Abstract

These workshop proceedings give a full report of the papers presented at the IDRC/ILCA workshop on 'Pastoral Systems Research in sub-Saharan Africa' held at ILCA's headquarters from March 21 to 24, 1983. Papers presented in English are summarised in French, and vice versa. All discussion sessions at the workshop are summarised in both English and French. These proceedings give an introduction to pastoral systems research. A majority of papers focus on the survey and diagnostic stage of pastoral systems research, and include ILCA's experience of remote sensing techniques and aerial surveys, the survey of vegetation resources, livestock productivity and animal nutrition, pastoral production strategies, the importance of wealth effects, household studies and labour data collection and livestock marketing studies. Two papers focus on the scope for improvement in pastoral production and two case studies highlight the experimental design and testing procedures relevant to pastoral systems research. The final discussions at the workshop were related to the strengths and weaknesses of ILCA's approach to pastoral systems research, and how this approach might be improved.
Preface

This document summarises the proceedings of the workshop on Pastoral Systems Research in sub-Saharan Africa held at ILCA's headquarters in Addis Ababa from 21 to 24 March 1983. The workshop was sponsored by the International Development Research Centre (IDRC), Ottawa, Canada and by ILCA. It was attended by 15 scientists from different countries in sub-Saharan Africa, by 20 scientists from ILCA and by 3 others.

The workshop focused on the techniques and processes in pastoral systems research with particular reference to ILCA's experience in sub-Saharan Africa. The 21 presentations were made by ILCA staff members and the discussion sessions were led by national representatives from different African countries. At the end of the workshop a panel of national representatives reviewed ILCA's progress in pastoral systems research and made suggestions for future work.

This document contains the written presentations made at the workshop and summaries of the discussion sessions. Each presentation appears in its source language and is followed by a summary in English or French, as appropriate. Summaries of each discussion session are presented in both English and French.

Acknowledgment is made to the ILCA staff who assisted in the running of the workshop, in particular Mr Addis Anteneh, the workshop organiser; and to Senedou Leon and Sophie Gorfineh who typed these proceedings.
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GENERAL INTRODUCTION
May I warmly welcome you here this morning. This workshop on our research in Pastoral Production Systems has been in the making for several years, plus a bit longer, the bit longer being the additional time we needed for the hard work in preparing the papers for this meeting, as well as the time needed to develop the courage to expose our experience and ideas to you.

Very little has been written on the analysis of the livestock aspects of farming systems research (FSR). The 1981 compendium of Farming Systems Research in Africa contains virtually no references on the subject. But this situation is changing. In 1982, IDRC published an excellent monograph on issues and policies influencing livestock development in Asia and this publication contains several valuable papers on the analysis of livestock systems. Winrock International are also increasingly productive in this subject, particularly in respect of Latin America. We at ILCA have now published nine major reports on various livestock farming systems in different parts of Africa. Excellent journals on the subject of FSR generally are also available; unfortunately, however, they contain very little livestock material.

Systems analysis is a term, like so many others that will be used in this workshop, that means different things to different people. To a computer engineer the meaning of systems analysis is very clear, but we use the term in a broader and less precise manner. The phrase 'systems analysis' or 'farming systems research', or the fancier semantic derivatives that describe a fancier research focus that extends beyond the farm level, such as 'farming systems perspectives' and 'farming systems research and development', provide little more than an innocuous umbrella under which people of different disciplines and background can work together, interactively, on the task of improving livestock and crop output and income.
Our discussions this week will focus upon rather specific and technical parts of our approach to livestock systems. The techniques we use in this work are obviously very important, but it is the approach we take to livestock and pastoral farming systems that I would like to see characterizing your views of ILCA's work, rather than the use of any of the specific research techniques we shall discuss this week.

The ILCA approach consists of two main items: a characteristic philosophy and a collection of techniques. I shall spend a few minutes talking about the philosophy that underlies our work; my colleagues will discuss mainly the techniques used and the results obtained. In brief, the philosophy is that there are such things as systems, and that things that operate as systems have to be regarded rather differently from things that operate in some other manner.

What is a system, are systems important and in what way do systems differ from non-systems? Let me try to explain by referring to ILCA as an institution. At ILCA we regard our organisation, ILCA, as a system. We, the staff, interact and work together for a common purpose and thereby have the key characteristics of a system. Thinking unkindly, other organisations may be regarded as a collection of individuals, and a collection does not constitute a system. With a collection you can take out a component and it makes little difference, similarly you can add one without making much difference. But if you interfere with one component of a system such as ILCA, remove it, alter it, or add another, you are likely to have important effects on the whole system, because it is a characteristic of a system that the components interact. It follows that grey hair and system management go well together!

There are two other important and inter-linked characters of a system I want to emphasise. The first is that a system has a boundary and that boundary must be clearly established in our description of the system. The second is that a system is purely a concept. By this I mean that an adequate description of a specific system will depend on the purpose of the description and the boundaries that are perceived for the system; a naturalist defines the same aggregation
of interacting activities in quite a different way to an economist, a politician or an agriculturalist. Obviously you need a clear notion of the specific purpose of your description of a system in order to describe either the system or its boundaries.

You will also appreciate that a description of a system is highly biased by the training of the person you have asked to describe it. If you doubt me set loose an agriculturalist, an economist and a sociologist to describe a specific system such as ILCA. Each will give an appropriate description that suits their particular purpose, but none is likely to be appropriate for the purpose of understanding the ILCA system as a whole. The first task is to think carefully about what is to be described, and even more importantly about what does not need to be described - if you try to describe everything you will never finish and will never produce a description that is of use to a specific audience.

To decide if a component observed in a system is important, one has to relate it to the purpose for which the system exists. In the ILCA system, for example, one finds components such as sociologists, chemists and librarians. It is only when we know the purpose of ILCA that we can start to decide if describing these specific components is important. If it is argued that the purpose of ILCA is to increase milk production, then we can decide on the basis of the likely effect of our sociologists etc. on milk production whether they are an important part of our system, or whether they can be disregarded in our description. If the purpose of ILCA is perceived as something different than simply increasing milk production, our description and judgement of the vital component parts must be different.

A key objective we all share is to improve livestock production; we also probably share a belief that using a systems approach is a sensible way to tackle this objective. This accepted, the key questions we then need to ask are what systems are to be improved and what constitutes an improvement.

In many livestock systems of concern to us there is very little information available and it is tempting to start extensive, time consuming baseline surveys to try to build the data necessary
for initial modelling and intervention. If this exercise is followed we frequently find, several years later when modelling and analysis of the data collected is started, that some key data required have not been collected. My very important point here is that it is essential that data collection, data analysis, and modelling go hand in hand. We must start with a very simple model at the outset to help determine what information is actually required and not wait until we have accumulated large lumps of information that are likely to be both too much and too little.

Having described in adequate terms the systems to be improved one then has to decide what constitutes an improvement. Improving milk production per cow may be technically possible in several different ways, but each way suggested may be financially or organizationally impractical. Clearly we need to consider not only increased outputs but also increased inputs; we need to consider if the inputs proposed are likely to be available, can they actually be safely used by our target farmers, and what do they cost? One also quickly realizes that livestock systems do not produce just one thing, and that they are not using just one resource. "Improving" a system that produces several products and uses many resources is a matter beset with many complications that are frequently overlooked in an otherwise simple technical approach to livestock improvement.

We must also ask who benefits from any improvement that may be made. If output is increased does the farmer benefit, or do prices decrease? In the latter case does the nation as a whole reap the rewards, or just one small part of the nation?

If the objective is to increase overall food production, obviously a most important task in Africa, we still need to ask if fulfilling this objective will feed hungry people. Hungry people are poor people; if they weren't poor they wouldn't be hungry; if they had the money to buy food, that food would certainly be produced and available. Clearly, a food production objective alone is inadequate and we need to consider equity distribution, cash flows, labour requirements, multiplier effects and all the rest of the bits and pieces that are critical in deciding on the value of our improvement.
Farming systems are rarely static, they are usually being continually changed in many ways by a multiplicity of external forces. We as systems researchers must make judgements as to where our target systems may be headed. Research appropriate to improving the productivity of large farms is frequently inappropriate to improving farming systems on small farms, and we need to be reasonably sure that the target system for our research effort has an appreciable life span.

ILCA's task is twofold: to apply existing knowledge to improve livestock production, and to undertake research on major gaps in that knowledge. The technical base for improving livestock production in Africa has proved to be less extensive than was perceived when ILCA was established just a few years ago. In consequence, we have recently been placing greater emphasis in our work at ILCA on what we loosely call component research. Yet I urge great caution on your part in regard to the use of the term "component research". Our primary interest and concern is not in understanding how a legume grows, or how a cow copes with a protein deficiency, but how key changes in vital parts of livestock production systems, such as improving pasture quality and dry-season nutrition, might improve the productivity and efficiency of the farming system as a whole. Our main task in many of the systems we work with lies in assessing the relationships among their key components. Strictly speaking this is not component research, rather it is process research. Others, however, may regard it as a development activity. May I suggest that the distinction between research and development is largely in the eye of the beholder. In line with our purposive philosophy, we regard the difference between the two as the reason one gives as to why the particular work is being done.

May I make a final comment about organising the staff of any institution to carry out a systems research approach. Many ways of doing this have been tried and the virtues of multidisciplinarity are usually loudly emphasised. I want to stress, however, there is little merit in having many disciplines represented if they are not required, and that the pursuit of multidisciplinarity as such can be overdone. In our experience what is required is staff with knowledge
that is highly relevant to the systems you are studying, and this staff needs to encompass a very wide range of training and experience. First class generalists backed up by specific selected specialists is the formula we seek. I am sure you will note this amongst our staff at ILCA this week.

During the course of the next few days we expect to learn a great deal from you. We appreciate greatly the time you have given to share your experience and your wisdom. We also value highly your willingness to work with us in helping develop our overall programme. IDRC have made a sizeable cash contribution to the organisation of this workshop. Their assistance has made it possible to invite more participants than would otherwise have been the case and it has been a spur to us to hold this important meeting. We are most grateful to them. We hope that you will benefit from the discussions of the next few days, and that you greatly enjoy your stay with us.
Workshop background, organisation and procedure

Addis Anteneh
Workshop Organiser, ILCA, Ethiopia

My sitting here and trying to explain the background to this workshop arises out of a historical accident. At the time when a definite idea had been formed about organising this workshop, I happened to be working with Dr. Poul Sihm, who was then the co-ordinator of arid zones research at ILCA. He was at the centre of the initial stages of the preparation of the workshop. Poul Sihm returned to the World Bank last year, but before we parted he extracted a promise from me that I would make sure this workshop took place. On his part he promised to keep a close watch on the workshop's progress and to participate in the discussions. Unfortunately he is unable to attend the workshop due to heavy pressure of work, but he has certainly kept an interest in its organisation - some of our distinguished participants work in World Bank livestock projects with which he is associated and were highly recommended by him. To this extent at least he has kept his side of the bargain. I hope I have succeeded in keeping mine by helping in the workshop's preparation.

I do not want to burden you with a detailed chronological account of what has happened since this workshop was first suggested two years ago. What I would like to give you is a brief pointer to those events which, in my opinion, have a story to tell about the dynamics of ILCA's work.

The origins of this workshop are very much related to one of the first livestock research activities of ILCA - that of monitoring livestock production systems under induced change. ILCA had then undertaken to monitor changes taking place in production and the social and economic impact generated by livestock development projects in the arid/semi-arid zones of Kenya, Ethiopia and Botswana, and had entered a commitment to develop and prepare a monitoring guideline. Monitoring subsequently became a rather unpopular term and activity,
not because it was not necessary but because it was being used and carried out mostly in the project financing framework, not totally befitting the character of an international research centre such as ILCA. Clearly, as you can realize, there could be no such thing as a monitoring guideline under the circumstances. The move away from monitoring to livestock production systems research in these areas entailed the need to clarify conceptual problems as well as questions of using systems research techniques and methodologies for livestock which, as the Director General pointed out earlier, have not featured strongly in the farming systems research approaches now coming into vogue. And in the meantime, African research and development institutions concerned with livestock as well as ILCA were continually gaining experience in the field. With all these things taking place, it was evident that ILCA alone could not produce a pastoral systems research (PSR)/livestock systems research (LSR) guideline or manual as a unilateral prescription.

It was thus decided quite early to convene this workshop to exchange ideas and experiences with selected African leaders in livestock research and development. The objectives of using this workshop to provide a forum for discussion of the merits of the PSR/LSR approach has thus become a primary one. The possible establishment of a network of pastoral/range livestock systems research in tropical Africa is another important objective which we hope you will consider. The development and preparation of a set of PSR/LSR guidelines remains a serious goal. We hope all participants will consider and give their views on this matter before the closure of the workshop.

The schedule of presentations and discussions is indeed a tight one. For the next few days we will have 3½ to 4-hour sessions each morning and afternoon. We have tried to arrange the sessions to present a logical flow of ideas. They start with the conceptual framework and continue with the survey and diagnostic phase, including the technical, social and economic components. Specific constraints identified, which follow on the third day, are based on the preceding phase and are presented in the framework of ILCA's on-going pastoral systems research programmes. We finish with the identification of
the scope for improvement on the fourth day and will close after the presentation and discussion of case studies to illustrate in some detail ILCA's experience in the use of PSR/LSR design and testing procedures in two areas - Nigeria and Niger.

We have arranged for either ILCA Board Members or senior members of ILCA's management to chair the different sessions. Their intimate knowledge of the issues and processes involved in ILCA's research work or their extensive experience in pastoral systems and the critical component problems facing these systems' potential improvements, will be a valuable asset in guiding the discussions.

The agenda submitted to you has gone through several revisions to take account of the changing picture presented by ILCA's growing field experience of livestock systems research in its on-going pastoral programmes and elsewhere. Many of the participants to whom we were able to send the schedule, together with our invitation to attend the workshop, are likely to be surprised at the considerable changes introduced since then. I hope you will appreciate how much thought and effort on the part of ILCA's management and staff has gone into the substantive aspects of the workshop's preparation.

As you will also note from the way the programme is structured we have gone a little further in our attempt to make participation as effective as possible. The device we proposed and which was accepted by most of our colleagues was for a review of specific topics, presented by ILCA staff, by selected discussion leaders from among our African colleagues. We had hoped to make the papers available some time before the start of the workshop, but we have not been able to do so for logistic reasons. We offer our apologies, but are certain that this particular handicap will be offset by the extensive knowledge and experience our lead discussants possess on the subject matter addressed by the papers. We expect the lead discussants to take the floor first after the papers have been presented, this to be followed by a general discussion, except in those cases where there is only provision for open discussion.

In the final analysis, the outcome of this workshop will have to be judged more by how much it will succeed in imparting better
knowledge from the experience and the generation of new ideas than by
the logistics which have gone into its organisation and running. My
colleagues in Training and Conferences, Liaison and Travel hope that
your participation will be useful and fruitful and that your days
inside and outside this conference hall will be enjoyable.

Finally, let me be permitted to thank on behalf of ILCA
those individuals and institutions outside ILCA who have been
instrumental in assisting the workshop to take place. We would like
to thank Dr. Barry Nestel for his support and advice both on the
concept and structure of the workshop and in obtaining IDRC support.
Our sincere thanks also go to IDRC who financed a substantial portion
of the cost of the workshop. We are most thankful and appreciative
of Dr. Hubert Zandstra, Associate Director of IDRC's Agriculture
Food and Nutrition Sciences Division and Dr. Bruce Scott, IDRC
Regional Director in Nairobi, without whose continued help and
interest it would have been difficult for many of us to attend.
The development experience

Stephen Sandford
Economist, Livestock Policy Unit, ILCA, Ethiopia

The purpose of this paper is to set our consideration of pastoral systems research within the framework of the experience of livestock and pastoral development in Africa during the last half century. The paper starts with some preliminary background material and then turns to those elements in past experience which are of particular relevance to pastoral systems research.

African livestock and pastoral background

I shall start with some statistics on populations (mainly based on Jahnke, 1982). Pastoral systems occur mainly in arid and semi-arid zones, which together I call "dry regions". Dry regions occupy about 55% of tropical Africa's land surface area¹ and account for 60% of its ruminant livestock population (expressed in terms of tropical livestock units of 250 kg liveweight equivalent). Not all the livestock of the dry regions are involved in pastoral systems. Depending on one's definition of a pastoral system, the proportion of tropical Africa's total ruminant livestock population involved in pastoral systems probably lies between 30% (if one counts only the population of the arid zone) and 50% (if one includes up to 2/3 of the livestock population of the semi-arid zone). The figure for the human pastoral population is even more difficult to determine - largely due to problems of definition - but the true figure probably lies between 15 and 25 million people, representing 6-10% of tropical Africa's total rural population.

I now proceed to some data on productivity (drawn largely from Jasirowski, 1973, and de Montgolfier-Kouévi and Vlalonou, 1981). Between 1950 and 1970 Africa's human population grew at about 2.5% of its tsetse-free land surface area.

¹/75% of its tsetse-free land surface area.
per annum but meat and milk output grew at just over 2%, indicating declining output per human caput. From 1970 until 1975 the rate of growth of the human population increased while that of livestock output decreased, indicating an even faster decline in per caput output. Effective demand, i.e. demand backed by cash to pay, has been rising faster than population so that the relation between domestic output and domestic demand has deteriorated at an even faster rate than per caput output. The result has been a decline in the export of livestock and their products and a rise in imports.

Increases in the total output from African ruminants has more or less matched increases in total ruminant population. In other words there has been no apparent change in productivity per head of ruminants at least until the mid 1970s. As far as one can tell these figures for tropical Africa as a whole are matched by figures for the dry regions.

I do not want to decry the devoted work of African national statisticians, and of FAO and ILCA staff who have laboured to produce these statistics. However, they would be the first to agree that these figures are often not well based in reality. The general picture they convey is probably right but might be wrong.

It is very difficult to find firm evidence concerning changes in the welfare of the human pastoral population in Africa. On the one hand there has been an encroachment by non-pastoralists into previously pastoral areas and there has been some population growth among pastoralists themselves. These factors suggest an increase in pressure on resources, with a probable consequent decline in welfare. On the other hand, mainly due to development of water supplies, the extent of the dry region effectively accessible to exploitation by livestock has increased, offsetting some of these pressures.

Most studies by social anthropologists suggest a decline in pastoralists' welfare. However a very recent study (Jamal, 1983) of Somalia suggests that pastoralists, on average, fare significantly better than crop farmers, mainly because of changes in the ratios between the prices of livestock and grain which enabled pastoralists to buy more grain in exchange for each animal sold. But Somalia's
easy access to the oil-rich and meat-hungry markets of the Middle East may make it a special case. Although in terms of the welfare criteria traditionally used by pastoralists (e.g. ownership or consumption of livestock, meat and milk), the welfare, on average, of pastoralists has declined, this has been more than matched by increased access to a range of new goods and services. I suspect, therefore, that on average the material welfare of pastoralists has increased. However, most studies agree that inequality within pastoral societies has grown, for a variety of reasons, so that the absolute number of pastoralists below a given level of material welfare, i.e. the number of poor people, may have increased, and almost certainly there has been an increase in both the number and proportion of those who feel themselves to be under-privileged relative to some norm.

An outline of pastoral development efforts

Pastoral development in the past has consisted of a mixture of general programmes, e.g. veterinary services, and of special development projects. It is difficult to summarise effectively the extent of this mixture. On a financial scale we can note that the total cost of government livestock development efforts in all ecological zones of tropical Africa between 1960 and 1975 has been estimated as US$ 600 million (Wissocq, 1978). Funds committed only to those special livestock projects in dry areas of tropical Africa in which one donor - the World Bank - was involved between 1965 and 1980 amounted to US$ 600 million and the livestock elements of further mixed crop-livestock projects in dry areas funded by the Bank amounted to a further US$ 200 million (Sandford, 1981). These figures should be viewed in relation to a total annual gross value of livestock output in all ecological regions of tropical Africa of about US$ 6 billion (at 1975 prices) if one excludes the value of traction and transport services supplied by livestock, and US$ 10 billion if one includes them (de Montgolfier-Kouévi and Vlavonou, 1981).

The nature of, i.e. the type of component involved in, pastoral development has tended to change over time with fashion and technology. In the 1920s and 1930s the main emphasis was on veterinary programmes to fight the three major diseases of the dry areas,
rinderpest, contagious bovine pleuropneumonia and anthrax. From the 1920s onwards, but primarily from the 1950s, there was a tremendous surge in the development of water supplies. Over the same period there was a growth in commercial ranching in those regions with European settlers. In some cases as early as the 1930s, but more generally after the Second World War, there were attempts to introduce controlled grazing schemes in areas used by traditional pastoralists.

Until the mid 1960s these efforts were financed primarily by domestic resources generated from within the countries of tropical Africa, with some external supplementation by private capital in the case of commercial ranching. The pace of development was rather slow and the main constraint was lack of finance for both staff and other forms of expenditure.

After about 1965 there was a significant quickening in the pace of development with the arrival on the scene of both the World Bank and USAID as important financiers of pastoral development. Since the mid 1970s the EEC/EDF has also become a financier of pastoral development on a significant scale. From 1965 to 1980 finance was no longer the critical constraint but experienced staff (whether local or foreign), viable components and suitable government policies and institutions became the main factors limiting progress.

From 1965 until about 1975 great emphasis was put on the development of ranching, on the model of the European settlers' ranches, by individuals, parastatal organisations and cooperatives of pastoralists. At this time little emphasis was put on general veterinary services other than the Pan African JP 15 rinderpest campaign.

From about 1974 onwards there was a progressive disenchantment with commercial ranching and a determined search for other components. There was some return to favour of general veterinary programmes but these were oriented more than before to problems other than those of the three major diseases which had been the focus of attention in earlier periods. There was some emphasis on "stratification", i.e. specialisation in production by regions and enterprises, with most attention being paid to intensive feedlots and to fattening of livestock on peasant smallholdings. Great emphasis was placed on
reforms in land tenure in pastoral areas, and especially on the association of relatively small groups of people with defined areas of land. This association was done on a smaller more detailed scale than the previous general association of one or two tribes with very large blocks of land. Sometimes this association of land and people took the title of "group ranches" (which have seldom behaved at all like commercial ranches) but in recent years the fashion has been to talk of "pastoral units".

From World War II onwards there has been a fairly continuous interest by governments in the reforming marketing systems. This has often involved the introduction of direct trading by government or of government control over a private marketing system. Sometimes these marketing systems have been linked with processing facilities, sometimes not.

The lessons from development efforts in the past

Although livestock development in Africa has often been characterised as peculiarly disastrous, in fact from 1963 to 1975 (de Montgolvier-Kouévi and Vlavonou, 1981) the growth rate of livestock output was practically identical with that of crop output. The most recent figures show that in the last decade (1969/71-1979/81) meat and milk output grew faster than cereal output (FAO Production Year Books).

However there has been virtually no change in output (productivity) per ruminant; and there seems little reason to believe that there has been any increase in the primary productivity (herbage yield per unit area) of accessible grazing land. The increase in total output has been achieved by increases in livestock numbers, and these increases have been made possible either by grazing a higher proportion of the existing vegetation on land always accessible, or by increasing the area of land accessible. The livestock system has been extended but not intensified.

In extending the system two kinds of improvement have predominated - the control of rinderpest permitting increases in cattle numbers, and the development of water supplies permitting increases in the area of land exploited. In both cases institutional and administrative as well as technological changes were involved.
Earlier huge losses from rinderpest were initially reduced by an administrative device – quarantine – albeit at high social cost. The subsequent development of a safe, easy-to-administer vaccine made rinderpest control much easier, more reliable and less costly to all, but the problem was already essentially under control, through quarantine, long before the tissue culture vaccine was developed. Improved technology played an earlier role in water development, in the form of hydrological skills, better borehole technology and machines that could move large quantities of earth quicker and more cheaply than could be done by hand. But the use of improved water technology – developed elsewhere – was in most places only made possible by organisational changes which permitted economies of scale in the employment of expertise, the acquisition and use of equipment and the raising of the necessary finance.

I am afraid that I have to point out here that in these most successful forms of pastoral improvement nothing remotely resembling what this workshop will define as pastoral systems research was employed. Both the technological and the organisational techniques employed were developed elsewhere and largely for other purposes, and very little thought or adaptation with respect to local circumstances were employed.

When we turn from extensive development to the intensification of production, i.e. the application of new skills and inputs to raise yields and values, there has been very little success in tropical Africa on any scale – either in increasing yields per head of livestock or, more importantly, per hectare of pastoral land. Yet yields and values have been raised elsewhere – both in pastoral areas in other countries and in non-pastoral forms of livestock production in the countries of tropical Africa.

The relative failure to intensify production in pastoral areas in tropical Africa can be attributed to a number of causes. In some cases there has been simple neglect. Deliberately or through lack of interest very little effort has been made in many countries to intensify production. In some cases this has been caused by a belief that pastoral production cannot be intensified or that this can only be done at the expense of ecological degradation.
In many cases government policies towards the livestock sector in general – or to the pastoral subsector in particular – have been defective. There may have been wrong policies, or contradictory policies, or simply an absence of policy. By policy in this case I mean some general issue, e.g. land tenure, pricing of commodities, organisation, etc., that is not related to some specific intervention for pastoral development.

In some cases the problem has concerned organisation and staff for specific pastoral development programmes. Staff have been too few, poorly trained and inadequately motivated. Organisations have been established with the wrong structure and work has been poorly coordinated. Administrative procedures, e.g. for procurement or financial control, have been inappropriate; and funds have either not been provided at all or were provided too late to be of proper use.

However when all other causes have been taken into account the fact remains that in many cases the failure to intensify production arose from attempting misconceived interventions and from a failure to try interventions which would have succeeded. These errors must have been due to ignorance. Ignorance can be put right by general training and by research. It is to research and knowledge I now turn.

Before looking at some specific issues there are some general comments to be made. Three years ago I did a desk review of about 30 livestock projects in dry tropical Africa which were financed by one donor. Two main points of interest emerged. The first was the low expenditure on research of any kind. In general agricultural projects financed by this donor approximately 3% of total project expenditure was allocated to research. By contrast in livestock projects in dry tropical Africa only 1.5% was so allocated. The second major point of interest was the indifference shown by project planners to the technical base for their interventions. This was not in general true of veterinary innovations. In the case of veterinary interventions considerable attention was paid in the project appraisal documents to their technical base, i.e. to the evidence that the innovation proposed would have the expected results. But in the case
of other innovations—especially range management innovations—extremely little attention seems to have been paid to the technical base (Sandford, 1981).

I now turn to some particular examples of interventions which have taken place in pastoral development which are relevant to our consideration of pastoral systems research (PSR). I do not want to preempt what my colleagues are going to say about the nature of PSR as a member of a general body of approaches more usually referred to as farming systems research (FSR). Let me however stress here four aspects of PSR.

Firstly, PSR is concerned with a production system as a whole. Although particular elements in the system may be the ones on which attention is focused, nevertheless this is in the context of a general understanding of the system as a whole and of the relation of the elements selected to other elements. Secondly, in PSR considerable attention is paid to understanding the whole system before attention is focused on particular elements within it or before attempting to change these elements. Thirdly, PSR, in contrast to approaches more dominated by technological or commodity interests, is characterised by the attention paid to the pastoralists' own points of view. Fourthly, in PSR research is not only carried out on research stations. A crucial element in PSR is the testing of proposed innovations in pastoralists' own enterprises and under the conditions which pastoralists usually face.

Three examples of relevance to a pastoral systems research approach
I now look at three examples of interventions where, I believe, a PSR approach might have led to greater success or to less costly failure.

In one country the pastoral areas were partitioned into huge "divisions"—of the order of 6 000 km² each—which were in turn divided into "paddocks". The range management intervention proposed was one in which a particular set of pastoralists would be associated with a particular range division, water supplies would be developed in each paddock, and the range management activities would then, with the help of a committee of pastoralists, determine which paddocks
could be "open for use" at any one time and which "closed" in order to implement a rest-and-rotation system. On the whole this programme has not been successful; and one can identify at least three major reasons for this.

Firstly, the programme did not adequately recognize the enormous spatial variability of rainfall, and the absolute necessity of allowing livestock to move from one division to another according to recent rainfall rather than confining them to particular divisions regardless of conditions. Secondly, the programme treated the livestock as homogeneous and failed to recognize that rotation of livestock between paddocks in a rather inflexible way prevented herders from providing particular species or classes of animals the particular types of vegetation, water and minerals which they needed at particular times.

Both these problems arose from the failure of the authorities to recognize the rationale behind the existing land use system. The third main reason for the lack of success was that no research on range management methods was carried out in that area prior to the project's implementation. The explicit assumption was that range management techniques for rest and rotation developed in the USA would be an improvement on the existing system of land use and that variations in these techniques could subsequently be made to suit local conditions. However, no further local research was carried out for at least the first 10 years of the project; and there is still no evidence that the management techniques suggested - and which the local pastoralists have ignored - would have raised land productivity.

My second example relates to the record of livestock research programmes in Africa in general rather than to a particular project. In a number of cases trials have been carried out on research stations on animal management practices, e.g. breeding seasons, supplementary feeding, and as a result recommendations have been made about practices which appear to be highly profitable. Pastoralists and other livestock owners have not followed these recommended practices because in their circumstances the practices have been unfeasible or uneconomic.
In a number of countries governments have intervened in marketing systems in order to improve their efficiency and provide pastoralists with higher prices for their livestock. Common among such interventions have been restricting permission to trade to those traders able to fulfill certain license conditions, and insisting that all trading takes place in formal markets, that sale be by auction and that livestock to be sold first be weighed. Such marketing interventions have usually been unsuccessful, firstly because no attempt was made to assess objectively the efficiency of the pre-intervention marketing situation - which was just assumed to be costly, inefficient and subject to manipulation by traders for their own profit; secondly, because often it was assumed that the function of livestock marketing was to extract beef animals from rural areas for urban consumption or export, and it was not realized that often the vast majority of transactions were of breeding animals, or animals for draught purposes - transactions for which sale by weight at auction is highly unsuitable. Also the long time interval between market days which may be suitable for the extraction of beef cattle from rural areas is highly unsuitable for transactions in smallstock and in cattle for other purposes. In other words the proponents of the interventions failed to understand pastoralists' or other livestock owners' purposes or needs in marketing stock and failed to have adequate regard for their point of view.

