research so as to evolve cost-effective yield-enhancing technologies to improve animal productivity.

Infrastructure and services

Livestock production faces a number of constraints related to health, breeding, nutrition and management. Livestock output worth INR 432 billion (at 2002–03 prices) is annually lost due to these constraints (Table 24).[6] This comprised 23% of the attainable output (actual output plus output lost) from the sector in 2002–03.

Table 24. *Losses in livestock production in India, 2002–03 (INR × 10^9)*

Species	Losses due to					Output		
	Breeding problems	Diseases	Feed scarcity	Inefficient management	Total losses	Actual output	Attainable output	Attainable output lost (%)
Cattle	50.8	100.1	71.2	34.4	256.5	595.1	851.7	30.1
Buffalo	22.5	20.8	79.0	9.7	132.0	670.1	802.1	16.5
Sheep	6.6	4.5	4.7	0.3	16.1	24.5	40.6	39.7
Goat	3.4	3.4	3.4	1.7	11.9	62.7	74.6	16.0
Pig	0.0	4.3	1.4	0.0	5.7	13.3	19.1	30.1
Poultry	0.0	5.1	2.5	2.2	9.9	120.2	130.0	7.6
All	83.3	138.3	162.3	48.3	432.1	1485.9	1918.0	22.5
% of total	19.3	32.0	37.6	11.2	100.0			

Source: Birthal et al. (2005).

Feed and fodder scarcity is the main limiting factor to improving production and productivity. Livestock output worth INR 162 billion a year is lost due to inadequate feeding and nutrition. Diseases cause an annual loss of INR 132 billion, and breeding problems add another INR 83 million to it. Magnitude of losses, however, varies across species. Nearly 30% of the

6. These estimates are based on information generated through focused group discussions with livestock producers conducted by a multidisciplinary team in 54 villages spread in Andhra Pradesh, Bihar, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Uttar Pradesh and West Bengal. Loss due to a particular constraint in an animal was estimated by multiplying probability of occurrence of that constraint, its period of occurrence and the difference in the maximum yield obtained under field conditions and the actual yield. Further multiplying yield loss/animal by the number of animals affected by that constraint provides an estimate of total loss due to that constraint.

attainable output of cattle and pig, 16–17% of buffalo and goat and 40% of sheep is lost due to various constrains.

Losses are huge despite rapid growth in public spending on veterinary services and animal health and expansion of veterinary infrastructure and manpower. In 2003 there were about 52 thousand veterinary institutions (veterinary hospitals, dispensaries, stockman centres etc.) and 38 thousand professional veterinarians to provide services to livestock producers (Table 25). Besides, there were about 70 thousand para veterinarians to assist professional veterinarians. Most of these institutions and professionals are in the public domain. For instance, 95% of the veterinarians are engaged in public sector. Between 1972 and 2003, veterinary institutions grew fivefold and number of veterinarians fourfold.

Table 25. *Veterinary institutions and veterinarians in India*

	No. of veterinary institutions	No. of veterinarians	Cattle equivalent units	
			Per institution	Per veterinarian
1972	9495	10,800	26,174	23,012
1982	33,323	18,000	8394	15,540
1992	40,586	33,600	7632	9219
1997	50,846	37,200	6129	8377
2003	51,973	38,100	5926	8084

Sources: GOI (various years): Basic animal husbandry statistics; National Commission on Agriculture (1976).

As a consequence of substantial increase in the number of veterinary institutions and professionals, number of livestock units served by a veterinary institution and a veterinarian fell considerably. Between 1972 and 2003, livestock units per institution fell from 26 thousand to 6000 and per veterinarian from 23 thousand to 8000. The National Commission on Agriculture (1976) recommended 5000 livestock units for every veterinarian as a norm for an effective delivery system. Besides public veterinary institutions, co-operatives, non-governmental organizations and private processors also provide livestock services.

Production losses although cannot be eliminated altogether, but can be minimized through appropriate development interventions, such as developing pastures and grazing lands, making available improved seeds and practices for fodder cultivation, improvements in breeding and health services etc. Delivery of services, however, remains weak (Ahuja et al. 2000). This is indicated by fodder cultivation, improvements in breeding and health services etc. Delivery of services, however, remains weak (Ahuja et al. 2000). This is indicated by frequent occurrence of diseases, and magnitude of losses caused by diseases and breeding problems. Inadequate supplies of medicines, vaccines and equipment are cited as reasons for inefficiency in public delivery system. Further, the focus in animal health has largely

remained on curative treatment with little attention on preventive measures. There are a number of diseases that can be controlled through preventive vaccination and care. This can be accomplished with a marginal investment in supplies, as infrastructure and manpower needed to undertake preventive vaccination is already in place.

Artificial insemination (AI) is widely acclaimed as an important tool for effecting genetic enhancement in animals. India started using AI in 1940s but largely remained confined to organized herds (military farms). In 1971–72 there were about 13 thousand AI centres in the country to provide breeding services (Table 26). Their number gradually grew to 48 thousand in 1997–98. Number of AIs done increased sixfold; from 3.9 million in 1971–72 to 24.5 million in 2003–04, improving coverage of breedable bovine population from 5 to 22%. The AI is largely confined to cattle and to lesser extent in buffaloes, sheep and goats.

Table 26. *Trends in AI in India*

	1971–72	1986–87	1992–93	1997–98	2003–04
No. of AI centres ($\times 10^3$)	12.9	37.0	39.6	48.2	46.3
No. of AIs done ($\times 10^6$)	3.9	9.3	16.7	18.8	24.5
No. of AIs done per centre	301.0	250.0	422.0	390.0	535.0
Total breedable population ($\times 10^6$)*	82.0	101.3	108.2	111.2	113.0
Breedable population inseminated (%)*	4.8	9.2	15.4	16.9	21.7

* Breedable cows and buffaloes.
Sources: GOI (various years): Basic animal husbandry statistics; National Commission on Agriculture (1976).

Impact of AI has not been encouraging. Success rate is reported to be in the range of 20–40%. In other words, 2–4 inseminations are needed for an animal to get conceived. Repeated insemination is a loss in the potential production of an animal, which discourages livestock producers to adopt AI. Low conception rate is attributed to inefficiency in the delivery system.

In addition to veterinary institutions, there are 197 cattle and buffalo breeding farms, 141 sheep and goat breeding farms, 112 pig breeding farms, 5 camel breeding farms, and 7 horse breeding farms in the country to produce and distribute quality bulls to livestock producers and various agencies engaged in livestock development. For poultry there are 422 breeding farms and 294 hatcheries to produce and distribute day-old chicks to poultry producers.

Credit

Credit for animal husbandry and dairy development is provided by commercial banks, co-operatives and regional rural banks as an investment credit. During 1970s credit for livestock was provided under the poverty alleviation programs like Integrated Rural Development Programmes (IRDP). Evidence indicates that nearly 71% of the beneficiaries of IRDP in 1999–2000 availed credit for dairying, though the proportion of rural households receiving assistance under IRDP was only 5% (GOI 2001). Institutional credit for livestock is considered as an investment credit and provided for dairying, poultry, piggery, sheep and goat husbandry. Table 27 shows ground level disbursement of institutional credit to livestock sector.

Table 27. *Ground level credit disbursement to livestock sector (INR × 10^9 at 1993–94 prices)*

	Agricultural sector	Livestock	Livestock as % of agricultural credit
1997–98	241	13.3	5.5
1998–99	262	14.2	5.4
1999–2000	307	15.0	4.9
2000–01	344	16.7	4.9
2001–02	385	13.8	3.6
2002–03	417	15.8	3.8

Source: NABARD: Annual reports.

Between 1997–98 and 2002–03 credit to agricultural sector (including livestock) increased by 73%; from INR 241 billion to 417 billion (at 1993–94 price). Share of livestock in agricultural credit declined from 5.5 to 3.8% although in absolute terms there was a marginal increase; from INR 13.3 billion to INR 15.8 billion. This is much less compared to livestock's contribution to agricultural GDP.

Bias in lending against livestock sector could be due to many reasons. Livestock are reproducible assets, and once created keep on reproducing adding to scale without much external assistance. Second, credit is provided only for investment purposes, and short-term credit requirements to meet operational costs are ignored, which could be as high as cost of acquisition of an animal. This has acted against the poor who are unable to meet operational costs from their own resources. Further, though the poor are eligible for institutional credit against mortgage of the animals, institutions hesitate advancing credit probably because of problems of moral hazards.

Insurance

Livestock production though less susceptible to small weather induced risks; mortality losses could be high under severely adverse conditions like drought, flood, cyclones and

disease outbreaks. Small producers are likely to suffer most from such natural calamities. Thus the National Commission on Agriculture (1976) recommended an insurance cover for livestock to protect producers from income shocks of adverse natural conditions, and to encourage investment in high-producing animals. As a follow up, a credit-linked insurance scheme was initiated in 1970s mainly for the beneficiaries of IRDP.

Livestock insurance is provided by public sector insurance companies, like General Insurance Corporation, National Insurance Corporation Limited, New India Assurance Company Limited and Oriental Insurance Company Limited and United India Insurance Company Limited. The insurance cover is available for almost all animal species. Normally, an animal is insured up to 100% of the market value. The premium is 4% of the sum insured for general public and 2.25% for IRDP beneficiaries. The government subsidizes premium for IRDP beneficiaries.

Progress in livestock insurance, however, has been dismal (Table 28). In 1988–89 nearly 19 million animal heads, equivalent to 4.2% of total livestock population (excluding poultry) were provided insurance cover. Number of animals insured, however, fell drastically in early 1990s. It is only after government's renewed emphasis on agricultural insurance in 1998–99, livestock insurance again started picking up. In 2002–03 about 29 million animal heads were insured. This comprised 6.1% of livestock population.

Table 28. *Livestock population covered by insurance*

	Population insured ($\times 10^6$)	Total population ($\times 10^6$)	% of livestock population insured
1988–89	18.6	445.3	4.2
1992–93	13.8	470.9	2.9
1997–98	16.4	485.4	3.4
2002–03	29.4	482.8	6.1

Source: GOI (various years): Basic animal husbandry statistics.

Research

Livestock research is a public funded activity, and is conducted in a number of central and state level institutions. At the national level, the Indian Council of Agricultural Research (ICAR) conducts research through its specialized institutions. There are eight national/central research institutes, six national research centres and four project directorates engaged in livestock research. Besides, there are 40 State Agricultural Universities (SAUs), including 7 with exclusive mandate of animal science research and education. The funding for SAUs comes from state governments and ICAR.

In the ninth five year plan (1997–2002) animal science research in ICAR received a total of INR 3.556 billion, equivalent to 19% of ICAR's total research outlay (Table 29). Animal

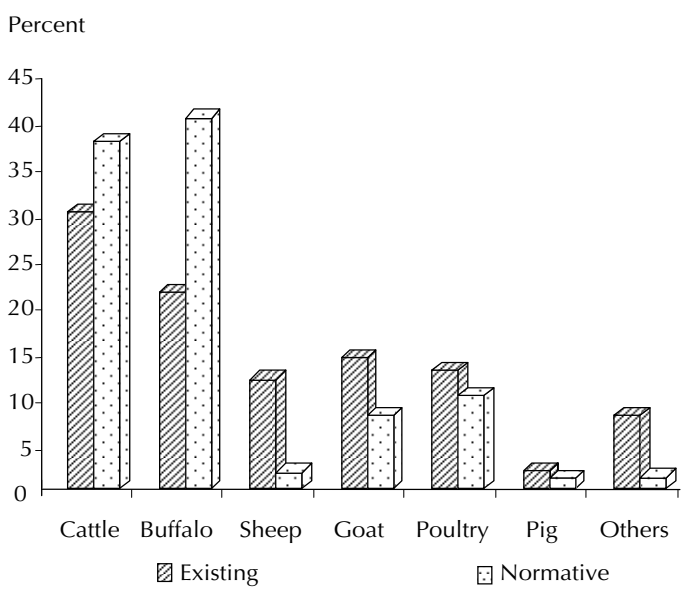
science research was given high priority during 1970s and accounted for 28% of total research outlay of ICAR. Its share, however, declined during 1980s, but was restored during 1990s. Yet, it remains less than the proportional contribution of livestock to agricultural GDP.

Species-specific resource allocation does not match with the contribution of different species to livestock income (Figure 16). Using 'modified congruence approach' and considering extensity and intensity parameters of efficiency, equity and sustainability, Birthal et al. (2002) showed that cattle receive about 8% and buffalo 19% less share in animal science research resources than they deserve. This is contrary to the general perception that livestock research in India has largely remained focused on cattle and buffalo (World Bank 1999). Allocation to poultry is almost in congruence with the suggested allocation. Existing allocation to small ruminant research especially to sheep is much higher than the suggested allocation.

Table 29. *ICAR's allocation of research outlay for livestock research (INR × 10^9 at 1993–94 prices)*

Plan period	Total outlay	Outlay for livestock	% of total outlay
Sixth five year plan (1980–85)	5.486	0.782	14.3
Seventh five year plan (1985–90)	5.038	0.708	14.1
Eighth five year plan (1990–95)	9.481	1.702	18.0
Ninth five year plan (1997–2002)*	17.498	3.356	19.2

* Includes funds received under NATP from World Bank.
Source: Birthal et al. (2002).

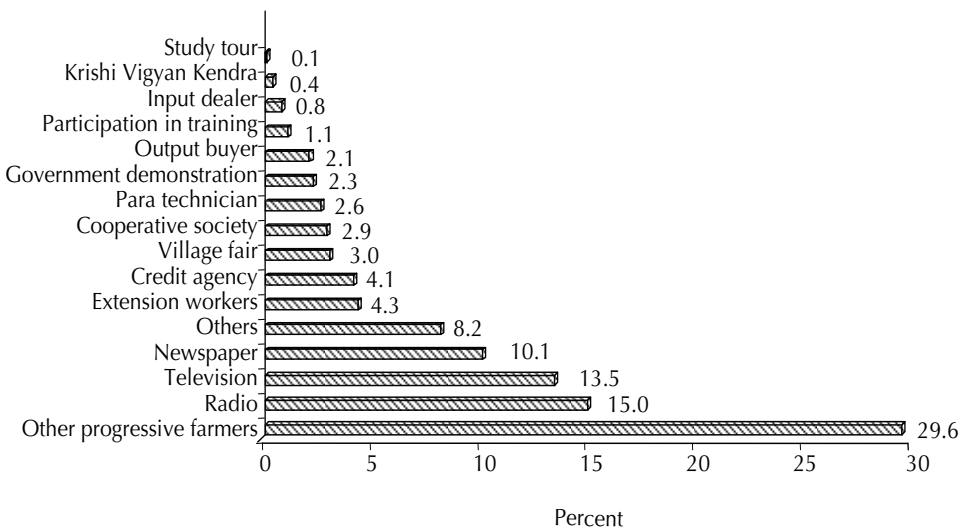


Source: Birthal et al. (2002).
Figure 16. *Existing and suggested allocation of livestock research resources, 1999–2000.*

Extension

During 1950s livestock extension activities comprised a part of the National Extension Programme (NEP). Initially, livestock received some attention under NEP, but the emphasis of NEP gradually shifted towards crop subsector. Activities related to livestock extension were transferred to the state departments of animal husbandry, which were not capable of handling the extension activities due to shortage of trained staff.