Conclusions

PSR is relatively new in Africa, and I do not want to preempt the discussions of the concluding sessions of this workshop by either wholeheartedly supporting or disclaiming PSR. Let me end by reemphasizing five points.

1. Although increases in livestock production in pastoral areas of tropical Africa have occurred in the past these increases came about by the extension of existing systems rather than through their intensification.

2. Intensification of production has not yet been successful in pastoral areas.
3. Part of the reason for this lack of success has been ignorance about which interventions should be introduced.

4. Part of the reason for this ignorance has been the generally inadequate volume of livestock related research.

5. However, part of the reason for the lack of success has been the making of inappropriate interventions due to a failure to carry out some of the stages included in PSR. In particular there has been a failure to understand the present system – both in terms of what people want to do (their ends) and why they adopt the means they do. Also critical has been the failure to test innovations developed elsewhere or those tested on research stations under the specific conditions of the natural and social environment faced by the pastoralists for which the particular innovation is planned.

References


Expérience en matière de développement

Résumé

Le thème de ce document porte sur l'analyse de la recherche sur les systèmes pastoraux dans le cadre du développement de l'élevage en Afrique au cours du dernier demi-siècle.

Les zones arides sur lesquelles vivent 60% des ruminants de l'Afrique tropicale couvrent 55% de la superficie du continent. La proportion de la population totale de ruminants de l'Afrique élevés dans les systèmes pastoraux se situe probablement entre 30 et 50%. Entre 1950 et 1970, la population humaine de l'Afrique a approximativement augmenté au rythme de 2,5% par an mais la croissance de la production carnée et laitière ne dépassait guère 2%, ce qui indique une baisse de la production par habitant. De 1970 à 1975, le taux de croissance de la population humaine a augmenté alors que celui de la production annuelle diminuait, traduisant ainsi une chute encore plus rapide de la production par habitant. En conséquence, on a observé une baisse des exportations de bétail et de produits animaux parallèlement à une augmentation des importations d'animaux et de produits de l'élevage.

Autrefois, le développement pastoral était synonyme d'un ensemble hétérogène de programmes à caractère général. Après 1965, il y a eu une accélération remarquable du rythme du développement, notamment avec l'arrivée sur la scène de la Banque mondiale et de l'Agency for International Development des Etats-Unis (USAID), toutes deux grands bailleurs de fonds dans le secteur du développement pastoral. Durant la seconde moitié des années 70, la CEE/FED est entrée elle aussi dans le club des grands bailleurs de fonds des projets de développement. Mais dans l'ensemble, c'est à une extension plutôt qu'à une intensification du système d'élevage qu'on a assisté. Celle-ci se caractérisait par deux types d'améliorations: la lutte contre la peste bovine qui permet d'accroître la population bovine et la mise en valeur des ressources en eau qui permet d'augmenter la superficie des terres exploitées. Malheureusement, dans la mise en œuvre de ces formes très adéquates d'amélioration pastorale, rien n'a été envisagé en ce qui concerne la recherche sur les systèmes pastoraux.
L'intensification de la production animale en Afrique tropicale ne s'est pas réalisée. Pour certains programmes de développement pastoral, les raisons qui expliquent cet échec tiennent sûrement à la négligence des responsables mais aussi aux contradictions et à l'incohérence des politiques gouvernementales tout comme aux carences en matière d'organisation et de personnel. Dans plusieurs cas, l'échec a été causé par le choix d'interventions inopportunes à la place d'autres interventions qui auraient pu être couronnées de succès.

Dans la recherche sur les systèmes pastoraux, l'accent est mis sur la compréhension de l'ensemble du système avant celle des composantes particulières du système ou avant toute tentative d'intervention sur ces composantes. Contrairement aux approches qui privilégient la technologie ou les produits, la recherche sur les systèmes pastoraux se caractérise par l'importance accordée au point de vue de l'éleveur. L'un des éléments les plus remarquables de la recherche sur les systèmes pastoraux c'est qu'elle prévoit le test des innovations envisagées au niveau de l'exploitation elle-même dans les conditions dans lesquelles vivent habituellement les éleveurs.

Quoique par le passé on ait pu enregistrer des accroissements de la production animale dans les zones pastorales de l'Afrique tropicale, ceux-ci étaient plutôt le fruit de l'expansion des systèmes existants que de leur intensification. L'intensification de la production dans les zones pastorales s'est jusqu'ici soldée par un échec. Cet échec s'explique dans une large mesure par l'incapacité d'identifier les types d'interventions appropriées.

Cette lacune s'explique en partie par le volume généralement inadéquat de la recherche sur l'élevage. Mais cet échec procède également d'interventions inadéquates qui s'expliquent par le fait que certaines étapes de la recherche sur les systèmes pastoraux ont été négligées. En particulier, on ne s'est pas attaché à comprendre le système actuel et à expliquer notamment les objectifs des populations concernées et la raison pour laquelle elles adoptent les moyens dont elles se dotent. Autre aspect important de cet échec: on n'a pas essayé les innovations mises au point sous d'autres cieux ou
au niveau des stations de recherche dans les conditions spécifiques de l'environnement naturel et social de l'éleveur auquel ces innovations sont destinées.
Towards a framework for pastoral systems research

Cees de Haan
Deputy Director General, ILCA, Ethiopia

Introduction

The International Livestock Centre for Africa (ILCA) has adopted a systems approach to research since its inception in 1975. This strategy originated from ILCA's Foundation Report, which stated that 'technical answers are available to many of the specific problems facing livestock development in Africa, but the major constraint lies in introducing change into existing socio-economic systems, exacerbated by inexperience in adapting technology to suit local conditions' (Nestel et al, 1973). The approach was reinforced by the growing realisation as experienced in development projects that the results of classical on-station research, whether in Africa or elsewhere, and Western technology could not be transferred directly to African traditional systems. A better understanding of those systems, and adaptive research was necessary to identify relevant improvements.

When ILCA started its research no methodology for livestock systems research (LSR) was readily available, and a considerable amount of time and resources was spent on developing methods of studying and understanding the complexity of livestock production systems, and on defining ways in which available technology could best be tested within a particular production system. With the emergence of a farming systems research (FSR) methodology (Gilbert et al, 1980; Byerlee et al, 1980; Shaner et al, 1982), ILCA has attempted to develop a systems approach analogous to the framework used in FSR, although the greater genetic variability of livestock, the lower degree of control because of mobility, the daily rather than seasonal inputs required for livestock, their multiple usages, and the greater influence of individual management makes LSR more complex than cropping systems research. Additionally in pastoral systems the greater mobility of people and livestock, problems of land tenure, and the
limited scope for improvements, adds to the complexity in the application of the approach.

This paper gives an overview of the ILCA research framework and highlights some of the results obtained. It focuses on pastoral systems of arid and semi-arid zones, but also includes the linkages with cropping in agropastoral systems. It uses mainly examples from ILCA's own field research in the Sahelian environment of Mali, and the semi-arid areas of Kenya and Ethiopia but also incorporates other situations in more humid areas or where ILCA was only indirectly involved.

Objectives of livestock systems research

The objective of livestock systems research (as in FSR) is to assist in the generation of relevant improvements for the well-being of a certain target population. These improvements can be technical and socio-economic in nature. LSR is not responsible for the extension of a new technology, or for making complete baseline surveys or management plans for a certain region. These distinctions should be emphasised, as it immediately puts limits on the number of producer units and the kind of parameters under study, the level of details in observations made, the frequency of data collection, etc.

For example in a pastoral area, LSR would describe the relationship between water resources and rangelands utilisation, diagnose labour and sanitary constraints for the extraction and use of the different types of water points, assess the effect of those constraints on animal productivity and identify users' rights. It would then use this information to design and test relevant technology, which could overcome those constraints. It would not make a complete inventory of all water points in the region, nor conduct a hydrological study of all underground water available. The latter tasks are clearly the responsibility of a development agency, which should use the technology developed and tested through LSR to design and implement water improvement schemes for the region.
Stages in LSR

LSR as defined above consists of a sequence of stages, designed to identify constraints in a particular system, and through experimentation or available knowledge identify possible solutions. These solutions are then tested in real life situations, initially with a high degree of scientific control, and as positive effects are noted with increasing producer participation and decreasing scientific involvement and control. Table 1 gives the different terms used in each of the stages.

Table 1. The terms used in the stages of livestock systems research

<table>
<thead>
<tr>
<th>Stage</th>
<th>Object of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Descriptive</td>
<td>Natural, livestock and human resources, production systems</td>
</tr>
<tr>
<td>2. Diagnostic</td>
<td>Constraints, in order of priority research requirements, chances of success to overcome them</td>
</tr>
<tr>
<td>3. Design</td>
<td>Possible solutions through on-station experimentation or body of knowledge</td>
</tr>
<tr>
<td>4. Testing</td>
<td>Producer management of improvements</td>
</tr>
<tr>
<td>a. researcher managed/ farmer executed</td>
<td></td>
</tr>
<tr>
<td>b. farmer managed/farmer executed</td>
<td>Acceptability of improvements</td>
</tr>
<tr>
<td>5. Extension</td>
<td>Evaluation of technical and socio-economic impact of improvement</td>
</tr>
</tbody>
</table>

Source: Adapted from Shaner et al (1982) and Norman (1982).

Three points should be emphasised in this context:

1. The different stages can overlap, e.g. it is not necessary to complete the whole diagnostic phase before any design or testing activity can take place.
2. Although the classical approach is to start with the descriptive phase, the research process can be initiated at any stage.

3. Continuous data analysis is essential for feedback of results and rapid progress from the descriptive/diagnostic phase to the testing phase. Micro-computers can play a useful role in this process. If no computing facilities are available, the data collection system should be organised in such a way that calculators can do the analysis.

Some considerations on sampling framework in LSR

With the increasing limitation on funds and the pressure from development agencies on research institutes to provide improvement the emphasis is on using rapid and low-cost appraisal techniques. Sample selection can be an important tool in enhancing the cost effectiveness of the diagnostic and testing phase. ILCA's results indicate that the following parameters are important in determining the management strategy, and therefore the profile of possible improvements, and should be considered in the sampling framework.

1. The livestock/man ratio ("rich vs poor"). It becomes increasingly apparent that a different degree of livestock wealth results in different management. For example, in the pastoral areas of Niger, Wilson and Wagenaar (1983) found a marked decrease in offtake with increasing herd size (see Table 2).

Table 2. Relation between herd size and offtake of WoDaaBe herds in Northern Niger (1983)

<table>
<thead>
<tr>
<th>Herd size</th>
<th>Offtake* (%) per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10</td>
<td>5.9</td>
</tr>
<tr>
<td>11-15</td>
<td>10.9</td>
</tr>
<tr>
<td>16-20</td>
<td>4.7</td>
</tr>
<tr>
<td>21-25</td>
<td>4.3</td>
</tr>
<tr>
<td>&gt;25</td>
<td>3.5</td>
</tr>
</tbody>
</table>

* Sales, slaughter and gifts

In this example the category owning between 11 and 15 animals also sold females which indicated that they were forced to sell. The poorest category could not sell, and practised migratory labour. Further examples of the importance of livestock/man ratio, and a rapid method of assessing the relative wealth will be given by Bekure and Grandin later in the workshop.

2. Men vs women. As shown by ILCA's subhumid programme in northern Nigeria (ILCA, 1982) there is often a conflict of interest in the male and female economic sphere particularly over milk offtake and sales. Milk offtake normally benefits the women, whereas the proceeds of livestock sales go directly to the men. Improvements like supplementary feeding, which are financed by men, therefore should not only result in increased milk offtake, but also in increased rates of calf survival, and at a later phase improvements should benefit both groups in order to avoid future inequities. In pastoral systems research, both groups should therefore be included in the sampling framework.

3. 'On-road' vs 'off-road' producers. Especially in agro-pastoral systems research activities tend to focus on the easily accessible 'on-road producer. Access to a road, as shown in Table 3 for the Ethiopian highlands, to a considerable extent affects producers' strategy, and therefore should be one of the considerations in selecting the sample.
Table 3. *Average livestock holdings per household of on-road and off-road producers* in the Ethiopian highlands

<table>
<thead>
<tr>
<th>Livestock</th>
<th>'On-road'</th>
<th>'Off-road'*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local breeds</td>
<td>2.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Crossbreeds</td>
<td>0.4</td>
<td>-</td>
</tr>
<tr>
<td>Oxen</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Sheep</td>
<td>4.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Goats</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Donkeys</td>
<td>1.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* Minimum of 2.5 hours away from an all-weather road.

Source: Gryseels (per. comm.).

Descriptive and diagnostic phase

The descriptive phase consists of a literature review and a general reconnaissance of the resources and production systems of the target region. It will generally provide an indication of the nature of the constraints but not a quantitative assessment of their importance or their priority ranking. The descriptive phase should be kept short (one to six months) to move as soon as possible into the diagnostic phase.

The different methods used by ILCA in the descriptive and diagnostic phase for resource assessment, and the measurement of vegetation, vegetation trends, animal productivity, importance of diseases, nutrition, resource allocation within the producers' units, and marketing will be presented in detail in this workshop, and are therefore not reviewed in this paper. Some results which merit special mention and which have assisted in developing ILCA's overall programme are:
1. Herd and flock management practices by individual owners seems to be one of the most important single factors affecting productivity. For example, Wilson et al (1982) found in central Mali the ratios of the production index (production kg per year per kg metabolic weight of breeding female) given in Table 4.

Table 4. Ratios of production index of small ruminants in the agropastoral system of central Mali

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Ratio</th>
<th>Goats</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean</td>
<td></td>
<td>1.47</td>
<td>2.31</td>
</tr>
<tr>
<td>Parity</td>
<td>All parities/first</td>
<td>1.40</td>
<td>1.23</td>
</tr>
<tr>
<td>Season of birth</td>
<td>Best/worst</td>
<td>1.23</td>
<td>1.14</td>
</tr>
<tr>
<td>System</td>
<td>Rice/millet</td>
<td>1.58</td>
<td>1.33</td>
</tr>
<tr>
<td>Flock (millet)</td>
<td>Best/worst</td>
<td>2.43</td>
<td></td>
</tr>
<tr>
<td>(rice)</td>
<td>Best/worst</td>
<td>5.58</td>
<td></td>
</tr>
</tbody>
</table>


Similar results were obtained in ILCA's Kenyan programme both with cattle and small ruminants. This is all the more surprising because grazing is communal to all and different owners have the same access to this principal resource. Individual management skills therefore seem to play a more important role than previously reported. However, ILCA has not yet defined the components which determine those management practices. In view of their overriding importance, more attention is presently being given to quantify these factors. Indeed if those parameters could be better quantified, and if through extension the management of the below-average flocks and herds could be raised to higher levels, considerable productivity gains could be obtained.
2. Strong linkages already exist between livestock and cropping, and the enhancement of these linkages merits a high priority in research, because they form a relatively easy entry point for improvement.

On an Africa-wide scale Brumby (1983) observed a significant correlation between the increase of total cereal production and cattle numbers, e.g. that each extra number in the cattle population was associated with an extra 0.25 ha of crop land and about 200 kg of annual grain output. On a regional basis, the strong relationship between livestock and cropping was shown by ILCA's aerial survey work in several systems. For example, Table 5 demonstrates this integration for central Nigeria.

Table 5. Relationship between livestock and cropping in central Nigeria

<table>
<thead>
<tr>
<th>% area cultivated</th>
<th>Cattle density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wet season</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>7.7</td>
</tr>
<tr>
<td>10-34</td>
<td>16.6</td>
</tr>
<tr>
<td>35-60</td>
<td>21.4</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>22.4</td>
</tr>
</tbody>
</table>

Source: Miligan, 1980.

The beneficial nature of this relationship expresses itself differently in the various situations. For example ILCA's systems studies in central Mali demonstrated a very clear effect of livestock ownership on millet yields, probably through the manure linkage (see Table 6).
Table 6. *Relation between village field millet yields (kg/ha) and livestock ownership in central Mali*

<table>
<thead>
<tr>
<th>Year</th>
<th>Millet yield (kg/ha)</th>
<th>Households with cattle</th>
<th>Households without cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td></td>
<td>679</td>
<td>440</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td>637</td>
<td>439</td>
</tr>
</tbody>
</table>

*Source: Fulton and Toulmin (1982).*

A similar close relationship in the field of animal traction was found by Gryseels (1983) in the Ethiopian highlands. His results clearly show a marked increase in the crop area cultivated by each family as well as a significant change in cropping patterns to higher value cereals as oxen numbers increase (see Table 7). Similar trends were observed by ILCA's central Mali studies (Fulton and Toulmin, 1982).

Table 7. *Relationship between area cultivated, cropping pattern and oxen ownership in the Ethiopian highlands*

<table>
<thead>
<tr>
<th>No. of oxen per farmer</th>
<th>Area cultivated (ha)</th>
<th>Area under cereals (%)</th>
<th>Area under pulses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.2</td>
<td>54</td>
<td>46</td>
</tr>
<tr>
<td>1</td>
<td>1.9</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>2.7</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>3 or more</td>
<td>3.6</td>
<td>92</td>
<td>8</td>
</tr>
</tbody>
</table>

*Source: Gryseels (1983).*
These findings have directed to a considerable extent the focus of ILCA's research thrust; for example, activities aimed at strengthening the integration of crops and livestock (legume agronomy, animal traction) are receiving approximately 150% more funding in 1983 than in 1981.

Even more important than the specific results, although less tangible, is the understanding ILCA staff have gained of systems and systems research after five years of work.

The identification of improvements

Possible improvements are identified and designed by the systems team, tentatively during the descriptive phase, but increasingly during the diagnostic phase. It should be emphasized that the identification of improvements and their priority ranking must be a team effort. Quantitative models describing the input/output relationships at the different systems levels are useful in assisting the team in the decision-making process.

The plant/animal sub-component is adequately represented by ILCA's herd productivity model. This model is being used to estimate the effect of supplementation or management strategies, such as the effect of early weaning, watering frequencies and distance to water on livestock productivity, and can therefore be used to rank the priorities for field research (Konandreas and Anderson, 1982; Konandreas et al, 1983). A simple example of an input/output model at the producers' unit level for the Ethiopian Borana system is graphically represented in Figure 1.
Rain 600 mm

Solar energy 750 kj cm²

LAND — 80 ha wet season
(100 ha) 50 ha dry season

WATER 400 l/day

200 ton dry matter¹ (Exc. browse)

CATTLE
1 bull
9 cows
4-5 ♀ immature
4 ♂ immature

SMALLSTOCK
6-10 sheep
7-9 goats

5-6 cows in milk
2000 l/yr

CAMELS
3

Milk in dry season?

Family consumption

Purchase of grain
200-300 kg/yr

Sales
US$ 300

¹ Food requirement of cattle and smallstock about 45 tons DM/yr.

Figure 1: Input/output relationships of a Borana pastoral production unit in southern Ethiopia
This particular example also illustrates the multidisciplinary approach to the identification of improvements. In the Borana system the herd demography study revealed a significant differential mortality between female and male calves (see Table 8). This is caused by a heavy reliance of the Borana on milk for subsistence, which probably forces them to slaughter male calves to enable a faster reproduction and to allow less suckling to increase the amount of milk available for human consumption. However, this strategy conflicts with government objectives aimed at increasing the meat offtake from these rangelands. An obvious way therefore to reduce this calf mortality, and to increase total offtake from this particular system, is to increase either the total milk yield or the amount of available grain to reduce dependence on milk. The joint ILCA/RDP (Ethiopian Rangelands Development Project) team therefore will shortly be testing the feasibility of millet cultivation around the heavily manured permanent dry-season camps and has started work on legume introduction for dry-season supplementation.

Table 8. Age/sex distribution (%) of cattle herds in southern Ethiopia (dry and lactating herds combined)

<table>
<thead>
<tr>
<th>Age/sex distribution (%)</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calf</td>
<td>12.2</td>
<td>9.3</td>
</tr>
<tr>
<td>Immature</td>
<td>14.7</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Source: Cossins (pers. comm.).

The design phase

The assumption that the new technology for improving Africa's traditional livestock production systems would be available, is only partially true. Generally it can be said that in the field of animal health and animal nutrition there exists a whole range of improvements, which can immediately be tested under pastoral con-
ditions. However, in the field of range management and in the integration of forage production into cropping systems, the available body of knowledge is still extremely scarce, and no clear-cut solutions to identified constraints are available. Production parameters have to be established, therefore, initially under controlled conditions, e.g. in on-station research. It is therefore essential that LSR has access to good research station facilities. One major distinction between LSR and classical research station experiments relates to the identification of the treatments. In LSR the treatments are defined by the socio-economic and political framework determined in the diagnostic phase. If for example the supply of fertilizer or agricultural equipment is not expected in the near future, such inputs would not be used in the experimental design.

The testing phase

Once the improvements have been formulated they have to be tested under producers' conditions. The object of these tests is to obtain scientifically valid conclusions regarding the effect of improvements and to assess producers' acceptance. The first objective distinguishes systems research from extension. In extension improvements are normally introduced without control groups, and without built-in scientific comparisons. In systems research the objective is not to cover the whole target population, but to make a scientifically valid comparison regarding the effect of certain treatments (improvements) on a minimum required sample size.

This means that systems research should always have a with/without comparison on a representative sample, simultaneously carried out under similar environmental conditions. A before/after comparison as carried out in many development projects will always have the confounding effect of different environmental conditions.

For this comparison, matched pairs of animals with similar characteristics within a herd or flock are preferred when inputs are very easily administered. ILCA is following this experimental procedure for example in the case of animal health inputs, and in concentrate supplementation in northern Nigeria. If the improvements
proposed require major changes in management strategies, or different organisational structures, then comparisons have to be carried out on a whole farm, or whole herd, basis. Examples of this procedure are to be found in ILCA's programme testing the use of fodder banks in northern Nigeria, and forage production and crossbreeding for dairy production in the Ethiopian highlands.

The latter programme, although not a pastoral system, illustrates the value of continued systems research. Although the initial results (Gryseels and Anderson, 1983) showed a very positive impact of the introduction of crossbreds and forage production (annual milk yield increased sevenfold to 2300 kg, cash income fourfold to US $ 800, food grain production by 40%), changes in the cropping pattern clearly demonstrated the need for more research on forage production. It was shown that farmers: 1. replaced their crop yielding the lowest gross margin (pulses) to grow forages with a resulting negative long-term effect on soil fertility; 2. allocated labour for soil preparation first to cereal crops, rather than the forages; and 3. applied fertilizers only to cereal crops because of recent increases in fertilizer prices. This in turn has caused ILCA to allocate more resources to the search for leguminous pasture plants requiring low labour and low fertilizer input. The first on-farm trial with a perennial grass legume mixture will start in 1983.

Improved range management practices are particularly difficult to test under pastoral conditions, and generally new organisational forms are required a priori. Even so, a good understanding of a traditional system frequently offers opportunities:

1. In the Malian delta, traditional forms of land tenure offer the possibility of establishing pastoral units which would enable the introduction of improved grazing schemes (ODEM/CIPEA, 1983 Wilson et al, 1983).

2. In Niger, building upon traditional water rights, a promising grazing scheme developed on a government station will be tested with a small number of experimental herders associations. Soon to be established water points under the control of those herders associations form the mechanism for testing this grazing scheme.
3. In the Kenyan group ranches, individual ownership of certain pastures allows the introduction of legume fodder banks to overcome the dry-season nutritional stress. ILCA plans to introduce fodder banks in on-herd trials in 1983.

**Extension phase**

Once the improvement has been satisfactorily tested under producers' conditions in farmer managed, farmer executed trials, it can pass to the extension service for further implementation. This will generally be carried out in the framework of a development project.

It is important to evaluate the improvement and, in this phase especially, its socio-economic impact. The direct involvement of a research institute in this evaluation is questionable. Ideally the project or extension structure will include the capabilities for the technical and socio-economic evaluation of the improvement. In the absence of such a structure and the information still being required, it should be national research institutes who take responsibility for this often politically sensitive task. The degree of ILCA's direct involvement is an open question.

In any case, the evaluation procedures should be simple and be focused on the specific improvement introduced. If a particular improvement is to be successful, it should produce a considerable gain in productivity and income, or added security. The data collection system to study the impact could therefore be reduced in sampling frequency and size. Qualitative information allowing the identification of trends in this case might be given more emphasis.

**ILCA's future role in LSR**

Livestock systems research is location specific, focusing on a particular target zone. It cannot be the role of an international centre like ILCA to take direct responsibility for the whole African production system. Rather, ILCA sees its role as 1. further developing the systems methodology for each of the major ecological zones, 2. developing improvements for the constraints identified in those zones, and 3. simultaneously assisting national research and develop-
ment agencies in establishing their own in-house capabilities. The interest which has recently emerged is encouraging.

- In northern Nigeria, ILCA is actively cooperating with scientists from the National Animal Production Research Institute (NAPRI) in establishing an LSR group, which focuses on an agropastoral system near Shika.

- In Mali, ILCA has recently signed a contract with the Institute National de Recherche Zootechnique Forestier et Hydrobiologique (INRZF) to assist in the establishment of a LSR group in the institute to focus on smallholder mixed farmers in southern Mali.

- Negotiations are at an advanced stage with the Directorate of Research and Special Services in Zimbabwe to assist them in the establishment of an LSR capability, focusing initially on two mixed farming systems, in high and medium potential areas respectively.

- The Government of the Cameroons has recently approached ILCA to assist them in developing LSR capabilities in the Institute de Recherche Zootechnique (IRZ) focusing initially on three different production systems there.

Summary

The complexity of livestock production systems in sub-Saharan Africa, and the multiple objectives of its producers requires that whole systems rather than components be studied. Livestock systems research, as practised by ILCA over the last year, represents an approach to such studies. By applying this approach ILCA has gained considerable knowledge of the constraints and opportunities in pastoral and agropastoral systems.

The testing of improvements under producers' conditions is a crucial and essential part of this approach. Livestock systems present particular difficulties in implementing these tests. Some experience has been gained but more methodology development is still required for this phase.

ILCA sees its role as that of further exploring these issues, assisting national agencies in developing systems research capabilities, and developing relevant improvements to the constraints
identified. With this combination of research thrusts ILCA believes that a sustained gain in African livestock productivity and overall food production can be achieved.

References


Vers un cadre de recherche sur les systèmes d'élevage

Résumé

Dès sa création en 1975, le CIPEA a adopté une approche par système analogue au cadre utilisé dans la recherche sur les systèmes d'exploitation agricole. Le présent document brosse un tableau général du cadre de recherche du CIPEA, présente certains des résultats qu'il a obtenus et met l'accent sur les systèmes pastoraux des zones arides et semi-arides.

La recherche sur les systèmes pastoraux se propose de contribuer à l'amélioration de la qualité de la vie d'une certaine population-cible. Cette amélioration peut être technique et socio-économique. La recherche sur les systèmes d'élevage est une série d'étapes conçues pour identifier les contraintes d'un système particulier et les moyens d'éliminer celles-ci par le biais de l'expérimentation ou par l'utilisation des connaissances disponibles. Ces solutions sont par la suite testées dans les conditions de l'exploitation, tout d'abord sous le contrôle du chercheur, dont le rôle sera progressivement transféré au producteur, à mesure que les résultats enregistrés s'avéreront encourageants.

Avec l'accroissement des restrictions budgétaires et des pressions qu'exercent les organismes de développement sur les instituts de recherche en vue de la mise au point par ceux-ci d'innovations, il faudrait privilégier l'utilisation de techniques rapides et peu coûteuses d'évaluation. La sélection des échantillons peut constituer un outil utile pour renforcer l'efficacité - coûts de la phase du diagnostic et de l'expérimentation. Les résultats obtenus par le CIPEA indiquent que les paramètres ci-dessous jouent un rôle important dans la détermination de la stratégie de gestion et partant, dans la forme des innovations éventuelles. Il faudrait donc en tenir compte dans la base d'échantillonnage: rapport bétail/homme (riche/pauvre); homme/femme; producteur situé à proximité de la route/éloigné de la route.
Lors de la phase de la description, on procède à un examen de la documentation et à une reconnaissance générale des ressources et des systèmes de production de la zone-cible. Cette phase fournit généralement une idée de la nature des contraintes même si elle ne permet pas de procéder à une évaluation quantitative de leur importance ou de leur rang de priorité.

Cette phase donne lieu à l'identification et à la mise au point d'améliorations potentielles par l'équipe étudiant le système. Ces activités s'intensifient au cours de la phase de diagnostic.

Après la formulation des innovations, on doit procéder à des essais dans les conditions de l'exploitation. L'objet de ces essais est de confirmer scientifiquement les effets des améliorations et d'évaluer le degré de succès des innovations chez les producteurs.

Une fois que les améliorations auront été testées dans les conditions de l'exploitation au cours d'essais dirigés et exécutés par les agriculteurs, on pourra passer à la phase de la vulgarisation pour une plus large diffusion. De telles activités s'effectuent généralement dans le cadre de projets de développement.

La recherche sur les systèmes pastoraux s'effectue en un lieu spécifique, sur une zone-cible particulière.
Summary of Discussion Session 1.
Chairman: Dr. L.J. Lambourne (ILCA)

Dr Chema referred to Dr de Haan's paper in which he mentioned possible on-station work during the design phase. Where would ILCA do this work in e.g. Kenya where it had no research station? Dr de Haan said that an LSR team working in a particular area did not have to do the on-station work itself but could involve other research groups in the process. If the results of ILCA's diagnostic phase indicated that on-station work was necessary, the co-operation of national authorities would be actively sought. Dr Chema asked at what stage of LSR should extension officers be involved; Dr de Haan said they should be involved at all stages.