In the subsequent decades, veterinary infrastructure and manpower in the public sector expanded considerably. Yet, extension activities remained grossly neglected. A recent survey by NSSO shows that only 5.1% of the households access any information on animal husbandry (GOI 2005). Corresponding figure for agricultural sector was 40.5%. Further, the main source of information on animal husbandry was other progressive farmers, followed by radio, television and newspaper (Figure 17). Livestock extension includes animal health and breeding services and transfer of technology, which none other than veterinarians and para veterinarians can deliver better.



Source: GOI (2005).
Figure 17. *Distribution of households seeking information from different sources (%).*

Conclusion and policy issues

Livestock production in India has been growing rapidly and the momentum is likely to continue in the near future, as sustained income growth and rising urban population are fuelling rapid growth in demand for animal food products. Besides, international market for livestock products too has been expanding, and the ongoing process of globalization creates scope for exports. Prospects for livestock sector growth thus appear bright.

Rapid growth in livestock production is more pro-poor than the growth in other subsectors of agriculture because of more egalitarian distribution of livestock compared to land. Besides, smallholders have sufficient endowment of labour of low opportunity cost and thus are capable of producing at a lower cost. Nevertheless, there are apprehensions whether smallholders would be able to expropriate benefits of demand-driven growth. They are constrained by a lack of access to markets, quality inputs, improved technologies, credit, information and services, and there is a danger that smallholder livestock producers may be displaced by large producers in the market place. The extent to which the poor smallholders would be able to expropriate benefits of emerging opportunities would depend on how policies, institutions and technologies address these constraints.

Livestock sector has not received as much policy attention as it deserves. Livestock sector remains underinvested, and also there is not much institutional and market support for livestock production. Besides, overall objective of the policy has largely remained on increasing milk and meat production without much appreciation for the role of livestock development in poverty reduction. Dorward et al. (2004) and Pica-Ciamarra (2005) argued that given a macro-economic framework livestock policies would be more pro-poor if they include strategies to (i) enhance livestock production, (ii) expand domestic markets, and (iii) support expanding markets.

Production enhancing policies include public actions that allow smallholder livestock producers to have an adequate access to inputs such as feed, land (grazing lands), animal health services, credit and risk-mitigating mechanisms (insurance). Feed insecurity in India is acute and some public actions are required to address this. These include incentives to producers' to allocate more land to feed–fodder crops, dissemination of improved production technologies especially seeds, management of common grazing lands, rejuvenation of pastures and development of fodder markets etc. Feed scarcity is localized and confined to arid and rainfed regions. In some irrigated regions, roughages mainly rice and wheat straw, are surplus and often burnt after harvest. Policies are needed for procurement, storage and transfer of surplus fodder to scarce regions.

Delivery of livestock services and information remains poor despite considerable expansion in veterinary infrastructure and manpower. Resource crunch is often quoted as the main reason, as in many states a considerable proportion of the animal husbandry budget is used for meeting salaries of the personnel, leaving little for medicines, vaccines, equipment etc. (World Bank 1996). Ahuja et al. (2000) suggested privatization of some services such as diagnosis, treatment and AI for their effective delivery. Another issue relates to prevention vs. curative treatment. The emphasis in animal health has largely remained on curative, and preventive measures have largely remained neglected. Since infrastructure and manpower

availability is not a significant constraint, marginal investment in prophylactic measures can yield higher dividends. As an initial step, some disease free zones can be created emphasizing both prophylactic and curative measures.

Lack of capital and higher production risks are important barriers to expansion of smallholder livestock production. At present, credit and insurance support to livestock production is meagre. Policy interventions are thus needed to improve credit flow to livestock sector and strengthen insurance support, especially to smallholder livestock producers as to enable them to diversify into livestock production.

Existence of an enabling market environment is an important precondition to sustain livestock production growth. While demand for animal food products has been rising, output marketing systems are not well-developed. Markets are largely informal and often exploitative of producers especially smallholders. They have small marketable surpluses, and sale in distant urban markets/consumption centres results into high market transaction costs. Lack of accessible markets also discourages smallholders to adopt better technologies and quality inputs. Co-operatives, producers associations and contract farms are important means of providing an easy market access to smallholders and reduce transaction costs. For instance, dairy co-operatives have been successful in providing an easy access to producers, but the success is not widespread because of their excessive politicization and bureaucratic control. The government should provide an enabling policy environment for emergence and growth of institutional arrangements that strengthen backward linkages.

Another related, yet more important issue is improving value addition to livestock production. The current situation is not encouraging. About 20% of milk and 2% of meat output undergoes value addition. Besides, the prices of processed animal food products are high due to lack of economies of scale in processing, and high packaging and storage costs. Improvements in value addition are necessary to sustain expanding markets, strengthen exports and counteract threat of cheap imports. Some public action is required to encourage private sector to invest in processing and cold chains together with public investment in infrastructure.

India has a competitive advantage in production of many primary livestock products, but is not competitive in exports of value added products because of high marketing and processing costs and distortions in world markets. Some countries provide huge production and market support to their livestock sectors, while in India such a support is almost non-existent. Thus, there is a strong argument for India to negotiate in WTO for reduction in distortions in world trade as to gain access to world markets. In fact, there exists a considerable potential for India to export livestock food products, mainly dairy products, to the neighbouring countries such as Bangladesh and Sri Lanka, which are

deficit in milk production. Nevertheless, to take advantage of expanding global markets, domestic industry has to improve efficiency and food safety and quality standards, which are becoming stringent in the global trade.

Finally, increasing investment in research is necessary to improve quantity and quality of livestock production proportionate with demand growth and consumer preferences. Share of livestock research in agricultural research outlay is less than the contribution of livestock to agricultural gross domestic product, and needs to be stepped up. Further, priorities in livestock research should be objectively assessed with due consideration of efficiency and sustainability of different livestock production systems and their potential impact on the poor livestock keepers.

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Annex 1: State-wise population of different species in India, 2003 ($\times 10^3$)

State	Cattle	Crossbred cattle (%)	Buffaloes	Goats	Total sheep	Cross-bred sheep (%)	Total fowls	Improved fowls (%)
Andhra Pradesh	9300	11.90	10,630	6277	21,376	1.78	101,985	72.55
Arunachal Pradesh	458	2.84	11	231	19	0.00	1610	11.61
Assam	8440	5.21	678	2987	170	0.59	14,658	17.63
Bihar	10,729	11.87	5743	9490	382	21.99	12,820	20.84
Goa	76	15.79	37	11	0	0.00	565	63.01
Gujarat	7424	8.61	7140	4541	2062	85.84	8100	58.48
Haryana	1540	37.21	6035	460	633	11.06	13,610	93.59
Himachal Pradesh	2236	30.28	774	1125	926	15.44	767	73.01
Jammu and Kashmir	3084	42.80	1039	2055	3411	58.69	5325	33.73
Karnataka	9539	16.79	3991	4484	7256	0.17	25,576	62.46
Kerala	2122	81.76	65	1213	4	0.00	10,992	29.62
Madhya Pradesh	18,913	1.68	7575	8142	546	21.98	11,676	34.80
Maharashtra	16,303	17.03	6145	10,684	3094	1.68	37,892	40.40
Manipur	418	16.51	77	33	6	0.00	2383	40.16
Meghalaya	767	3.00	18	327	18	5.56	2762	4.92
Mizoram	36	25.00	6	17	1	100.00	1114	29.53
Nagaland	451	53.88	34	175	4	50.00	2673	35.28
Orissa	13,903	7.65	1394	5803	1620	0.74	16,886	23.55
Punjab	2039	75.09	5995	278	220	32.27	10,773	90.90
Rajasthan	10,854	4.27	10,414	16,809	10,054	0.66	6185	54.24
Sikkim	159	50.31	2	124	6	0.00	321	33.02
Tamilnadu	9141	56.23	1658	8177	5593	13.75	86,120	46.16
Tripura	759	7.51	14	472	3	0.00	2271	15.90
Uttar Pradesh	18,551	8.81	22,914	12,941	1437	2.64	11,262	43.97
West Bengal	18,913	5.92	1086	18,774	1525	1.51	43,700	22.24
A&N Islands	64	20.31	16	64	0	0.00	857	21.47
Chandigarh	6	83.33	23	1	0	0.00	152	92.11
Dadra and Nagar Haveli	50	2.00	4	21	0	0.00	106	23.58
Daman and Diu	4	0.00	1	4	0	0.00	28	7.14
Delhi	92	63.04	231	17	3	33.33	458	99.34
Lakshdweep	4	50.00	0	47	0	0.00	129	61.24
Pondicherry	78	80.77	4	48	3	33.33	207	60.39
Chattisgarh	8882	2.85	1598	2336	121	1.65	8005	37.60
Uttaranchal	2188	10.42	1228	1158	296	30.41	1967	74.99
Jharkhand	7659	1.89	1343	5031	680	2.35	13,465	8.17

Source: All India Summary Report, 17th livestock census and basic animal husbandry statistics 2004, Government of India.

Annex 2: State-wise milk and egg yield in India, 2003–04

State	Milk (kg/day per animal)				Eggs (no./layer per annum)	
	Crossbred cows	Indigenous cows	Buffaloes	Goats	Local fowls	Improved fowls
Andhra Pradesh	7.15	1.89	3.81	–	60.0	275.0
Arunachal Pradesh	7.70	1.18	–	–	184.0	325.0
Assam	3.29	0.91	1.79	0.19	91.5	184.6
Bihar	5.78	1.81	3.65	0.14	89.9	183.7
Goa	6.96	1.62	3.16	–	87.0	265.0
Gujarat	8.22	3.20	4.08	0.38	106.4	292.0
Haryana	6.79	4.32	5.96	0.79	143.5	233.1
Himachal Pradesh	3.36	2.01	3.24	0.44	172.8	208.9
Jammu and Kashmir	–	–	–	–	–	–
Karnataka	5.58	2.07	2.54	0.08	96.8	235.1
Kerala	7.01	2.61	6.21	0.57	120.0	226.0
Madhya Pradesh	5.86	1.69	3.34	0.44	91.1	201.6
Maharashtra	6.76	1.46	3.56	0.21	116.0	264.0
Manipur	6.74	1.37	3.05	–	58.4	112.8
Meghalaya	8.96	0.74	1.77	–	102.0	217.0
Mizoram	8.25	1.56	1.75	–	68.0	206.0
Nagaland	7.18	0.79	2.25	0.33	134.0	170.0
Orissa	5.50	0.53	2.63	0.11	116.5	281.0
Punjab	8.68	3.10	6.65	0.10	80.0	250.0
Rajasthan	6.22	2.79	4.29	0.57	105.0	255.0
Sikkim	5.00	2.00	2.00	–	120.0	225.0
Tamil Nadu	6.18	2.66	4.13	–	92.1	236.3
Tripura	3.73	1.16	2.50	0.03	91.0	170.0
Uttar Pradesh	6.74	2.41	4.26	0.70	140.0	243.3
West Bengal	5.55	1.93	5.33	0.12	99.4	226.9
A&N Islands	4.43	2.17	2.98	0.42	113.0	197.0
Chandigarh	8.80	3.00	6.00	–	170.0	265.0
Dadra and Nagar Haveli	–	–	–	–	–	–
Daman and Diu	–	–	–	–	–	–
Delhi	6.35	4.22	6.02	–	–	242.0
Lakshdweep	4.15	3.19	–	0.64	180.0	240.0
Pondicherry	5.45	2.37	4.80	–	120.0	193.0
Chattisgarh	3.86	0.91	2.80	0.22	90.8	200.7
Uttaranchal	6.74	1.90	4.18	–	143.8	207.1
Jharkhand	6.06	1.73	6.12	0.13	217.0	217.0
Total	6.53	1.92	4.24	0.32	103.94	253.99

Source: Basic animal husbandry statistics 2004, Government of India.

Annex 3: Decomposition of growth in milk production in India between 1993–94 and 2003–04

	Total in-milk population ($\times 10^6$)	Crossbred cows	Indigenous cows	Buffaloes	Goats*
			Percent share		
TE 1994–95	59.1	7.0	46.8	42.2	3.9
TE 2003–04	68.3	9.6	40.4	45.4	4.6
	Milk production ($\times 10^6$ t)		Percent share		
TE 1994–95	60.5	14.2	27.7	53.7	4.4
TE 2003–04	86.7	18.0	22.3	55.4	4.3
			Milk yield (kg/annum)		
TE 1994–95	1024	2061	606	1305	1143
TE 2003–04	1269	2383	702	1548	1179
			Share in increased milk production (%)		
Yield	36.7	5.1	10.1	21.1	0.4
Number	56.2	20.3	1.0	31.7	3.3
Interaction	7.1	2.4	0.1	4.5	0.1
Total	100	27.8	11.2	57.3	3.8

* In cattle equivalent, 10 goats are assumed equal to one cow or buffalo.
Sources: Basic animal husbandry statistics, Ministry of Agriculture, and Government of India.

Annex 4: Decomposition of growth in egg production in India between 1993–94 and 2003–04

	Total layers ($\times 10^6$)	Local (% share)	Improved (% share)
TE 1994–95	124.4	53.7	46.3
TE 2003–04	202.3	43.5	56.5
	Production ($\times 10^6$)	% share	
TE 1994–95	20,270	34.5	65.5
TE 2003–04	37,513	23.3	76.7
	Egg yield (no./annum)		
TE 1994–95	163	105	230
TE 2003–04	185	100	251
	Share in increased egg production (%)		
Yield	4.9	–2.1	7.0
Number	88.9	12.9	76.0
Interaction	6.2	–0.7	6.9
Total	100.0	10.1	89.9

Sources: Basic animal husbandry statistics, Ministry of Agriculture, and Government of India.

Annex 5: Contribution of livestock to income and employment in different states in India

State	% share in agricultural value of output (2001–02)	% share in rural employment (1999–2000)
Andhra Pradesh	28.48	7.52
Arunachal Pradesh	19.89	0.41
Assam	14.89	0.60
Bihar	28.35	2.35
Goa	18.96	2.07
Gujarat	24.94	11.85
Haryana	33.04	17.04
Himachal Pradesh	28.37	11.09
J & K	34.32	1.61
Karnataka	21.68	2.79
Kerala	29.51	7.25
Madhya Pradesh	23.65	1.59
Maharashtra	23.21	2.45
Manipur	32.68	2.57
Meghalya	38.24	1.51
Mizoram	23.35	0.18
Nagaland	18.20	0.05
Orissa	11.67	1.24
Punjab	30.96	28.46
Rajasthan	27.63	16.50
Sikkim	18.37	0.60
Tamil Nadu	21.82	3.97
Tirpura	10.81	1.63
Uttar Pradesh	24.40	5.63
West Bengal	22.26	0.88
All India	25.12	5.49

Annex 6: Regional distribution of primary dairy co-operatives and processing plants, 2003–04

	Distribution (%)				Member/ DCS*	Milk procurement		Output procured (%)	Distribution of processing plants (%)		
	DCS	Members	Milk procured	Milk output		T/DCS per year	Kg/ member per year		Co-ops	Private	Total
Andhra Pradesh	5.1	6.4	5.5	7.9	140	62	443	5.0	4.3	3.1	3.5
Assam	0.1	0.0	0.0	0.8	31	17	548	0.2	0.0	0.0	0.0
Bihar	4.2	2.0	2.3	3.6	52	32	614	4.6	3.0	0.2	1.1
Gujarat	11.0	21.2	29.0	7.3	213	152	715	28.7	6.9	2.9	4.1
Haryana	3.9	1.9	1.9	5.9	54	28	517	2.3	2.2	7.0	5.5
Himachal Pradesh	0.2	0.1	0.1	0.9	72	39	537	1.2	1.3	0.4	0.7
Karnataka	8.5	14.3	12.9	4.4	187	88	470	21.2	6.9	4.5	5.2
Kerala	2.9	5.8	3.5	2.4	219	70	317	10.6	4.7	2.1	2.9
Madhya Pradesh	4.6	2.1	1.8	6.1	49	22	457	2.1	4.3	3.1	3.5
Maharashtra	16.7	13.0	15.4	7.2	86	53	619	15.4	24.6	23.3	23.7
Orissa	1.5	1.0	0.7	1.1	74	28	380	4.6	2.2	0.2	0.8
Punjab	6.6	3.3	4.3	9.5	55	37	673	3.2	5.2	6.6	6.1
Rajasthan	8.8	4.4	5.9	9.1	55	39	707	4.7	7.3	1.9	3.6
Tamilnadu	6.9	16.3	9.6	5.4	262	80	306	12.8	10.8	3.9	6.0
Uttar Pradesh	16.2	6.4	4.6	18.1	44	16	374	1.8	13.4	37.8	30.2
West Bengal	2.1	1.4	1.9	4.2	75	52	694	3.2	0.9	1.0	0.9
India Total	100.0	100.0	100.0	100.0	111	58	521	7.2	100.0	100.0	100.0

*DCS = Dairy co-operative societies.

Lessons from a changing world: Implications for livestock research and development

International Livestock Research Institute

Introduction

Globally, livestock systems are highly varied. They range from very extensive systems in low rainfall areas in which livestock breeds that have adapted over millennia are herded to exploit scarce water and feed resources, to highly industrial systems in which optimal feed, genetics and health inputs are combined within a controlled environment and the products sold internationally.

For much of the developing world, particularly in Asia and Latin America but also in densely populated parts of Africa, many livestock systems are changing rapidly. Human populations are growing and becoming more urbanized and richer. This has led to a rapid increase in demand for different livestock and livestock products. With this increased demand has come a new set of market requirements, particularly for product quality and safety.

This paper describes these broad changes in global livestock systems over the past few years and how these systems are likely to change in future. We pay specific attention to the increasing demand for livestock and livestock products in Asia, examining the main drivers of change in demand as well as the changing requirements for the livestock products demanded.

Within this systems-change and demand-led context, research needs to be responsive to what is changing. We discuss, for contrasting systems, how research and development can contribute to greater, more equitable and sustainable livestock sector growth through different technological, policy and institutional innovations. Feeds and nutrition, genetics and breeding, health and environmental management options for contrasting systems are assessed and specific opportunities for new scientific tools and approaches are examined. Finally, we look at the diverse opportunities that livestock provide for poverty alleviation.

Livestock systems evolution

Classifying livestock systems

Livestock systems worldwide can be categorized for the purpose of targeting research and development based on the integration with crops and relationship to land use into: (i) rangeland based systems; (ii) mixed farming systems, including rainfed or irrigated systems, and (iii) landless systems (Seré and Steinfeld 1996; Thornton et al. 2003). These systems encompass livestock production in most of the developing world. Smallholder producers tend to dominate mixed systems and pastoralist forms of production in rangeland systems. Large-scale commercial operations are important in rangeland based ranching systems and industrial type operations, particularly in producing pigs and poultry.

Livestock production contexts and the opportunities for using livestock as an instrument for poverty reduction are strongly influenced by natural resource endowments, alternative opportunities for use of land and labour, access to agricultural services, especially input and output markets, and use of technologies. Livestock systems in humid and tropical highland climates tend to have higher agro-climatic productive potential than systems in arid and semi-arid areas. In addition, access to market opportunities, whether domestic or foreign, and technologies are key determinants of the competitiveness of smallholders and the development opportunities that can be exploited to help poor people. Finally, alternative uses of land and labour strongly influence choice of appropriate production system, in that a shortage of one can lead to systems that rely primarily on the other. Several development trends and pathways can therefore evolve in livestock systems depending on the quality of the underlying resource base, the value of key factors, and the existence of accessible marketing opportunities. While the resource base may change only slowly through degradation or climate change, relative factor scarcity and market opportunities may change relatively rapidly; thus they provide the primary forces for changes in livestock systems over time.

There is wide diversity in livestock systems, ranging from semi-subsistence smallholder pastoral systems in marginal areas to large-scale industrial system producing for quality conscious consumers in domestic or export markets. Such diversity, and the potential dynamics of changing systems, presents formidable challenges, opportunities and entry points for the effective use of livestock in poverty reduction. In order to facilitate priority setting and to better target research and development investments, three generic contrasting livestock system types have been identified on the basis of resource potential, factor scarcity, and degree of market access. These system categories are: crop–livestock systems in marginal areas; intensifying crop–livestock systems in high potential areas; and, landless

industrial systems. Intensifying crop–livestock systems and industrial systems are largely driven by rising consumer demand for livestock products.

Crop–livestock systems in marginal areas

These systems are often characterized by limited agro-ecological potential, remoteness, and weak integration into markets. In many countries, they contain the majority of poor, highly vulnerable people. These systems include rangeland-based systems where the degree of crop–livestock integration is low as well as mixed cropping systems where the degree of crop–livestock integration is highly variable and market orientation is weak. In these mixed systems generally few purchased inputs are used so manure is important for soil fertility, particularly when land resources are scarce. Feeding systems rely to varying degrees on crop residues and rangeland. Examples of these systems include pastoralist, agro-pastoralist systems in the Sahel of West Africa, small-scale dual purpose systems in the Andean Region in central and southern America; mixed dry land systems in India, and the rice–cattle systems, maize–cattle systems and plantation crop–small ruminants and cattle systems in Southeast Asia. Livestock breeds are predominantly indigenous breeds that tend to have low productivity but are well adapted to the harsh environments.

Livestock provides a primary source of livelihoods for the majority of poor households. These systems are predominantly subsistence or semi-subsistence based because of their weak integration into markets. There are limited development opportunities, caused by one or a combination of constraints on demand, supply, and the inadequate provision of public investments. Demand side constraints include: low incomes; limited income-diversification opportunities; limited purchasing power; and, market demand. On the supply side opportunities are constrained by the vulnerability of these systems, which may be exposed to loss of animals due to drought, distress sales, and the resulting risk considerations that lead to low productivity due to limited adoption of improved technology. Inadequate infrastructure such as roads and communication facilities and weak institutional arrangements for service delivery such as in animal health and production services, increase transactions costs for any commercial activity.

Rapid population growth is a key driver of the evolution of these systems, inducing significant changes in land use and changing farming and livestock practices, by changing the relative supply of land and labour. Most pastoral and agro-pastoral areas are increasingly evolving into intensified mixed crop–livestock systems. High population densities also place severe pressure on the natural resource base and feeding systems. This is manifested in high rates of land and water degradation and increasing encroachment of crop farming into pasture land. Insecure land rights, periodic droughts, and extreme weather variability

are exacerbating these problems. The rapid pace of these dynamic changes is putting pressure on the capacity of traditional self-sustainable systems to cope. This is leading to a downward spiral into poverty for large numbers of livestock keepers and other poor people who depend on livestock, as well as having negative impacts on the sustainability of the natural resource base. The increasing vulnerability of these households and communities has and will contribute to growing conflict over access to land and water resources such as grazing areas and watering points. Increasing variability from climate change is expected to worsen such conflicts and further threaten livelihoods. In the absence of appropriate interventions these trends are expected to continue as population pressure increases in these areas.

Intensifying crop–livestock systems in high potential areas

These systems are found in areas of high and medium agro-ecological potential or irrigated zones, and include livestock systems in rangeland systems and mixed systems, particularly in areas close to urban consumers. Examples of these systems are the extensive meat and milk production systems in the highlands of Costa Rica, dairy systems and mixed crop–livestock systems in Colombia, peri-urban dairying systems in East Africa, rice–wheat–livestock systems in the Gangetic plains of India, wheat–maize–cattle systems in southwestern China, and small-scale buffalo milk production systems in India.

Depending on the system, the level of crop–livestock intensification in terms of production per land unit ranges from medium to high but the degree of market integration is generally high. In some systems, such as in the Gangetic plains and the mixed systems in southwest China, crop residues provide the main feed resource. In these areas, feeding systems exhibit strong seasonality of feed availability.

These systems encompass a diverse range of livestock production systems with varying development opportunities. Some areas are characterized by good and permanent access to transport and farm inputs, and are served by good public infrastructure. Smallholders may be relatively responsive to the opportunities provided by expanding livestock markets in these areas, for example, in the mixed crop–livestock systems in the highlands of Colombia, livestock production is expanding and providing increasing income-earning opportunities for poor people (Thornton et al. 2003). In other areas, such as the rice–wheat–livestock systems in parts of the Gangetic plains of India, the potential of the system to further intensify and specialize in producing high value livestock products is constrained by inadequate provision of key public goods such as roads and support services and weak market access.

Growing demand for livestock products and proximity to urban markets is one of the main drivers of livestock system changes. These changes are leading to expanding markets for livestock products and offer substantial opportunities for large numbers of smallholder livestock producers and poor people dependent on livestock food chains in situations where there is a supportive public and private investment environment. Empirical evidence from the smallholder dairying sector in Africa and Asia show beneficial direct and indirect impacts through generating income and employment in activities such as transporting, delivering, processing and equipment repair (Omore et al. 2004). However, in many high potential systems, large numbers of smallholders are not benefiting from the growing demand for livestock products because of numerous infrastructural, technical, institutional and policy constraints. An increasing concern is that the emergence of large-scale vertically integrated and concentrated industrial type livestock operations is crowding out smallholders and threatening their livelihoods. The growing pressures to respond to a rapidly growing demand for livestock products is also contributing to the loss of animal genetic resources in many intensifying systems.

Landless industrial systems

Landless industrial livestock systems have driven the growth of the livestock sector worldwide but at a much faster rate in developing countries. Worldwide, large-scale industrial livestock systems currently account for three-quarters of the supply of poultry, over two-thirds of all eggs and 40% of pork (Bruinsma 2003). These systems also account for the largest share of the rising volume of international trade in livestock products. Livestock production in industrial systems is increasingly concentrated in a few large countries in the developing world, mostly in East Asia and Latin America. For example, between 1967–69 and 1997–98 two countries, China and Brazil, accounted for two-thirds of the increase in livestock production in the developing countries. In these systems livestock production is de-linked from the natural resource base because feed inputs are purchased and it does not supply manure for crop production.

Large-scale industrial livestock systems are driven by the rapid growth in demand for livestock products, particularly meat and milk, increased flow of Foreign Direct Investment (FDI) to the developing world, growing importance of supermarkets in retail food chains in developing countries, declining real prices for feed grains, and technological change that has resulted in advances which have improved feed-to-meat conversion efficiencies, animal health, reproduction rates and reduced transport costs (Naylor et al. 2005). A primary driving force is also the rising opportunity costs of labour in growing economies, as agricultural workers migrate to new urban work opportunities. Smallholder landless livestock systems, such as urban backyard livestock and dairy production, are also driven by

the same market forces, but exist where labour is relatively available. In many developing countries the policy and institutional environment is also a key driver of the trend towards industrial systems.

The observed trend towards large-scale livestock operations in developing countries is expected to continue in the foreseeable future, especially in countries experiencing high rates of economic growth. The growth of industrial livestock systems and the tendency towards vertical integration and increased concentration has important implications for poverty. Without appropriate and proactive public action, large-scale industrial systems may displace large numbers of smallholders and other poor people dependent on livestock food chains. A range of technical, policy, and institutional interventions can, however, be used to help the poor benefit from these systems through generating employment and income along the livestock food chain.

Understanding how livestock systems are evolving together with categorizing livestock systems given above provide a useful analytical framework to analyse, prioritize, and target alternative technical, institutional and policy interventions for specific contexts. It provides useful insights into questions such as: how will improvements in feeding, management, health and breeding practices, as well as new institutional arrangements and policies brought about as a result of research, affect poverty levels? And which particular intervention—targeted at which particular role of livestock—will have the greatest impact on our ultimate goal? And what will be the mechanisms involved? In addition to the need to understand how livestock contribute to poverty reduction, there is also the need to understand how major changes in the world, such as population growth, globalization, climate change and market diversification, will affect these mechanisms.

Changing livestock product demand in Asia and emerging responses in supply chains

Rising consumption of animal source foods

From the beginning of the 1970s to the mid-1990s, consumption of meat in developing countries increased by 70 million tonnes, almost triple the increase in developed countries, and consumption of milk by 105 million tonnes of liquid milk equivalents (LME), more than twice the increase that occurred in developed countries. The market value of that increase in meat and milk consumption totalled approximately to USD 155 billion (in 1990 USD), more than twice the market value of increased cereal consumption under the better known 'Green Revolution' in wheat, rice and maize (Delgado et al. 1999).

Despite these changes the caloric contribution per capita of meat, milk and eggs in developing countries at the start of the new millennium was still only a quarter that of the same absolute figure for developed countries, and at 10% accounted for only half the share of calories from animal sources observed in the developed countries (Delgado 2005).

Table 1 shows the net increments in annual consumption levels for meat and milk in 2003 compared to 1983, and projected changes to 2020, for both developed and developing countries. Developing countries accounted for three-quarters of the expansion in global consumption. Except for dairy, the projected future growth of consumption to 2020 is expected to be less than the spectacular rises of the past 20 years, but still very high. As shown in Table 1, the rise projected for dairy product consumption in developing countries is huge at a net increment in annual consumption of 152 million tonnes by 2020 compared to 2002/2003, exceeding even the 132 million tonnes net increment in annual consumption in 2002/2003 compared to 1983. Past growth in developing country dairy was driven by India; although this will continue for some time, future growth is likely to also be driven by China, as will be explored below.