Dr Zulberti pointed out that in recent work on the main components of project success the early participation of farmers in the descriptive and diagnostic phases had been identified as one of the most important ones. Also the role of extensionists was crucial especially when testing was being done because of the multiplication effect of their participation. Dr de Haan agreed. Dr Zulberti suggested that participants used the term 'pastoral systems research' during the workshop rather than 'farming' or 'livestock systems research'. Dr de Haan explained that he had used the term 'livestock systems research' because he wanted to highlight the specific difficulties inherent in livestock as a part of an overall farming system. The focus of the workshop was indeed on pastoral systems, although he had given a broader scope in the opening paper.

In referring to Mr Sandford's paper, Dr Zulberti said that the development of water systems was not necessarily a consequence of machinery reducing the cost of earth movement, because the ILO had data showing that the cost of earth movement was cheaper with hand labour. Mr Sandford pointed out that in most pastoral areas it was very difficult to hire people for manual labour and often pastoralists had a low productivity in this regard.
Dr Abel questioned whether or not there had been a sincere development effort in the arid and semi-arid areas—such areas were frequently marginal ones politically, economically and ecologically with their people poorly represented. Mr Sandford agreed that there were extreme difficulties in channeling development efforts to pastoral areas—he felt it was unrealistic to expect governments to commit large sums over long periods to the development of marginal areas. Development efforts needed to be self-supporting after as short an initial investment period as possible.

Dr Sorbo said he felt that ILCA was confronted by two main problems in the field of systems investigations: the problem of improving the conceptual and data technical tools by which one approaches the realities of production systems; and the problem of applying these tools and techniques to finding solutions to decision-making in practical tasks. He felt ILCA's activities needed to be focused on both problems, not just the second. Dr de Haan agreed, but said that under pastoral producers' conditions ILCA's main focus should be on the testing of hypotheses e.g. making scientifically sound conclusions regarding the impact of improvements, but not going beyond the sample size and the inputs required to test the specific hypotheses. If that focus were kept in mind, the distinction between research and development would be clear.

Dr Chema asked Mr Sandford to clarify what he had said about the control of rinderpest by quarantine. Mr Sandford said that quarantine was very difficult to administer and was very costly in terms of both government efforts and inconvenience to pastoralists. Tissue culture vaccine was in every way a vastly superior method of control. He said he had been making the point that quarantine had controlled rinderpest first, but was not advocating a return to quarantine control.

Dr Rhissa said that he thought that the failure of projects to intensify animal production was not primarily due to the negligence of governments, the lack of adequate policies, bad co-ordination or poor planning. But rather this failure was due to the approach used in which the producer was not involved from the start of intensification programmes. Dr Rhissa felt that ILCA should intervene only after
the state had determined its precise needs; ILCA could then after field studies apply a package of solutions which the state could choose and adapt according to their own needs. Mr Sandford agreed that development planners had tried to think and act too much on behalf of producers instead of directly involving them in the planning process. But he still thought that negligence, poor policies and poor planning had also been major problems. Mr Sandford thought that there was a role for ILCA to intervene earlier than Dr Rhissa proposed. ILCA ought to be able to make valuable suggestions which themselves help populations and states to determine their precise needs.

Dr Abel said that the understanding between local people and foreigners could be good and that in some countries the extension service was so alienated from the local farmers that only an outsider had a fair chance of getting useful information. Communication between farmers and scientists was both useful and possible.

Dr von Kaufmann said that systems research was about change and was iterative. One could not expect farmers to comment easily on something new – their answers would be motivated by all sorts of reasons. Iteration meant going forward and seeing the farmers' reaction, then going back and adjusting the innovation, then putting it to the farmers again. Evaluation was a continuous process.

Dr Diakite felt that Mr Sandford had not taken into account the problem of financing – finances were in general inappropriate, inadequate and conditional. Mr Sandford agreed that financing conditions were often quite inappropriate and that one expected too much too soon. But he doubted if the fact that one was dealing with 'traditional populations' had much to do with it. The problem was that development projects often tried to do foolish things rather than that traditional populations hesitated to do wise ones.

Dr Diakite felt that Mr Sandford underestimated the importance of international health agreements. Mr Sandford thought that they were not necessarily well founded – indeed often they were manifestly not in the interests of developing countries. He believed that disease
eradication or control policy should not be regarded as sacrosanct but should be subject to review and justification from time to time.

Prof. Saka Nuru said that it was acknowledged that national institutes had carried out research into various national livestock problems over the years with considerable success. However, traditional research had its limitations in that its direct application to the field was not feasible. ILCA's role was different in that it not only looked at the problem in its totality through its multi-disciplinary approach, but also carried the applied research to the farmers' level. However, ILCA had to continue to rely on the basic research resources of national institutions and to relate its work to the needs of the development agencies of each country. A closer link with national bodies was therefore desirable.

Mr Sandford said that the way in which PSR had been described — and so defined — may have given the impression that the only 'output' of PSR was successfully tested improvements. There were other valuable outputs — which were only spin-offs of PSR as defined by Dr de Haan, but were the outputs of other ways of defining PSR. These outputs were in terms of the better understanding by everyone concerned in pastoral development. A piece of PSR which led to no successful improvements could still be valuable in terms of increased understanding and consequently better oriented development efforts.

Dr Bekure commented that if one confined systems research to the production of technology to increase productivity, one closed the door to research on e.g. marketing which did not deal with the producer directly but yet was important for the producers' incentives and for an understanding of producers' perceptions. Dr von Kaufmann agreed that testing technology was not the only subject for FSR. If the diagnostic phase revealed extension as the bottleneck, then FSR would focus on how many farmers should there be per extension officer, what would be the logistic package and how could the package be best presented to farmers.
Dr Grandin pointed out that ILCA was not involved in adaptive research/extension for its own sake. ILCA's purpose was to understand the process of doing PSR, to work out the necessary methods. This could be done partially by other research activities which helped to evaluate the role or process of PSR. Dr Lambourne said that ILCA had a mandate which required it to "assist national efforts which seek to bring about a change in the systems of production..." ILCA thus had two roles: to look for ways of improving and changing existing production systems, and to find those systems which were best left in their present equilibrium because of ecological or social reasons.

Dr Habou suggested that most livestock projects were more interested in the animal than in man - but in the long run man was the centre of any production system. Mr Sandford commented that the disregard in planning of the human element was much more obvious in the 1960s than either before or after that period. It was perhaps too early to judge whether the changes from the 1960s to the 1970s in this respect had led to better projects.

Dr Ngutter suggested that ILCA should ask governments and research institutions what role they would like ILCA to play in their own countries rather than ILCA assuming they knew each country's problems a priori. Dr de Haan said that the essence of systems research was that the problems of a certain production system were not known a priori. ILCA would see its involvement along the following lines: governments ask ILCA for a systems study in a certain target area chosen by the government; ILCA then decides in discussion with the government research and extension agencies the kind of co-operative agreements required.
Résumé des débats de la première séance
Président: M. L.J. Lambourne (CIPEA)

Le Dr Chema a fait allusion au document présenté par M. de Haan dans lequel celui-ci mentionnait des travaux éventuels au niveau de la station au cours de la phase de conception. Où est-ce que le CIPEA pourrait effectuer ces travaux, par exemple au Kenya où le Centre ne dispose pas de station de recherche? M. de Haan a déclaré qu'une équipe de RSP travaillant dans une zone donnée n'avait pas à effectuer elle-même les travaux au niveau de la station et qu'elle pourrait au contraire demander à d'autres groupes de chercheurs de participer aux travaux. Si les résultats de la phase de diagnostic du CIPEA indiquaient que les travaux au niveau de la station étaient nécessaires, on chercherait activement la coopération des autorités nationales.

Le Dr Chema a demandé à quel niveau de la RSP devaient intervenir les agents de vulgarisation. M. de Haan a déclaré qu'ils devaient intervenir à toutes les étapes.

Le Dr Zulberti a souligné que dans des travaux récents sur les éléments essentiels de la réussite des projets, la participation précoce des exploitants dans les phases de description et de diagnostic a été identifiée comme déterminante. Le rôle des vulgarisateurs était également très crucial, notamment lorsque les tests étaient effectués en raison de l'effet multiplicateur de leur participation. M. de Haan a accepté ce point de vue. Le Dr Zulberti a suggéré que les participants utilisent l'expression "recherche sur les systèmes pastoraux" au cours du séminaire plutôt que celle de "recherche sur les systèmes d'élevage" ou "d'exploitation agricole".

M. de Haan a expliqué qu'il avait utilisé l'expression "recherche sur les systèmes pastoraux" parce qu'il voulait mettre l'accent sur les difficultés spécifiques inhérentes à l'élevage conçu comme un élément du système global d'exploitation agricole. Il était évident que ce séminaire avait pour principal objectif les systèmes pastoraux bien que dans son exposé préliminaire, il ait parlé dans une perspective beaucoup plus large.
Parlant du document présenté par M. Sandford, le Dr Zulberti a déclaré que dans la mise en place de systèmes d'adduction d'eau, la conséquence de l'utilisation de machines pour les travaux de terrassement n'entraînait pas nécessairement la réduction des coûts, car le BIT disposait de données montrant que le coût de ces aménagements était moins élevé avec le travail manuel. M. Sandford a souligné que dans la plupart des zones pastorales, il était très difficile de recruter une main-d'œuvre pour des travaux manuels et que souvent la productivité des éleveurs dans ce domaine était faible.

Le Dr Abel a demandé si oui ou non il y avait eu un réel effort de développement dans les zones arides et semi-arides, celles-ci étant fréquemment des régions marginales aux plans politique, économique et écologique, et leurs populations étant mal représentées. M. Sandford a reconnu qu'il était très difficile de canaliser les efforts de développement dans les zones pastorales. A son avis, il était peu réaliste d'attendre des gouvernements qu'ils engagent des sommes importantes sur de longues périodes pour le développement de zones marginales. Les efforts de développement devraient être auto-entretenus après une période d'investissement initiale aussi brève que possible.

Le Professeur Sorbo a souligné qu'à son avis le CIPEA était confronté à deux problèmes essentiels dans le domaine de la recherche sur les systèmes. Le problème de l'amélioration des instruments conceptuels et techniques de collecte de données qui permet d'aborder les réalités des systèmes de production et le problème de l'application de ces outils et techniques à la formulation de solutions en vue de la prise de décisions dans des domaines pratiques. Il a estimé que les activités du CIPEA devraient être axées sur la solution de ces deux problèmes et non seulement sur celle du second. M. de Haan a exprimé son accord mais a déclaré que dans les conditions de la production pastorale, le CIPEA devrait se concentrer essentiellement sur le test des hypothèses, par exemple travailler en vue de parvenir à des conclusions scientifiquement valables en ce qui concerne l'impact des améliorations, mais que l'envergure de tels tests ne
devrait pas dépasser la taille d'un échantillonnage et les facteurs requis pour vérifier les hypothèses spécifiquement identifiées. Si l'on garde cela présent à l'esprit, la distinction entre recherche et développement devient claire.

Le Dr Chema a demandé à M. Sandford de clarifier sa pensée lorsqu'il a parlé de la lutte contre la peste bovine par la quarantaine.

M. Sandford a répondu que la quarantaine était difficile à mettre en pratique et qu'elle était coûteuse et pour le gouvernement et pour les éleveurs. Le vaccin à base de culture tissulaire était dans tous les cas une bien meilleure méthode de lutte. Il a déclaré qu'il avait voulu souligner que la quarantaine avait été utilisée par le passé pour lutter contre la peste bovine, mais qu'il ne tenait pas pour autant à se faire l'avocat de la quarantaine.

Le Dr Rhissa a déclaré qu'à son avis, l'incapacité des projets d'intensifier la production animale ne relevait pas essentiellement de la négligence des gouvernements, de l'inefficacité des politiques adoptées et de l'inadéquation de la coordination ou de la planification. C'était plutôt l'approche utilisée dans laquelle le producteur n'était pas présent pendant la phase initiale de l'intensification des programmes qu'il fallait incriminer. Le Dr Rhissa a estimé que le CIPEA ne devait intervenir qu'après que l'État ait déterminé de manière précise ses besoins; le CIPEA pourrait alors, après des études de terrain, utiliser un ensemble de solutions que l'État pourrait choisir et adapter en fonction de ses propres besoins.

M. Sandford a reconnu que les planificateurs du développement avaient trop souvent essayé de penser et d'agir à la place du producteur plutôt que de l'intégrer directement dans le processus de planification. Mais il persistait à croire que la négligence, de même que des politiques et une planification inadéquates avaient également constitué de sérieux problèmes. M. Sandford pensait que le CIPEA pouvait intervenir plus tôt que ne l'avait suggéré le Dr Rhissa. Le CIPEA devait être à même de formuler des suggestions valables qui pourraient aider les populations et les États à déterminer leurs besoins.

Le Dr Abel a déclaré que la compréhension pourrait régner entre les autochtones et les étrangers et que dans certains pays, le service de
La vulgarisation était tellement éloigné des préoccupations des agriculteurs locaux que seul un étranger pouvait accéder à des informations utiles. La communication entre les agriculteurs et les scientifiques était à la fois utile et possible.

M. von Kauffmann a déclaré que la recherche sur les systèmes portait sur les changements et qu'elle était itérative de nature. Il ne fallait pas s'attendre à ce que les exploitants agricoles puissent exprimer facilement leurs impressions sur quelque chose de nouveau. Leurs réponses seraient motivées par toutes sortes de raisons.

L'itération signifiait l'observation des réactions de l'agriculteur puis l'adaptation des innovations qui seraient de nouveau présentées à l'agriculteur. L'évaluation était un processus continu.

Pour le Dr Diakité, M. Sandford n'avait pas pris en considération le problème financier. Le financement était en général insuffisant et conditionnel. M. Sandford a reconnu que les conditions de financement étaient souvent réellement inadéquates et que par ailleurs, l'on avait tendance à faire preuve d'un optimisme exagéré en ce qui concerne le volume et les délais des financements. Mais il a déclaré qu'il ne pensait pas que le fait qu'il s'agissait de "populations traditionnelles" en soit la raison principale. Le problème était que le projet de développement essayait très souvent de réaliser une entreprise insensée et non que les populations traditionnelles hésitaient à faire des choses censées.

Le Dr Diakité a déclaré qu'il estimait que M. Sandford sous-estimait l'importance des accords sanitaires internationaux. M. Sandford estimait que ceux-ci ne se justifiaient pas nécessairement et qu'en fait, très souvent, ils n'alliaient manifestement pas dans le sens des intérêts des pays en développement. Il estimait que la politique d'éradication des maladies ou de lutte contre celles-ci ne devrait pas être considérée comme sacro-sainte mais qu'elle devrait de temps à autre faire l'objet de révision et de justification.

Le Professeur Saka Nuru a déclaré qu'il était reconnu qu'au cours des années qui venaient de s'écouler, les instituts nationaux avaient
effectué des travaux de recherche sur plusieurs problèmes nationaux d'élevage avec beaucoup de succès. Toutefois, la recherche traditionnelle avait ses limites en ce sens qu'une application directe sur le terrain n'était pas faisable. Le rôle du CIPEA était différent dans la mesure où, grâce à son approche multidisciplinaire, il éduquait les problèmes dans leur globalité mais aussi parce qu'il menait à bien des activités de recherche appliquée au niveau de l'exploitation agricole. Toutefois, le CIPEA devait continuer à s'appuyer sur les ressources qu'offrent les institutions nationales en matière de recherche de base et à faire en sorte que ses travaux concordent avec les besoins des organismes de développement de chaque pays. Il était donc souhaitable que des liens plus étroits soient établis avec les organismes nationaux.

M. Sandford a déclaré que la manière dont la RSP avait été décrite et définie avait pu donner l'impression que la seule contribution de la RSP consistait à mettre au point des améliorations testées avec succès. Il y avait d'autres contributions valables qui n'étaient que des effets secondaires de la RSP telle que définie par M. de Haan mais qui découlaient d'autres manières de définir la RSP. Il s'agit précisément de l'accroissement des connaissances de tous ceux qui s'intéressent au développement du système pastoral. Des travaux de RSP qui n'ont pas donné lieu à des innovations adoptées pourraient néanmoins être valables, notamment en développant les connaissances sur le sujet et partant, en permettant de mieux orienter les efforts de développement.

M. Bekuré a souligné que si l'on confinait la recherche sur les systèmes à la mise au point de techniques en vue d'accroître la productivité, on fermerait la porte à la recherche sur la commercialisation qui ne s'appliquait pas directement au producteur mais était toutefois importante en ce qui concerne la motivation des producteurs et la compréhension de l'opinion des producteurs. M. von Kauffmann a reconnu que le test de techniques n'était pas le seul objet de la recherche sur les systèmes d'exploitation agricole. Si la phase de diagnostic révélait que la vulgarisation constituait un goulet d'étranglement, la RSA mettrait l'accent sur le nombre des exploitants
agricoles qui doivent être couverts par un agent de vulgarisation, sur ce que devrait être la logistique à mettre en œuvre et sur la manière de présenter de la façon la plus avantageuse cette logistique aux exploitants agricoles.

Mlle Grandin a souligné que le CIPEA ne participait pas à une vulgarisation/recherche d'adaptation en soi. L'objectif du CIPEA était de comprendre le processus de la RSP pour élaborer les méthodes nécessaires. Cela pouvait s'effectuer partiellement par d'autres activités de recherche qui ont contribué à évaluer le rôle ou le processus de la RSP. M. Lambourne a déclaré que le mandat du CIPEA consistait à "aider les pays intéressés dans leurs efforts en vue d'introduire des changements dans les systèmes de production..." Le CIPEA avait ainsi deux rôles: chercher les moyens d'améliorer et de changer les systèmes de production actuels; trouver les systèmes qui étaient les meilleurs dans leur état actuel d'équilibre, compte tenu des conditions écologiques ou sociales.

Le Dr Habou a souligné que la plupart des projets d'élevage s'intéressaient davantage à l'animal qu'à l'homme. Mais qu'à long terme, c'est l'homme qui se trouve au centre de tout système de production. M. Sandford a déclaré que la négligence en ce qui concerne la planification de l'élément humain était beaucoup plus évidente dans les années 60 qu'avant ou après cette période. Il était peut-être prématuré de dire si les changements intervenus entre les années 60 et les années 70 à cet égard, on donné lieu à de meilleurs projets.

Le Dr Ngutter a suggéré que le CIPEA devrait demander aux gouvernements et aux institutions de recherche, le rôle qu'ils voudraient que le Centre joue dans leurs pays respectifs plutôt que de supposer qu'il connaît les problèmes de chaque pays à priori. M. de Haan a déclaré que l'essence de la recherche sur les systèmes était que les problèmes d'un système donné de production n'étaient pas connus à priori. Le CIPEA devrait s'engager sur la base des éléments suivants: les gouvernements demandent au CIPEA d'effectuer une étude de système dans une zone-cible donnée choisie par lui-même; le CIPEA
décide ensuite, à la suite de concertations avec les organismes de recherche et de vulgarisation du gouvernement, du type d'accord de coopération requis.
THE SURVEY AND DIAGNOSTIC PHASE OF PSR
Integration of remote sensing techniques for resource evaluation in pastoral systems research

Peter N. de Leeuw and Kevin Milligan

Introduction

The leading assumption of this paper is that natural resource surveys and inventories are an essential prerequisite for planned development and should be integral components of the descriptive and diagnostic phases of livestock systems research.

In the past, range resource assessment at ILCA was rarely formally placed in this sequential framework, but awareness that such assessment was needed has been increasingly felt. The trends in ecological and vegetation research at ILCA is a convincing illustration. For instance, in Mali during the earlier years, emphasis was placed on detailed ecological studies on the Niono ranch in order to understand the vegetation dynamics of the upland Sahelian ecosystem. This was combined with extensive vegetation mapping in the Niger Delta and its surroundings according to the exacting procedures of the Zurich-Montpellier school of phyto-sociology. Initially, there was little concern about the application of this research to other disciplines or to the production systems within which the research was done. Such research was considered a laudable pursuit in its own right. In recent years, inter-disciplinary research has become prominent resulting in data flows from ecological research that were more oriented to the needs of range and animal nutrition science, without neglecting the pure research aspects of the work. This more pragmatic and applied approach led to maps of the ILCA study area that not only depicted vegetation types, but also contained complementary information for carrying capacity estimations and assessment of land use suitability for grazing, flooded rice and rainfed cropping.
This trend was not restricted to ILCA alone, but also noticeable in the various national and international agencies engaged in other surveys and inventories. As will be shown in the sections on resource surveys and methodology, emphasis moved from heavy and costly procedures to rapid, cost-effective and consumer-oriented data generation. Although cost escalation reinforced this trend, the knowledge that many of the earlier inventory reports remained shelf-bound and never effectively influenced their designated audiences, was more important.

This paper is designed to provide a short and selective overview of resource surveys and their methodologies that seem most appropriate to pastoral and agro-pastoral regions in Africa. Full acknowledgement must be given to Dent and Young (1980) from whose book several tables and figures are derived and on which substantial parts of the text is based. The most recent applications of remote sensing techniques are briefly summarised and put in the context of rapid appraisal methods and early warning procedures within a livestock systems research approach.

Types of surveys - a historical perspective

Soil survey

Soil survey involves the production of a pedological map, which shows the distribution of soil units defined primarily according to their morphology and their physical, chemical and biological characteristics.

These units are based on the description of soil profiles, their comparison and subsequent grouping into a classification system that is significant for the aims and purpose for which the survey was intended. Stobbs (1970) classified soil surveys in three classes from exploratory to detailed and indicated the appropriate mapping scales (Table 1). Classification of soil types varies with survey objectives but usually follows either the FAO soil map of the world (FAO-UNESCO, 1970-80) or the U.S. Soil Taxonomy (Soil Survey Staff, 1975) and the selection of what system is used depends often on the donor agency that has commissioned the survey.
General purpose soil surveys are most appropriate in sparsely settled areas in developing African countries, where there was and often still is a dearth of basic geographical information on resources. Exploratory and reconnaissance surveys provide a first approximation of such data. In densely settled areas small-scale surveys serve no direct useful purpose and instead detailed surveys are needed (Table 1). General purpose soil maps may serve as a basis for further stages of interpretation, namely land evaluation (see below), which apart from soil units includes other relevant physical, economic and sometimes social factors.

During the 1960's a large number of soil surveys were carried out in Africa. Although they were meant as a basis for a land resource inventory, they have been criticised in that their only purpose was to make a soil map, as a desirable end in itself. A more tenable criticism is the cost and time involved in describing, mapping and reporting. Dent and Young (1980) calculated that for a survey at a scale of 250,000, 100 man-days/1,000 km² were needed or about US$ 15/km² at 1980 prices, of which the actual interpretation of aerial photos (scale 1:40,000) would take 7 to 10 man-days. This is somewhat lower than the 8 man-months/1,000 km² needed for resource mapping in the Sudan (Wilson, 1979). If these costs are applied to the reconnaissance survey of the Amboseli-Kibwezi sheet in Kenya, this project of 12,600 km² would have cost US$ 200,000.

Land systems survey

Although soil surveys have been used to produce derived information on land resources, capability and suitability, more direct approaches to natural resource inventory were sought, that would be more rapid and less costly. In anglophone Africa the most common approach is the use of the land system concept as the basic mapping unit for subdividing and classifying land. A land system is defined as an area with a recurring pattern of topography, soils and vegetation and with a relatively uniform climate. This area is subdivided into land facets which are the smallest areas that can be recognized and delineated on aerial photographs and are usually linked by geomorpho-
Table 1. Types of soil survey

<table>
<thead>
<tr>
<th>Type</th>
<th>Map units</th>
<th>Scale</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory</td>
<td>Associations of phases of great soil groups</td>
<td>1:1,000,000 and smaller (schematic maps)</td>
<td>1. To locate areas of substantial soil difference (inventory)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconnaissance</td>
<td>Associations of phases of soil series or higher categories (great soil groups or families)</td>
<td>1:62,500 to 1:500,000</td>
<td>1. To survey areas suited only to extensive use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detailed low</td>
<td>Phases of associations</td>
<td>1:30,000 &amp; smaller</td>
<td>For forestry and grazing development areas</td>
</tr>
<tr>
<td>intensity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


logical process. A land system can be alternatively defined as an area with a recurring pattern of genetically linked land facets.

As part of the integrated approach, derived information is reported on vegetation, range and water resources, on actual and potential land use, the latter being based on land suitability ratings for each land system and its constituent facets.

Numerous integrated surveys have been carried out by the Land Resources Division in Africa, in particular in Nigeria, Zambia and Malawi (LRD, 1966-79). In the agropastoral zone in northeast Nigeria, emphasis was put on assessing range resources, actual and potential seasonal stocking rates and associated limitations to use such as flooding, inaccessibility and tsetse challenge (de Leeuw et al, 1972;
de Leeuw, 1976). From these inventories came recommendations on seasonal de-stocking requirements if a more balanced utilisation of pastoral land was desired (Tables 2 and 3). Although these recommendations were rarely actively implemented, they helped to increase the awareness of the problems in ministries and planning authorities.

In the subhumid zone in Nigeria land systems and soil mapping was followed by a detailed land evaluation based on the suitability for eight individual crops. Suitability was assessed from climatic limitations, soil physical and chemical characteristics and erosion hazards and this led to a map of crop options at a scale of 1:250,000 (Hill et al, 1978).

The main advantages of the land systems approach is speed and relative cheapness, the integration of different environmental factors and a clear communication of results (although some reports run to over 1,000 pages). Disadvantages are a high degree of generalisation, variable and somewhat ill-defined mapping units and the static nature of the information presented. Greater emphasis should be given to the dynamic aspects of environment such as soil moisture regimes, successive stages in the vegetation (cropping/fallows, effects of fire on woody/herbaceous species balance) and the interactive effects between range resources and livestock use.

Natural resource surveys and land suitability evaluation

As has already been shown above for the central Nigeria survey (Hill et al, 1978), a basic natural resource survey can lead to the production of maps and other data on which land evaluation is based.

The information needed for a range resource inventory concerns amounts and seasonal distribution of dry matter production, digestible protein, etc., but to define mapping units and to delineate their boundaries calls for some combination of vegetation physiognomy and species frequency according to established principles of vegetation mapping.
Table 2. The estimated actual and potential wet-season cattle population in northeast Nigeria (in thousands)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Estimated</th>
<th>Potential</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsetse-free</td>
<td>1,987</td>
<td>1,214</td>
<td>+65</td>
</tr>
<tr>
<td>Tsetse</td>
<td>584</td>
<td>2,352</td>
<td>-75</td>
</tr>
<tr>
<td>TOTALS</td>
<td>2,571</td>
<td>3,569</td>
<td></td>
</tr>
</tbody>
</table>

Source: de Leeuw (1976).

Table 3. Potential year-round population (1000 AUs)

<table>
<thead>
<tr>
<th>Type of land</th>
<th>Tsetse-free zone</th>
<th>Tsetse zone</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wet season</td>
<td>dry season</td>
<td>wet season</td>
<td>dry season</td>
</tr>
<tr>
<td>savanna</td>
<td>1,000</td>
<td>-</td>
<td>1,576</td>
<td>972</td>
</tr>
<tr>
<td>fallows</td>
<td>213</td>
<td>148</td>
<td>229</td>
<td>115</td>
</tr>
<tr>
<td>cereal residues</td>
<td>-</td>
<td>363</td>
<td>-</td>
<td>180</td>
</tr>
<tr>
<td>alluvial/flooded land</td>
<td>-</td>
<td>840</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td>Sub-totals</td>
<td>1,213</td>
<td>1,351</td>
<td>1,805</td>
<td>1,667</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td></td>
<td>3,028</td>
<td></td>
</tr>
</tbody>
</table>

Source: de Leeuw (1976).
The fundamental descriptive features for livestock production systems are the types and numbers of livestock, the livestock intensity and the degree of nomadism. The livestock intensity is the number of livestock units per square kilometre of grazing land. Where present, livestock systems may be classified as total nomadism, semi-nomadism or transhumance (for definition, see Ruthenburg, 1980). These descriptive headings can also be used for the livestock component of mixed or predominantly arable farming. The activity flow-chart of a land suitability evaluation is given in Figure 1.

Land Suitability Evaluation

Initial consultations
(a) objectives
(b) data and assumptions
(c) planning of the evaluation

Kinds of land use
Major kinds of land use or land utilisation types

Land use requirements and limitations

Comparison of land use with land

Land suitability classification

Presentation of results

Resource surveys
Land mapping units

Land characteristics and qualities
Land improvements

Source: Dent and Young (1980), p. 146

Fig 1. Schematic representation of activities in land evaluation.
The resource survey has the function of dividing the study area into a number of relatively homogenous units and of providing the information necessary to evaluate each of these units for the kinds of land use under consideration. Thus, resource surveys should not be treated as a separate activity, but as an integral part of the evaluation. For example, in a semi-arid region that is dependent on pastoralism, a survey effort would be directed towards range and water resource surveys and the determination of livestock carrying capacity. Seen in this light, the numerous surveys and mapping carried out in francophone West Africa by IEMVT could be termed pastoral resource surveys. Dent and Young (1980) enumerate the land qualities related to livestock production as follows (Table 4).