Table 1. *Increase in total annual meat[1] and milk[2] consumption,[3] 1983 to 2020, actual and predicted ($\times 10^6$ t)*

	Actual change 1983–2003	Projected change 2003–2020	Levels in 2003
Developed countries			
Bovine + sheep/goat meat	–2	+6	33
Poultry + pig meat	+21	+4	74
Dairy (LME)	+34	+18	268
Developing countries			
Bovine + sheep/goat meat	+22	+14	42
Poultry + pig meat	+71	+50	101
Dairy (LME)	+101	+152	223
World meat	+112	+74	250
World milk (LME)	+134	+170	491

1. Meat = beef, pork, mutton and goat, and poultry; 2. Milk = all dairy consumed as human food except butter in liquid milk equivalents; 3. Consumption = direct use as food, uncooked weight bone-in.
Sources: Increases in total annual meat consumption between 1983 and 1997 are based on differences between annual three-year averages based on the year shown, calculated from FAOSTAT (FAO, various years). The meat figures for 2003 are derived from preliminary worksheets obtained form the FAO commodities division. The milk figures pertain to 2002. The 2020 projections are from the July 2002 version of Rosegrant's IMPACT model (Rosegrant et al. 2001; Delgado 2005).

Dietary diversification into animal source foods in Asia

Although people spend more on food as their incomes rise, the share declines as they start to spend on other things as well. The overall share of food in household expenditures is in

fact declining in Asia over time, as predicted by Engel's law, but at 50 to 60% is still very high by the standards of the OECD countries (Gulati et al. 2005). However, people the world over also tend to substitute higher priced food calories for lower priced food calories as household incomes rise, and rapidly developing Asia is no exception. In particular, as incomes rise, there is a shift from almost exclusive reliance on grains and other starchy staple crops to diets including small amounts of meat, milk, eggs, fish, fruits and vegetables. Table 2 shows the changes in per capita consumption of selected foods over the period 1990–2000 in selected Asia cases. In most of the eight countries considered here, per capita grain consumption increased very slowly (Bangladesh, the Philippines and Thailand) or decreased slightly (China, India and Pakistan). Only in Indonesia and Vietnam did the annual growth rate in per capita grain consumption exceed 0.2%, with the highest being 1.2% in Vietnam.

Table 2. *Changes in per capita consumption of animal foods in selected Asian countries (kg/person per year)*

	Bangladesh	India	Pakistan	Indonesia	The Philippines	Thailand	Vietnam	China
Milk 1990	13.6	53.9	113.2	4.1	7.0	13.7	1.3	5.9
2000	13.9	64.9	152.8	7.2	8.1	22.4	4.7	9.6
Annual growth (%)	0.2	1.9	3.0	5.9	1.5	5.0	13.5	5.0
Meat 1990	2.8	4.6	11.9	8.0	6.1	21.4	16.0	25.9
2000	3.1	5.0	12.1	8.3	9.6	24.8	24.4	50.1
Annual growth (%)	1.0	0.9	0.2	0.4	4.7	1.5	4.3	6.8
Eggs 1990	0.6	1.2	1.7	2.1	1.9	10.5	1.2	6.4
2000	1.0	1.4	2.1	3.0	2.2	10.1	2.2	16.2
Annual growth (%)	4.6	1.9	1.9	3.7	1.6	–0.4	5.8	9.7
Fish 1990	7.4	3.8	2.0	14.8	12.2	20.9	13.2	11.5
2000	11.7	4.7	2.3	20.3	10.6	30.6	19.0	25.7
Annual growth (%)	4.7	2.0	1.6	3.2	–1.4	3.9	3.7	8.4

Source: FAO Food Balance Database cited in Gulati et al. (2005).

In contrast, milk consumption experienced some of the highest annual growth rates over the same period: 13% in Vietnam, and 5–6% in Indonesia, Thailand and China. Per capita demand for meat grew very rapidly (over 4% annually) in China, the Philippines and Vietnam and more modestly in Thailand, Bangladesh and India. With the exception of Thailand, where demand is high but stagnant, annual growth in the demand for eggs ranged from 1.6% in the Philippines to over 4% in China, Bangladesh and Vietnam. Similarly, the growth in demand for fish and seafood was over 3% per year in five of the seven countries under consideration.

It is worth noting that the two countries with the highest GDP growth rates, China and Vietnam, have also experienced some of the highest growth rates in per capita demand for

animal source foods. The relationship between income and consumption of animal source foods can also be seen by looking at the patterns across countries. For example, Thailand, with the highest per capita income among the seven countries, also has the highest per capita levels of consumption of meat, eggs, fish and fruit. Bangladesh, with one of the lowest incomes, has relatively low levels of consumption of many of the high-value foods. Regional factors, such as local prices and preferences, also play a role in determining high-value food consumption patterns. For example, milk consumption is much higher in South Asia than in Southeast Asia, while fish consumption is greater in Southeast Asia. Such comparisons also give a hint of the continuing favourable conditions for further expansion of consumption in those countries where per capita consumption remains very low by global standards.

Table 2 describes food consumption patterns in terms of aggregated categories such as 'chicken' and 'milk', but households also purchase more expensive items within each category as income rises. For example, they may shift, from whole chickens to packaged boneless cuts, and from raw milk to pasteurized milk and/or sweet meats. Thus, as incomes rise, the expenditure on each category of high-value food rises more quickly than the quantities.

Growth in export demand for high-value agricultural commodities

The opportunities faced by farmers in developing countries are increasingly affected not just by the composition of domestic demand, but also by that of export demand. The fact that demand is growing much faster in developing countries than in developed countries is due to the contested markets for new production will in future be in the developing countries, and less in the highly protected developed countries as has been the case up to now. As shown in Table 3, the growth in agricultural and fishery exports in the eight countries has been substantial: 4.8% per year over 1990–2000. But the export demand for high-value agricultural commodities has increased even more rapidly. By far the largest category of high-value agricultural exports is fishery products. Fish and seafood exports from these eight countries grew from USD 8.8 billion to USD 17 billion, representing an annual growth rate of 6.9%. In seven of the eight countries, the growth rate was over 4% per year. Five of these countries (China, Thailand, India, Indonesia and Vietnam) now export more than USD 1 billion per year in fish and seafood products.

Meat product exports from these countries were smaller (USD 2.5 billion in 2000) and grew more slowly (2.7%), mainly because China's meat product exports declined over the decade. Excluding China, meat product exports from the other seven countries expanded at 11% per annum. Dairy and egg exports are relatively small, USD 270 million in 2000,

but grew at 9.7% per year over the 1990s. The growth was concentrated in four countries (India, Indonesia, the Philippines and Thailand), which experienced growth rates between 6 and 46% per year. In all four countries, dairy exports dominate this category, but egg exports are significant in India and Thailand.

Table 3. *Changes in exports of selected foods over 1990–2000 (USD × 10^6/year)*

	Bangladesh	India	Pakistan	Indonesia	The Philippines	Thailand	Vietnam	China
Agricultural products (including fishery products)								
1990	325	3320	1015	2975	1575	6681	832	12,748
2000	470	6005	1173	5753	1917	10,087	3719	17,841
Annual growth (%)	4	6	2	7	2	4	16	3
Dairy and eggs								
1990	0	3	–	17	0	25	4	58
2000	0	45	2	75	13	45	4	86
Annual growth (%)	–	33	–	16	47	6	0	4
Meat products								
1990	5	79	1	14	1	314	29	1483
2000	0	325	7	13	2	782	119	1257
Annual growth (%)	–35	15	23	–0	6	10	15	–2
Fishery products								
1990	167	468	101	1109	419	2321	185	3997
2000	371	1483	160	1831	484	4472	1702	6624
Annual growth (%)	8	12	5	5	2	7	25	5

Source: FAO Agricultural Trade Database, cited in Gulati et al. (2005).
Note: Agricultural exports are defined broadly to include the sum of agricultural exports, as defined by the FAO, and fishery product exports. Compound annual growth rates are rounded to the nearest percentage.

While useful for an overview of the extent of trade, the export figures in Table 3 can be misleading if used as an indication of self-sufficiency in a given commodity, since they are commodity-aggregates and not given on a net basis; most countries both export and import products simultaneously. For example, roughly 30% of milk consumption in Bangladesh is import-based, although Table 3 shows no net imports of dairy and eggs into Bangladesh. Furthermore, consumption of milk products is rising rapidly in China, as is milk production. However, the latter is not keeping up with the former, so imports are rising rapidly as well. In 2003, China was a net importer of 2.8 million tonnes LME of dairy products, compared to 0.6 million tonnes 20 years earlier (FAOSAT 2005). Import demand for milk in various forms is likely to grow substantially in China over the next decades (Fuller et al. 2004). Presently that demand is primarily met from Oceania, but it is likely that it will begin to affect demand for exports from Southeast Asian countries and possibly South Asian countries in the foreseeable future.

Factors behind growth of demand for animal source foods

What is causing the growth in demand for animal source foods in Asia? Key drivers are rising incomes, urbanization and associated changing preferences, cheaper prices and increasing consumer perceptions of food safety.

Income growth

As discussed above, household income growth and dietary diversification go hand in hand: the share of food expenditures allocated to starchy staples declines relative to more expensive sources of calories. Thus, the level of per capita income is an important determinant of the composition of food expenditure, and the rate of growth of income is a key factor in determining the pace of change in food consumption patterns. Table 4 shows the level of real per capita gross domestic product (GDP) and the growth rate over 1990–2002. Thailand has the highest per capita GDP by a significant margin, followed by the Philippines, Indonesia and China. Vietnam and the three South Asian countries have lower levels of per capita GDP, all close to the range of USD 400–500 in 2002.

Table 4. *Trends in per capita income and per capita income growth*

	GDP per capita (1995 USD)			Annual growth rate (%)
	1990	1996	2002	1990–2002
South Asia				
Bangladesh	278	325	396	3.0
India	324	402	493	3.6
Pakistan	448	507	518	1.2
Southeast Asia				
Indonesia	777	1113	1060	2.6
The Philippines	1091	1122	1209	0.9
Thailand	1997	3015	3000	3.5
Vietnam	211	305	413	5.7
China	350	630	944	8.6

Source: World Bank (2004) cited in Gulati et al. (2005).

China and Vietnam experienced the most rapid rates of per capita GDP growth over the period 1990–2002, 8.6% and 5.7%, respectively. Bangladesh, India and Thailand achieved healthy growth rates of more than 3% per year. Average per capita growth rates in Pakistan and the Philippines were the lowest, hovering around 1% per year. These averages hide the large shocks experienced by Thailand, Indonesia and (to a lesser degree) the Philippines as a result of the Asian financial crisis. Although growth has returned to all three, Thailand and Indonesia are only now returning to their pre-crisis level of per capita GDP.

The response of consumer demand to income growth varies greatly over commodities and locations. Generally, animal source food demand tends to be 'elastic' with respect to household income, meaning that poor households in particular tend to increase their consumption of animal source foods by a greater percentage than the percentage increase in income they get, implying that the share of animal source foods in their household budgets is growing (Huang and Bouis 1996). The variability of income responses depending on location is well illustrated by the recent study for China by Ma et al. (2004) reported in Table 5, which shows the percentage that household expenditures increase on a given product when their total expenditures (i.e. income) increases by 1%. As can been seen, income responses differ markedly by product between the wealth of coastal districts centred on Shanghai and the much poorer southwest districts such as Sichuan and Yunnan. The wealthy zone was already saturated for pork and egg consumption by 2000, and is diversifying into dairy, seafood and beef. The poorer southwest is also diversifying from a much lower consumption base, and is still buying more pork and eggs, but also diversifying into other products.

Table 5. *Demand responses (%) to 1% household income increase in China, 1999–2001*

Region	Pork	Eggs	Chicken	Seafood	Beef	Dairy	Mutton
Urban households							
Coastal	0.00+	0.01	1.30	1.96	1.22	1.92	–0.18
Southwest	0.24	0.58	1.27	3.11	1.45	1.06	2.15
Rural households							
Coastal	0.79	0.82	1.80	1.00	1.13		1.97
Southwest	0.86	0.66	1.00	4.68	1.68		2.36

Notes: These are conditional expenditure elasticities from household data. Rural expenditure did not include dairy products. Coastal = Shanghai, Jiangsu, Zhejiang and Shandong. Southwest = Sichuan, Guizou and Yunnan.
Source: Ma et al. (2004).

Table 5 also illustrates differences between urban and rural income response in China. As pointed out previously by Huang and Bouis (1996), average urban per capita incomes and consumption of animal products tend both to be more than twice the level of equivalent rural measures in China. Thus the income responses below for urban households apply to (approximately twice) higher levels of base consumption, implying that the absolute quantities demanded per household increase more than (twice as much) in urban areas than rural ones if the response parameters are equal.

Almost half the world's population still live on less than the equivalent of USD 2 per day, and the majority of these nearly three billion people live in Asia (World Bank 2005). Under such poverty, the primary struggle is to meet basic caloric needs and the consumption of animal source foods tends to be low. Yet hundreds of millions of Asians have crossed the

USD 2/day threshold in the last two decades, especially in cities, and this has led to the surge in demand for animal source foods. Yet 1.5 billion people in India, China, Indonesia, Bangladesh and Pakistan alone still live on less than USD 2 per day, suggesting that the surge of demand for basic meat and milk products will continue for many years to come as the region develops.

Urbanization and population growth

Urbanization is associated with, not only higher average household incomes, but also differences *vis-à-vis* rural areas in the market value of time of food preparers (such as working wives), easier access to a more varied set of stores, more food consumed outside the home, increased contact with advertising and changing lifestyles more generally. A study of food demand in Vietnam indicates that urban households spend more on meat, fish, and sugar and less on rice than rural households, even after controlling for income and household characteristics (Minot et al. 2003). These changes are presumably related to the greater variety of food available and perhaps the higher opportunity cost of time of household members.

Another aspect of the shift towards higher-value food is the growing demand for prepared or semi-prepared foods. The rise of supermarkets is both a response to this demand and surely helps fuel new demand for such consumption. Food consumed outside the household at restaurants, fast food establishments and street stalls is another trend in urban areas and is highly correlated with the rise in consumption of animal source foods (Delgado 2003). A recent study in China indicates that food consumption away from home is occurring rapidly in small market towns and villages in rural China (Gale et al. 2005). As incomes rise and women join the work force, the opportunity cost of the time spent cooking and shopping rises, making these choices more attractive.

Table 6 shows that the percentage of the population living in urban areas has increased over the period 1980–2002 in all seven countries. The Philippines is by far the most urbanized, with over half its population in urban areas, followed by Indonesia, China and Pakistan. Thailand is the least urbanized. As claimed recently by Mohan and Dasgupta (2005), Asia's growth in the 21st century will primarily be urban growth, and it is likely that large parts of Asia will experience the structural transformation from being 75% rural to 25% rural that Latin America went through in the 20th century. This has enormous implications for the demand for animal source foods.

Finally, population growth itself increases the total demand for all food, including both animal source foods and staples. As shown in Table 6, the annual population growth rate

over 1990–2000 among the eight Asian countries discussed here varies from 1% in China to 2.5% in Pakistan. The top four net contributors to world population in the second half of the 1990s were in decreasing order of net new population: India, China, Pakistan and Indonesia, adding together on a net basis about 34 million new mouths to feed per annum (World Bank 2005). Population growth from 1970 to 1999 in the developed countries, for comparison, was only 0.7% per annum (Delgado 2003).

Table 6. *Urbanization and population growth*

	Urban population (as % of total population)		Population growth rate (%)
	1980	2002	1990–2000
South Asia			
Bangladesh	15	26	2.3
India	23	28	1.9
Pakistan	28	34	2.5
Southeast Asia			
Indonesia	22	43	1.5
The Philippines	37	60	2.2
Thailand	17	20	1.1
Vietnam	19	25	1.7
China	20	38	1.0

Note: The definition of the urban population varies across countries, so it is difficult to compare levels of urbanization across countries.
Source: World Bank (2004) cited in Gulati et al. (2005).

Cheaper meat, milk and eggs

Since the 1970s global prices of most meats and milk have declined by about half relative to industrial products (Delgado et al. 1999). This is reflected in many developing countries' internal price structures and one might think that cheaper milk and meat have driven the rise in consumption. While cheaper milk and meat have made these products more accessible to the poor, many other agricultural prices including cereals have seen similar declines and real price declines would not explain dietary diversification. On the other hand, there is lots of evidence suggesting that consumers in Asia and elsewhere are quite likely to substitute one meat for another when relative prices change among them. Demand studies also suggest that poultry demand tends to be quite sensitive to the price of fish and vice versa (Delgado 2003).

Table 7 illustrates some of the major world price swings for various meats over the 1991 to 2003 period. These are adjusted for inflation. If meats were a perfect substitute for each other, if world markets were perfectly integrated, and if preferences were not changing, we would expect these prices to move in lockstep with each other, which they clearly have

not. In part this reflects the disproportionate surge in production of pigs and chicken made possible by the extension of new technology and the cheapening of feed grains. However, the main explanatory factor of differential price trends is likely to lie in the fourth driver of demand for animal source foods, which is the perception of food safety.

Table 7. *Total real (inflation adjusted) price changes for meats, 1991 to 2003 in % (Total % change over the period)*

Period	Chicken	Pork	Sheep/goat	Bovine
1991/93 to 1996/98 (actual)	+11	–30	–41	+10
1996/98 to 2001/03 (actual)	–44	–36	+7	–3

Price changes are computed from worksheets of nominal USD prices for benchmark world series obtained form the FAO commodities division and deflated using the US Department of Commerce Seasonally Adjusted Quarterly US GDP deflator. Percentage differences were measured between the midpoints of the annual averages shown.
The commodities were represented as follows: Chicken—Brazilian free-on-board (f.o.b.) export series for broilers; Pork—US frozen pork export unit values; Beef—Australian manufacture cow beef charges-interest-freight (c.i.f.) prices to the US; Lamb—New Zealand frozen whole carcass sales in London wholesale markets.
Source: Delgado (2005).

Consumer demand for and perception of food safety

Increasingly world trade in meat and milk is affected by perceptions as to the safety of products, driven both by actual risks and the perception (often misguided) of actual risks. While growing world demand for bovine meat (beef and buffalo) has tended to outstrip supply in recent years as shown by the real price increases from 1991 to 1996/98 in Table 7, fears related to BSE have depressed what would otherwise likely have been soaring excess demand for beef products. In the highly segmented markets for meat and dairy justified by disease and food safety concerns, price movements are sometimes in different directions for the same commodity produced in different countries. Thus Australian beef producers not affected by BSE did very well price-wise, while US exporters did less well price-wise over the past two years as they could not have access until December 2005 to the Japanese market.

Similarly, both regulatory bans and adverse consumer reaction to avian influenza have had major but differing impacts on poultry prices in different countries since 2003. Interestingly, inflation adjusted prices for poultry declined fairly steadily on world markets from the start of the Asia economic crisis in 1997 until the spread of the present avian influenza outbreak in 2003. Since 2003, world prices for poultry products from disease free countries have nearly doubled, almost regaining the pre-Asian economic crisis levels, as the supply to this market has been severely curtailed and overall demand is strong. In those countries such as Thailand and Vietnam affected by disease and trade bans, however, poultry consumption has plummeted and export in uncooked form is not an option (FAO 2005). On the other hand, domestic demand for pig meat in those countries has reportedly soared. Even in

countries largely unaffected by avian influenza, such as France, poultry consumption is down by about 20% in 2005, which shows that in this business, perception is more important to demand than reality (FAO 2005).

The willingness of Asian consumers to pay for food safety is still largely unstudied. Twenty-five years ago, it would have been hard to imagine that Indian consumers would be prepared to pay as much or more per litre for safe bottled water as they do for raw milk on a widespread national basis. Because of the importance of zoonoses and the high perishability of animal source foods, food safety concerns are likely to be especially important to consumers.

Emerging responses in supply chains

The rise of short-cycle livestock and scaling-up of individual farm sizes

Rapid growth in the level and changes in the nature of demand for livestock-origin foods in developing countries have promoted equally rapid change in supply patterns in the developing world. Demand for quantity has provided the incentives for rapid expansion of production of short-cycle animals such as pigs and poultry, which can occur rapidly in response to inflows of investment capital. Three-quarters of the expansion in world meat production since the 1970s has been pork and poultry, and at least two-thirds of further expansion through 2020 is expected to come from these species (Delgado 2005). Livestock production growth has also been increasingly concentrated in a few large countries in the developing world, mostly in East Asia and Latin America. Between 1967/69 and 1997/98, two countries, China and Brazil, accounted for nearly two-thirds of the global increase in meat production.

Most particularly, there is a distinct trend in the scaling up of individual livestock farms. In Thailand, the number of farms with more than 5000 birds in the poultry sector increased by 135% between 1993 and 1995. In the Philippines, six firms account for 80% of the broiler meat market. In 2004, five companies in Brazil were responsible for 85% of livestock exports (Delgado et al. 2003). As livestock production has expanded rapidly in developing countries, intensive livestock production involving perishable commodities such as meat and milk has tended to be located in areas closer to urban markets and feed suppliers, to benefit from lower transportation costs. This may partially explain the concentration of large-scale intensive livestock production along the Eastern Seaboard of China, near Bangkok in Thailand and near Sao Paolo in Brazil.

Several factors explain the trend in scaling-up of short-cycle livestock production in developing countries. First, rapid growth in demand concentrated in urban areas has made the short-cycle livestock sector attractive to investment capital, in a way that smallholder and rural multi-purpose livestock was not. Second, technology transfer from the developed

countries to developing countries for producing these short-cycle animals is relatively easy, in areas such as breeding, feeding, animal health and housing. Rapid expansion in poultry production in Asia could have occurred technologically-speaking 25 years earlier than it did, but it only did occur once demand growth starting in the 1970s provided the market (Delgado et al. 2004). Third, developing countries tend to have less stringent environmental and animal welfare standards, weak enforcement of regulations and limited private sector spending to mitigate the effects of negative cost externalities (Nell 1998). Large firms have more of a problem disposing of manure sustainably, as spreading on crop fields is not often an option, unlike for most small farms. In fact, Delgado et al. (2003) have shown that large short-cycle livestock farms in Brazil, India, the Philippines and Thailand pollute more per unit of output than small farms. Since they do not compensate for this, it gives large farms a significant cost advantage, although probably not enough to explain scaling up on its own. Fourth, liberalizing Foreign Direct Investment (FDI) in many developing countries that made available additional resources for large investments and economies of scale tends to give competitive advantages to large-scale enterprises.

Increasingly vertically-coordinated and concentrated supply chains

The demand trends explored above involved not only increased demand for quantity, but also a growing willingness to pay for food safety and quality in developing countries, particularly in those urban areas of Asia and Latin America where overall demand has grown the most. The demand for safety and quality emphasizes the need for control over critical points in the supply chain, starting from the farm. This helps explain the trend towards vertical co-ordination of supply, often accomplished through contract farming. Ensuring market recognition of quality outputs requires credibly certifying the use of quality inputs and care, which is easier in vertically integrated systems. This integration typically gives a larger role to feed millers and food processors in livestock value chains. Since it is cheaper to contract with larger farms than smaller ones, these factors are also driving the emergence of large-scale livestock enterprises, particularly in East and Southeast Asia and Latin America, but there are also examples in Africa (such as Farmers Choice in Kenya).

Another result of the demand for convenience, predictable quality and safety is the growing market reward for satisfying these wants, which has led to increased private sector industrial investment in retailing as well as production. These trends are associated with the growing importance of supermarkets in retail food chains in developing countries (Reardon and Berdegué 2002). Although these developments in the agri-food industry are driven by demand factors that make them profitable, they are also greatly facilitated by the increased flow of Foreign Direct Investment under globalization. Change in supermarket procurement systems is a rapidly growing trend in Asia particularly in East and Southeast

Asia starting from the 1990s and into the 2000s, with a shrinking number of procurement officers responsible for a growing share of total purchases from farms.

The diffusion of supermarket operations in semi-fresh products such as dairy and fresh food such as poultry and meat has been somewhat slower compared to processed food such as prepared and packaged food. However, sectors such as poultry, beef and pork which are experiencing increasing concentration in processing and production are rapidly being taken over by supermarkets in developing countries. The changes in supermarket procurement systems to ensure safety and quality have led to the emergence of demanding private standards, private enforcement of public standards and processes for controlling risks that favour large-scale operators with the capital to make investments in technological, institutional and organizational innovations that are necessary to remain competitive and withstand public scrutiny (Reardon and Berdegué 2002).

Lengthening supply chains and sanitary certification issues

Concurrent with the increased importance of supermarkets has been the growing length of market chains, with commodities moving rapidly from one corner of the world to another. Inevitably this is more difficult with perishable livestock products, but the improved capacity and availability of refrigerated freight services have revolutionized such trade, allowing fresh salmon, for example, to be flown great lengths to reach its destination. And this is even true in developing countries, particularly where land-locked countries, for example Ethiopia, air freight carcasses and other meat products to the Middle East. Some Middle Eastern meat market enterprises are developing partnerships with multiple supply sources for small ruminants as far away as Mongolia and Uruguay.

Some negative implications of changing supply chains

The observed trend towards large-scale livestock operations in developing countries is expected to continue in the foreseeable future, at least for monogastric livestock. An increasingly concentrated and vertically integrated livestock sector has important implications for poverty, the environment, and animal and human public health. Without appropriate and proactive public action, large-scale livestock operations may displace small-scale producers on family farms particularly the 'asset and information poor' who cannot easily make the additional investments and meet the farm and post farm production and management practices and other requirements to meet the changing product specifications of the 'new' livestock economy.

On the other hand, poor people may actually benefit from concentration and vertical integration of the livestock sector in developing countries if such transformations generate

additional employment and income in other parts of the value chain. There may also be more scope for smallholder success in dairy, where true economies of scale in production if not in processing are less, and in forms of contract farming involving small-scale producers where larger units will not be able to gain access to land and labour.

Regarding the environment, the greatest challenges arise from nutrient waste management, loss of indigenous animal genetic resources, and environmental pollution arising from discharges and run-offs in water sources. Additional negative environmental impacts arise from emissions of toxic and green house gases to contribute to global warming. There is limited empirical information on the environmental and social impact from large-scale intensive livestock production in developing countries. The increasing concentration of livestock and people, particularly around peri-urban areas in developing countries, pose great public health challenges from contaminated food, pollution and diseases.

The rapid growth of large-scale industrial livestock operations that typically seek uniformity in product has also been associated with accelerating loss of livestock genetic diversity in developing countries. There is limited empirical evidence to reliably quantify the magnitude of livestock genetic losses but the evolution of livestock systems in these countries suggest that the development and expansion of large-scale intensive livestock operation are relying increasingly on a narrow range of genetic resource material for commercial breeds of poultry, pig, and cattle that are well adapted to concentrate feed and confined housing systems. The rapid pace of expansion of large-scale commercial operations in developing countries tends to rely overwhelmingly on imported breeding materials to meet the strong demand for livestock products.

Thus much of the supply response for meat, at least in developing countries, has involved significant private sector entry into production and retailing. Supply chains have been influenced by industrial practices from this entry, but fundamentally are the result of market responses to increased demand for quantity, quality and safety. The resulting scaling-up in farm sizes and concentration of supply chains pose threats as well as opportunities. Dealing with these threats as well as capitalizing on the emerging opportunities requires proactive attention to technology and policy issues that in combination can realize the opportunities while mitigating the threats.

Threats and opportunities in a systems perspective and changing technological, institutional and policy options for dealing with them

Livestock production systems respond to factors that cause change, such as rising market demand, growing population pressure and emerging disease threats, to name but three. The threats and opportunities brought about by these changes are best understood in a systems context. The relevance and balance of technological, institutional and policy interventions for livelihood-enhancing outcomes will vary by the type of production system and the factor or factors driving change. Although livestock production systems are as diverse as other aspects of global agriculture, it is useful to think in terms of three main categories, all of which may or may not be present in a given geographic zone.

At one extreme, there are truly industrial livestock systems, veritable 'factories' for industrial-grade commodities. In the middle, and by far the most important in developing countries, there are intensifying smallholder crop–livestock systems. At the other end of the spectrum are the systems in marginal or 'low potential' areas, generally dry and harsh environments with limited capacity to expand production in response to changing markets.

Common to our efforts to improve livelihoods in each of these systems is the need to assess the mix of technological, institutional, and policy constraints that is reducing productivity and that influences environmental impacts and equitable growth. The specific system, its mix of constraints and the basket of possible technological, policy and institutional interventions will determine the likelihood of success in improving livelihoods and the relative roles played by the private and public research and development (R&D) communities.

Industrial production systems

Private sector R&D is the prime driver of efforts to further enhance productivity and profitability in intensive, industrial-type livestock. The R&D is epitomized by multi-national company support to non-ruminant production, particularly for chicken meat and eggs and, to a smaller degree, pig meat. These landless, industrialized systems achieve high livestock productivity and quick supply growth based on improved and more uniform genetics and controlled conversion of high-energy feeds into muscle and fat. There is no doubt that they have kept consumer prices of chicken, eggs, pig meat—and in some countries milk—from rising rapidly under the surge in new demand. More integrated control of the supply chain also can improve food safety and mitigate some disease threats.