Table 4. Land qualities related to livestock production

- Nutritive value of natural pastures
- Nutritive value of improved pastures
- Resistance of degradation of vegetation
- Resistance of soil erosion under grazing conditions
- Toxicity of grazing land
- Availability of drinking water for livestock
- Climatic hardships affecting livestock
- Endemic pests and diseases
- Access within the production unit
- Size of potential management units
- Location: - (a) existing access
- (b) potential access


Remote sensing methodology

Remote sensing methods have been classified according to the altitude at which imagery is taken, and include satellites, and photographs and visual observations from low-flying aircraft. Satellite imagery and conventional aerial photographs usually provide total cover, whereas low-altitude aerial surveys are usually based on sampling strips. The characteristics of these methods are summarised in Tables 5 and 6.
Table 5. *Some characteristics of the different methods used in remote sensing*

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Scale of general use</th>
<th>Usual cover</th>
<th>Sensors</th>
<th>Primary Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>satellite</td>
<td>1:1,000,000-1,250,000</td>
<td>total</td>
<td>various, basically scanning radiometers</td>
<td>mapping</td>
</tr>
<tr>
<td>high-level aircraft</td>
<td>1:20,000-1:100,000</td>
<td>total</td>
<td>cameras</td>
<td>mapping + overall quantifications of use + use of patterns</td>
</tr>
<tr>
<td>low-level aircraft</td>
<td>1:300-1:20,000</td>
<td>sampling</td>
<td>cameras</td>
<td>quantifications of use + use of patterns</td>
</tr>
<tr>
<td>low-level aircraft</td>
<td>not applicable non-photogrammetric</td>
<td>sampling usually quadrats</td>
<td>human observers and oblique small-format cameras</td>
<td>quantification of use + use of patterns phogrammetric</td>
</tr>
<tr>
<td>landrover, light aircraft or foot</td>
<td>not applicable non-photogrammetric</td>
<td>sampling usually quadrats, frequently linked with low-level photogrammetry</td>
<td>human observers using a range of resource survey equipment</td>
<td>'ground truth'</td>
</tr>
</tbody>
</table>

*Source: Watson and Tippet (1981), Fig. 1.*
Satellite imagery

The main source of imagery has come from the LANDSAT series, which produces monochromic or colour-enhanced images of 34,000 km² with a resolution of 80 m (LANDSAT-3) at a frequency of every 18 days. Thus, images at different seasons and successive years are readily available and relatively cheap.

LANDSAT is increasingly used for rapid small-scale reconnaissance surveys when mapping is envisaged at a scale from 1:1,000,000 to 250,000. Usually monochrome prints are used for landscape or land systems mapping, while false colours are more appropriate for vegetation and land use.

Interpretation of one LANDSAT image costs about US$ 20/1,000 km² (1980) and it is possible to map large areas in no more than a few months. Mitchel and Howard (1978) reported that a land systems map of Jordan (c. 100,000 km²) was mapped on a scale of 1:1 million in 1.5 months of interpretation, one month of field work and two weeks for report preparation and printing.

In addition to LANDSAT, satellites (or aircraft) have been equipped with infrared detectors that record the far-infrared radiation of the earth's surface and can distinguish vegetation and soil types by their thermal emission characteristics. Recently Tucker (1983) used the thermal channel of the NOAA satellite to detect reflectivity differences and found that variations in dry standing biomass could be derived from remote-sensed temperature differences (Table 6).

Aerial photographs

Since the 1950s aerial photo interpretation has become an important tool for soil and other surveys, in particular for reconnaissance studies in Australia and developing countries. Black-and-white photos are most commonly used but other types of film have been tried for specific purposes: near infrared for tree differentiation in forest evaluation and false-colour photography in vegetation and land-use surveys and large-scale disease detection of crops and forests. Colour photos have been tried for mapping desert landscapes.
and urban fringe zones and also for sampling land use and vegetation patterns from low-flying aircraft (Watson and Tippet 1981; K. Milligan, personal communication).

Side-looking radar (SLAR)

Although SLAR has very low resolutions (Table 6), it is used for mapping regions which are rarely cloud-free to permit other methods of remote sensing. SLAR was the basis for a reconnaissance resource inventory of the Amazon basin and for a country-wide land use and vegetation map of Nigeria. The quality of this map is being tested through comparison with low-altitude vegetation sampling as well as with existing land-use maps based on aerial photo interpretation (Hill et al, 1978; Milligan and de Leeuw, in press).

Spectral radiance

Linear or ratio combinations of two wavelength regions, red and near infrared (see Table 6), measured at ground level (1-1.3 m) at low altitude from aircraft (60-200 m) or from satellites have been used to estimate green standing biomass (Tucker, 1980). For instance in the Serengeti (McNaughton, 1979) and in the Amboseli ecosystem in East Africa (Western and Grimsdell, 1979) satisfactory correspondence was reported between clipped ground biomass and 'green machine' measurements on the ground and from low-flying aircraft at least for open grassland with a low woody cover. Estimating biomass in vegetation types high in woody cover is less promising, although Herlocker and Dolan (1980) in north-east Kenya found a good correlation between clipped green biomass of dwarf shrubs and hand-held radiometer readings. Similarly, promising results were obtained in the Sahelian zone in Senegal from radiometer readings of the NOAA-7 satellite during the 1981 rainy season. From these readings (calibrated with ground clippings) a map was made of cumulative biomass production for a 30,000 km$^2$ region in classes of 200 kg/ha in the range from 0-1,600 kg DM/ha (Tucker, 1983; Gaston and Boerwinkel, 1982).
<table>
<thead>
<tr>
<th>Remote Sensing System</th>
<th>Wavelength</th>
<th>Resolution</th>
<th>Special Facilities</th>
<th>Applications in Soil or Related Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Air Photography</td>
<td>0.4-0.7 μm</td>
<td>Very high</td>
<td>Chlorophyll reflects strongly, water absorbs</td>
<td>Detection of drainage; impedance survey; differentiation of tree species</td>
</tr>
<tr>
<td>Near-infrared Monochrome Photography</td>
<td>0.7-0.9 μm (plus visible, 0.4-0.7 μm)</td>
<td>High</td>
<td>Ground surface</td>
<td>Urban fringe surveys, display</td>
</tr>
<tr>
<td>True-colour Photography</td>
<td>0.3-0.7 μm</td>
<td>High</td>
<td>False-colour photography</td>
<td>Urban fringe surveys, display</td>
</tr>
<tr>
<td>False-colour Photography</td>
<td>0.5-0.9 μm</td>
<td>High</td>
<td>False-colour photography</td>
<td>Urban fringe surveys, display</td>
</tr>
<tr>
<td>Thermal Infrared</td>
<td>8-14 μm</td>
<td>Low</td>
<td>Thermal infrared</td>
<td>Records heat emitted by the ground surface</td>
</tr>
<tr>
<td>Side-looking Airborne Radar (SLAR)</td>
<td>0.8-3.0 cm</td>
<td>Very low</td>
<td>Side-looking airborne radar (SLAR)</td>
<td>Possibly reconnaissance in cloud-covered areas</td>
</tr>
<tr>
<td>Satellite MSS</td>
<td>0.5-1.1 μm</td>
<td>High relative to small-scale image</td>
<td>Satellite MSS</td>
<td>Uniform coverage of large area, initial overview in other surveys</td>
</tr>
</tbody>
</table>

Source: Dent and Young (1980), Table 3.4, p. 50.
Although Tucker (1980) concluded that 'for large area surveys, the spectral method has been shown to work well and allows for synoptic coverage of large areas from aircraft and/or satellite platforms', several problems in the calibration techniques have to be resolved (solar zenith angle, sunlight vis-à-vis overcast conditions etc.) before a more general adoption of this methodology can be recommended.

Low-altitude aerial survey

Aerial observations have become an integral part of reconnaissance and inventory surveys. For a detailed discussion, reference is made to Milligan and de Leeuw (1983) who have reviewed the the aerial survey methodology within the framework of ILCA's livestock system research programmes in Mali, Niger and Nigeria.

Source: Thalen (1981), Fig. 4.

Figure 2. Possible combinations of complementary reconnaissance rangeland survey techniques.
The integration of remote sensing techniques and ground truth

Introduction

In most resource surveys at the reconnaissance level, information is gathered from space, air and ground and it is clear that information quality improves from space to ground as do costs. Consequently, a balance needs to be struck between extensive and intensive methods which is geared to the objectives of the survey undertaken.

Thalen (1981) reviewed the different method combinations for the evaluation and resource mapping of arid rangelands with the focus on assessing what grows where and when and how good is it. He showed that the most cost-effective approach for arid land vegetation surveys was the use of low-altitude aerial surveys in combination with LANDSAT imagery or detailed topographical maps. However, to produce a rangeland map of the Kalahari desert in Botswana (240,000 km\(^2\) at a scale of 1:500,000) LANDSAT imagery at different scales was used for orientation and initial delineation of rangeland types together with complementary conventional aerial photography and aircraft observations for more detailed type identification and description as well as for stratification and subsequent ground truth sampling (Fig. 2).

A similar approach was used to describe, assess and map the natural resources of Mali south of the 18° parallel. A broad land systems map was produced from LANDSAT-2 false-colour composites enlarged to a scale of 1:200,000. With the major land systems so identified, representative sample transects were selected from false-colour images and subsequently photographed with hand-held cameras from light aircraft simultaneously at scales of 1:2,000 and 1:8,000. The resulting slides were analysed for tree and grass cover, land use and soil surface characteristics and correlated with false-colour pixel distributions on the LANDSAT prints so as to relate the latter to the real world. Transect photo data were then used for the location of ground samples for data collection on soils, vegetation and cropping. However, it is unfortunate that an appraisal of this approach has to await the publication of the maps and reports.
An integrated appraisal approach

As shown by Milligan and de Leeuw (1983) the use of aerial surveys within the different ILCA programmes has been less integrated than was desirable. Data collection from aircraft was often done as an independant exercise and data integration was carried out afterwards by interested researchers (e.g. de Leeuw and Milligan, 1981).

Having gained experience of aerial surveys in the context of livestock systems research (Milligan et al, 1982; Milligan, 1982), a better planned and more integrated approach seems worth testing. Some work has already started in the Maasai system project where aerial surveys are part of an inter-disciplinary study and direct comparisons between a large volume of ground truth data and aerial survey observations can be made (e.g. Peacock et al, 1982).

The proposed approach differs from earlier work in that it is planned to execute a rapid appraisal of a target area (50,000 to 100,000 km² in size) which should deliver a comprehensive description of the resource base and the people that use it together with a constraint diagnosis of the production system in the area.

As set out in Fig. 3, the appraisal is executed in time sequence with the following steps:

1. From satellite imagery and other information, landscape (landform or land system) units and vegetation zones are delineated and areas of particular interest defined.

2. Systematic and/or stratified low-altitude aerial surveys are carried out over the whole zone at the same or different intensities according to strata. After an initial data analysis and mapping of range, water livestock and human resource distributions, the target area is subdivided in homogeneous 'land units', which provide the base for further aerial survey and ground observations.

3. Range resources are further assessed by multi-scale low-level aerial photography along transects and if possible, biomass estimates are made from radiometer readings followed by ground sampling of biomass for quality and quantity and species composition. At the same time ground teams select representative households for
Fig 3. A rapid appraisal approach for pastoral systems research
rapid appraisal of human and herd demography, labour budgets and income and expenditure. If large seasonal differences in resource distribution are expected, a second aerial survey is planned to look at all system attributes that are subject to large seasonal variations.

Early warning procedures

Forecasting of environmental conditions, in particular of range and water resources relative to existing livestock and human requirements, would be a prerequisite for the better long-term management of fragile ecosystems that are subject to varying climatic events.

It is postulated that timely prediction is most urgent in regions with a short single rainy season and with range resources that largely consist of annual grasses. The need is much lower in regions with bimodal rainfall patterns. While in the Sahel two successive rainy seasons with poor rainfall will have a disastrous impact on long-term livestock productivity due to its two-year continuous time span, a similar event in East Africa (e.g. the Maasailand) is of much shorter duration (10-12 months).

The same is true for recovery rates following droughts. While it took nearly ten years for Sahelian cattle herds to reach their pre-drought levels, livestock populations in Kajiado (south-east Kenya) recovered in half that time. More important than population recovery has been the long-term effect of the Sahelian drought on livestock ownership patterns. Since the drought, ownership has shifted markedly from herders to outsiders (traders and civil servants). This trend is a concomitant result of the unfavourable price ratios between stock and grain during drought since many producers not only lost stock through death but had to sell at low prices to buy high-priced grain and became indebted to traders, moneylenders and others. Such a 'drought syndrome' can be reduced if pastoralists can be persuaded to react timely to the deteriorating situation by early selling of stock and early purchase of grain.

Prediction in mono-modal rainfall regions can be based on available resources at the end of the growing season. As disappearance rates of standing biomass are fairly well known, and if the size
of the livestock population dependent upon the resources is known from aerial surveys, the balance between supply and requirements can be calculated for the dry season. If the region covered is sufficiently large (the NOAA satellite can cover up to 600,000 km² in one composite image), cropping areas south of the pastoral zone can be included from which potential crop yield estimations can be derived.

Once the alert for pending drought is raised, adapted management strategies can be put into operation (supplementary feeding, mobilisation of additional water resources in under-utilised areas etc.) combined with accelerating the flow of stock through marketing channels and providing credit for early grain purchases.

The integrated approach could thus be extended to include an 'early warning' component. To be effective it is essential that biomass estimations through remote sensing are reliable for large regions, and it thus seems worthwhile to accord a high priority to developing this methodology.

References


Intégration des techniques de télédétection pour l'évaluation des ressources dans la recherche sur les systèmes pastoraux

Résumé

Cet exposé s'articule autour de l'hypothèse selon laquelle les enquêtes et les recensements sur les ressources naturelles constituent un préalable fondamental au développement planifié et devraient constituer une composante intégrale des phases de description et de diagnostic de la recherche sur les systèmes d'élevage. Le document est conçu pour donner un aperçu bref et sélectif sur les enquêtes sur les ressources et les méthodologies qui semblent les plus appropriées aux régions pastorales et agro-pastorales de l'Afrique.

Les types d'enquêtes précédemment utilisés ont notamment porté sur la pédologie, les systèmes fonciers, les ressources naturelles et les caractères des sols. Une enquête pédologique implique l'établissement d'une carte pédologique qui indique la distribution des unités pédologiques définies en premier lieu en fonction de leur morphologie et de leurs caractéristiques physiques, chimiques et biologiques. Dans l'Afrique anglophone, l'approche la plus commune se fonde sur l'utilisation du concept de l'unité territoriale considérée comme l'unité cartographique de base pour la subdivision et la classification des terres.

Les méthodes de télédétection ont été classées en fonction de l'altitude à laquelle les photos sont prises; elles incluent l'utilisation d'images transmises par des satellites, de photos et d'observations visuelles à partir d'un appareil volant à basse altitude. Les images recueillies par satellite et les photographies aériennes de type classique fournissent en général une couverture globale alors que les enquêtes à basse altitude sont généralement basées sur des bandes d'échantillonnage. La source essentielle des images recueillies par satellite provient des séries Landsat qui produisent des images monochromatiques ou en couleur de 34 000 km² avec une résolution de 80 m, prises à des intervalles de 18 jours. Le Landsat permet ainsi de disposer d'images peu coûteuses aux différentes saisons et sur des années successives.
Depuis les années 50, la photo-interprétation aérienne est devenue un 
outil important pour les enquêtes pédologiques et autres. Les photos 
en noir et blanc sont les plus communément utilisées mais d'autres 
types de pellicules ont été essayés à des fins particulières, y 
compris l'utilisation de photographies de proche infrarouge et de 
fausse couleur. Parmi les autres techniques utilisées, on note celles 
du radar à vision latérale, de la radiance spectrale et des enquêtes 
à basse altitude. Dans la plupart des enquêtes sur les ressources, la 
qualité de l'information s'améliore et les coûts diminuent quand on 
passe de l'espace au sol. Il convient d'établir un équilibre entre les 
méthodes extensives et intensives en vue d'atteindre les objectifs de 
l'enquête entreprise. Il est proposé une approche intégrée en matière 
d'évaluation qui diffère de l'approche utilisée dans les travaux 
antérieurs en ce sens qu'elle est conçue pour permettre l'évaluation 
rapide d'une zone-cible qui doit donner lieu à une description 
exhaustive des ressources de base et des populations qui les utilisent 
aussi qu'un diagnostic relatif aux contraintes du système de 
production de la zone. L'évaluation est effectuée en séries 
chronologiques avec les étapes suivantes:

1. Délimitation des unités de paysage et des zones de végéta-
tion et définition des zones d'intérêt particulier sur la base 
d'images transmises par satellite et d'autres données.

2. Enquêtes à basse altitude systématiques et/ou stratifiées 
sur l'ensemble de la zone à la même intensité ou à des intensités 
différentes selon les strates. Après une analyse préliminaire des 
données, et le levé de la distribution des parcours, de l'eau, du 
bétail et des ressources humaines, la zone-cible est subdivisée en 
unités territoriales homogènes qui fournissent la base d'enquêtes 
aériennes et d'observations au sol plus approfondies.

3. L'évaluation des ressources des parcours se poursuit par les 
photographies à basse altitude à échelles multiples le long de 
transects et, si possible, des estimations de la biomasse sont effec-
tuées sur la base de mesures radiométriques suivies par le prélèvement 
au sol d'un échantillonnage de la biomasse en vue d'en déterminer la 
qualité, la quantité et la composition par espèce. En même temps, des
équipes au sol sélectionnent des ménages représentatifs pour une évaluation rapide de la démographie humaine et animale, des budgets, des revenus et des dépenses.

L’approche intégrée peut être élargie pour inclure une composante "système de prévision avancée". Pour être efficace, il est essentiel que les estimations de la biomasse par la télédétection soient fiables pour de vastes régions et il semble par conséquent indiqué d’accorder un rang élevé de priorité à la mise au point de cette méthodologie.
Low altitude aerial surveys in pastoral systems research

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Introduction

The recent development of the science of low-altitude aerial survey has provided a rapid, reliable and cost effective method for assessing the numbers and distribution of livestock and people over large tracts of land.

In the past, descriptions of pastoral systems had to rely upon indirect methods, such as vaccination counts or tax returns, for obtaining information about livestock numbers. Such methods have well-publicised errors and biases. However, it is rarely pointed out that these indirect methods are usually based upon counts taken only once a year and thus seasonal distributions are unknown. Also, because the animals are generally congregated into camps for these counts, their actual distribution in relation to resources during their daily grazing orbit is not known.

The methods of low altitude aerial survey were initially developed by ecologists in East Africa wishing to map the distribution of wild animals in national parks. Specific strategies suitable for assessing livestock and people are still being perfected and ILCA has taken a leading role in exploring the possibilities. An area of particular interest has been the inclusion of recordings of rangeland resources. This information, especially on vegetation and water availability, can be compared to the observed livestock distribution and thus an understanding of resource utilisation can be included in the descriptive phase of pastoral systems research. Such comparisons often allow identification of specific constraints to livestock distribution and thus a diagnosis of possible interventions to improve the system.
This paper describes the basic methods now being used for low altitude aerial survey and illustrates the types of results that can be obtained and how these results are being presented. The possibilities of linkage and integration between such aerial surveys and other methods of remote sensing are covered in another paper at this workshop (de Leeuw and Milligan, 1983), and thus this paper will discuss how low level aerial survey can be used to diagnose constraints within pastoral systems and the relative cost effectiveness of such operations.

Methodology: survey procedures and data collection

Details of ILCA's methodology are given in previous papers (Grimsdell et al., 1979; 1979a; Okali and Milligan, 1980) and reports (Milligan et al., 1979; 1982; Milligan, 1980; 1981, 1983). What makes the general method different from other remote sensing techniques is that the aircraft is flown at a very low altitude, so that a team of observers on board can make direct visual counts of animals, people and range resources that pass by the aircraft.

Flight and sample procedures

ILCA usually carries out its aerial surveys using a systematic, unstratified flight pattern (see Fig. 1), so that every part of the study area is covered evenly and uniformly and results can immediately be presented as distribution maps. It also provides a data base for post-survey stratification.

Spacing between the systematic parallel flight lines is usually decided by a balance between time and cost constraints and the required levels of sampling and precision of results. Flight lines based upon the 10 km UTM grid projection provide a useful system for global reference. However, sometimes a flight pattern that exactly corresponds to existing maps will be more useful when ground truth work is carried out or planned in the study area.

Each flight line is divided into intervals down its length. These intervals, together with the parallel flight lines, allow the entire study area to be divided into a grid pattern of fixed dimen-
sions. All information collected can thus be related to the individual grids and the resulting maps show simple and clear distribution patterns.

Fig 1. Flight pattern, grid system and sampling.

The area actually sampled is restricted to a fixed band on either side of the aircraft (Fig. 2). This band is determined by the projection, from the observer's eye to the ground, of two parallel rods attached to each wing strut. The choice of a suitable flying altitude is important. The higher the altitude, the greater the sample area observed and thus the greater the expected precision of results; however, animals and people become increasingly difficult to see and count at higher altitudes. The selected altitude is usually between 400 and 1000 feet above ground level. Depending upon survey design, overall sample cover is usually between 5 to 20%.
The strip sampled (w) on either side of the aircraft is determined by the projection, from the observers' eye to the ground, of the two rods (a and b) fixed on the wing struts. Strip width can be varied by altering these rods and is directly proportional to the aircraft height above the ground (h). Typical settings for cattle surveys are h = 1000 feet, w = 500 metres.

Fig 2. Schematic representation of aircraft during observation flight.

Information collection and analysis

In the aircraft, there are two back seat observers who count and photograph the numbers of animals and dwellings seen in the sample band in each grid. Individual observer bias, which varies according to certain factors such as the effects of vegetation structure and time of day, requires careful calibration and correction. A front seat observer, seated beside the pilot, is responsible for navigation and recording ecological conditions. Depending upon survey requirements, ecological zones and seasons, these would normally include:

- vegetation physiognomy;
- tree density per hectare, dead trees and indicator tree species;
- grass cover, height and greenness and extent of burning;
- water sources and extent;
- farm areas, extent and major canopy crops.
Ecological recordings are supplemented by hand-held side-looking photography and occasional vertical photography.

The primary objective of an animal and human survey is usually to answer the fundamental questions:

How many? - this can be worked out from simple statistics upon the recordings down each individual sample flight line;

Where? - this can be readily seen from the grid distribution maps;

Why? - relationships between animals and people and their environment can be tested by a series of multivariate analyses. Although simple correlations can be confounded by partial relationships, step-wise regressions or more preferably analyses of variance or factor analyses can display all the variables in terms of their individual relationships to each other.

The opportunities for such analyses can be envisaged from Fig. 3, which represents some data sets that could be collected from a typical survey. Assuming that one variable such as cattle herds, is of particular interest, this can be separated from the rest of the data file. The general distribution of cattle herds can be seen by examining the grid entries on this data element. The relations of cattle herds to any of the data files can be examined statistically and, in the case of fig. 3, cultivation, grass cover and distance to water are all likely to influence cattle herd distribution. The final analysis, which is particularly important to the identification of actual constraints to cattle herd distribution, is to give a priority rating to each of the data files in terms of their sequential ability to explain variation in the cattle herd distribution.

The total number of data files for analysis is not restricted to information collected during flight, but can include other information from existing maps. In this way, the importance of parameters such as rainfall, geology or administrative boundaries could also be assessed.
BY CODING ALL ORIGINAL INFORMATION AT A COMMON FORMAT AND SCALE, ANALYSIS (SUPERIMPOSING DATA, IDENTIFYING PROXIMITY OF RESOURCES AND MATHEMATICAL WEIGHTING) ARE POSSIBLE WITH RESULTS IN A 'SPATIAL CONTEXT'.

Fig 3. Typical data elements used in the computer data handling technique.

**Results: resources inventory and land stratification**

To illustrate some of the results from low-altitude aerial survey and the way these results are being analysed and presented, examples are taken from ILCA's work in Nigeria, Mali, Niger and Ethiopia.
Animal and human populations: abundance and distribution

An initial analysis of data provides overall population totals for the study area, including herd or camp sizes, and densities. Table 1 shows results from the entire 81,555 km\(^2\) USAID/NRL project area in Niger, during two seasons.

Table 1. Seasonal livestock populations (+% SE) in the NRL project area, Niger.

<table>
<thead>
<tr>
<th>Animal type</th>
<th>Heads</th>
<th>Stocking</th>
<th>Herds</th>
<th>Mean Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (Nos)</td>
<td>Stocking (Ha/Hd)</td>
<td>Total (Nos)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
<td>Wet</td>
</tr>
<tr>
<td>Cattle</td>
<td>288,653(12)</td>
<td>376,533(16)</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>Bororo</td>
<td>152,814(15)</td>
<td>246,900(17)</td>
<td>54</td>
<td>33</td>
</tr>
<tr>
<td>Azawak</td>
<td>135,839(12)</td>
<td>129,632(17)</td>
<td>60</td>
<td>63</td>
</tr>
<tr>
<td>Sheep/goats</td>
<td>780,289(8)</td>
<td>1,147,914(11)</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Camels</td>
<td>70,162(9)</td>
<td>155,708(32)</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>Donkeys</td>
<td>13,540(14)</td>
<td>23,375(12)</td>
<td>588</td>
<td>345</td>
</tr>
</tbody>
</table>

Such population and herd sized totals give information about likely production levels and economy in the project area. A comparison between the seasons suggests changing herding strategies. For example, the population of the Bororo cattle was 62% greater during the wet season than during the dry season, while the Azawak cattle breed numbers remained stable between seasons; this suggests that the Bororo cattle are more mobile and may be part of a larger-scale transhumant pattern. Detailed distribution analysis detected: areas of seasonal herd splitting; areas of total herd immigration; areas of cattle influx linked to immigration of primarily sheep and goat owners; areas of influx associated with livestock ownership by settled cultivators; and a substantial wet-season immigration of camels.

Similar tables for the total pastoral population of the NRL project area identified five distinct pastoral groups: three Tuareg;
one WoDaaBe Fulani; and one Arab. An immediately interesting result was that, while the initial project preparation document for the area estimated 50,000 people, the actual number of pastoralists alone was about 175,000.

Although information about the total number of animals or people in an area is valuable because it indicates the size of the target group and thus the possible total regional benefits that might result from successful intervention, information about distribution is often more important, in that it indicates the regional impact of animals upon their resources, and guides follow-up research and development activities into areas of concentration. For example, an examination of the livestock and pastoralist distribution in this NRL project area showed that the Bororo and Azawak cattle breeds had very different areas of concentration and these corresponded to the distribution of WoDaaBe Fulani and tented Tuareg respectively. These differences in distribution immediately indicated that detailed information about either breed or tribe would only be relevant to certain parts of the zone, while the opportunities for research or development contact with the two tribal peoples would be different. The different transhumance patterns between the two groups suggest different flexibilities in management strategies which are likely to affect their long-term development paths and choice of interventions.

ILCA is at present using four different methods to represent the results of distribution data (Fig. 4). As the original data is collected on a grid basis, each grid may be shaded to represent the density it supports (choropleta symbolism). Alternatively, the individual grid information can be represented as squares or circles (proportional point symbolism), whose sizes correspond to the observed densities. Such representation of actual recordings, on a grid by grid basis, can often be more easily interpreted if variations between adjacent grids are mapped as contours which can also be represented as a three surface view.
Dry-season grass distribution in a central region of the pastoral zone of Niger - May 1981

Figures shown are percentage grass cover

Fig 4. Methods of representing aerial survey distribution data.
A common feature of pastoral systems is the changes in seasonal distribution patterns of livestock and people. Although it is almost impossible, by aerial survey, to link these movements to individual specific herds (without radio collaring or herd marking) the patterns of herd concentrations can be easily understood from repeated seasonal surveys. If these distribution patterns are investigated on the ground, by social interview, and movement histories are established, regional mobility strategies can be mapped and quantified.

As stated in the introduction, most of the ground census data relates to one period of the year. For example, ground census figures for the Jos Plateau of Nigeria, based upon vaccination and tax returns, suggested a population of about 300,000 cattle, while aerial surveys (Milligan, 1980) showed a dry-season population of 140,000 and a wet-season population of 400,000. Often ground studies have provided general indications of movements; however, the value of an actual census can be illustrated from work by ILCA in the Nigerian subhumid zone which was generally considered to be an area of dry-season grazing, with animals returning north early in the wet season when surface water becomes again available and the southern tsetse belts expand. Table 2 shows that two of ILCA's four case-study areas had high wet-season concentrations: an exactly converse pattern to that expected.

Table 2. Cattle densities in four case-study areas in the Nigerian subhumid zone.

<table>
<thead>
<tr>
<th>Area</th>
<th>Density (no. km²)</th>
<th>Mean size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dry (km²)</td>
<td>wet</td>
</tr>
<tr>
<td>Kurmin Biri</td>
<td>2,500</td>
<td>17.3</td>
</tr>
<tr>
<td>Abet</td>
<td>2,475</td>
<td>37.4</td>
</tr>
<tr>
<td>Mariga</td>
<td>2,750</td>
<td>6.6</td>
</tr>
<tr>
<td>Lafia</td>
<td>3,500</td>
<td>12.7</td>
</tr>
</tbody>
</table>

- 90 -
The Niger delta region in Mali is another area of marked seasonal movements of livestock. This seasonally flooded region within the Sahel supports, during the period of greatest animal concentration, about 1,200,000 cattle and an additional 500,000 sheep and goats. Maps of the seasonal distributions of cattle are illustrated in Fig. 5.

Fig 5. Seasonal cattle distribution in the Niger delta region of Mali.
These maps show, during October, high cattle densities in the transition zone surrounding the delta and low populations where water is lacking and also in the central basin which is inaccessible due to flooding or because it is protected by river barriers. The March pattern showed a concentration of cattle in the floodplain which supported 72% of the total population. Two distinct sub-populations were detected; one south of the River Niger in the Djenne region; the other north, near Lake Debo. During June, cattle were leaving the delta, and distinct movements westwards and eastwards from Lake Debo were recorded.

Environmental conditions

All environmental variables recorded during a survey can individually be illustrated as distribution maps based upon the aerial survey grid pattern. Alternatively, average or total figures can be computed for particular regions.

An example of these resource maps for the Mali delta region shows that only about half of the survey areas can be termed 'upland Sahel with little or no flooding' (Fig. 6). Farming is of high density in the Mema Jura to the east of Mopti and in the Sanari plains. The rest of the area consists mostly of flooded plains and backswamps (34%) with considerable land devoted to floating rice cultivation. The highest levels of rice cultivation were recorded in the Macina plains and those south of Mopti; these plains are broken by higher level terraces, levees and point-bar systems, which are much less inundated and show a mixture of rainfed and rice farming.
Fig 6. Levels of flooding, rice and cereal cultivation in the Niger delta region of Mali.
As for livestock, seasonal changes in environmental conditions can also be illustrated by a series of seasonal maps and graphs. An example of a graphic application for the drier areas surrounding the Mali delta is given in Fig. 7, for grass cover during March and June. Such frequency distributions of grass cover levels are often related to the levels of grazing: in general, curves with a rightward skew indicate understocking, while a leftward skew indicates overstocking, except where there are other causes for dry matter disappearance.

![Graph showing frequency distribution of seasonal grass cover levels in the upland Sahel region bordering the Mali delta.](image)

Fig 7. Frequency distribution of seasonal grass cover levels in the upland Sahel region bordering the Mali delta.
The actual environmental variables collected during a survey will depend upon the objectives of the survey and the capabilities of the survey team. Questions about specific environmental conditions can often be answered; such as possible changes in degradation which can be inferred from soil and erosion patterns, from grass cover, or from the distribution of dead or indicator plant species. In Niger, the distribution of a small shrub, *Calotropis procera*, was recorded as well as the distribution of dead trees (Fig. 8); the former was in response to USAID requests based upon observations that this species had increased substantially in their area during the past few years and the suggestion that it may indicate deteriorating conditions.

![Dead trees and Calotropis procera](image)

**Fig 8. Distribution of Calotropis procera and dead trees in the NRL project area in Niger.**

Interrelations between animals and environment

The interrelations between animals or people and the various measured environmental parameters can provide information that will directly suggest appropriate management interventions into the pastoral system. For example, if animals are usually concentrated into cultivated
areas, opportunities for better interactions with farmers may exist; whereas, if cattle are usually away from cultivated areas and are concentrated in the natural rangelands and savannas, grazing reserves or improvement of range management practices may be feasible. Similarly, direct linkages to specific variables can indicate their relative importance and thus whether they are likely to be a constraint to the system. For example, if animals mostly graze near water sources can be investigated.

While any set of two variables can be examined, for example grass cover to distance from water, it is often more valuable to study the system as a whole, considering the combined and cumulative effects of many variables upon another independent variable. The objective may be to identify, for example, which out of all the variables recorded most closely corresponds to the distribution of cattle, on the assumption that such a variable may thus be a limiting or controlling factor to cattle distribution.

This particular stage in the analysis is perhaps the most valuable to pastoral systems research, as it moves away from the basic descriptive phase of the system into the diagnostic phase, hypothesising specific constraints that can be validated and tested by ground research teams. It is important to stress that results from such analysis are necessarily "predictive" rather than "causal". For example, results could indicate that animals are usually concentrated near water, i.e. that a knowledge of water distribution allows one to predict animal distribution. Water may, in fact, not be the cause of the observed animal distribution, which could be due to factors not even recorded during the survey, such as tribal or border conflicts, or that a particularly desirable plant occurred near these water sources. Clearly, a ground research team, equipped with the predictive hypotheses generated from an aerial survey, can quickly clarify their validity.

In the USAID/NRL study area, the overall cattle population distribution during May could be best predicted from a knowledge of cultivated areas, grass cover and distance to various water sources. During October, cultivation and grass cover continued to be most important but predictions could also be made from the general veg-
etation structure and tree density maps. However, the two cattle breeds were conspicuously different. Bororo distribution could nearly always be predicted from grass cover, further refined by vegetation and tree density distribution. Azawak were most concentrated in cultivated areas and near water sources. Thus there was a clear division between the two breeds in terms of their relationship to natural vegetation versus man-induced conditions. Such observations indicated that the basic options between rangeland development or water development may have a different relative value for the two breeds and the pastoral group associated with them.

In the southern Ethiopian rangelands, 19 variables, including cultivation, grass cover, vegetation physiognomy, growing period gradients and distance to three water source types, were included in an analysis of livestock distribution. The distance to ponds was nearly always the best predictor of livestock distribution. From such knowledge, the relationship between cattle and ponds was more closely examined. Figs 9 and 10 show two ways that this information was presented.

![Figure 9](image.png)

**Fig 9.** *Cattle distribution in relation to water sources in the SORDU project area of southern Ethiopia.*
Cattle density per square kilometre

205
150
100
50
45
40
30
25
20
15
10
5
0

Contours show distance (km) to ponds

25 kilometres

Fig 10. Number of cattle and the distance to ponds in the SORDU project area, southern Ethiopia.

Land stratification

Over large tracts of land, ecological conditions usually vary considerably and consequently so do opportunities for intervention. Thus an effective diagnosis of the principal constraints within a pastoral system will often require an initial stratification of land into major vegetation or ecological units; followed by an assessment of probable constraints within each strata; followed by an evaluation of whether particular strata are likely to respond to the proposed interventions.

In Niger, geomorphology and landscape were used to divide the NRL project area into six landtypes. Further subdivision into
management units depended on the supposition that, at the present state of pastoral development, practical interventions require units that are geographically distinct, with suitable operational bases. The project area in Niger was finally divided into four major strata with 10 units. Specific research and development possibilities could be identified for each unit. For example, one of the units, the Ighazer plains, was essentially a clay soil floodplain while another was a sand dune grassland. While the development of surface water in pools and ponds was likely to persist in the former, ground seepage in the latter would necessitate construction of deep boreholes. However, controlled animal stocking was likely to be of little value in the floodplains where there was a low grass cover of scattered perennial tufts, compared to the dunes which had a good cover of annual grasses.

A similar approach to land stratification was adopted for the Mali delta region, with breakdown into four strata subdivided into 19 units, for each of which aspects of the animal and human populations as well as the environmental conditions could be described (Table 3).

Table 3. Cattle and selected environmental conditions in four land management strata in the Mali delta region.

<table>
<thead>
<tr>
<th>Land management strata</th>
<th>Area (km²)</th>
<th>Cattle population</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Oct. (’000)</td>
<td>March (’000)</td>
</tr>
<tr>
<td>Upland Sahel</td>
<td>13,197</td>
<td>226</td>
<td>63</td>
</tr>
<tr>
<td>Transition zone</td>
<td>5,811</td>
<td>237</td>
<td>91</td>
</tr>
<tr>
<td>Elevated plains</td>
<td>5,818</td>
<td>230</td>
<td>189</td>
</tr>
<tr>
<td>Inundated plains</td>
<td>11,117</td>
<td>114</td>
<td>871</td>
</tr>
</tbody>
</table>
Discussion

The general iterative sequence of pastoral systems research can be seen to have four essential phases:

- **DIAGNOSTIC**
- **DESCRIPTIVE**
- **PROMOTE**
- **TRIALS**

Low-altitude aerial survey is mainly valuable at the descriptive and diagnostic phases. The descriptive phase provides an inventory of the resources, together with an evaluation of their structure and functioning within the production system. This descriptive phase needs to be open ended, as comprehensive as possible and, most importantly, should be both rapid and cost-effective.

Thereafter, the diagnostic phase must first identify the main constraints, devise ways of tackling them and then evaluate the probability of the success of any proposed interventions. The remote sensing nature of low level aerial surveys means that the constraints to the system can only be proposed or hypothesised, and ground validation is essential. Results of the work provide predictive statements, for example that animals tend to be found near wells, but the actual reasons and mechanism for this may be more complicated: animals may be near water for reasons other than water, while developing alternative water sources may be either technically or socially unfeasible.

Fig. 11 indicates how the essential flows from description towards diagnosis can operate. The survey immediately answers the resource questions: How many? Where? and When? while the interrelationships provide the hypotheses: Why? These hypotheses about possible causation and limiting factors to the system are posed within the multi-variate animal, human, environment context.
Although low-altitude aerial surveys record a large number of parameters relating to the animal and human populations as well as their environment, numerous parameters cannot be recorded. For example, while the animal population size and distribution are recorded, age and sex structures are not. Similarly, baseline information about human demography, household and labour budgets and decision making processes are not recorded, neither are environmental factors, such as geology and rainfall, though these often exist in published literature. While detailed range resource maps have been produced from intensive photo-interpretation and ground truthing, the general vegetation descriptions made during flight will often be sufficient to indicate whether range resources are an important constraint to animal distribution and thus whether further, more detailed, research is in fact necessary.
A particularly useful advantage of low aerial survey is its ability to guide aspects of the sampling design of ground investigations (Okali and Milligan, 1980). If detailed animal production studies require a stratified sample design based upon herd size, this can be directed from the results of the aerial surveys. Subsequently, aerial and ground data can be linked together and detailed results from the ground can be extrapolated to the entire study area. Similarly, if household studies are to be based upon wealth strata and if the wealth characterization can be linked to factors visible from the air such as camp size, number of granaries, or cattle holdings, the basic sample frame and its locations can be determined before the ground work begins.

Outside its advantage as a multiple resource inventory technique, low altitude aerial surveys are both rapid and cheap. Although survey time will depend upon sample procedures and various logistic considerations, an area of about 100,000 km$^2$ could be covered in three to four weeks and preliminary reports from the survey could be made available to ground teams one month later. Costs are variable. The actual flying operations themselves are usually substantially less expensive than man-time costs, and thus analysis and reporting time become important considerations. Normal costs, from planning to reporting, are about US$ 1.00 per km$^2$, although costs would be higher for particularly intensive investigations. This amount usually represents as little as 1% of the total research and development costs within a pastoral project.

References


Les enquêtes à basse altitude dans la recherche sur les systèmes pastoraux

Résumé

La technique des enquêtes à basse altitude qui connaît depuis peu un certain essor s'est avérée une méthode rapide, fiable et peu coûteuse pour évaluer le nombre et la distribution des populations animales et humaines sur de vastes superficies. Le document décrit les méthodes de base utilisées actuellement pour effectuer les enquêtes à basse altitude, y compris les procédures de vol et d'échantillonnage et la collecte et l'analyse de l'information.


Les enquêtes à basse altitude sont surtout importantes dans les phases de la description et du diagnostic de la recherche sur les systèmes pastoraux. Le recours que font les enquêtes à basse altitude à la télédétection signifie que les contraintes aux systèmes identifiés par le biais de telles enquêtes ne constituent que des hypothèses et que la confirmation par l'observation au sol est indispensable.

L'un des avantages les plus importants des enquêtes à basse altitude réside dans le fait qu'elles permettent d'orienter certains aspects du plan d'échantillonnage des enquêtes au sol. Si les études détaillées sur la production animale font appel à un plan d'échantillonnage stratifié basé sur la taille des troupeaux, il est possible d'obtenir un tel plan grâce aux résultats produits par les enquêtes aériennes. Par la suite, il est possible d'établir la corrélation entre les données issues des enquêtes aériennes et des observations au sol; ainsi des informations détaillées recueillies au sol peuvent être extrapolées.
pour l'ensemble de la zone d'étude. De même, si les études sur les ménages doivent être basées sur la stratification de la richesse et si la détermination de la richesse peut être liée à des facteurs tels que la taille des campements, le nombre de greniers ou de bovins visibles à partir d'un appareil, le cadre d'échantillonnage de base et ses éléments peuvent être déterminés avant le début des travaux au sol.

Les enquêtes à basse altitude représentent une technique multiple; en outre, elles sont à la fois rapides et peu coûteuses. Une superficie d'environ 100 000 km$^2$ peut être couverte en trois à quatre semaines et les rapports préliminaires relatifs à l'enquête pourraient être mis à la disposition des équipes au sol un mois plus tard. Normalement, les coûts (de la phase de la planification à celle de l'élaboration du rapport) sont d'environ 1 dollar E.-U. par km$^2$, quoique pour les enquêtes particulièrement intensives, ce chiffre puisse être dépassé. Les sommes consacrées aux enquêtes à basse altitude représentent en général 1% seulement des coûts totaux de recherche - développement des projets pastoraux.
Summary of Discussion Session 2.
Chairman: Dr Cees de Haan (ILCA)
Discussion led by Dr Noumou Diakite (Mali)

Dr Rhissa suggested that finance be sought for aerial surveys of all the countries in the Sahel zone from international organisations such as OAU, World Bank, UNDP. Dr Abel warned that in using remote sensing there was one danger in particular that resulted from the detachment of the observer from the object of the survey. Objects that were visible on photographs and images may not be relevant to the local users of the land. Land classification from remote sensing may, because it ignored local use of particular resources, result in development plans which adversely affected local land users. There was also an unnecessary waste of existing information in the form of local knowledge of the land and its use which had been tried and tested over a long period. It was not, in Dr Abel's view, sufficient to use the social scientists of an inter-disciplinary team to counteract the inadequacies and dangers of remote sensing. He suggested that if local land classification systems were described and used from the outset, some of the dangers of inappropriate classification would be removed. If different ethnic groups practised a variety of land uses on the same land, each of their classification systems should be incorporated into an integrated scheme, otherwise certain groups may be placed at a disadvantage in the competition for land which commonly accompanied planned changes in land use.

In commenting on the paper by Drs Milligan and de Leeuw, Prof. Saka Nuru said that the remote sensing technique would be a useful preliminary aid in the conceptual framework of LSR in terms of its time-saving and cost benefit effect before more serious work was done by scientists at a particular location. But he said that it was only useful when used as a complement to ground surveys which were probably more reliable in the identification of parameters of interest. There were certain constraints to the technique, such as the difficulty in identifying goats due to their small colour and size. Dr Milligan pointed out that sheep and goats were not normally a problem because of an aspect of their behaviour - they usually ran when an aircraft
approached and thus could readily be distinguished from cattle. It was difficult to separate sheep from goats, and thus they were normally classified as 'shoats'. Prof. Saka Nuru asked what was the relative efficiency/sensitivity of the remote sensing technique vis-à-vis the ground survey. Dr Milligan replied that counting animals from the ground was time-consuming and there were numerous practical and theoretical problems. Dr Milligan agreed that ground truthing was important, depending on the level of information that was required.

Items estimated from the air could be checked and some biases corrected from ground survey calibration. Also a knowledge of the ground conditions helped one to make correct observations from the aircraft. Prof. Saka Nuru strongly supported the idea that ILCA should be involved in a country-wide use of the remote sensing technique in order to get a better picture of the distribution of natural resources as an aid to future planning for livestock development.

Dr Zulberti emphasised the need for a conceptual framework before any information was collected to avoid gathering a large amount of data, some of which might not then be used. Dr Chema also stressed the need for a specific purpose to be clearly defined at the beginning of the survey. Dr Milligan agreed, and stated that specific objectives were indeed identified before each flight. The hypotheses and questions that were stated at the start formed the basis for the kind of data that was collected and the design of the sampling strategies.

Dr Hiernaux asked Dr de Leeuw whether or not he thought that the use of satellite remote sensing methods and aerial surveys could result in increased costs due to the many field observations that had to be made to support such methods. Dr de Leeuw said that this highlighted the need for researchers to be more clear about what data they really needed from such surveys.
Résumé des débats de la deuxième séance

Président: M. Cees de Haan (CIPEA)
Débats dirigés par le Dr Noumou Diakité (Mali)

Le Dr Rhissa a suggéré de rechercher le financement d'enquêtes aériennes pour tous les pays de la zone sahélienne auprès d'organisations internationales telles que l'OUA, la Banque mondiale et le PNUD. Le Dr Abel a déclaré que l'utilisation de la télédétection comportait un aléa particulier qui résultait de l'éloignement de l'observateur de l'objet de l'enquête. Les objets qui étaient visibles sur les photos et sur les images peuvent ne rien signifier pour les utilisateurs locaux de la terre. La classification des ressources territoriales par télédétection pourrait se traduire par des plans de développement néfastes pour les utilisateurs locaux, notamment parce qu'elle ne tient pas compte des utilisations locales de ressources particulières. En outre, on ne tirait pas parti d'informations disponibles sous forme de connaissance locale de la terre et de ses utilisations et éprouvée par le temps. Aux yeux du Dr Abel, il n'était pas suffisant d'utiliser les spécialistes de sciences sociales d'une équipe interdisciplinaire pour pallier les insuffisances et les dangers de la télédétection. Il a déclaré que si les systèmes locaux de classification des terres étaient décrits et utilisés dès le départ, certains des risques de classification inadéquate pourraient être écartés. Si divers groupes ethniques ont adopté diverses formes d'utilisation des terres sur la même superficie, chacun de leurs systèmes de classification devrait être incorporé dans un schéma intégré, autrement, certains groupes pourraient être placés dans une situation désavantageuse dans la compétition pour les terres qui accompagne en général les changements planifiés de l'utilisation des terres.

Dans son commentaire sur le document de MM. Milligan et de Leeuw, le Prof. Saka Nuru a déclaré que la technique de la télédétection constituait un outil préliminaire dans la conception du cadre de la recherche sur l'élevage en raison de l'économie de temps qu'elle permet et de son effet coûts/bénéfices avant que des travaux plus approfondis ne soient entrepris par des scientifiques sur un site déterminé. Mais il a déclaré qu'elle n'était utile que lorsqu'elle
était utilisée comme complément d'enquêtes au sol qui étaient probablement plus fiables dans l'identification des paramètres importants. Cette technique comportait certaines contraintes telles que la difficulté d'identifier les chèvres en raison de leur couleur et de leur petite taille. M. Milligan a souligné que les moutons et les chèvres ne constituaient pas normalement de problèmes à cause d'un aspect de leur comportement: il s'enfuient généralement lorsqu'un avion approche et peuvent ainsi être facilement distingués des bovins. Il est difficile de distinguer les moutons des chèvres et ils ont donc été normalement classés en "cavins". Le Prof. Saka Nuru a demandé quelle était la fiabilité/efficacité relative de la technique de télédétection par rapport aux enquêtes au sol. M. Milligan a répondu que le dénombrement des animaux à partir du sol prenait beaucoup de temps et qu'il posait de nombreux problèmes théoriques et pratiques. M. Milligan a reconnu que la confirmation au sol était importante, compte tenu du niveau d'informations requis. Les estimations faites à partir de l'appareil peuvent être vérifiées et certaines distorsions corrigées par calibrage basé sur les enquêtes au sol. La connaissance de la situation au sol a également permis de faire des observations correctes à partir de l'appareil. Le Prof. Saka Nuru s'est déclaré entièrement en faveur de l'idée selon laquelle le CIPEA devrait participer à l'utilisation à l'échelle des pays des techniques de télédétection pour avoir une image plus claire de la distribution des ressources naturelles en vue d'une assistance à la planification future du développement de l'élevage.

Le Dr Zulberti a mis l'accent sur la nécessité d'un cadre conceptuel avant la collecte des données, pour éviter le rassemblement d'informations abondantes dont certaines pourraient ne pas être utilisées. Le Dr Chema a également souligné la nécessité de définir clairement un objectif précis au commencement de l'enquête. M. Milligan a accepté ce point de vue et a déclaré que des objectifs spécifiques étaient en fait identifiés avant chaque vol. Les hypothèses et les questions formulées au départ constituaient la base à partir de laquelle les divers types de données étaient collectées et la conception des stratégies d'échantillonnage mise au point.
M. Hiernaux a demandé à M. de Leeuw si oui ou non il estimait que l'utilisation des méthodes de télédétection par satellite et par enquête aérienne pourrait résulter en un accroissement des coûts en raison de la multiplicité des observations qui devaient être faites sur le terrain pour appuyer de telles méthodes. M. de Leeuw a déclaré que cela soulignait la nécessité pour les chercheurs de définir de manière très claire les types de données dont ils ont besoin dans de telles enquêtes.
Les végétations et les ressources fourragères dans les systèmes pastoraux

Pierre Hiernaux
Ecologiste, zones arides (Afrique de l'Ouest), CIPEA, Mali

Le but des études menées sur la végétation et les ressources fourragères dans les systèmes pastoraux est de détecter et d'analyser les contraintes nutritionnelles pour l'élevage qui sont liées à une insuffisance de ces ressources, et de proposer des solutions pour y remédier.

Comme pour d'autres aspects du système, l'étude est structurée en phases descriptives et de diagnostic, éventuellement suivies de tests au niveau expérimental puis progressivement mis en place dans les systèmes.

Une particularité des études sur la végétation tient à ce que celle-ci est à la fois une des ressources alimentaires principales de l'élevage qu'il faut quantifier et dont il faut analyser les processus de production et de reproduction, mais c'est aussi un paramètre majeur de l'environnement, et qui reflète, par sa structure et son fonctionnement, les autres composantes de l'environnement. A travers sa structure physique, floristique, ses variations saisonnières ou interannuelles, la végétation est un indicateur synthétique des conditions de milieu qui peut être utilisé pour identifier et caractériser l'environnement.

M. Bille traitant des méthodes utilisées pour l'étude de la dynamique de la végétation, ma présentation se limite aux méthodes d'inventaire et d'analyse des processus de production végétale en les illustrant par des exemples extraits des travaux du CIPEA au Mali.

La phase descriptive
Buts: - Stratifier l'environnement dans lequel évoluent le ou les systèmes pastoraux étudiés.
- Caractériser la production fourragère de chaque strate et les variables écologiques qui la conditionnent.

Méthodes: Les relevés et les cartes phyto-écologiques

Les relevés

Un inventaire des ressources fourragères est réalisé sur le terrain par relevés méthodologiques de la végétation et du milieu. Un relevé consiste à noter systématiquement pour un site-échantillon les valeurs prises par une série de paramètres de la structure de la végétation et de l'environnement. Pour la végétation, ce sont des paramètres de la structure des peuplements herbacés et ligneux (recouvrement, densité, stratification...), la composition floristique, la biomasse aérienne, etc.. Pour l'environnement ce sont les caractéristiques climatiques et édaphiques du site: nature de la roche-mère, unité géo-morphologique, descripteurs du profil de sol... mais aussi les indications sur l'occupation du sol - statut agricole et pastoral.

Pour faciliter les comparaisons et autoriser les manipulations statistiques, la superficie des sites-échantillons est fixe et l'emplacement est matériellement délimité sur le terrain. Dans les études faites au Mali, la superficie des relevés est fixée à 100 m² (carré de 10 m de côté) pour le tapis herbacé et 2,56 ha (carré de 160 m de côté) pour le peuplement ligneux. Dans les deux cas, l'étude des distributions aire-espèce a guidé le choix de la superficie qui est proche de l'aire optimale phytosociologique.

La durée d'un relevé est comprise entre 2 et 6 heures pour un relevé du peuplement ligneux et 1/2 à 1 heure pour un relevé phyto-écologique (1 observateur).

L'échantillonnage des relevés

De l'emplacement et du nombre de stations écologiques choisies dépendront la précision des résultats et leur représentativité. Un plan d'échantillonnage fixe la liste des situations à observer et le nombre des répétitions à effectuer dans chacune d'elles. Le nombre des situations est déduit d'une stratification hiérarchisée de l'espace.
régional étudié en régions, secteurs, séries ou séquences et enfin en stations écologiques. Il est égal au produit du nombre des stations par celui des séries multiplié par le nombre de secteurs de chaque région. Le nombre des répétitions est généralement compris entre 3 et 10. Le tableau 1 présente les paramètres de l'échantillonnage réalisé au Mali. Au total, cinq cent relevés de reconnaissance (et 100 relevés ligneux) ont été effectués sur une superficie de 71 000 km², soit en moyenne 1 relevé pour 142 km² (un carré de 12 km de côté) et une moyenne de 3 répétitions par groupement végétal.

Tableau 1. Paramètres de l'échantillonnage stratifié des relevés phyto-écologiques au Mali

<table>
<thead>
<tr>
<th>Niveaux de perception</th>
<th>Régions continental</th>
<th>Delta &quot;mort&quot;</th>
<th>Delta &quot;vif&quot;</th>
<th>Total zone d'étude</th>
</tr>
</thead>
<tbody>
<tr>
<td>secteurs</td>
<td>4 (climat)</td>
<td>3 (climat)</td>
<td>9 (inondation)</td>
<td></td>
</tr>
<tr>
<td>séries</td>
<td>8,5 (sol)</td>
<td>8 (sol)</td>
<td>6 (sol)</td>
<td>7,7</td>
</tr>
<tr>
<td>stations</td>
<td>1,78 (artif.)</td>
<td>2,25 (artif.)</td>
<td>1 (artif.)</td>
<td>1,7</td>
</tr>
</tbody>
</table>

| Nombre de strates      | 60                  | 54          | 54          | 172               |
| Nombre de répétitions  | x 3                 | x 3         | x 3         |                   |
| Nombre de relevés      | 180                 | 162         | 162         | 504               |
| Nombre de relevés      |                      |             |             |                   |
| effectivement réalisés | 167                 | 164         | 169         | 500               |
| Taux d'échantillonnage  | 168                 | 155         | 103         | 142               |
| superficie km²/relevé  |                      |             |             |                   |
Le tableau d'échantillonnage fixe l'effectif des observations et les localise grossièrement. Pour préciser leurs emplacements, les documents cartographiques et les photographies aériennes sont très utiles. Si l'échelle des photographies aériennes et leur actualité sont appropriées, cette localisation peut être directement utilisable sur le terrain au niveau duquel il ne restera plus qu'à vérifier la correspondance avec les critères d'échantillonnage retenus et, pour le détail de l'emplacement, à veiller à la représentativité de l'élément choisi vis-à-vis de l'ensemble de la station écologique. La photographie aérienne s'avère un instrument très précieux dans la phase technique de l'échantillonnage, tant pour le contrôle de la représentativité des sites que pour résoudre au mieux les problèmes d'accès. La durée d'une campagne à relevés telle que celle qui a été faite au Mali est de 22 jours de terrain pour 10.000 km² pour un observateur (en moyenne 4 relevés phyto-écologiques/jour et 1 relevé ligneux/jour). A condition toutefois de choisir une saison propice, surtout pour les herbacées (septembre à janvier au Sahel).

L'analyse des données des relevés phyto-écologiques

Les données recueillies dans les relevés peuvent être présentées sous la forme d'une matrice où les objets sont les relevés et les descripteurs à la fois les taxons (composition floristique qualitative ou quantitative) et les états des variables écologiques observées ou mesurées (Fig. 1). De cette matrice de base d'autres matrices sont dérivées dont les objectifs sont les états des variables du milieu et les descripteurs sont soit les espèces, soit les relevés groupés par formation végétale. Les dimensions très élevées de ces matrices rendent indispensable le recours à un ordinateur performant. Ce traitement mécanographique des données réclame un codage des données et leur transcription sur cartes perforées ou bandes magnétiques.

Après une série de tests pour contrôler l'échantillonnage (mesure de l'interdépendance des variables sur la base des calculs de probabilité, ou de l'information mutuelle sur les tables de contingence), les groupements végétaux sont définis par une comparaison des compositions floristiques des relevés. Ces groupements sont alors caractérisés par les espèces et les états des variables écologiques auxquels ils sont significativement liés.
### MATRICE DE BASE
#### DES DONNEES PHYTO-ECOLOGIQUES

<table>
<thead>
<tr>
<th>OBJETS: RELEVE</th>
<th>R_1</th>
<th>R</th>
<th>R_N</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>E_1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ x_{11}, \ldots, x_{1N}, \ldots, x_{p1}, \ldots, x_{pN}, y_{11}, \ldots, y_{1N}, \ldots, y_{q1}, \ldots, y_{qN} \]

\[ x: \text{présence-absence, abondance-dominance, recouvrements, effectifs, biomasse...} \]
\[ y: \text{état de la variable L dans le relevé R.} \]

**Mesures de distance:**
- Groupements phyto-socio-ecologiques
- Mesures d'interdépendance: structure du milieu
- Vérification de l'échantillonnage.

### MATRICES DERIVEES

<table>
<thead>
<tr>
<th>Variable L</th>
<th>Etat</th>
<th>Etat</th>
<th>Etat</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESPECE E</td>
<td>U_1</td>
<td>U_K</td>
<td>U_{NK}</td>
</tr>
<tr>
<td>RELEVES</td>
<td>R_1</td>
<td>R_K</td>
<td>R_{NK}</td>
</tr>
</tbody>
</table>

\[ U_K: \text{fréquence (ou participation) de l'espace E dans les relevés R_K où la variable L présente l'état K.} \]

**PROFILS ECOLOGIQUES**
- Fréquences UK/RK relatives:
- Fréquences UK, NR/RK, UE corrigées:
- Probabilités: profil écologique indice.

**Fig. 1. Organigramme de l'analyse des données phyto-écologiques.**
Les calculs sont souvent complétés par une ordination en espace réduit qui permet d'ordonner réciproquement entre eux groupements végétaux, espèces végétales et variables écologiques. La projection des groupements végétaux et états des variables de l'inondation sur le plan des axes factoriels 1 et 2 dans une analyse factorielle des correspondances faites sur les relevés phyto-écologiques du Delta est un exemple des ordinations obtenues (Fig. 2).

Il faut compter un jour de travail pour coder et inscrire les données de 10 relevés phyto-écologiques (1 jour pour 5 relevés ligneux), soit environ 10 jours pour 10.000 km² échantillonnés comme précédemment pour un observateur. Il faut ajouter à cela la durée des calculs et de l'interprétation qui n'est pas proportionnelle au nombre des relevés.

La carte

La caractérisation des groupements végétaux est complétée par une carte dont le thème principal, synthétique corrélatif est celui des unités phyto-écologiques.

La clef de cartographie est directement établie à partir des résultats de l'analyse des données de relevés qui fournit en outre une liste d'indicateurs. Pour lever la carte, on a recours à la télédétection par photo-interprétation des photographies aériennes (panchromatiques, et infrarouge au 1/50 000ème pour le Mali). Elle est d'autant plus aisée que les photos ont servi à l'échantillonnage et aux prospections de terrain. Dans l'approche empirique utilisée, la clef de photo-interprétation est forgée progressivement au cours des rapprochements répétés entre l'image et la vérité de terrain. La télédétection peut procéder d'une démarche plus systématique; il suffit d'adoindre aux descripteurs de terrain ceux qui caractérisent l'emplacement observé sur le document de télédétection: relief, structure, texture et ton des images photographiques, signatures spectrales sur les fiches de relevé. Des calculs identiques aux précédents établissent la valeur indicatrice de ces paramètres ou de leur combinaison, ce qui, dans le cadre de données géographiquement cotées, permettrait une cartographie automatique. Il est cependant douteux que les indicateurs multispectraux puissent répondre aux caractérisations complexes et hétérogènes qui participent à la définition des groupements végétaux.
Fig. 2. Analyse factorielle de la matrice espèces x états de variable, 127 relevés des plaines d'inondation du delta intérieur du Niger, projection du "nage matriciel" sur le plan des axes 1 et 2.
Une fois les clefs de cartographie et de photo-interprétation établies, le lever d'une carte par les méthodes indiquées et à l'échelle 1/50 000 km$^2$ prend 60 jours/homme pour 10 000 km$^2$ (25 jours de pré-photo-interprétation: 6 photos par jour, 10 jours de vérification de terrain, 25 j. de corrections et de dessin).