On the other hand, industrial systems generate large concentrations of waste nutrients. In many countries, who pays the bill for managing this nutrient surplus is an important

challenge for public policy research, particularly when regulatory institutions are weak (FAO 2005). There may also be a danger in the shrinking of animal genetic diversity as proprietary breeds with desirable characteristics for producing uniform industrial products begin to account for growing shares of total production. Finally, increasing densities of animals kept create the need for rising use of antibiotics and may increase the risk of disease transmission due to higher concentrations of animals and people being in one place. Governments are increasingly having to address the environmental and human health threats resulting from the transfer of feed nutrients into towns and cities and the accumulation of wastes. In the urban and peri-urban settings that most often house industrial systems, related threats may result from the use of urban wastewater to produce forages for these dairy units.

Technological interventions are especially important in these systems, and are driven by the private sector, which is well placed to capture the benefits through patents. As with other industrial ventures, regulatory approaches to threats are easier to implement than in the case of a massive number of smallholders.

Intensifying crop–livestock systems

These systems include the vast majority of people in developing countries who depend on livestock for income. Where crop–livestock systems are responding to increasing market demand, improving the feed resources derived from major crops is one way to sustain the competitiveness of crop–livestock farmers and landless livestock keepers, the majority of whom depend upon crop residues for their livestock's basal diet, at least for a major part of the year. Research to improve both food (for humans) and feed (for livestock) in these food–feed crops requires close collaboration between crop breeders, agronomists and livestock scientists, and strong linkages to the seed systems which serve the crop farmers. Manure in these systems is often a valuable resource for sustainability as opposed to a pollutant ending up in waterways.

Intensification in these systems is invariably associated with higher animal-to-land ratios and greater labour input to the farm. This creates employment, but at some point pollution becomes an issue. Rising opportunity costs of labour may also become an issue, as is happening in China. Desirable genetics appropriate for smallholder systems as opposed to just average productivity increases also become an issue, as illustrated by the reversion of smallholders in some areas to mixed indigenous–exotic animals as opposed to the pure-breeds introduced previously.

Conditioning smallholder decision-making in intensifying systems on feeding practices will be related to farmer decisions on a shift from the local indigenous breed of cow or pig to a crossbred, and in turn this decision will be influenced by the risk of infectious and endemic

diseases. Generally in intensifying smallholder crop–livestock systems health constraints are associated less with infectious diseases, because of small herds and increasing levels of stall-feeding, but are associated with undernutrition and endemic diseases like parasitism, pneumonias and scours, which are management responsive.

Institutional issues are especially important in these systems, as large numbers of small farmers find it difficult to brand their livestock products and consequently often receive lower prices. On the other hand, regulations are typically very hard to enforce at this level, so policy interventions not accompanied by improved technology and institutions is not likely to be very successful.

Livestock systems in marginal (or 'low potential') areas

Technological options in these systems are much more limited than in the more market-led industrial or intensifying crop–livestock systems. Vaccines for infectious diseases—epidemic (e.g. foot and mouth disease, FMD) and endemic are often important, as in the case of Rinderpest eradication. Yet policy and institutional complements to technology are even more important than in the other main systems, as these systems are almost by definition to be found where institutional and policy frameworks are relatively weak.

For marginal systems, feed technologies often relate not so much to the feed itself, but to the availability and access to feed. Livestock keepers in such systems are often nomadic or transhumant and rely on being mobile to enable not only access to feed, but also management of the natural resource base—so as to prevent overgrazing leading to soil degradation for example. In many instances, increased cropping is restricting mobility and forcing new issues of conflict, overgrazing and limited access to water. Issues relating to policies and local community institutions are thus especially important in managing feed resources and disease control in marginal areas.

Technologies for harnessing opportunities and mitigating threats

Four major technology areas, for which responses to challenges to demands from changing livestock systems are required, will be discussed. These are feeds and nutrition, livestock health, animal genetic resources and livestock–environment interactions. The mix of technologies varies depending on whether they are addressing market-led or marginal systems.

Feeds and nutrition

For market-driven systems, appropriate livestock feed is a key issue in ensuring that livestock productivity is raised to a level for producers to be competitive in expanding and

emerging markets. Highly industrialized systems may import feed rations, or ingredients and use recommendations from developed countries, for example for pig and poultry production in Asia (FAO 2005) and these may go hand in hand with exogenous animal genetic resources. Such options may work in terms of livestock productivity, but may also present new challenges in terms of pollution and nutrient management (FAO 2005) that need to be addressed through policy options (see below).

Urban and peri-urban livestock producers are often landless and may rely on local markets for feed inputs. New research being led by the International Water Management Institute (IWMI) in collaboration with ILRI and local partners in peri-urban Hyderabad, India and Faisalbad, Pakistan seeks to understand some of the livestock feed related opportunities in such areas—where para grass *(Brachiaria mutica)* grown on wastewater is a major feed source. Two feed related issues are relevant here—one relates to understanding the key risk points on the chain from feed production, consumption and milk production in relation to the potential transmission of health problems because of wastewater use. The second is to identify alternative feed sources, because in some cases, market-driven vegetable growing is taking over from para grass—reducing the major feed source. For peri-urban livestock producers, access to information and a range of service providers—especially for feed is crucial.

Where crop–livestock systems are intensifying, a particularly successful option has been the development of food–feed crops. This research requires a partnership between the crop and livestock sectors. The livestock research focuses on the nutritional value of crop residues and then crop breeders incorporate these traits into their breeding programs and seed delivery systems. Internationally, the Systemwide Livestock Programme (SLP) has played a major role in fostering such partnerships for key staple crops including sorghum (Gurava Reddy et al. 2005) and millet (Blümmel and Rai 2003) in India, cowpea in West Africa (Tarawali et al. 2003) and groundnut in India (Blümmel et al. 2005; Prasad et al. 2006). In the latter case strategies originally focused on providing farmers with access to improved dual purpose groundnut varieties have also moved on to address multi-stakeholder approaches, identifying constraints and opportunities in relation to the use of the new varieties.

A particularly noteworthy example of how feeding strategies can be adapted to changing systems is in the use of sweet potatoes for pig feed in China (www.casren.org). This is a case where a combination of technologies, institutional arrangements and policies were brought together to increase the market success of smallholder pig farmers in responding to a rapid rise in the demand for pork. The feed related technology components included dual-purpose sweet potato varieties, methods for ensiling vines and tubers, pig health interventions and improved pig genetics (farmers access to improved piglets). This was then

linked to local institutional changes and capacity strengthening so that service providers could improve the performance of input supply and output markets. With these innovations, local pig producers doubled the number of pigs they were able to sell.

Forage species have been tried and tested throughout the world, with many disappointments and some examples of success. One successful example is International Centre for Tropical Agriculture (CIAT's) work with partners introducing forage species in six Southeast Asian countries (http://www.ciat.cgiar.org/asia/forages.htm), and in other parts of the world (Shelton et al. 2005). Among the key factors influencing where such specialized crops will be successful is the market demand for livestock products (e.g. Napier grass in Kenya influenced by growing dairy demand).

For marginal systems, feed technologies often relate not so much to the feed itself, but to the availability and access to feed. Livestock keepers in such systems are often nomadic or transhumant and rely on being mobile to enable not only access to feed, but also management of the natural resource base—so as to prevent overgrazing leading to soil degradation, for example. In many instances, increased cropping is restricting mobility and forcing new issues of conflict, overgrazing and limited access to water. Issues relating to the policies and local community institutions are thus important in managing feed resources in marginal areas.

An emerging option with respect to feed resources is the use of geographic information system (GIS) approaches to target appropriate feed strategies, not only in relation to agroclimatic parameters, but to social and economic variables that are likely to influence the availability and use of, for example, crop residues. This approach has proved successful in Ethiopia in developing and targeting research on maize as a food–feed crop.

In many instances, there is a growing recognition that a single feed-based intervention may not necessarily be appropriate, but rather an approach that considers feeding strategies—the mix and constraints related to feed resources that farmers have to grapple with in order to sustain and, ultimately, make their livestock productive and competitive and how these might be used to maximum effect, in combination with strategies that improve individual components. Increasingly it is becoming evident that the availability of research-generated prescriptions for feed options is insufficient to generate significant improved livestock production through better nutrition at farm level. A much greater vision is required of how farmers make changes and the role of such technologies functioning within a web of interlinked actors, in order to determine the success or otherwise of such options, as with the new groundnut varieties in India (Prasad et al. 2006).

Animal health

This section will highlight some examples of the livestock health technologies available or emerging that may play a role in responding to the threats and opportunities in different systems. With the support of the UK Department for International Development (DFID) and in partnership with many national and international organizations, ILRI led a review of the strategic research needs in animal health to help reduce poverty in sub-Saharan Africa, South Asia and Southeast Asia (Perry et al. 2003). They classed them as falling into the following three fundamental groupings:

- Epidemiology, economics and impact assessment leading to sound science-based decision support
- Technology development and modification
- Innovation tools that consider the effective use and application of new technologies.

Differing technology priorities in market-responsive and marginal systems

In the relatively controlled environments of intensive and industrial systems focused on pig, poultry and to a lesser extent dairying, the technology focus is in improving the efficiency of production, for which there are a variety of 'production management medicine' tools, many of which are adaptations of the preventive medicine and herd health programs developed in the West some decades ago. These are driven mainly by the private sector, with sophisticated diagnostics, vaccines, software and information management tools. In some cases the more sophisticated examples are even moving towards becoming 'compartments', as seen emerging in pig and poultry production in Europe, with increasingly sophisticated bio-security facilities. These are implemented to reduce the health and food safety risks at the start of product value chains, and provide an 'island' of low disease status that sometimes contrasts dramatically with the disease endemicity outside. There are examples of such approaches in the pig sectors of Thailand, Kenya and Zimbabwe. But there are also examples of businesses that combine bio-secure facilities with separate contract farming enterprises, and these provide the opportunity to extend the genetic, feed and health technologies to their outgrower business partners.

In smallholder urban and peri-urban systems, with high concentrations of people sometimes keeping multiple species of livestock and other domestic animals, the threat of zoonotic diseases plays a most significant role. In such cases it is often not the lack of effective technologies to respond, but rather issues of their availability at an affordable price, the understanding of disease ecology and the risks to livestock keepers and consumers and how to evolve institutional arrangement and policies to most effectively implement available and emerging technologies and control strategies. These challenges can be met with sound application of epidemiology and risk assessment tools.

The story is not dissimilar in many intensifying mixed crop–livestock systems responding to market opportunities, in which it is the deployment of vaccines and therapeutics to control the endemic diseases that remains a priority, and for which it is modifying existing technologies that provides research opportunities. An example that has had success in some settings has been the use of intra-ocular vaccines for preventing Newcastle disease of poultry, in which there was a need both for an innovative approach to vaccine administration appropriate to use by community animal health workers rather than veterinarians, as well as the development of effective understanding of the incentives to and roles of different players in the community to ensure the sustainability of vaccine (and long-term population immunity of village poultry populations).

Role of new epidemiology, economics and information management technologies

For all of these system examples, tools for the modelling of disease epidemiology, dynamics and impacts have become a very important and evolving branch of the sciences in both human and veterinary medicine, and have proved valuable in the understanding and control of infectious and non-infectious diseases. As an example we consider FMD, important in South and Southeast Asia, in terms of its impacts on small-scale producers in both market responsive and marginal systems, and on regional and international trade opportunities for livestock products. Modelling has been used in several different ways in evaluating the dynamics and control of FMD, and the recent outbreaks in the UK and continental Europe in 2001 gave rise to a flurry of modelling activity (see for example Ferguson et al. 2001a, 2001b; Kao 2001; Keeling et al. 2001; Morris et al. 2001; Woolhouse et al. 2001; Schoenbaum and Disney 2003; Wilesmith et al. 2003; Kitching et al. 2005). In the developing world there is a growing literature on the economic returns from FMD control in different settings (see for example Perry et al. 1999; Perry et al. 2002, Randolph et al. 2002; Perry et al. 2003; Perry and Randolph 2004; Rich et al. 2005).

The modelling and associated studies undertaken in the developing world have shown that FMD has direct impacts on the health and welfare of the different livestock species kept by the poorer sectors of society in Africa and Asia (such as the impacts on smallholder producers in Laos: see Perry et al. 2002), but the extent of these impacts varies considerably by system. The more marginal systems of the Horn of Africa, for example, appear less affected by the transient lameness and condition loss, depending on the season, but the mere presence of the disease constrains them, and others in their countries (notably the crop–livestock systems and even the more bio-secure intensive systems) from taking advantage of their livestock resources for lucrative export markets.

The economics modelling tools have shown that where FMD has been successfully controlled allowing meat and other products to be exported, significant national economic benefits to the country concerned have resulted. Furthermore, the multiplier effects of these national benefits have been transmitted to other sectors of society, including the very poor, through employment opportunities, institution strengthening, the development of viable support services and the raising of domestic meat prices. For the public sector, it is important to better target and improve these programs for the benefit of the poor. In recent case studies undertaken by ILRI and its partners in southern Africa, Laos, Thailand and the Philippines it was found that an imbalance occurred in which the public sector often bore most of the costs of FMD control and the benefits were almost exclusively captured by private sector exporters. It is important to consider carefully how to optimize the economic benefits from public programs in a more socially equitable way to alleviate poverty while supporting broader economic growth.

The rapidly advancing tools and capacities in biotechnology: Scientific advancement continues at a pace, particularly in the developed world, improving the capabilities of the 'hard' technologies. Rapid advances in genetics, proteomics, immunology, vaccine design and delivery, and chemotherapeutics offer unprecedented opportunities to develop new tools to prevent, control and treat animal diseases (see for example Arvin and Greenburg 2005; Henderson 2005). Vaccines are of particular importance to a wide range of diseases, given the sound principles behind them of developing and sustaining population immunity, combined with the evidence of the overwhelming economic viability of vaccine development, particularly for human diseases (see for example Ehreth 2003; Chabot et al. 2004).

Promising candidate approaches in vaccine development include improved adjuvants, greater payload of vaccine antigens, new modes of presenting antigens to develop effective immune responses, such as the use of virus, bacterial and plant vectors, alternative vaccination protocols and the use of different routes of immunization other than by injection.

With the availability of these new tools of modern science comes an increased complexity in the institutional arrangements for vaccine development, production and distribution. Research consortium of public and private sector institutions from upstream science to downstream delivery are required. One example ILRI is involved in is a consortium for developing a recombinant vaccine for *Theileria parva*. In this consortium, The Institute for Genomic Research in USA (TIGR) and the Ludwig Cancer Institute in Belgium led the work in identifying a long-list of candidate antigens. These were screened by ILRI using new immunological screening assays and eight promising antigens were identified and vaccine

prototype constructs produced by the private-sector biological company, Merial. ILRI then conducts in-house vaccination trials and will link with national agricultural research institutions and regulators in East Africa for field trials, product registration and delivery issues. This approach could be replicated for a number of other tropical diseases in which vaccines are needed.