La durée effective globale de la phase descriptive suivant les méthodes décrites ci-dessus se chiffre à 100 jours/homme pour 10 000 km$^2$ en comptant 10 j. forfaitaires pour l'établissement du tableau d'échantillonnage (étude bibliographique, première observation des documents photographiques) et 28 j. pour les calculs et l'interprétation des résultats.

**La phase de diagnostic**

**But:**
- Détecter les contraintes à la nutrition animale liées à une insuffisance quantitative ou qualitative des ressources fourragères.
- Proposer des solutions techniques ou des voies de recherche pour les résoudre.


**Les techniques de mesure de biomasse**

Les techniques utilisables sont très nombreuses et sont l'objet d'une documentation abondante. Nous nous limitons à indiquer quelques-unes des méthodes pratiquées dans le cadre du projet du CIPEA au Mali.

-120-
Biomasse aérienne du tapis herbacé

Technique destructive - Quels que soient les organes et catégories considérés (matière verte, matière morte, graminées; légumineuses, taxon, strates physionomiques, stade phénologique...) la mesure est faite par prélèvement pratiqué par coupe sur les placettes délimitées. Le principal problème technique est celui de l'échantillonnage: il faut fixer les formes, la taille, le nombre et la disposition de ces placettes sur le terrain pour que les mesures soient représentatives de la station.

Pour la forme de la placette, on sait que la forme circulaire réduit au minimum les effets de bordure et que la forme rectangulaire minimise la variance associée à la micro-hétérogénéité mais augmente les effets de bordure. Finalement la forme carrée est retenue. Le nombre et la surface élémentaire des placettes déterminent la précision de la mesure mais aussi son coût. Si l'on tient compte du coût, la surface optimale se situe suivant les cas entre 1 et 4 m². Le nombre de placettes pour un seuil de précision requis est fonction de l'hétérogénéité du tapis herbacé mais aussi du plan d'échantillonnage. Avec une répartition aléatoire (ou systématique-aléatoire), une trentaine de répétitions suffisant à atteindre une précision satisfaisante, la précision sur la moyenne

\[ P = \frac{s \cdot t}{\sqrt{n}} \]

\( s \) : écart-type  
\( x \) : moyenne  
\( n \) : nombre de répétitions  
\( t \) : valeur du t de Student pour \( n-1 \) degrés de liberté au seuil de 0,05

se stabilise entre 5 et 25% selon l'hétérogénéité du parcours. La disposition aléatoire ou systématique des placettes sur l'unité étudiée n'est pas toujours aisée; elle est souvent remplacée par une distribution subjective stratifiée moins fiable mais plus efficace. Il faut compter une à deux heures par mesure de biomasse sur le terrain.

Technique non destructive - Les lectures des contacts sous un point ou des intersections sous segment qui sont préconisées par de nombreux auteurs sont des mesures indirectes: la biomasse est calculée
à partir de la densité de la végétation. Ces méthodes fournissent en plus des informations très détaillées sur la structure du tapis végétal. Mais elles exigent beaucoup de temps et seront réservées à des mesures fines de la dynamique du tapis végétal (cf. présentation de J.C. Bille).

De la biomasse à la production et aux disponibilités fourragères

Dans une première approche, les compensations entre production et dégradation sont négligées; on se contente de répéter les mesures de biomasse et les analyses bromatologiques par intervalles au cours du cycle annuel. Ces résultats permettent d'établir les premiers diagnostics.

La courbe de la biomasse et de la teneur en protéine d'un parcours sahélien à Schoenefeldia gracilis montre que même si le parcours est protégé jusque là, le taux de protéine est inférieur à 6% une grande partie de l'année durant laquelle la qualité moyenne du parcours est insuffisante (Fig. 3).

Dans une approche toujours globale, il est possible de comparer diverses situations liées à l'utilisation du parcours, la différence entre la parcelle pâturée et le témoin souvent appelée consommation apparente traduisant globalement le bilan de l'ingestion de la croissance modifiée et la dégradation sous pâture.

Cette approche peut être perfectionnée en faisant la part des divers phénomènes qui concourent au bilan "biomasse", en différenciant la production brute et la production nette dans un pâturage sahélien. Les résultats obtenus au Sahel sont d'ailleurs variables, disent les auteurs.

Sur un principe similaire, on mesure la production sous pâture par prélèvements couplés à l'intérieur de cages fourragères déplacées à intervalles rapprochés. Le tableau 2 donne un exemple où sont comparées les productions sous pâture et sous trois régimes de fauche d'un parcours à Echinochloa stagnina. La comparaison oriente les recherches vers l'expérimentation de modes de gestion optimisant la production par rotation des parcours.
Tableau 2. Production de repousses feuillées d'un parcours

<table>
<thead>
<tr>
<th>Intervalle</th>
<th>PRODUCTION DE REPOUSSES FEUILLEES (kg MS/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>entre les fauches</td>
<td>DU 28/12/80 AU 13/7/81</td>
</tr>
<tr>
<td>(semaines) ou pâture (p)</td>
<td>Prod.cumulée</td>
</tr>
<tr>
<td></td>
<td>m</td>
</tr>
<tr>
<td>1</td>
<td>4737</td>
</tr>
<tr>
<td>2</td>
<td>4807</td>
</tr>
<tr>
<td>4</td>
<td>4496</td>
</tr>
<tr>
<td>p</td>
<td>2346</td>
</tr>
</tbody>
</table>

Biomasse aérienne (kg de MS/ha)

Début des pluies régulières
pluies précoces
fin des pluies

Fig. 3. Evolution mensuelle de la biomasse et de la teneur en protéine d'un pâturage herbeux à Schoenefeldia gracilis mis en défense (ranch de Niono).
Il est très difficile de fixer des normes de temps pour ce type de recherches tant elles sont fonction de cas particuliers. Mais d'une façon générale, elles portent sur un cycle annuel complet, plusieurs cycles si les fluctuations interannuelles sont importantes. A titre d'exemple - Pour le delta, les études menées sur 10 parcours, 3 années durant, occupaient une équipe de 5 personnes, 2 semaines pour la mise en place puis une semaine par mois.

La phase d'expérimentation

But: Analyser l'impact d'une variable du système ou d'une innovation technique sur le fonctionnement du système.
Mettre au point une technologie adaptée pour promouvoir un aménagement préalablement testé localement.

Les expérimentations sectorielles
Elles sont menées sur quelques sites ou stations en conditions contrôlées souvent assez artificielles par rapport aux réalités du système de production.

Pour les pâturages, elles consistent principalement à analyser l'impact de pratiques pastorales vraies ou simulées sur la production et la dynamique d'un parcours. L'impact de la date d'entrée dans les parcours du delta (simulée par la fauche) sur leur production et effet de la précocité des incendies, illustrés par les essais menés sur un pâturage à *Andropogon gayanus* (Fig. 4), sont un exemple d'expérimentation sectorielle dont les résultats orientent les propositions d'aménagement du système de gestion.

Les résultats obtenus sur les divers parcours amènent à préconiser une première pâture ou un incendie les plus précoces possibles après la maturité des herbacées.

Par ailleurs, l'impact des régimes de fauches répétées à intervalles d'une, deux, quatre ou huit semaines sur la production de repousses, figure dans le tableau 3 pour quatre pâturages du delta. D'après les valeurs de production cumulées, il existe pour chaque parcours un rythme de fauche optimal (entre 1 et 2 semaines pour *Echinochloa*, 2 et 4 semaines pour *Andropogon ... etc*).
Biomasse
(kg de MS/ha)

Légende:
- Coupe précoce (CP)
- Coupe tardive (CT)
- Brûlage précoce (BP)
- Brûlage tardif (BT)
- Témoin (non pâturé)

Fig. 4. Effet de la date de fauche ou d'incendie sur la repousse d'un parcours à Andropogon gayanus.
Tableau 3. Repousses feuillées de quatre graminées des plaines d'inondation du Niger soumises à divers rythmes de fauche. Productions journalières en kg MS/ha.

<table>
<thead>
<tr>
<th>Intervalle entre deux fauches (semaines)</th>
<th>Repousses Stagnina 80</th>
<th>Feuillées (déc. à juillet) 81</th>
<th>d'Echinochloa 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>25,3 2</td>
<td>28 8,9</td>
</tr>
<tr>
<td>2</td>
<td>31,8 1,6</td>
<td>26,7 1,7</td>
<td>37,2 4,4</td>
</tr>
<tr>
<td>4</td>
<td>23,3 0,8</td>
<td>24,9 0,1</td>
<td>- -</td>
</tr>
<tr>
<td>8</td>
<td>26,6 0,3</td>
<td>-</td>
<td>- -</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervalle entre deux fauches (semaines)</th>
<th>Repousses Andropogon gayanus 1980</th>
<th>Feuillées Panicum anabaptistum 1982</th>
<th>Vetiveria nigritiana 1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- -</td>
<td>- -</td>
<td>6,2 0,7</td>
</tr>
<tr>
<td>2</td>
<td>5,1 0,4</td>
<td>6,9 1,7</td>
<td>8,7 0,7</td>
</tr>
<tr>
<td>4</td>
<td>6,4 0,6</td>
<td>7,7 1,4</td>
<td>11,4 0,8</td>
</tr>
<tr>
<td>8</td>
<td>4,3 0,5</td>
<td>6,2 1</td>
<td>(15,1) (3)</td>
</tr>
</tbody>
</table>
Les expériences sectorielles peuvent aussi comporter des essais de pâture dont les effets seront analysés à court et long termes. C'est le cas des expérimentations menées sur le ranch de Niono pour quantifier l'impact de la pâture saisonnière des parcours sahéliens.

Le test des innovations

Les innovations suggérées par les résultats de ces essais doivent être testées sur quelques unités de production afin de vérifier quels en sont les impacts sur le système et de mettre au point les technologies appropriées.

Un test de la rotation des parcours de saison sèche est en cours à Diafarabé. Les éleveurs de la Coopérative de Diafarabé ont bien voulu se prêter à une expérimentation de rotation hebdomadaire sur trois soles pour une partie de leurs troupeaux laitiers villageois. Le protocole a été élaboré au cours d'une série de réunions où nous nous sommes efforcés d'expliquer les buts techniques de l'essai aux éleveurs. Les éleveurs assurent le gardiennage et la gestion de leurs troupeaux; nous nous contentons de mesurer les effets sur la végétation et le poids des animaux.

Nous n'avons pas vraiment franchi l'étape suivante dans le projet Mali. Cependant un certain nombre de travaux réalisés dans le cadre du contrat passé entre le CIPEA et l'Opération de développement de l'élevage dans la région de Mopti s'intègrent à la phase de promotion des innovations au niveau de l'ensemble d'un système de production. C'est en particulier le cas des cartes des parcours, des capacités de charge potentielle, et de la structure foncière des systèmes pastoraux du delta intérieur du Niger et de ses marges sahéliennes ainsi que tout le travail concernant la mise en place des unités pastorales pilotes, autant de documents qui doivent servir à la réforme structurelle et foncière indispensable à la promotion des innovations technologiques proposées, en particulier toutes celles qui sont relatives à la gestion des parcours.
Cet exemple illustre un aspect de la recherche sur les systèmes pastoraux. De même que lors de l'échantillonnage, il a fallu considérer une hiérarchie des niveaux d'organisation de la végétation et du milieu, de même les systèmes de production animale sont structurés en niveaux d'organisation avec à la base les unités de production, puis les communautés de base agrégées en groupes plus ou moins homogènes à leur tour intégrés dans des sociétés d'autant plus complexes qu'elles sont vastes. Dans l'aménagement d'un système, il faut veiller à ce que les proportions soient adaptées à chacun des niveaux d'organisation et coordonnées entre elles. Même si l'unité de production est le maillon fondamental du système et si la détermination individuelle des éleveurs ou propriétaires d'animaux est indispensable à tout aménagement, certaines décisions ne peuvent être prises qu'à un niveau d'organisation supérieur. L'organisation de rotations pastorales sur les terrains de parcours villageois nécessite une décision collective (cas de la coopérative des éleveurs à Diafarabé). La modification du calendrier qui fixe l'entrée des animaux dans les parcours du Delta doit être prise à un niveau encore supérieur puisqu'il concerne non seulement les éleveurs de la plaine et du Sahel environnant mais aussi les riziculteurs, les pêcheurs, et les services régionaux (vétérinaire, santé, enseignement).

Actuellement une décision est prise chaque année par une commission paritaire organisée par le Gouvernorat de la Région. Les documents cartographiques réalisés pour le contrat ODEM/CIPEA ne sont certes pas très utiles à l'éleveur qui a une connaissance empirique infiniment plus détaillée des parcours de son secteur, mais elles peuvent jouer un rôle important dans le dialogue entre les éleveurs et les cadres des organismes de développement pour le choix des aménagements.
Vegetation and feed resources in pastoral systems

English Summary:

The aim of studies on vegetation and feed resources in pastoral systems is to detect and analyse the nutritional constraints to livestock production and to put forward solutions to relieve them. Vegetation is one of the main feed resources for animal production which has to be quantified and its production and reproduction processes need to be analysed. Vegetation is also a major environmental parameter which reflects the other components of the environment.

The aim of the descriptive phase of studies on vegetation and feed resources is to stratify the environment in which the pastoral system or systems under study evolve. Such studies also aim to characterise forage production within each strata and the ecological variables which condition it. An inventory of forage resources is carried out in the field using methodical surveys of the vegetation and the environment. A survey consists of systematically noting for a sample site the values recorded for a series of parameters covering the structure and the vegetation of the environment. For vegetation these parameters cover the structure of herbaceous and ligneous associations, the floristic composition, the above-ground biomass. For the environment the parameters are the climatic and edaphic characteristics of the site, the nature of the bedrock, geomorphology, topography, description of the soil profile and indications on land use, pastoral and agricultural status etc.

The accuracy of the results depends on the position and number of ecological stations selected. A sampling plan establishes the list of situations to be observed and the number of replicates of each. The number of situations is worked out from a graded stratification of the area under study into regions, sectors, series or sequences and finally into ecological stations. The sampling table establishes the number of observations and situates them in rough terms. To situate them accurately, maps and aerial photographs are very useful. Aerial photography is a very useful tool in the technical sampling phase, both for checking the representativeness of sites and for solving access problems.
Data collected in surveys can be presented in the form of matrices in which the objects are the surveys and the descriptors the taxons and the states of the ecological variables observed or measured. The large size of these matrices makes a computer essential. This kind of data processing requires the coding of data and their processing onto punched cards or magnetic tapes. The calculations are often completed by a factorial analysis which allows the reciprocal processing of plant groups, species and ecological variables.

The characterisation of plant groups is completed by a map whose main theme is phyto-ecological units. The key to the map is directly established from the results of the data analysis from the sample areas which also provides a list of indicators. Remote sensing is used to make the map; photo-interpretation of aerial photographs is easier if the photographs have also been used for sampling and ground truthing.

The aim of the diagnostic phase is to identify the constraints to animal nutrition linked with inadequate quantity or quality of feed resources, and to propose technical solutions or lines of research. The techniques which can be used for measuring biomass are numerous. In destructive techniques measurements are made by cutting samples from the small sample areas delineated in the field. The shape, size, number and pattern of sample areas have to be predetermined in the field, so that measurements will be representative of the ecological station. One or two hours must be allowed for each measurement of biomass in the field. In non-destructive techniques readings are taken from contacts at a point or intersection at a segment. Biomass is calculated using vegetation density as the basis. These methods also provide very detailed information about the structure of the vegetation cover. However, they are time-consuming and should be reserved for measurements of the dynamics of the plant cover.

The aim of the experimentation phase is to analyse the impact of a variable within a system or a technical innovation on the functioning of that system, and to develop an adapted technology so as to promote a locally tested management scheme. Sectorial experiments are carried out on several sites or stations under controlled conditions which are often rather artificial when compared to the realities of the
production system. For pasture they consist mainly of analysing the impact of pastoral practices, real or simulated, on the production or dynamics of a rangeland. Results obtained on different kinds of rangeland lead to a recommendation to start grazing or to burn off as early as possible after the grass has matured.

The innovations suggested by the results of these trials must be tested on several production units in order to verify their impact on the system and to develop an appropriate technology.
L'évolution du milieu

J.C. Bille

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Les causes de l'évolution

La description de l'évolution du milieu suppose une conception suffisamment claire des lois biologiques qui s'appliquent aux systèmes pâturés et des liaisons internes dans ces systèmes. On peut, en première approximation, représenter un tel système par le diagramme ci-après:

Fig. 1: Représentation d'un éco-système pâturé
On y remarque des compartiments pour la plupart reliés entre eux, et ces liaisons symbolisent l’existence de flux susceptibles d’aller d’un compartiment à un autre, généralement dans les deux sens. Ce schéma a pour but d’attirer l’attention sur le problème le plus habituellement rencontré lors des mesures de dynamique des pâturages : on demande à un écologiste de décrire les modifications perçues dans le sol et les plantes sans proposer aucune indication sur trois éléments indissolublement liés aux précédents :

- les animaux, leur type, leur nombre, l’époque à laquelle s’exerce leur action, etc...

- la gestion du territoire, représentée sur le diagramme par des points d’interrogation aussi multiples que les données qui la composent;

- ce qui entre et ce qui sort du système, dans le meilleur des cas exprimé sous forme d’unités monétaires.

Il est important de bien se rendre compte que la simple notification des changements dans la végétation n’apporte aucune information si elle n’est pas accompagnée de mesures sur les divers flux à l’intérieur du système et à travers le système. En outre, l’intérêt réside habituellement dans les changements liés à l’exploitation et non dans ceux qui sont induits par des causes naturelles (telles que le climat) ; c’est alors une méthode indirecte d’appréciation de la gestion. Le premier point consiste donc à dissocier les types d’évolution.

Types d’évolution

Il n’y a de changements climatiques tangibles et rapides que ceux qui correspondent aux variations interannuelles des précipitations habituelles aux zones tropicales. Cette variabilité est d’autant plus élevée que le climat est plus aride, et se traduit presque immédiatement sur la croissance végétale à des degrés divers. La sécheresse modérée d’une seule année réduit la production primaire ; une sécheresse intense détruit une partie des plantes pérennes, ou certaines espèces seulement, ou empêche les germinations. Il y a presque toujours un arrière-effet climatique sur l’année suivante, soit par l’intermédiaire de la
production de diaspores, soit en raison des traumatismes subis par les végétaux pérennes. Nous considérons cependant que ce type de changement est à court terme, brutal, marqué et assez éphémère.

Si par contre on modifie à la fois la plupart des éléments et des flux à l'intérieur du système, de nombreux phénomènes vont se produire: on pourra avoir une réduction permanente de l'ensemble des végétaux, ou simplement de certaines espèces, ou encore un transfert de productivité des plantes herbacées vers les plantes ligneuses. Tous les équilibres du système étant perturbés, il y aura aussi des conséquences sur les sols (perte de fertilité, érosion, reprise de pédogenèse) qui se feront sentir pendant 10 ans, 50 ans ou un siècle.

La cause la plus usuelle de ce second type de changements est une sur-exploitation du système (c'est-à-dire que ce qui en sort n'est pas compensé par ce qui y entre), en particulier par l'intermédiaire des animaux domestiques. Ce sont des évolutions à long terme, appelées à tort tendances évolutives car ces tendances ne sont perçues que lorsque l'évolution a déjà eu lieu et qu'il est trop tard pour intervenir.

Mesure des changements à long terme

Nous imaginerons à partir de maintenant que pour une raison quelconque, on ne dispose pas d'une étude scientifique complète du système de production à l'étude et qu'on ne veut pas réaliser cette étude, soit qu'on ne dispose pas de l'expertise nécessaire, soit qu'on ait une prévention innée contre ce type de travail. On souhaite cependant mesurer ou évaluer ce qui se passe dans la végétation. Les possibilités seront illustrées à partir d'exemples choisis au Kenya, où le CIPEA s'est efforcé de réaliser un exercice de ce type.

Contraintes particulières à la mesure simple des changements dans la végétation

Les paramètres les plus souvent utilisés pour la description des formations végétales sont la diversité, la structure, la périodicité des phytocénoses d'une part, et l'abondance, la fréquence, la constance, la dominance, la fidélité, la vigueur et le couvert de chaque espèce.
d'autre part. Certains de ces paramètres sont qualitatifs et mal adaptés à la mesure de nuances subtiles; la mesure des autres demande une somme de travail qu'on ne peut guère conseiller pour une intervention bon marché.

Ainsi, la détermination du couvert par espèce qu'on pourrait aisément relier à la productivité est réalisable par représentation graphique de la végétation, par énumération des plantes associée à des mesures sur leurs dimensions, par des méthodes de type P.C.Q. et par des systèmes ponctuels à base de tiges fixées sur des cadres, sur des roues et autres dispositifs. Considérant que la mesure d'un changement se fait à partir d'une comparaison de mesures, et par suite suppose des mesures répétitives, aucune des techniques citées n'est à la fois assez rapide et assez précise pour répondre aux besoins.

Un autre type de contrainte est lié à la représentativité des observations effectuées, et par suite à l'échantillonnage: les procédés classiques de description de la végétation supposent toujours qu'on travaille sur une unité homogène et non pas, comme c'est nécessaire dans une étude de système de production, sur une unité de gestion pastorale où l'hétérogénéité est une vertu capitale. Même si l'on ne se sent pas concerné par les querelles académiques des spécialistes, il faut admettre que la méthodologie appropriée n'est pas décrite dans les manuels d'écologie qui d'ailleurs évitent pour la plupart de traiter du sujet.

Dispositif de terrain utilisé au Kenya

Le dispositif qui a été mis au point au Kenya considère un territoire relativement vaste et soumis à un type d'exploitation donné comme site échantillonné. Les points-échantillons constituent un réseau permanent et sont disposés de façon systématique (par exemple, un point tous les 2, 3 ou 5 km) le long d'un itinéraire fixe qui sera parcouru lors de chaque évaluation.

L'un des points joue un rôle privilégié, en ce sens qu'il est repéré au sol par un moyen quelconque (peinture, barres métalliques, petites excavations, masses de métal enfouies,...) et qu'on y effectue
des mesures précises sur la végétation. Les autres points seront
décrits en fonction de ce lieu, et seulement sous forme d'estimations
comparatives. Les deux types de points de contrôle ont été appelés
respectivement Transect principal et Points secondaires, et l'ensemble
du dispositif est tel que présenté par le diagramme suivant:

Fig. 2: Plan de surveillance des terrains de parcours
Réalisation pratique des observations

En dépit des indications portées sur le diagramme, les mesures ne présentent qu'une indication voisine du couvert, et ne prétendent pas se substituer aux procédés plus scientifiques habituels. Elles consistent en effet à poser un anneau de petite taille (de l'ordre de 2,5 cm) tous les 50 cm le long de deux lignes de 50 mètres et à noter la présence de végétaux dans la surface, en restreignant le choix à quatre possibilités: rien, un peu d'herbe avec une espèce, beaucoup d'herbe avec 1 ou 2 espèces. Si le tapis est trop clairsemé, on se contente de noter l'interception des plantes le long des mêmes axes.

Par ailleurs, deux bandes de 100 x 1 m incluant les mêmes lignes servent à localiser les arbres qui s'y trouvent, en notant leur position, leur diamètre et l'extension de leur couronne. Aux points secondaires, on note si les arbres sont plus ou moins nombreux qu'au point de mesure, si le couvert herbacé est plus dense ou plus faible; on établit la liste des trois espèces qui paraissent dominantes dans chaque strate, et on note la pression de pâturage.

Des tests sévères ont montré au Kenya que différents observateurs donnent des informations comparables, que le contrôle du réseau ne demande habituellement pas plus que le temps de parcourir la distance, augmenté d'environ 4 heures, et que l'observateur le moins spécialisé fournit des données acceptables. On peut remarquer que ces résultats donnent des indications sur :

- la répartition des espèces végétales sur la surface, et les changements dans cette répartition (espèces envahissantes, ou qui disparaissent sous l'action du bétail ou pour une autre raison, déboisement sélectif et autres modifications qualitatives);

- le potentiel productif de la zone et sur ses variations, en liaison avec l'utilisation des savanes, et des renseignements immédiats sur la dénudation ou l'érosion.
Périodicité et résultats

Les résultats sont liés à la périodicité des mesures. Un contrôle annuel ne révèle le plus souvent que l'influence du climat de l'année (connu par ailleurs, dit-on dans ce but inclure un pluviomètre dans le réseau, c'est-à-dire si aucune station météorologique n'existe à moins de 50 km). Un changement à long terme lié à l'exploitation n'apparaît généralement qu'après 3 ou 5 ans. Les résultats qui suivent donneront une idée du type d'informations recueillies au Kenya:

Tableau 1. Exemple des résultats de strates herbacées obtenus au Kenya

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Digitaria milanjiana</em></td>
<td>3,9 +/-0,9</td>
<td>5,5</td>
<td>7</td>
</tr>
<tr>
<td><em>Pennisetum stramineam</em></td>
<td>4,3 &quot; 3,3</td>
<td>1,3</td>
<td>1,5</td>
</tr>
<tr>
<td><em>Themeda triandra</em></td>
<td>0,5 &quot; 0,7</td>
<td>0,5</td>
<td>4,5</td>
</tr>
<tr>
<td><em>Sporobolus fimbriatus</em></td>
<td>1,4 &quot; 0,5</td>
<td>2</td>
<td>0,5</td>
</tr>
<tr>
<td><em>Cynodon plectostachyum</em></td>
<td>0,5 &quot; 0,7</td>
<td>2</td>
<td>1,7</td>
</tr>
<tr>
<td><em>Microchloa indica</em></td>
<td>2,1 &quot; 0,8</td>
<td>0,5</td>
<td>-</td>
</tr>
<tr>
<td><em>Chloris spp.</em></td>
<td>-</td>
<td>4</td>
<td>2,7</td>
</tr>
<tr>
<td><em>Pennisetum mezianum</em></td>
<td>0,7 &quot; 0,8</td>
<td>0,8</td>
<td>T</td>
</tr>
<tr>
<td>non graminéen</td>
<td>5,5 &quot; 0,6</td>
<td>3,7</td>
<td>0,3</td>
</tr>
<tr>
<td>Total</td>
<td>20,2</td>
<td>22</td>
<td>19,4</td>
</tr>
<tr>
<td>litière</td>
<td>9,1</td>
<td>15</td>
<td>13,7</td>
</tr>
</tbody>
</table>

Strate herbacée, points secondaires

<table>
<thead>
<tr>
<th>Espèce</th>
<th>Couvert relatif 1979 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transect</td>
</tr>
<tr>
<td><em>Digitaria milanjiana</em></td>
<td>36,1</td>
</tr>
<tr>
<td><em>Chloris spp.</em></td>
<td>13,9</td>
</tr>
<tr>
<td><em>Pennisetum spp.</em></td>
<td>7,7</td>
</tr>
<tr>
<td><em>Sporobolus spp.</em></td>
<td>2,6</td>
</tr>
<tr>
<td><em>Eragrostis spp.</em></td>
<td>6,2</td>
</tr>
<tr>
<td><em>Cynodon</em></td>
<td>8,8</td>
</tr>
<tr>
<td>Autres graminées</td>
<td>1,5</td>
</tr>
</tbody>
</table>
Mesure des changements à court terme

Sauf cas très exceptionnel, les changements dans le milieu au cours d'une même année sont les variations dans la biomasse végétale. Il est bien entendu qu'on ne peut en aucun cas assimiler la biomasse à une époque quelconque avec la production primaire nette d'une année ou d'une période donnée, même si on dispose d'un territoire en défens et qu'on suppose résolus les problèmes de mesure des masses (énorme variabilité dans l'espace, échantillonnage difficile, longueur et coût des opérations de terrain). Le graphique suivant illustre cette affirmation:

Fig. 3: Comparaison de la productivité de la biomasse observée sur une période d'un an
Les trois courbes, obtenues au Kenya, diffèrent non seulement par leur forme mais même par l'époque des maxima et minima s'ils existent. Le matériel végétal ingéré par le bétail ne peut pas non plus être calculé à partir des courbes dont les variations incluent les pertes par piétinement, l'action des décomposeurs et celle d'éventuels autres consommateurs primaires. Les mesures de biomasses végétales ne peuvent donc en aucun cas être utilisées pour un autre but que l'estimation de la quantité de matériel alimentaire offert aux animaux.

Mesures sur le terrain

La technique des coupes réalisées sur de petits plots est bien connue, mais est souvent pratiquée avec de nombreuses variantes:

- échantillons répartis au hasard à l'intérieur d'une formation végétale déterminée: outre que le travail demande l'existence d'une carte de végétation à grande échelle et une certaine aptitude de l'opérateur à décider s'il se trouve bien dans la formation voulue (des détails de terrain peuvent ne pas avoir été cartographiés), le procédé est très long et peu réaliste;

- échantillonnage volontairement biaisé: on ne garde que les plots qui semblent représentatifs, mais il est alors interdit de proposer un écart-type et un intervalle de confiance pour le résultat;

- mélange de mesures vraies et d'estimations: on effectue les estimations sur des plots répartis au hasard, et on vérifie l'estimation par une mesure, par exemple une fois sur 10 de façon à introduire un facteur correctif pour l'ensemble des résultats. Le procédé réduit très sensiblement la quantité de travail et a été utilisé au Kenya sur une surface où une action multidisciplinaire intensive était en cours, justifiant de tels efforts.

Le tableau reproduit ici donne une idée des résultats obtenus. Pour toutes les valeurs, les mesures ont été arrêtées dès que l'intervalle de confiance de la moyenne était inférieur à 20% de cette moyenne qu'il faut donc lire: m +/-0,1 M.
Tableau 2. *Exemple d'une biomasse herbacée mesurée pendant toute une année pour quatre unités écologiques*

<table>
<thead>
<tr>
<th>Mois</th>
<th>Biomasse herbacée (kg MS/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Oct.80</td>
<td>355</td>
</tr>
<tr>
<td>Mars 81</td>
<td>275</td>
</tr>
<tr>
<td>Juin 81</td>
<td>560</td>
</tr>
<tr>
<td>Oct.81</td>
<td>465</td>
</tr>
<tr>
<td>Oct.80</td>
<td>305</td>
</tr>
<tr>
<td>Mars 81</td>
<td>270</td>
</tr>
<tr>
<td>Juin 81</td>
<td>600</td>
</tr>
<tr>
<td>Oct.81</td>
<td>455</td>
</tr>
</tbody>
</table>

Un autre type de mesures de terrain est la détermination des taux de croissance de l'herbe, qui évite certains des reproches adressés à l'utilisation des biomasses. Il faut disposer d'une centaine de petites cages destinées à protéger les plots-échantillons au cours de périodes assez courtes (de l'ordre de 2 semaines) pour que la croissance végétale s'y effectue au même rythme qu'aux endroits non protégés. On considère que la production à l'intérieur des cages est assez proche de la productivité nette à l'extérieur pour lui être assimilée.

Mesures indirectes

De très nombreuses méthodes existent, et on peut citer pour mémoire les mesures par densitométrie sur photographies aériennes en noir ou couleur, panchromatique ou infra-rouge; les procédés radiométriques divers: on enregistre au sol, ou en vol à basse altitude, ou à partir d'un satellite, la réponse du milieu dans certaines fréquences d'émission micrométriques; et plus récemment l'analyse des composantes de réflexion du milieu qui demande l'usage d'un ordinateur et dont les deux tendances sont actuellement:
- l'analyse par vecteurs construits dans un espace multidimensionnel à partir des composantes de rayonnement;

- l'analyse multi-temporelle qui compare deux images successives d'une même scène prises à des époques telles que l'inclinaison du soleil soit différente.

Aucun procédé de mesure indirecte des masses végétales n'a encore donné pleinement satisfaction, car le travail présuppose souvent un terrain plat, une végétation homogène sur de vastes espaces (faible définition des documents-satellites) et un accès aisé aux bandes d'enregistrement des mesures, ce qui n'est jamais possible pour les pays d'Afrique tropicale.

En outre, les mesures indirectes ne dispensent pas du travail de terrain nécessaire pour calibrer les données de télédétection, de sorte que les causes d'erreur s'ajoutent et que le résultat final est peu fiable. Les observations aériennes à basse altitude qui clasent les couverts végétaux et la proportion de matériel vert en un petit nombre de catégories, fournissent finalement des informations plus précises et à moindre coût que les procédés les plus sophistiqués.

Utilisation des connaissances et choix du type d'investigation

Le texte qui précède montre en particulier que, si toutes les mesures de changements sont des actions répétitives, les mesures de changements à court terme sont infiniment plus coûteuses et plus contraignantes que celles des évolutions à long terme. Si l'on compare la réalisation d'une étude scientifique complète de base qui fournira dès le départ tous les éléments de connaissances nécessaires pour juger simplement des tendances du milieu (description des séries de végétation), et la seule mesure de la dynamique telle qu'elle vient d'être traitée, on voit aussi que la différence réside surtout dans un étalement dans le temps des efforts et des dépenses pour la seconde approche.

En fait, le choix d'une méthode dépend surtout des possibilités d'investigation et de l'intensité des actions de développement prévues. En cas d'intensification poussée de la production animale, les études les plus complètes sont encore bon marché mais il serait inutile
d'effectuer un suivi des quantités d'aliments disponibles, par exemple, si l'on n'a ensuite aucune possibilité d'intervention sur la gestion du territoire et si l'on ne dispose pas sur le terrain à la fois d'agents techniques compétents, d'une législation qui permette d'agir et de l'infrastructure nécessaire à la mise en place d'une intervention complexe.

En outre, la seule mesure des changements dans le milieu est une activité sectorielle à la suite de laquelle on aura acquis très peu d'informations sur les possibilités de cultures ou de reconversion du système de production. Par contre, le suivi de la dynamique végétale devrait accompagner toute intervention humaine sur les systèmes de production animale, au même titre que le suivi de la production secondaire ou des résultats socio-économiques. Il devrait également être une composante automatique de toute expérimentation pastorale, même lorsque le but de l'expérience est aussi spécifique que l'amélioration génétique d'une race animale ou l'accroissement de la production laitière.
Vegetation trends

English Summary:

To describe vegetation trends presupposes an adequate and clear knowledge of the biological laws applicable to grazed eco-systems and the links within these systems. Merely noting down changes in the vegetation provides no information at all if it is not accompanied by measurements of the various flows within and through the system. The starting point is to distinguish between the various types of vegetation trend.

If the majority of components and flows within the system undergo change, several trends may occur; there can be a permanent reduction in the overall vegetation, or merely in some species, or a transfer of productivity from grass towards ligneous species. Because the overall balance of the system has been disturbed the soil will also be affected; fertility is lost, erosion sets in, or soil development begins again, for a period of 10, 50 or 100 years. The most usual cause of this type of trend is over-utilisation of the system, particularly by domestic animals. Such trends are long-term, wrongly called evolutionary trends simply because they are noticed only after the evolution has taken place, by which time it is too late to take any action.

The classical procedures for describing vegetation assume that work is being carried out on a homogeneous unit and not as is inevitable in the case of production systems studies, on a pastoral management unit the heterogeneity of which is its chief virtue. According to the approach adopted in Kenya any relatively large area subject to a given utilization is considered as the sampling site. The sampling points constitute a permanent network and are arranged in a pattern along a fixed route to be covered during each evaluation. The method uses main transect points and secondary points.

Measurements with this technique offer only an approximation of the vegetation cover. However the results give indications on the distribution of plant species over the area and changes in this distribution and the productive potential of the zone and its variations, in
relation to utilisation of grazing land as well as immediate information on degradation or erosion. Results obtained in Kenya are described.

Short term measurements of change are then described. Changes taking place during the same year are variations in plant biomass. However the measurement of plant biomass cannot be used for any purpose other than for evaluating the quantity of feed on offer. The techniques of hand sampling from small plots are well known. Variations include sampling plots distributed at random within a specific plant formation, deliberately biased sampling and a mixture of actual measurements and estimates. Another type of field measurement is determination of the grass growth rate.

Indirect measurements include densitometer measurements made from black-and-white, panchromatic or infra-red aerial photographs by which the response of vegetation in certain short-band wavelengths is measured on the ground, by low level survey or by satellite. A new method is that of computer analysis of the reflectivity of vegetation. No indirect method of measurement has so far proved satisfactory. Indirect measurements do not preclude the field work necessary for calibrating remote sensing data, and as a result the sources of error accumulate and the final result is unreliable. Low level aerial survey, classifying vegetation and the proportion of green matter into a few broad categories, provides more accurate and cheaper data than the more sophisticated methods.

Measurements of change in the short term are far more costly and cumbersome than those over the long term. The choice of method depends primarily on what is feasible and the intensity of the development effort planned. Measurement of change in the vegetation by itself is a disciplinary activity. It provides very little information on the possibilities of growing crops or on ways of transforming the production system. On the other hand, the monitoring of vegetation dynamics should accompany any human intervention in an animal production system, just as the monitoring of secondary production or of the socio-economic results should do. It should also be automatically a component of every pastoral research project, even when the purpose of research is as specific as the genetic improvement of an animal breed or an increase in milk production.
Summary of Discussion Session 3.
Chairman: Dr Cees de Haan (ILCA)
Discussion led by Dr Ibrahim Gueye (SODESP, Senegal)

Dr Diakite pointed out that there was often a problem of transferring research information to extension workers and herdsmen because of the difficult language often used to describe research. Dr Nestel warned that one shouldn't fault ecologists and forage scientists for conducting elegant research in their own field of specialisation - that was their role in a systems research team. One had to determine at what stage one brought in social scientists to question the likely benefit, if any, to be gained from pursuing a particular line of research.

Dr Akilu stressed that rangeland management had social, socio-economic and political implications. Researchers and extension workers couldn't solve these problems on their own. There was a need to involve the politicians to decide on policies conforming to the aspirations of herdsmen.

Dr Thomson asked if one always needed to do experiments on a research station - could one not go directly to the producer and do on-farm trials. Often there was a wealth of information on technologies which aimed to solve some of the obstacles facing producers, which were identified during the diagnostic phase. Did one need to repeat this work? Dr de Haan said this depended on the situation - sometimes one could leave out the experimental phase and go directly to the producer, but sometimes one could not.

Dr Ngutter pointed out that work by vegetation/forage ecologists was often not useful to the development planner unless such information could help in determining the technical trade-offs possible between, say, smallstock and large stock on a given range with a given botanic composition, without affecting the botanic composition in an undesirable way.
Dr Zulberti asked Dr Hiernaux if the bi-weekly or four-weekly grazing systems mentioned in his paper could be applied or recommended in areas where the annual variation in rain was 50% to 200% of the mean and when pastoralists moved from area to area according to the availability of pasture. Could not research on rotation be more oriented to these conditions? Dr Hiernaux said that the proposals for rotational grazing concerned the pastures of the entire Niger delta, the productivity of which was high. The proposals were based on results obtained on experimental sites. Trials were currently underway in the field to test the relevance of these techniques to the existing pastoral system.

Dr Barry pointed out that an understanding of the natural resources entering into animal feed was important for maintaining the ecological equilibrium, often highly fragile, in the Sahel countries. Pastoral people and their herds were in a delicate situation due to variability in rainfall, expansion of cash cropping and traditional husbandry methods. Inventories of natural resources needed to be applied to the real situation of pastoral people - thus one should consider socio-economic factors. The problem was how to get these people to adopt their knowledge of rangeland management in the light of long periods of drought and considerable variation in rainfall.
Résumé des débats de la troisième séance

Président: Cees de Haan (CIPEA)
Débats dirigés par le Dr Ibrahim Guèye (SODESP, Sénégal)

Le Dr Diakité a souligné qu'il se posait souvent des problèmes de transfert des données de recherche aux vulgarisateurs et aux éleveurs à cause de la difficulté du langage souvent utilisé pour décrire la recherche. M. Nestel a déclaré qu'il ne fallait pas blâmer les écologistes et les agrostologues à cause des travaux complexes qu'ils effectuaient dans leur domaine de spécialisation, ce qui correspondait à leur rôle au sein d'une équipe de recherche sur les systèmes. Il fallait déterminer le niveau auquel il fallait faire intervenir les spécialistes des sciences sociales pour se pencher sur les avantages éventuels, si tant est qu'il y en ait, à tirer de la mise en œuvre d'une voie de recherche particulière.

Le Dr Akilu a souligné que la gestion des parcours comportait des effets socio-économiques et politiques. Les chercheurs et les vulgarisateurs ne pouvaient pas tout seuls résoudre ces problèmes. Il fallait l'intervention des politiciens pour prendre des décisions conformes aux aspirations des éleveurs.

M. Thomson a demandé si l'on avait toujours besoin de mener les expériences sur une station de recherche; ne pouvait-on pas aller directement aux producteurs et effectuer des essais au niveau des exploitations agricoles? Il y avait souvent des informations abondantes sur les techniques qui visent à résoudre certains des problèmes auxquels les producteurs ont à faire face. Celles-ci avaient été rassemblées au cours de la phase de diagnostic. Était-il nécessaire de refaire ces travaux? M. de Haan a déclaré que cela dépendait de la situation. Quelquefois, on pouvait sauter la phase expérimentale et aller directement aux producteurs, mais d'autres fois, cela n'était pas possible.

Le Dr Ngutter a souligné que les travaux entrepris par les écologistes sur la végétation et sur les fourrages n'étaient très souvent pas utiles pour le planificateur du développement à moins que de telles
informations puissent aider celui-ci à déterminer les avantages techniques éventuels qu'il y a par exemple à éléver du petit bétail au lieu de grands animaux ou vice-versa sur un parcours déterminé, avec une composition botanique donnée, sans affecter de manière négative la composition botanique.

Le Dr Zulberti a demandé à M. Hiernaux si les systèmes de pâture bi-hebdomadaire ou quadri-hebdomadaire mentionnés dans son étude pouvaient être appliqués ou recommandés dans des zones où la variation annuelle de la pluviométrie était de 50 à 200% de la moyenne et lorsque les éleveurs se déplaçaient d'une zone à l'autre en fonction de la disponibilité des pâturages. La recherche sur les pâturages tournants ne pouvait-elle pas être mieux orientée vers l'étude de telles situations? M. Hiernaux a déclaré que les propositions de pâturages tournants concernaient les pâturages de l'ensemble du delta du Niger dont la productivité était élevée. Ces propositions étaient basées sur les résultats obtenus sur les sites expérimentaux. Des essais étaient en cours sur le terrain pour tester l'applicabilité de ces techniques au système pastoral existant.

Le Dr Barry a souligné que la connaissance des ressources naturelles entrant dans l'affouragement de l'animal était importante pour le maintien de l'équilibre écologique souvent très fragile dans les pays du Sahel. Les peuples pastoraux et leurs troupeaux étaient dans une situation précaire en raison de la variabilité de la pluviométrie, de l'expansion des cultures commerciales et des méthodes d'élevage traditionnelles. L'inventaire des ressources naturelles devait s'appliquer à la situation réelle des populations pastorales; ainsi les facteurs socio-économiques devaient être pris en considération. Le problème était de savoir comment amener ces populations à repenser leurs méthodes de gestion des parcours à la lumière des longues périodes de sécheresse et des variations considérables de la pluviométrie.
Livestock productivity and management

R. Trevor Wilson\textsuperscript{1} and P. Semenye\textsuperscript{2}

\textsuperscript{1}Team Leader, Arid Zones (West Africa) Programme, ILCA Mali

\textsuperscript{2}Animal Scientist, Arid Zones (Eastern and Southern Africa) Programme, ILCA, Kenya.

Introduction

Effective and realistic planning for total development in Third World areas requires not only that baseline data be obtained relating to the existing situation but also that future trends are predicted with a reasonable degree of accuracy. While it is possible for economists to derive output figures using a variety of methods for "with project" situations it is usually the "without project" and the "base" situation which are suspect, as often the base utilised is little better than an educated guess.

Of all the elements utilised for the formulation of an integrated development plan it has normally been the livestock sub-sector which has been the weakest link. Perhaps there have been good - even almost valid - reasons for this. The traditional reluctance of pastoralists and livestock owners in general to enumerate, or to have enumerated, their animals and the mobile nature of the assets in question have made accurate or even reasonably approximate estimations of total numbers almost impossible to obtain. Indirect methods of estimation such as those based on returns for tax, marketed output, sales of hides and skins are also notoriously inefficient. Aerial surveys have to some extent alleviated this problem but is not only at the population or regional level that errors are apparent: parameters at the level of the herd and of individual animals have also been generally unknown. In the latter case, estimates of production - birth and death rates, growth, offtake - have been based on factors derived from usually non-comparable situations in more developed economies or data from experimental or livestock breeding.
units where management for "improvement" of local breeds (usually by
crossing with exotic, i.e. highly specialised and non-adapted stock)
takes place.

In recent years methods have been developed for the more
realistic estimation of livestock parameters in traditional systems.
These relate to estimates of total livestock in a given area as well
as to the determination of individual and herd production character-
istics. By combining the two sets of data, precise figures for the
total livestock output of an area can be derived, with known
confidence limits. Once this point has been reached it is feasible
to manipulate the data for predictive purposes, taking into account
natural factors such as rainfall variability and effects of disease
and anthropogenic factors such as responses to market stimuli and
improved veterinary control.

Evolution of survey methodology

Low-level aerial surveys are particularly suitable for the enumeration
of total animal numbers related to both time and space. Sequential
surveys at fixed or varying intervals can be used to establish short-
term changes in livestock numbers, trends in total effective size of
the herd and seasonal or longer-term movement patterns.

The method is particularly suitable for the determination
of total animal numbers and, provided a series of flights over time
is flown, can also be used to establish the gross dynamics of an
animal population. It is not possible to obtain precise data on
recruitment (birth) and mortality rates from aerial surveys, nor is
it possible to establish population structure or sex ratios with
any accuracy—although in early surveys attempts at this were made
using size criteria based on photographic samples. Thus for estab-
lishment of population dynamics and demography, as well as for
individual growth rates, production parameters for meat and milk
production and levels of offtake, some sort of ground survey is
necessary.

Until the early 1970s livestock production data for
traditional societies were almost invariably based on the work of
anthropologists and sociologists whose main interests were outside
the field of livestock production. Otherwise data have been compiled, often by economists who themselves have usually had little experience of livestock production, from questionnaire surveys. In general it can be considered that both socio-anthropological and formal questionnaire methods provide too little and too inaccurate data of the kind required to established livestock population and production parameters. There are exceptions, however, some of these types being adequate for certain data: the good ones generally result from the quality and knowledge of the observer rather than from the raw information given. In addition (but perhaps to a decreasing extent as social and educational horizons expand) formal questionnaires may induce a response block in the more conservative pastoral societies. There is no substitute for physical inspection - and physical contact with - as large a number of animals as possible. Once the livestock owner realizes that the researcher has a real interest in (and an ability with !) the animals, then considerable information, as opposed to the "data" of an elicited response caused by a questionnaire, is usually forthcoming.

Thus, some years ago, attempts were made to establish a "zootechnical" method of survey which would provide data of the kind and of the accuracy required for detailed development planning. The method, which is described fully in the next section, was primarily designed for use with cattle, sheep and goats. It has also been used in camel and donkey studies. Integrated development plans for several semi-arid areas in northeast Africa have been formulated using livestock data from these studies. These include plans for Darfur in western Sudan in which livestock data were obtained from transhumant Baqqara Arabs and indigenous sedentary cultivators; and for Tigre in northern Ethiopia with data from short-cycle transhumant Afar in the Rift Valley and sedentary Tigrean cultivators on the Ethiopian Plateau. In West Africa a study of agropastoral systems forming part of the ILCA semi-arid and arid programme used data obtained from transhumant Fulani and sedentary Bambara cultivators in central Mali. Further studies forming part of the ILCA subhumid and humid programme and of their monitoring programme are under way in Nigeria and Kenya respectively.
The ground survey

Three levels or depths of intensity of survey can be recognized:

1. pre-survey
2. initial survey
3. continued survey

The ultimate level of survey will depend on the kind of information required and the use to which the data will be put. It should be noted, however, that it is a prerequisite of the method that the earlier stages must be carried out. It may be possible to telescope a continued survey either with one or with both earlier survey stages but usually some initial work will need to be done.

Pre-survey

A knowledge of the natural environment, the social groups and the general pattern of livestock distribution and ownership is fundamental to any further survey. Initial stratification can be carried out using LANDSAT imagery and (if an integrated aerial/ground survey is envisaged) aerial reconnaissance. Some time, however, must be spent on the ground in all parts of the survey area, preferably as part of a multi-disciplinary team. This should comprise at least the animal scientist, a range ecologist and a social anthropologist or socio-economist. Unless one of these is thoroughly familiar with the area in question and/or the local language a guide/interpreter will be required and in any case may be desirable or necessary for political reasons.

During this phase it should be possible to select representative areas and representative villages or other units for the initial survey stage. An outline of the subsequent stages should also be given to the probable participating units.

If an aerial census to determine total numbers is not to form part of the subsequent stages of survey then available statistical data should be collected at this point. In any case such data may well be useful for comparative purposes and also may help to establish household and individual ownership patterns. Market and slaughterhouse figures also need to be collected.
At this point, however, we think it would be useful to illustrate some of the problems which are inherent in the published data relating to these aspects. The FAO Production Yearbooks are the most commonly quoted source for livestock numbers. These rely to a considerable extent on national authorities for their data, although they often make adjustments. They give little idea, unfortunately, of the distribution of animals within countries and among people in these countries. Some preliminary work may well be required to determine the importance of livestock in the area being studied — not simply in terms of numbers but in the contribution of livestock to the overall economy. ILCA is using a classification of "pastoral" for people obtaining more than 50% of their gross income from livestock and "agropastoral" for those obtaining between 10% and 50% from animals. Another problem is the continuing lack of importance attached to small ruminants by national authorities and development agencies. Yet in the seven countries which occupy the semi-arid belt of northern tropical Africa from the Atlantic to the Red Sea, sheep and goats together account for 15.5% of the standing domestic ruminant biomass. This is shown in Table 1 which also includes figures for Kenya. In some statistics small ruminants are virtually ignored altogether and we can quote here the Office du Niger in Mali which, as Table 2 which is taken from the census records shows, indicated only 12.0% of families owning goats. The real situation (Table 3) is very different and this table also shows another aspect, not evident in Table 1 except for Niger and Kenya: in the semi-arid zones, particularly in the agropastoral areas, goats are generally of much more importance than sheep numerically and, on account of their potential birth rate, are probably creating an ever widening gap. Ownership patterns and flock sizes are one aspect that would be useful for us to look into during the field studies.
<table>
<thead>
<tr>
<th>Country</th>
<th>No. of sheep &amp; goats (000 head)</th>
<th>Ratio: No. of sheep to one goat</th>
<th>Number of sheep &amp; goats per inhabitant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senegal</td>
<td>2.805</td>
<td>1.95</td>
<td>0.73</td>
</tr>
<tr>
<td>Mauritania</td>
<td>8.200</td>
<td>1.56</td>
<td>6.41</td>
</tr>
<tr>
<td>Mali</td>
<td>11.478</td>
<td>1.04</td>
<td>2.13</td>
</tr>
<tr>
<td>Niger</td>
<td>9.360</td>
<td>0.40</td>
<td>2.10</td>
</tr>
<tr>
<td>Chad</td>
<td>4.508</td>
<td>1.00</td>
<td>2.17</td>
</tr>
<tr>
<td>Sudan</td>
<td>27.644</td>
<td>1.31</td>
<td>2.13</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>40.270</td>
<td>1.35</td>
<td>0.90</td>
</tr>
<tr>
<td>Kenya</td>
<td>8.395</td>
<td>0.90</td>
<td>0.73</td>
</tr>
<tr>
<td>TOTAL</td>
<td>112.805</td>
<td>1.16</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Biomass of sheep & goats as % of total:

<table>
<thead>
<tr>
<th>Country</th>
<th>Biomass of sheep &amp; goats as % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senegal</td>
<td>12.2</td>
</tr>
<tr>
<td>Mauritania</td>
<td>28.2</td>
</tr>
<tr>
<td>Mali</td>
<td>22.8</td>
</tr>
<tr>
<td>Niger</td>
<td>21.7</td>
</tr>
<tr>
<td>Chad</td>
<td>10.2</td>
</tr>
<tr>
<td>Sudan</td>
<td>14.7</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>14.4</td>
</tr>
<tr>
<td>Kenya</td>
<td>8.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14.7</td>
</tr>
</tbody>
</table>

Table 1. The importance of sheep and goats in selected African countries.
Table 2. Livestock holding according to official statistics in a sample of villages in both millet and rice subsystems in the central Mali agropastoral system

<table>
<thead>
<tr>
<th>Subsystem/village (No of households)</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>Donkeys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% owning</td>
<td>range in numbers</td>
<td>% owning</td>
<td>range in numbers</td>
</tr>
<tr>
<td>Pogo (62)</td>
<td>71.6</td>
<td>1-70</td>
<td>70.0</td>
<td>1-50</td>
</tr>
<tr>
<td>Kamono (10)</td>
<td>100.0</td>
<td>1-50</td>
<td>90.0</td>
<td>5-60</td>
</tr>
<tr>
<td>Sissako (33)</td>
<td>75.8</td>
<td>1-40</td>
<td>81.8</td>
<td>3-20</td>
</tr>
<tr>
<td>Teninaana (29)</td>
<td>72.4</td>
<td>2-30</td>
<td>72.4</td>
<td>5-55</td>
</tr>
<tr>
<td>Siguine (21)</td>
<td>80.9</td>
<td>1-25</td>
<td>85.7</td>
<td>2-35</td>
</tr>
<tr>
<td>Thing (40)</td>
<td>75.0</td>
<td>1-50</td>
<td>77.5</td>
<td>2-66</td>
</tr>
<tr>
<td>Siraouma (26)</td>
<td>96.2</td>
<td>1-12</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>N'Debugou (114)</td>
<td>53.5</td>
<td>2-30</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>Ntile (62)</td>
<td>38.7</td>
<td>2-22</td>
<td>3.2</td>
<td>2</td>
</tr>
<tr>
<td>Bamada (39)</td>
<td>23.1</td>
<td>1-14</td>
<td>5.1</td>
<td>2-8</td>
</tr>
<tr>
<td>N6 (35)</td>
<td>85.7</td>
<td>2-140</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>N9 (72)</td>
<td>63.9</td>
<td>2-40</td>
<td>1.4</td>
<td>5</td>
</tr>
<tr>
<td>N5 (27)</td>
<td>85.2</td>
<td>2-50</td>
<td>21.7</td>
<td>2-10</td>
</tr>
<tr>
<td>N10 (53)</td>
<td>83.0</td>
<td>1-38</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>B1 (55)</td>
<td>96.4</td>
<td>1-39</td>
<td>7.3</td>
<td>1-3</td>
</tr>
<tr>
<td>B6 (39)</td>
<td>89.7</td>
<td>1-15</td>
<td>33.3</td>
<td>1-8</td>
</tr>
</tbody>
</table>

1) Nil holding excluded for all species.
2) Millet subsystem from Administrative census
3) Rice subsystem from Office du Niger census
Table 3. Ownership patterns of sheep and goats in an agropastoral area in central Mali

<table>
<thead>
<tr>
<th></th>
<th>Irrigated rice subsystem</th>
<th>Rainfed millet subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goats</td>
<td>Sheep</td>
</tr>
<tr>
<td>Number of owners</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>Number owning sheep or goats</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Number owning goats but no sheep</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Number owning sheep but no goats</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mean flock size&lt;sup&gt;1&lt;/sup&gt;</td>
<td>9.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Mean flock size&lt;sup&gt;2&lt;/sup&gt;</td>
<td>9.3</td>
<td>11.5</td>
</tr>
<tr>
<td>Range in flock size</td>
<td>0-23</td>
<td>0-64</td>
</tr>
</tbody>
</table>

<sup>1</sup>Of all owners, i.e. irrespective of whether the holding of one species is nil.

<sup>2</sup>Of only those flocks in which animals are held, i.e. nil holding excluded.

Initial survey

This stage is designed primarily to provide data on population structure and individual animal growth rates. From these parameters it is possible to postulate instantaneous individual and flock output without any additional knowledge of birth rate, death rate or actual levels of offtake. Indeed some of these parameters may be deduced from the population structure at least as accurately as they can be extrapolated from questionnaires.

Large numbers of each animal species are required to establish realistic population means with a sufficient level of reliability. In real terms this will probably involve not less than 1,000 head of each species (in Darfur data were collected in this phase for 5,600 cattle, 1,900 goats and 1,200 sheep and in central Mali almost 10,000 smallstock were involved). Population classes based on dentition - 4 pairs incisors worn, 4,3,2,1 pairs incisors
and milk teeth - while subject to some reservations, are likely to provide data on demography just as valuable as can be obtained using the more or less subjective ages in years given by most owners. For the class of milk teeth some reasonably accurate age indications of younger animals can be expected and can, with experience, be utilised in conjunction with tooth growth and wear to establish sub-groups within this class.

Fig. 1 shows the kind of population data which can be obtained using a questionnaire technique (this one was done in Tchad) compared with that obtainable from a "handling and mouthing" exercise (this was done in Mali) and relates to sheep. Fig. 2 shows data for cattle at two extremes of the range of systems likely to be encountered in the traditional sector, both these being obtained by the latter method. We think it probable that for Mali we have sufficient population data of this kind but it may be worthwhile doing some demographic work in other countries. What might be useful in Mali in the rice subsystem of the agropastoral sector would be to compare the percentage of work oxen in large herds with those in smaller ones.

Sample selection within the broader ecological/social strata established during the pre-survey poses some problems. A frame suitable for randomisation of the sample is unlikely to exist given the differences which will probably be found in ownership patterns and flock sizes. Some subjectivity might need to be accepted, after the primary stratification governing locality and group size has been adequately taken into consideration. A representative sample should be the aim.

At this stage considerable additional information on the animals may be obtained at little extra cost. In all cases this might include details of external morphology: such physical data may have little direct relevance to the primary objectives of the study but nevertheless may well provide useful comparisons, particularly as existing descriptions of African livestock, and especially of small-stock, are generally inadequate and often of considerable antiquity. In some cases, and certainly where a continued survey is not envisaged, it is worthwhile attempting to obtain individual reproductive his-
Fig 1. Population demography of Sahelian smallstock
Sedentary associated with irrigated rice - Mali

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS</td>
<td>62.8%</td>
<td>37.2%</td>
</tr>
</tbody>
</table>

Transhumant + sendentary associated with rainfed millet - Sudan

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS</td>
<td>31.2%</td>
<td>68.8%</td>
</tr>
</tbody>
</table>

Fig 2. Sex and age composition of the three principal domestic species presented for slaughter at Niono
Stories of breeding females: if such data can be obtained then it is possible to calculate such parameters as birth rate, frequencies of multiple births and parturition histories.

Tables 4 and 5 illustrate the kind of information which can be compiled with a lot of perseverance and not a little luck. Where a continued survey is expected these latter parameters are probably of too tenuous a nature to be worth the investment in time required at this stage.