When imperfect technologies need to be relied on, innovations are required to investigate how to best have impact within the constraints of the system. Even when reasonable technologies are available, they are not well adapted to the circumstances of livestock systems in the developing world. A classic example is in FMD. Current needs for the FMD-free countries are vaccines that induce immunity rapidly (to slow virus spread), there is not a need for broad protection across strains (as strain identification can be completed in a matter of hours), there is no need for long immunity (as vaccinated animals will likely be slaughtered to regain FMD-free status), and there is no need for vaccines that are heat stable (as cold chain technology is universal). In contrast, the specifications for many of the developing countries in which FMD is endemic are different, and include long immunity (to help achieve high population immunity and reduce the cost of vaccinations), broad strain protection (as virus identification and response mechanisms are often slow or ineffective), and heat stable vaccines with less reliance on rigorous cold chains (to cope with tropical climates or poor cold chain infrastructure). Clearly this dichotomy presents considerable opportunity for international partnerships in vaccine development, evaluation and registration.

Delivery, adoption and impacts of animal disease control interventions

The increasing range of technological innovations at our disposal for improving animal health come in various forms, and on top of the technology hardwares are the new approaches to their distribution, delivery, adoption, use and impact, in the form of innovation and knowledge management systems (see for example Hall et al. 2002). An important component of innovation systems is the establishment of a 'web of relationships', meaning that communications and collaborations are an increasingly important part of livestock research and development. While technologies can facilitate the growth and operation of such 'webs of relationships', it is the social and political aspects that demand the hard work. We have seen recent examples of where the need for these has been driven by circumstances, such as the international networks that have rapidly risen in response to the avian influenza outbreaks in Southeast Asia, but clearly there are long term needs of different regions that can be better served by strategic proactive development of partnerships, taking maximum advantage of technological developments. Technologies are also under development to better understand human communication and interaction in

promoting innovation, under the general title of complex systems science modelling (see for example Eubank et al. 2004).

Health and food safety constraints to market access for livestock products

In considering the constraints to market access for the poorer sectors of society, it is important to think of broader groupings of diseases and other constraints under the category of Sanitary and Phytosanitary (SPS) issues. A key finding of a recent ILRI/FAO study (Perry et al. 2005) was that capacity in many developing countries is lacking with respect to compliance with, or even understanding of, SPS requirements, and of broader issues related to exporting livestock products. There is a need for combining policies, institutional and human resource capacity, and technologies developments to respond to these needs. Furthermore, very little is known about the implications for poverty reduction in those countries that are currently exporting, and clearly such understanding is crucial to political and economic support to trade initiatives. While there is a general understanding that benefits from export markets can a) open up domestic markets to smallholder producers, b) that smallholders can become directly involved as outgrowers or contract participants, c) that there are opportunities for wage employment in production and marketing sectors, d) that there will be technology spill-overs to smallholders (including animal genetic resources, feeds, services, market infrastructures and technologies), and e) that price transmission (both to poor producers and consumers) is important, these different effects have not been evaluated in most settings. Importantly there are now several very useful modelling techniques, such as Social Accounting Matrix (SAM) models, that can be used to evaluate the distributional impacts of benefits derived from market access.

Animal genetics and breeding

As with animal health, the challenge in animal genetics and breeding is to mix new technologies with sound decision making and practical implementation through institutions that can develop strategies for the co-evolution of livestock genetics and livestock systems and to manage the delivery of the appropriate genetic change. For this to succeed, both a supportive policy environment and strategic public sector interventions are essential.

Differing technology priorities in market-responsive and marginal systems

As for other livestock technologies, genetic technologies for the relatively controlled environments of intensive and industrial systems focused on pig, poultry and to a lesser extent dairying, are developed and delivered by the private sector. Genetic selection and breeding programs are very sophisticated and increasingly supported by marker-assisted selection techniques.

At the other extreme of marginal systems in semi-arid and arid areas or in higher-rainfall areas disconnected to markets, indigenous breeds, adapted to the prevalent climatic and disease environments, are essential (Baker and Rege 1994). Indigenous livestock have co-evolved in these systems over millennia and have critical genes for resilience to the climatic and disease shocks found in these environments. Improvement programs for indigenous livestock need to be linked to feeding, health and environmental strategies in marginal areas.

Decisions on genetic technologies and breeding strategies are much more complex in systems intermediate between these two extremes. There are a number of principles and factors that need to be strategically balanced. One important principle is that the genetics of livestock in a system needs to be carefully balanced with the feeding, health and broader environmental and market demand components of the system. What is required is to manage the co-evolution of genetics (genes rather than breeds) within systems. This co-evolution will take place at different speeds within different systems. Within this context, there will be a constant need to improve productivity since increasing demand will need to be supplied from a relatively non-increasing land and water resource base and without increasing the efficiency of production, smallholder producers in mixed systems will be uncompetitive.

New molecular tools and their application in conserving genes and managing genetic change

As with the description of animal health, animal genetics is being transformed daily, with new technologies and approaches. In recent years, the genomes of major livestock species have been sequenced and rapid progress will be made in functional genomics. These results will be quickly adapted into breeding programs for intensive and industrialized pig, poultry and dairy production. This will be largely done by the private sector.

A major challenge for the public sector will be preserving the critical genetic resources for climatic adaptation and disease resistance. There is an important danger that critical genetic resources, adapted over the millennia will be lost through indiscriminate crossbreeding and introducing inappropriate genotypes. As an indicator of this risk, it is estimated that approximately one-third of known breeds of livestock worldwide, the majority in developing countries, are threatened with extinction (Schearf 2003). This is most important in systems where resistance and resilience of livestock are critical. Modern molecular and bio-informatics methods can play an important role in identifying what genetic traits are under threat of disappearance and what genotypes appear to be best adapted to different livestock systems.

While modern science tools can play an important role in identifying gene conservation issues, there is a major public policy and institutional gap that needs to be addressed if animal genetic resources are to be effectively conserved. One major evidence gap is the lack of knowledge of what genes will be conserved within what systems based on the productivity and income objectives of livestock keepers and what genes will need to be conserved through public investment for a public good. Conserving animal genetic resources as an international public good will need to consider lessons from the provision of other environmental services in other disciplines.

Delivery and adoption of genetic change in smallholder systems

The real challenge for the public sector is in delivering practical genetic changes to diverse and intensifying smallholder systems. A key research issue is to understand, in different systems, the balance of the need for improved productivity with survival under smallholder management. This requires a good knowledge of the drivers and constraints in the system and an understanding of the underlying genetic diversity of livestock populations.

Once this over-arching genetic balance is determined, the practical issues of how breeding systems can be organized to deliver the required genotypes must be addressed. Different approaches and options that require further development include:

- nucleus crossbreeding ('creep-upgrading') systems designed to allow co-evolution of genotype with production system changes
- community-based breeding programs that address current constraints: e.g. small herd/flock sizes with little opportunity for selective breeding, inadequate capacity for recording, uncontrolled mating etc.
- strategies (including development of composite breeds or specialized (cross)breeding herds/facilities) to generate sustained replacement stock in systems where crossbreds are the best option.

Research and development efforts to address these issues are critical and require much more thought and investment.

Livestock–environment interactions

For intensive, market-led livestock systems, the potential of livestock production to impact negatively on the environment is all too apparent, and in the majority of cases at this end of the spectrum, the strategies to address such challenges are policy (see below) together with information access and response mechanisms rather than technology based. This includes, for example, ensuring farmers have appropriate information and incentives on feed rations, that will minimize pollution. Nevertheless, in intensifying crop–livestock systems, there are new opportunities to address the fine balance between increasing production and

minimizing impact on the natural resource base. A recent example is research that is beginning in the context of the Rice–Wheat Consortium (www.rwc.cgiar.org) to address the trade-offs between the very successful conservation agriculture approaches, which require crop biomass to be left on the soil, and the demands for livestock feed, which necessitate feeding the crop biomass to animals (www.vslp.org). Approaches that facilitate increased biomass for feed (e.g. through introducing food–feed crops), nutrient cycling and use of livestock manure are among the strategies successfully introduced in West Africa.

In marginal systems, livestock are very dependent on their environment for survival, and interventions that enable an improved understanding of the dynamics and management options of biodiversity and natural vegetation to ensure sustainability are important. Understanding where land degradation is taking place as a result of over grazing, or where it is climate related can be informative and new interventions based on satellite technologies may be applied for such studies. There are a number of potential decision support tools that can be applied. One example is a specific web-based program for real time short-term pasture and stocking management has been developed by Commonwealth Scientific and Industrial Research Organization (CSIRO) and partners in Australia (see Pastures from Space—www.pasturesfromspace.csiro.au) and has the potential for application to marginal areas. In Kenya, working with communities to provide them with information on the impacts of land management options on the resources available for their livestock has generated positive results (Neselle et al. 2005). Geographic information system (GIS) approaches, and ecological assessment have proved to be useful options here.

Institutional innovations for harnessing opportunities and mitigating threats

Institutional innovations are emerging as essential attributes of strategies to address challenges facing livestock producers in intensifying systems. Opportunities to experiment and understand better the potentials and roles of farmer co-operatives, associations and how they can facilitate access to capital, to market information, market recognition for quality, and other opportunities are among the key approaches relevant here, for which a few examples are elaborated below.

Collective action through producer or farmer organizations can be used to empower smallholder livestock producers with limited resources or political voice. It has been used to improve smallholders' bargaining power and enable them to gain access to information, credit, and markets in food chains that they otherwise would be excluded from. In India, for example, collective action was used in Operation Flood, a dairy development program to provide support in marketing, production, and input services to dairy co-operatives (World

Bank 2005). The growth of this program has been stimulated by public sector technical support and has contributed to improving the incomes, health and nutrition of more than 10 million households. In Kenya, collection points have also been used in public–private partnerships as well as in public–private–NGO partnership to build economies of scale and facilitate pre-processing, quality screening, bagging and assembly in the dairy and horticultural sector (Freeman and Estrada-Valle 2003).

A range of institutional arrangements is being used to support smallholders in their efforts to capture the expanded livestock opportunities in domestic and foreign markets. Institutional innovations that help reduce transaction costs and private sector risks in key support services as well as in input and output markets can help smallholders compete in dynamic markets, facilitate the co-ordination, and enhance participation in livestock food chains. In Chile, public sector grants have been used successfully to support business development services providing a wide range of advisory services for small and medium sized enterprises (World Bank 2005).

In Kenya, the Kenya Agricultural Commodity Exchange (KACE), a private sector firm is helping smallholders in the crop and livestock sector to find better markets and better prices for their produce through accessing relevant and timely market information (Mukhebi 2005). The KACE market information system (MIS) consists of various electronic and non-electronic components designed to link the farmer to market outlets at different levels of commodity value chains, from other farmers to traders, commodity dealers, processors and even exporters and importers.

There is a need to encourage institutional arrangements that strengthen market systems and encourage private sector participation in ways that benefit poor people and can be maintained by the private sector after the initial public sector support. The role of the public sector in the longer-term will be to provide quality assurance and regulatory support. Time limited public–private investments have had some success in developing countries. For example, public procurement arrangements such as extension, disease control and animal health services have been successfully outsourced to encourage private sector investments in the delivery of these services in Uganda and Chile. In India and Kenya there have been public and donor supported grants to disseminate market information and technical advice to smallholders using a range of Information Communications Technology (ICT) tools. On the demand side, vouchers have been used to stimulate the demand for inputs and business development services in Malawi and Chile (World Bank 2005). It is important that such limited-time public investments to support private sector market development promote both demand and supply at the same time to encourage long-term private sector investments (Joffe and Jones 2004).

Vertically integrated livestock food chains are mainly driven by the private sector and the growing need to meet foreign and domestic consumer concerns. In some cases smallholder linkages with multinational firms can provide vital access to markets and technical support that enhances their competitive position. For poultry and pig farmers in Brazil, multinational firms supply feed, veterinary and other support services to thousands of smallholders and then slaughter, package and sell the finished products often under their brand name (The Economist, November 2005). In East Africa, private sector support has facilitated the concentration of large numbers of producers into dairy co-operatives to help them meet higher levels of efficiency and production of high quality products.

Innovative partnerships and community based strategies for land management and understanding land degradation are especially important in marginal areas. Forming associations can enhance access to resources and empower the poor in these environments. Conflicts often arise over scarce natural resources (such as land and water) between livestock keepers and landowners, or settled farmers. Research in Niger has shown that understanding local regulatory and governance systems and working closely with communities can be important in developing conflict mitigation options.

From the discussion above, there are a number of technical, policy and institutional responses to changing livestock systems that are proving to be successful. A key feature, however, is that there needs also to be some different approaches to research, drawing together options mentioned above and many others too, in such a way as to generate responsive, knowledge rich options that are accessible to the beneficiaries. Whilst compartmentalized—specific commodity oriented—technology or policy focused research may have been previously appropriate or convenient, if research outputs are to lead to development outcomes, there now needs to be a more holistic approach that takes account of the whole value chain, from consumer to producer with the plethora of diverse stakeholders in between as well as the backwards and forward links and influences.

The flows and uptake of knowledge and information, benefiting from an innovation systems perspective (Hall et al. 2003; NCAP 2005), become much more important; traditional technology and policy issues undoubtedly have a part, but an inter-linked part within a bigger whole. An implication here is that a range of new technical skills that cut across disciplinary lines will be increasingly important—these may include, among others, decision making linked to economics, modelling, epidemiology, specialists linking to innovation systems management.

Research systems also need to take new approaches, such as facilitating broader consortia arrangements that enable appropriate disciplinary mixes and enhance knowledge sharing, emphasizing synergies and value addition from such ventures (e.g. CGIAR Challenge

Programs such as the Challenge Program on Water and Food, www.waterandfood.org). Perhaps somewhat exemplary in this context is the evolution that has taken place in the Systemwide Livestock Programme (www.vslp.org) which in playing its role as a systemwide program to bring synergies between CG centres and their partners involved in livestock research has evolved from a fairly broad focus on crop–livestock systems, to playing a key role in fostering research on food–feed crops and now focusing on a systems approach to conservation agriculture and livestock balances.

Public policies for harnessing opportunities and mitigating threats

Public policies impact the results of livestock system changes differently depending on the system in question. In industrial systems, policies are often supported by the industries as a means to achieve common goods of disease prevention or to prevent individual behaviours prejudicial to the industrial sector as a whole. In addition, individual agents stand out more clearly. Sanitary and environmental regulation tends to be easier to implement. Demands of policy from the sector tend to be for provision of items such as infrastructural investment (electricity, roads, water) that make cold chains in producing areas possible. As developing countries increasingly enter export markets for livestock products, there is also rising producer demand for enforcing sanitary regulations essential to achieving and preserving access to international trade markets.

In intensifying crop–livestock systems, public policy can stimulate the growth of institutions for collective action where such solutions are useful to mobilize capital, provide extension, and provide brand recognition for small farm products. Institutional innovations in these systems tend to work better where the resulting organizations include significant producer participation in governance. A facilitating approach from the public sector towards institutions of collective action allows the latter to directly support small farmers. Smallholders in intensifying crop–livestock systems often sell into changing urban markets, and thus need to meet increased food safety requirements. Policy interventions in these cases need to balance competing needs and interests, and avoid just implementing developed country approaches that either will not be implemented, or will raise milk and meat prices beyond the range of the urban poor. For example, in Kenya where consumers boil milk, significant employment and income is generated through local sale of unpasteurized milk with relatively low health risks to consumers (SDP, no date). National governments can be supported by research partners through risk analysis and evaluating impacts of changing regulations, particularly as it relates to the poor.

A particular role for policy in smallholder crop–livestock systems is to ensure adequate investment in the knowledge good for smallholders that industrial systems organize on their own, such as research, extension and disease surveillance.

In marginal areas, local as well as national policies can have significant implications for the way that livestock are managed, their owners are empowered and the access they have to resources, both natural and infrastructural. Thus policies for these areas are especially important for sustainability issues. Research has shown that engaging with policymakers, especially at local level, can have beneficial results for livestock owners and the broader communities in which they exist (Neselle et al. 2005). Policies that facilitate payments for ecosystem services provide livestock owners in marginal areas with opportunities to benefit from appropriate management of their animals and land. This is working successfully in a number of parts of the world (Pagiola et al. 2005) such as Costa Rica (http://www.virtualcentre.org/en/res/download/silvo_gef.htm) and in East Africa where biodiversity payment schemes have been explored (Nkedianye and Reid 2005).

For both marginal and intensifying smallholder or pastoralist areas, policy interventions will often need to consider trade-offs in interest between large- and small-scale producers, and between producers and consumers. These trade-offs need to be estimated and often cannot be directly observed, and thus require public sector sponsored policy research.

Livestock in the livelihoods of the poor

There is a perception that there is not much that can be done for the poorest of the poor in terms of livestock-related interventions, policies and programs; that in fact, such research and development efforts typically help the better-off and not the poorest. A review of ILRI and partners' experience, much of it in Africa, over the last decade suggests otherwise.

Livestock are integral to the livelihood strategies of hundreds of millions of resource-poor crop–livestock farmers and pastoralists and of many millions of the rural and urban landless throughout the developing world. While the way livestock contribute to livelihoods varies considerably between households and regions according to the different types and attributes of livestock, the level of household resources, and the degree of market integration, the fact that they typically play multiple roles for poor households is fairly universal. A range of global studies by ILRI, partners and others show that the value of livestock to the poor lies in combinations of some or all of the following (Winrock 1992; Holden et al. 1997; LID 1999; Perry et al. 2003; Thornton et al. 2003):

- food
- regular cash income, from selling small animals such as goats or poultry, or from milk or eggs (particularly for women)
- household nutrition
- exchange of livestock products (e.g. milk) for grain
- bank account—savings to be accumulated when times are good and a 'chequing account' to be used when household cash needs arise

- income diversification strategy
- draught power for own farm and for renting to others
- transport of water, people, produce and inputs
- manure for own crops or for sale
- fuel for cooking
- ability to transform resources from common property resources into high-value food
- employment opportunity
- reinforcing social support networks and fulfilling cultural roles.

For poor households, livestock are used for *ex ante* risk management, as a source of precautionary savings (e.g. to sell for cash when family emergencies occur). Smallholder farming households in India have been found to invest in portfolios that lean towards the holding of liquid assets, e.g. bullocks vs. pumps (Rosenzweig and Wolpin 1993). Livestock are also used for *ex post* risk coping, along with sale of other liquid assets, use of loans (i.e. going into debt), risk pooling in informal insurance arrangements and use of child labour (de Janvry and Sadoulet 2005). Livestock are typically used for consumption and asset smoothing (much more so than for income smoothing), but households still sacrifice consumption to protect livestock (Fafchamps et al. 1998; McPeak 2004).

ILRI and its partners research has also shown the importance of understanding household poverty dynamics in different areas and systems. Studies undertaken in India, Uganda, Kenya and Peru show that households move out of poverty for very different reasons than they fall into poverty, and very different policies and programs are needed to help households climb out of chronic poverty than are required to stop households from falling into deep poverty (Krishna 2004; Krishna et al. 2004; Kristjanson et al. 2004, 2005; Krishna 2006; Krishna et al. 2006).

This research highlights how livestock asset holdings are a key indicator of a household's poverty status for many communities. In general, even chronically poor households own some small animals—chickens, pigs, sheep or goats, but if they own large animals, (e.g. cattle, buffaloes), they are no longer considered poor by the community. In all four countries the findings of the studies suggest that diversifying income through livestock has helped many households in many villages escape poverty. This means very different things in different locations, implying targeted policies and interventions are needed. Intensifying livestock activities, e.g. through improved breeds also showed up as important in one Peruvian region, but not in the other, again highlighting the need for different pro-poor livestock-related approaches in different systems and areas.

These studies also provided evidence that economic growth is necessary, but not sufficient for poor households to get out of poverty, because even as many households have escaped poverty (during periods of strong economic growth), many others are still falling into

poverty. Thus both 'safety net' policies, to keep households from falling into poverty (health, insurance etc.), are needed, alongside 'cargo net' policies (asset-building, improved market access etc.), to help households climb out of poverty (Barrett and McPeak 2004). More research identifying specific livestock-related cargo net and safety net policies for different areas and livestock systems is needed.

While economic growth in general is not sufficient, broad-based agricultural productivity growth has been instrumental to raise incomes of poor farm households as well as households of landless labourers who primarily depend on agricultural wages. A large number of empirical studies of the Green Revolution in Asia demonstrated how agricultural growth reached large numbers of small farms, increased demand for rural labour, and lifted enormous numbers of people out of poverty (see, for example, Rosegrant and Hazell 2000). In those countries with successful productivity increases, public investments in agricultural research and development (R&D) and rural infrastructure were the most important drivers of growth, and there is much evidence of the high payoffs to these investments (Alston et al. 2002; Thirtle et al. 2003). Studies in India, Vietnam and Uganda have found that public spending in these areas is also strongly pro-poor and equity oriented (Fan et al. 2000; Fan et al. 2004).

Other lessons from ILRI and partners' fieldwork over the last decade highlight the important role livestock play in more marginal systems with respect to buffering against shocks for households vulnerable to drought, disease etc. Infrastructure, information, institutions and empowerment are major areas for more research and development here. For example, in East Africa, land policy, livestock market and disease information systems, and ecosystems payments are all areas where ILRI is working closely with Maasai communities to empower them with more knowledge and to test new approaches and policies that will help them adjust to huge and rapid changes in their environment (Kristjanson et al. 2002; Nkedianye 2003; Reid et al. 2006).

Access to markets is an issue facing poor livestock smallholders across the developing world, and is determined by both household characteristics and the broader institutional/physical infrastructure. Lapar et al. (2003) show that smallholder participation (and selling decisions) to markets are related strongly to income, educational level, extension visits, composition of livestock assets and information, suggesting that these are all possible areas for pro-poor interventions. Some approaches that are encouraging in quite diverse areas/environments, to name just a few, include women's (and mixed) dairy goat groups, farmer field schools that include livestock interventions, farmer/herder study and exchange visits, poultry interventions and extension, improved food–feed crops (that also improve soil fertility, such as cowpea, peanut, soya bean, sweet potato), and milk marketing and policy

reforms (e.g. that enhance raw milk market activities rather than outlaw them). Attention to enhancing grassroots collective action efforts is an important area for livestock-related research and development efforts (e.g. streamlining regulations and improving incentives for forming groups, livestock-related training for groups, exchange visits). As Holden et al. (1997) concluded, after a review of over 800 livestock projects globally, 'Many of the factors that prevent the poor from improving their livelihoods, and that limit the impact of technical projects on the poor, relate to weaknesses in the organizations that support farmers in their livestock-rearing activities'.

Conceptualizing approaches for addressing poverty through livestock

In terms of conceptual frameworks for addressing poverty through livestock-related programs, ILRI recently reviewed what others are using.

de Janvry and Sadoulet (2005) proposed a conceptual framework for achieving success in rural development that addresses four main issues:

1. Fully understanding and explaining the determinants of rural wellbeing for rural households and their organizations
2. Identifying the entry points—the policies, interventions and programs—for rural development interventions that can improve wellbeing
3. Identifying the processes through which pro-poor rural policies and programs are determined
4. Identifying instruments for greater efficiency in implementing these policies and programs.

This in turn led to identifying four major entry points for investing in rural development:

i. programs to increase access to assets
ii. programs to improve the quality of the context where assets are used
iii. transfer programs for social protection
iv. programs to promote the social incorporation of the poor (i.e. empowerment).

ILRI's strategic plan (MTP 2005–2007) adopts a sustainable livelihoods framework with a livestock lens that recognizes the four main issues above, and identifies three pathways in which to improve the contribution of livestock in poor households: securing assets of the poor, improving the productivity of their livestock systems and improving their market opportunities. Thus from a conceptual point of view, our approach is in line with that of others that have worked on rural development issues for many years. The challenge remains, however, to identify the most promising specific policies, interventions, strategies and programs for different areas and environments around the developing world.

What could be added to de Janvry and Sadoult (2005) framework is a systems approach. For ILRI this is key, as global livestock systems take on a wide range of characteristics, from extensive, mobile pastoral systems in marginal environments on one end of the spectrum, to very intensive, mixed crop–livestock systems in high rainfall and good market access areas on the other end of the spectrum. Taking a systems perspective is critical because not only does the physical environment vary considerably across systems, but the institutional and policy environments vary widely as well. The result is that different approaches, strategies, policies, programs and interventions are likely to be called for in different livestock systems.

For example, in marginal areas livestock plays much more of a coping role, helping poor households deal with extreme variability in their environment and the ensuing vulnerability they face—in these areas livestock research and development can help reduce vulnerability in many ways, such as provision of vaccines, insurance schemes, providing information and empowering pastoralists, early warning systems, disease and drought-tolerant indigenous animal breeds and forages, and on institutional and infrastructural development. More research is needed here in examining alternative risk coping instruments—e.g. insurance, credit, off-farm employment (e.g. guaranteed employment in public works); how to reduce the risk of holding livestock for precautionary savings—e.g. drought resistant pastures, dual-purpose crops and animals, water control, vaccines, feed stocks, early-warning systems; and ways in which to enhance risk coping value of livestock—e.g. interventions that reduce transactions costs of getting animals to markets, government procurement and/or improved access to credit for recapitalization. One insight from ILRI's pathways out of poverty work is that key safety net strategies and policies relate strongly to nutrition and human health, and without better safety nets in place, interventions aimed at helping households escape poverty probably will not succeed. More work is needed on identifying appropriate livestock-related safety net strategies, policies and interventions for different systems and areas.

At the other end of the spectrum, in the intensive areas, we see market-led growth as key. Technologies will play a greater role in helping smallholders keep competitive, while policies and institutions (e.g. marketing groups) will also be important. This is where focusing on 'cargo-net' policies, i.e. those that help households climb out of poverty, can help. More research is needed here on interventions aimed at increasing value-addition to livestock products of poor producers and finding market niches for animal products of relatively poor/small family producers; improving health aspects of animal production by smallholders; promoting efficient organizations, based on effective leadership and accountability; and effective ways in which to enhance the capacity to regulate and enforce quality standards by producer organizations.

The middle ground is where it is tougher to make broad generalizations, and ILRI is currently working on characterizing these systems and examining (e.g. through modelling) the impacts of different strategies and interventions in a wide range of 'mixed crop–livestock' systems and locations.

Poverty alleviation and livestock policies

A recent review of livestock policies for poverty alleviation across Asia, Africa and Latin America (Pica-Ciamarra 2005) argued that livestock policies would be more pro-poor if they included strategies for:

1 'establishing the basics for livestock production—actions that allow poor livestock producers to have secure and adequate access to basic production inputs, such as land, feed and water for animals, as well as risk coping mechanisms for natural disasters and price shocks;
2 kick-starting domestic livestock markets—all actions intended to promote a pro-poor functioning of the credit market, an efficient and pro-poor system of animal health and extension services delivery, and adequate access to output markets for smallholders; and,
3 supporting and expanding livestock markets—long-term public actions that encourage and support the sustainable production of high quality commodities; they encompass research for improving feeds and livestock breeds, environmental protection, food quality control, certification and grading, which are necessary components for products to be competitive in international markets and to avoid smallholders being crowded out by foreign competitors.'

The review also highlights the limited references in national policy documents, particularly poverty strategy documents, throughout Asia, Africa and Latin America to the contribution that livestock can make in development. When referring to livestock, the documents usually identify increased production as the overall development objective for the sector, rather than reducing poverty through livestock production (Pica-Ciamarra 2005).

Poverty, livestock and institutions

Institutional innovations are also needed for improved access to feed through property rights, contracts, markets and programs. These include mechanisms such as land rental contracts, grazing contracts, land for manure contracts, share contracts for transhumance, reduction in marketing transaction costs (e.g. improved roads), and feed safety net programs during extended droughts. There is also a need to better understand and support collective action efforts related to livestock production and marketing. Staal et al. (1997) argued that,

while individual smallholder households may face insurmountable transaction costs to markets, grassroots organizations reduce marketing costs and government should provide an enabling environment for local groups and private enterprises to collaborate.

A recent World Bank study that examines drivers of pro-poor growth, gives the following investment recommendations for Asia. First, give priority to diversification, both to high-value agriculture and a dynamic non-farm sector, increasingly linked to agro- and urban industrialization. Second, shift emphasis to less-favoured areas, which may now and in the future provide higher returns in terms of both growth and poverty reduction. Third, attempt to manage a massive exit from agriculture through investment in skills and education, and by facilitating efficient land markets and consolidation (Byerlee et al. 2005).

While livestock can contribute significantly to attaining these goals, well designed and managed R&D programs that address policy, institutional and technical issues in an integrated manner will be critical if we are to deliver on that potential for poverty alleviation through livestock. There are still many gaps in our understanding of how best to help the poor through livestock-related interventions in different systems and locations and more experimentation is needed. ILRI is very interested in seeing what can be learned from Indian experiments as such lessons will also aid other countries and regions struggling with the poverty challenge.

Conclusion

There are three main themes that arise from this paper. The first is that it is critical that livestock researchers understand how livestock systems are changing, whether in the systems in more marginal areas or in the rapidly changing systems responding to market demand for livestock and livestock products. Second, within different systems, it is important that a mixture of technology, policy and institutional innovations be combined if sustainable and equitable livestock sector growth is to be achieved. Third, beyond broader livestock sector growth, specific attention will need to be paid to how the poor can benefit from the emerging opportunities. This will not happen without targeted and intelligent public-sector research and development actions.

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