Table 4. Data on kidding for 42 flocks of sedentary goats in the Niono area (calculated from initial survey)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>4 pairs incisors</th>
<th>3 pairs incisors</th>
<th>2 pairs incisors</th>
<th>1 pair incisors</th>
<th>Milk teeth</th>
<th>All goats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number in sample</td>
<td>180</td>
<td>77</td>
<td>61</td>
<td>111</td>
<td>15</td>
<td>444</td>
</tr>
<tr>
<td>Type of birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triplet</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twin</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total births</td>
<td>88</td>
<td>150</td>
<td>85</td>
<td>78</td>
<td>5</td>
<td>986</td>
</tr>
<tr>
<td>Total kids born</td>
<td>887</td>
<td>161</td>
<td>89</td>
<td>79</td>
<td>5</td>
<td>1221</td>
</tr>
<tr>
<td>Average litter size</td>
<td>1.33</td>
<td>1.07</td>
<td>1.05</td>
<td>1.01</td>
<td>1.00</td>
<td>1.24</td>
</tr>
<tr>
<td>Parturitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.71</td>
<td>1.95</td>
<td>1.39</td>
<td>0.70</td>
<td>0.33</td>
<td>2.22</td>
</tr>
<tr>
<td>Mode</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Range</td>
<td>0 - 10</td>
<td>0 - 5</td>
<td>0 - 3</td>
<td>0 - 1</td>
<td>0 - 1</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

- 162 -
Table 5. Number of parturitions per breeding cow for sedentary cattle in the Mopti area (from initial type survey)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Number of calves</th>
<th>Total Cows</th>
<th>Total Calves</th>
<th>Number of cow reproductive years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 1 2 3 4 5 6 7+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>197</td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>180</td>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>205 1</td>
<td>206</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>145 27 1</td>
<td>173</td>
<td>29</td>
<td>86.5</td>
</tr>
<tr>
<td>4-5</td>
<td>28 95 14</td>
<td>137</td>
<td>123</td>
<td>205.5</td>
</tr>
<tr>
<td>5-6</td>
<td>12 56 43 2 2</td>
<td>115</td>
<td>156</td>
<td>287.5</td>
</tr>
<tr>
<td>6-7</td>
<td>6 23 51 19 1</td>
<td>100</td>
<td>186</td>
<td>350.0</td>
</tr>
<tr>
<td>7-8</td>
<td>2 3 18 20 31</td>
<td>74</td>
<td>223</td>
<td>333.0</td>
</tr>
<tr>
<td>8-9</td>
<td>1 7 8 6 4</td>
<td>26</td>
<td>83</td>
<td>143.0</td>
</tr>
<tr>
<td>9-10</td>
<td>1 2 7 18 7 3</td>
<td>38</td>
<td>150</td>
<td>247.0</td>
</tr>
<tr>
<td>10+</td>
<td>1 1 3 1</td>
<td>6</td>
<td>23</td>
<td>45.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>777 206 136 57 61 11 3 1</td>
<td>1252</td>
<td>974</td>
<td>1697.5</td>
</tr>
</tbody>
</table>
In addition to normal help from the livestock owners a team composed of the animal scientist and a recorder is the minimum required. Providing there is a degree of confidence between these two, that both are aware of the descriptive "shorthand" being used and both understand the principal language of communication within the studied community, good results can be expected. Up to 300 head of smallstock or 80-100 cattle can be processed in a five-hour session.

A complete "initial survey" of this type might be expected to take about six to eight man-months occupying a time span of four to six months including full data analysis and report completion.

Continued survey

The continued survey is designed to provide full and reliable data over the whole range of production parameters. These include birth, death and offtake rate (the latter by components such as sales, gifts, ritual and emergency slaughter), individual weight gains by season and year, meat and milk production and flock dynamics. Individual identification of animals is necessary. The most convenient method from the point of view of the survey is by coloured and numbered plastic ear tags. The application of these can be expected to create some consternation and initial resistance in most societies, but this has so far not proved too difficult to overcome. It does again, however, condition sample selection and the aim should be a representation of the generality of the areas. A minimum of ten units for each species should be aimed at with not less than 300 animals of each species being recorded initially. Very small units and atypically large ones should be avoided. If the latter are selected they may lead to inaccurate estimate of offtake, particularly if they are operated on a commercial rather than a subsistence basis and if the study is aimed at establishing production and identifying constraints in the traditional sector.

At this first visit when each animal is identified, as much information as possible on its physical characteristics and its relationships to other animals in the unit should be obtained. All this information should be transferred subsequently to the back of an individual record card.
Recently we have analysed here in Addis Ababa, with the aid of the ILCA computer, some three and a half years' data for Mali and about two and half years' data for Kenya. Data from the highlands programme and from the programme in Nigeria have also been, or are in the process of being, analysed. So we now have considerable expertise in field data collection and analysis of results including programmes for analysis and modelling.

Physical and family relationship data enable positive identification to be made should ear tags become accidentally lost; family data are also useful in establishing the most prolific and productive blood lines.

Subsequent visits need to be made at fairly short intervals (two weeks or less) in the early stages of this phase. All events in the flock in the intervening interval should be recorded and subsequently entered on the individual card. Newborn animals need to be identified, cross-referenced to their dams and weighed: relevant details should be entered on the dam's card and on a new card for the young.

A canvas sling suspended from a spring balance of the dial type is suitable for weighing smallstock but some kind of crush and weighbridge will be needed for cattle. A crush is also required for adult horses but a suitable sling and a 200 kg dial can be used for donkeys and foals. Camel weighing poses problems and undoubtedly requires some ingenuity (in the Darfur studies "live" weights were established post-mortem in concurrent slaughterhouse studies). We were able to arrive at a formula for estimating the weight of camels and there is another one available. These are given in Fig 3.
\[ P = 53 \text{ TAH} \]

where \( P \) = Weight in kilograms

\( T \) = Girth behind the breast pad

\( A \) = Abdominal girth over the hump in metres

\( H \) = Shoulder height

\[ Y = 5.071 \times X - 457 \]

where \( Y \) = Weight in kilograms

\( X \) = Girth in front of breast pad in centimetres

(best taken with camel in squatting position)

Fig 3. *Estimation of camel weight from linear measurements.*

The main problems in the early period of this stage are associated with getting the livestock owner to appreciate the need for full reports of all events. Outgoings in which the tag is returned to the recorder are less of a problem than incomings. The principal deficits in the latter respect are failure to report deaths of newborn animals in which both birth and death have occurred between visits; failure to report stillbirths or abortions; and failure to report deaths of one or more siblings of multiple births. It is not necessary to check every animal physically at each visit but whole unit checks need to be carried out at regular intervals to identify any discrepancies.

Once some confidence in the ability of both the researcher and the owner to record and report all events has been achieved, the frequency of visits can be reduced to something between four and six weeks. Longer intervals may be acceptable where there is some literacy in the group being studied and where a group member undertakes to record data.
In order to achieve worthwhile and reliable results which can be used for productive purposes or as aids to biotechnical innovation this type of study should take a minimum of three years. Such a period would minimize seasonal effects in the results other than in exceptional cases. Normally, some useful indications of production parameters would be forthcoming after the first 12 to 18 months.

A programme involving the three main species of domestic livestock in 30 units totalling 1000 head in the region could be expected to occupy a technician more or less full time, with supervisory scientific and analytical work including report writing, in the region of three man-months per year.

A comparison of some results from initial and continued surveys

In both Kenya and Mali in 1978 we carried out initial surveys of the type described here with the intention in both countries of going on to continued surveys. How much and what kind of information have we obtained from the latter and how does it differ from that obtained in the former?

For population structure the initial survey obviously is the definitive one as we generally use much larger numbers of animals. We have already had some examples of this in Figs 1 and 2 and we have tried to indicate how population structure is affected by management objectives.

We have also said that for establishing weight or growth curves the initial survey can be satisfactory. This is true, however, only for certain limited objectives, for example to find a generalised growth curve and mature average weights. Fig. 4 shows direct comparisons for Mali for initial and continued surveys for sheep and goats from birth to 18 months. There is quite a lot of correspondence but also some divergences. The main problems are at the older end of this age range where, either the ages in the initial survey were underestimated, or they were weighed at a time of the year which was particularly favourable to them. What Fig. 4 cannot show, and what can only be obtained from a continued survey, is a breakdown of weights by type of birth and parity. With a continued survey we can
Fig 4. A comparison of growth curves for the same population when estimated from a single survey and calculated from long-term data.
also have weight curves by season of birth among other things. Initial surveys do not give seasonal weight variations either: an example of these for cattle, using the same age classes by dentition that we might use in an initial survey, is given in Fig 5. This shows the magnitude of seasonal weight changes indicating the main stress points, and where, for example, supplementary feeding needs to be considered and to what classes of stock it should be given. Continued surveys can also give a much better idea of the variations in weight for age as shown in Fig 6.

Turning to reproductive traits, we saw in Table 4, taken from an initial survey, the kind of data it is possible to extract. Comparing tables 4 and 6 it can be seen that one reproductive trait is fairly close for the goat in both surveys - the average litter size. We also came very close, at 1.06, for sheep in the initial survey although, as we have implied earlier, we think we were lucky. What the initial survey will not tell us is the age at first parturition (although we can get some idea of this from dentition/parturition data), the parturition interval or the distribution or parturition intervals in relation to parity. The continued survey will show us this, as can be seen from Figs 7 and 8; Fig. 7 also shows the increase in litter size with parity, something which can be deduced but with less accuracy from an initial survey as table 4 illustrates.

One of the principal drawbacks of an initial survey is the lack of any firm data on deaths and offtake. Again it is possible to compile some figures from population structure and individual breeding female histories - total animals born, now in flock, died, sold etc., but these are subject to considerable errors of recall. A continued survey enables us to establish precise figures for these parameters.
Fig 5. *Seasonal weight changes in cattle*
Fig 6. Computer scattergram of individual weights and calculated growth curve for a sheep population
Table 6. *Some reproductive parameters for sedentary sheep and goats in the Niono area*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Age at first parturition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (days)</td>
<td>470.5</td>
<td>484.4</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>90.5</td>
<td>105.5</td>
</tr>
<tr>
<td>Range</td>
<td>341–673</td>
<td>275–739</td>
</tr>
<tr>
<td>Number in sample</td>
<td>52</td>
<td>54</td>
</tr>
<tr>
<td><strong>B. Interval between successive births</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval (days)</td>
<td>253.9</td>
<td>271.3</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>69.1</td>
<td>79.5</td>
</tr>
<tr>
<td>Range</td>
<td>150–491</td>
<td>156–638</td>
</tr>
<tr>
<td>Number in sample</td>
<td>225</td>
<td>280</td>
</tr>
<tr>
<td><strong>C. Multiple births: litter size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Number (%) of parturitions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>557 (100.0)</td>
<td>668 (100.0)</td>
</tr>
<tr>
<td>Twin</td>
<td>528 (94.8)</td>
<td>521 (78.0)</td>
</tr>
<tr>
<td>Triplet</td>
<td>28 (5.0)</td>
<td>144 (21.6)</td>
</tr>
<tr>
<td>Number of young</td>
<td>587 (100.0)</td>
<td>818 (100.0)</td>
</tr>
<tr>
<td>II. Number (%) of young</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>528 (89.9)</td>
<td>512 (63.7)</td>
</tr>
<tr>
<td>Twin</td>
<td>56 (9.5)</td>
<td>288 (35.2)</td>
</tr>
<tr>
<td>Triplet</td>
<td>3 (0.5)</td>
<td>9 (0.1)</td>
</tr>
<tr>
<td>III. Average litter size (II/I)</td>
<td>1.054</td>
<td>1.225</td>
</tr>
<tr>
<td>D. Number of young per annum (CII x 365)</td>
<td>1.52</td>
<td>1.62</td>
</tr>
</tbody>
</table>

Note: Calculated from data obtained over 3 years of ILCA continued surveys.
Fig 7. Components of small ruminant annual reproduction rate
Fig 8. Distribution of parturition intervals and ages at first parturition for sheep and goats.
The great advantage of the continued survey is its preciseness and the opportunity it provides to calculate and utilise statistically significant values. The combination of various parameters such as the birth rate (a function of parturition interval and litter size), death rates, weights of females and young at weaning enable us to calculate certain production indices. These are extremely useful for determining the effect of management, biological and economic factors on production. Table 7 shows the differences which can arise between, for example, species and also between sexes, parities, seasons, flocks and so on. These factors then indicate, by their magnitude, their relevance and their importance in any proposals for improving livestock production. Fig 9 illustrates a possible improvement pathway for small ruminants. It has the initial advantage of costing very little in financial terms and should provide real benefits in a comparatively short space of time.

Table 7. Ratios of comparative advantages for sources of variation in indices I, II and III in the agropastoral system

<table>
<thead>
<tr>
<th>Source</th>
<th>Index I</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Goats</td>
<td>Sheep</td>
<td>Goats</td>
<td>Sheep</td>
<td>Goats</td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>males to females</td>
<td>1.08</td>
<td>1.05</td>
<td>1.04</td>
<td>1.03</td>
<td>1.03</td>
<td>1.05</td>
</tr>
<tr>
<td>Parity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>all parities to first</td>
<td>1.54</td>
<td>1.29</td>
<td>1.42</td>
<td>1.25</td>
<td>1.40</td>
<td>1.23</td>
</tr>
<tr>
<td>Birth type:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>twin to singles</td>
<td>1.37</td>
<td>1.23</td>
<td>1.48</td>
<td>1.45</td>
<td>1.55</td>
<td>1.43</td>
</tr>
<tr>
<td>Season:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>best to worst</td>
<td>1.17</td>
<td>1.11</td>
<td>1.26</td>
<td>1.16</td>
<td>1.23</td>
<td>1.14</td>
</tr>
<tr>
<td>System:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rice to millet</td>
<td>1.82</td>
<td>1.45</td>
<td>1.53</td>
<td>1.31</td>
<td>1.58</td>
<td>1.33</td>
</tr>
<tr>
<td>Flocks:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>millet best to worst</td>
<td>2.17</td>
<td>2.62</td>
<td></td>
<td></td>
<td>2.43</td>
<td></td>
</tr>
<tr>
<td>rice best to worst</td>
<td>9.34</td>
<td>5.30</td>
<td></td>
<td></td>
<td>5.58</td>
<td></td>
</tr>
</tbody>
</table>
Identify best flocks in both sub-systems and determine management factors governing output

Preach and practise improved management in all flocks

Isolate local strains of epidemic diseases (e.g. pasteurella), prepare autovaccines and conduct mass campaigns

Selection within flocks of best individual males (growth rate) and twins for breeding

Institute seasonal breeding if worthwhile advantage can be demonstrated from this practice at this stage

Further improvement in management (flock stratification) to delay age at first parturition and to prevent parturitions occurring at intervals of less than 240 days

Veterinary treatment against external (and external) parasites

Manipulation of flock structures (culling of old females and sale of surplus young females) to obtain maximum production of young (parturition internal + litter size)

Study possibilities of transfer of rice sub-system benefits (water, crop residues, and by-products) to millet sub-system

Fig 9. Interventions pathways for small ruminants in the agro-pastoral system
Additional notes on weight and milk recordings

Livestock weighing

Weighing just after daylight on each weighing day is comparatively easy on the animals and holds variation to a minimum. Weighing of cattle later than the time they are usually released from their night enclosure causes a lot of commotion, and should be avoided. Also to be avoided is weighing when animals are coming back for the night after grazing the whole day or soon after drinking water. However, there are situations, as in Kenya, where calves are weighed in the evenings in an effort to spread livestock activities throughout the day. Calves in this case are weighed late in the evenings, because they are left by their dams early in the morning after suckling and they do not feed until the dams come back for the night. Whatever time of weighing is picked, the key thing is consistency.

Frequency of weighing

Accurate weights should be obtained at all times. To ensure this the scales being used should be calibrated frequently and test weights should be used before any weighing and strategically thereafter.

For calves four weighings are necessary up to the age of two years. The weights are at the ages of 1, 3, 7 and 18 months. "Birth weight" should be taken within 24 hours of actual birth whenever possible. On the other hand it weight at actual birth of the breed in question is not known at all, it is then worthwhile to measure it.

We have weighed 53 calves in Kenya once every month up to the age of four months. The correlation of 30 days with that of 60 days is 95 %, for 60 and 90 days is 95 % and for 90 and 120 days is 94 %. Because of this high correlation it is obvious that one can cut down the number of weighings to two without losing accuracy.

For weighing calves up to the age of 120 days a weighbridge is not necessary. Up to this age liveweights are easily taken by a scale of 100 kg hanging from a tripod. Above this age weighbridge is necessary. An ideal weighbridge is one with a yoke as it facilitates tagging and mouthing and it restrains an animal for other measurements. A weighing scale mounted on the back of a four-wheel
drive pick-up is better than one on a trailer. The former can be moved faster and more easily from one site to another, covering distances of over 100 km per day.

Two weighings are recommended within the first four months as this is a critical period of the life of a calf. It is also the period when calf growth is nearly entirely dependent on milk. It therefore gives the best measure of milking ability. Weighing at the age of seven months is taken as the weaning weight, for measuring the mothering ability. It is not possible to weigh all calves at the exact age of seven months and adjustment is necessary for calves falling between six and eight months, to correct them to 210 days.

The final calf weight at 18 months after standardisation for age differences is a better measure of genetic differences in growth rate than earlier weights discussed above.

Monitoring of seasonal weight changes
If a measure of the productivity value of the range is desired as dictated by seasons, mature steers or wethers are the choice. Steers and wethers are preferred because changes in their liveweights are not affected by physiological status of pregnancy or milk production. In some situations one may require to study seasonal effects on liveweight as affected by specific animal product, e.g. milk production, in which case the appropriate animal type is used.

Milk yield measurement
Zebu cows are known for refusing to let down their milk without the stimulus of a calf sucking. So when computing lactation yield of zebu cows milk taken by calves must be taken into consideration.

Several methods of measuring total milk yield have been tried: weighing before and after suckling, oxytocin injection, bucket feeding, partial suckling and liveweight growth rate milk equivalent.

Weighing of calves, lambs or kids before and after suckling is a very sound method except that it requires a very sensitive scale able to pick differences in the range of 50 g to 3.5 kg. Such scales exist but are not suitable for weighing livestock which never remain
still during weighing. The weight difference obtained in some cases is negative due to the fact that before weighing after suckling the young animal may have urinated or defecated. This method requires a lot of labour, so that not many animals can be recorded and a very small sample may to be taken, leading to unsatisfactory statistical analyses.

Injection of oxytocin to stimulate milk let-down is possible only on a research station. In some countries, e.g. Kenya, oxytocin can be administered only by a qualified veterinarian. How many calves and sampling times is it possible to study under free range conditions? Bucket feeding and partial suckling methods are related. In order to bucket-feed partial suckling is necessary first to stimulate milk let-down and calves have to be taught how to drink from a bucket. Complete milking-out under-estimates total yield from milking plus suckling by as much as 18 % (Amble et al., 1965).

Calculation of the amount of milk equivalent to observed growth rate is good only for the first three or four month of the life of a calf, that is before it starts grazing. Necessary formulae for converting liveweight and growth rate to milk equivalent are available (Konandreas and Anderson, 1982; MAFF, 1975). The remainder of the lactation yield is best estimated by computing the net energy available for milk production, combined with milk offtake measurements. With this method yield evaluation of many cows is possible and in Kenya the method is used with over 600 cows. A cows are known to attain their peak production within the first four months of lactation this method is therefore adequate in estimating maximum milk yield potential.

Number of milk measurements and yield rating

Milk offtake is normally recorded twice a day. Pastoralists normally milk twice and, among the Maasai, approximately 80 % milk twice and 20 % once a day.

With the Kenyan pastoral tribe of Maasai a paired 't' test was conducted between a.m. and p.m. yields on 2,939 milking days. The difference between the two means (30 ml) was significant (P 0.05) but not large enough to matter. It is therefore suggested
to do only one milk offtake measurement per day. This will cut down the cost of evaluating zebu cows' potential for milk and beef production, leading to increased number of such evaluations for improvement purposes.

The minimum number of measurements is four per month, preferably two in the morning and two in the evening. These should also be made on days of average activities, rather than when cows are on heat or following vaccinations or dipping.

Pastoral tribes rate their cows for their yield potential by simple classifications into good, average and poor on milk offtake. This classification is specially applicable to cows with a previous lactation. Cows on their first lactation are rated provisionally on their current yields. On analysis of 2,301 records, actual production was found to conform with the yield rating of the owners; good cows gave 1.28, average 0.96 and poor 0.86 liters per day. The differences were highly significant (P 0.005). If breed improvement is envisaged it would be easy to use pastoral peoples' rating to identify the good producers, the best of which could be used as dams of young bulls for progeny testing.

As an added variable to milk offtake it is recommended to note the number of teats being milked on each measurement occasion, and also the method of calf restraint.

References


Productivité et gestion du bétail

Résumé

Cet exposé décrit l'évolution de la méthodologique d'enquête, y compris celle utilisée pour les enquêtes à basse altitude, les enquêtes par questionnaires et les méthodes "zootechniques" d'enquête. Il examine ensuite les enquêtes au sol à trois niveaux: la pré-enquête, l'enquête initiale et l'enquête continue.

La pré-enquête fournit des données sur l'environnement naturel, sur les groupes sociaux et sur la structure générale de la distribution et de la propriété du bétail. Au cours de cette phase, il devrait être possible de sélectionner des zones, villages ou autres unités territoriales représentatifs pour la phase "enquête initiale".

La phase enquête initiale est conçue tout d'abord pour fournir des données sur la structure de la population animale et sur les taux de croissance individuelle. A partir de ces paramètres, il est possible de calculer la production instantanée des individus et du troupeau même si l'on ne dispose pas de données supplémentaires sur les taux des naissances et de mortalité ou sur les niveaux réels de l'écoulement. Une enquête initiale complète peut prendre environ six à huit mois/homme (et s'échelonner) sur une période allant de quatre à six mois, y compris l'analyse complète des données et l'élaboration du rapport.

L'enquête continue est conçue pour fournir des données complètes et fiables sur l'ensemble des paramètres de production. Celles-ci incluent les taux de naissance, de mortalité et d'écoulement (ce dernier étant composé d'éléments tels que vente, don, abattage rituel et in extremis), les gains pondéraux individuels par saison et année, la production carnée et laitière et la dynamique des troupeaux.

L'identification individuelle des animaux est nécessaire. Ce type d'étude devrait durer un minimum de 3 ans pour produire des résultats valables et fiables. Une telle période permettrait de réduire au...
minimum les effets saisonniers sur les performances, sauf dans les cas exceptionnels. Normalement, certaines données utiles sur les paramètres de production apparaissent après les 12 à 18 premiers mois.


Les avantages relatifs de plusieurs méthodes de mesure de la production laitière sont examinés. Ceux-ci incluent le pesage avant et après l’allaitement, les injections d’oxytocine, l’engraissement à façon, l’allaitement partiel et l’équivalent en lait du taux de croissance pondéral. Le prélèvement de lait est normalement enregistré deux fois par jour.
Introduction

Wilson and Semenye's paper outlined the procedures followed by ILCA's field teams in surveying the productivity of livestock in arid and semi-arid areas. They emphasised that quite large differences may exist between herds and flocks within the same production system in contrast to quite strong similarities in mean productivity among the pastoral systems themselves.

Productivity is largely determined within a particular environment by genotype, health and nutrition. For most of the extensive pastoral areas we are concerned with there exist no potentially better breeds than the present well adapted zebu-based cattle and the local strains of sheep and goats; but ILCA's systems studies have shown, even in these adapted animals, the occurrence of serious losses associated with disease. The nature of arid and semi-arid grazing lands, with short and unreliable periods of rainfall, necessarily means that animals and their keepers undergo long periods of nutritional hardship.

Genotype

Current low reproductive rates and heavy calf mortality prevent any deliberate selection for productivity in cattle apart from the rigorous natural selection that this situation implies. In small-
stock the common pattern is to sell or slaughter for meat a large proportion of the males at early ages — from six months to one year. In the absence of any deliberate attempts to keep the fastest growing males for future breeding, it is probable that they are the first to be eaten, and that the smaller or slower growing are the more likely to be left for breeding. There may thus be an unintentional, but beneficial, selection for multiple births, of which the offspring are always lighter at birth and slower growing. It is possible that individual herders do exert selection for particular types of animals; among the Maasai of Kenya for example it is basic policy to promote both large and small framed cattle chosen from every recognizable breeding "line" in the herd. This ensures a wide range of variation in the herd and is held to maximize production in the wet season and minimize losses in the dry season over the herd as a whole. In ILCA's Kenya studies Sahiwal crosses are found to grow faster than local Maasai zebu calves, and the pastoralists appear to be retaining Sahiwal cross cattle for breeding rather than offering them for sale, despite the higher prices that they fetch. Free-range grazing on common land and use of common watering points mean opportunities for animals to mate with males from another herd or flock and are therefore inconsistent with a deliberate policy of genetic improvement. Aprons are used by some pastoralists in range areas to prevent breeding of sheep and goats until the best mating season, and castration of inferior males is a recognized practice. The basic attitudes and mechanisms for genetic improvement are there to be used if clear-cut methods for identifying the most productive animals for the environment could be developed and ways of exploiting their merit could be promoted.

Health

The interaction of nutrition and health in deciding overall productivity has been recognized in all ILCA programmes. Efforts have been made from an early stage to diagnose the main diseases, study their epidemiology and impact on production, and test available control measures.
In 1982 an agreement was reached with the research branch of the Kenya Ministry of Livestock Development to conduct collaborative research on the incidence and impact of animal diseases on Maasai herds and flocks. Through this arrangement the research branch has made available one senior and one junior veterinarian. The former is responsible for designing the research project (contents, sampling, phasing, analysis and interpretation of data) in consultation with ILCA scientists and for supervising the junior veterinarian, who is responsible for carrying out the field investigation in collaboration with the ILCA team. This component of the research was launched in June 1982.

In Mali and northern Nigeria veterinarians have been appointed to ILCA teams to carry out surveys of epidemiology of common diseases in livestock being recorded in the main programme and the causes of mortality in animals dying or slaughtered. The widespread practice of killing animals in extremis for meat, makes it difficult to arrive at reliable statistics for the number of deaths due to disease. In Mali it was found that most deaths occurred in the overgrazed zone outside the live delta and major causes included tick-borne diseases and pneumonia-like infectious diseases (Pasteurella, Diaplococcus). No evidence was found of protozoal parasites but sarcoptic mange was common and many samples examined showed the presence of the internal parasites Moniezia, Eimeria, Paramphistomum, Oestrus ovis, Echinococcosus, or Fasciola hepatica.

The Mali team has now set up a section of Animal Health and Nutrition reflecting the close relationship of these two aspects of animal productivity, and research in the present phase will give more attention to disease and parasites as causes of the high mortality in young animals, which averages 21% in calves up to 12 months, and 6.2% for the herd as a whole. Preweaning mortality was as high as 35% in goats and 30% in sheep, varying between pastoral systems (rice, millet) and with type of birth. Of the total deaths recorded 16% were abortions, 22% were still births or occurred on the first day, and a further 14% in the first 7 days. Seventy percent of all deaths occurred before 15 months.
Fewer figures are available from the newer Ethiopian rangelands project concerning disease incidence, but similarly heavy losses of young animals have been recorded and there can be no doubt that many are disease related.

In all systems studied, internal and external parasites are prevalent and tick-borne diseases are major problems. In some Fulani areas ticks are regularly removed by hand, usually by children; internal parasites are "treated" by use of traditional herbal preparations or by the annual "cure salée" or access to salt outcappings, which is believed to have curative properties. Most pastoralists are aware of the symptoms of common diseases, indeed they also recognize and classify diseases, by signs and by postmortem indications, into groupings which can readily be translated into standard Western terms.

ILCA's systems studies have made it possible to assess major diseases and to estimate their impact on productivity. Work now in progress will make it possible to evaluate various approaches to disease control, in economic and in practical terms, and their relationship to nutrition and management of the flock or herd. Wilson (1982, and this workshop) has outlined a programme for improvement of smallstock productivity involving the upgrading of management, diagnosis and control of epidemic diseases, selection of males for growth rate and twin-born females for retention as breeders, control of breeding times, treatment of parasites, careful culling of least productive females and supplementary feeding for special purposes.

**Nutrition**

**General**

The most useful record for nutritional purposes is liveweight since this is an integrated measure of the nutritional response of the animal, and liveweight gains or losses give a sensitive indication of nutritional adequacy or inadequacy. Weighing is possible, given a weighing scale or tripod and clock face balance and necessary assistance, during both initial and continued surveys, as described by Wilson and Semenye in this workshop, and yields very useful information. Where weighing facilities are not available, a very useful
approximation may be made by measuring heart (or chest) girth of cattle and estimating the liveweight from these by means of one of the published formulae. The relationship between heart girth and weight depends on breed, and to some extent on condition and sex.

A more robust, easily applied but more subjective method is to visually assess body condition. This is readily done on large numbers of animals and, if clear criteria are set for distinguishing grades of condition, it can be reproducible. Up to five grades are easily distinguished; it is often claimed that nine or ten grades can be used by experienced observers but reproducibility within, and particularly between, observers may be rather poor. The fewer the grades the more repeatable the grading, but the greater the differences in body weight corresponding to each change of grade. In-frequent watering of cattle is likely to superimpose a two or three day cycle on liveweights, as also on visual estimates of condition. Since individual cattle may take in up to 30 litres of water (30 kg of liveweight) in five minutes one may question the interpretation of measurements made either before or after watering. In these conditions heart girth may be a more reliable measure.

More detailed information about nutrition can be obtained from samples of blood, faeces, or body tissues. In ILCA studies in northern Nigeria we have analysed samples of blood to correlate with the mineral content of range grass and browse species, and samples of liver to estimate tissue stores of copper and vitamin A in cases where forage analysis has suggested these might be low. Blood plasma inorganic phosphate analysis has often been used to assess the adequacy of supplies of phosphorus, an element closely linked with animal performance, but recent work in the semi-arid tropics of Australia has shown that more reliable information is obtained by analysis of small samples of rib-bone obtained by simple surgery. The skeleton acts as reserve of minerals, and bone is readily mobilised to maintain plasma concentrations when the P content of the diet falls too low. We have analysed many samples of milk from the Ethiopian pastoral programme, but milk composition seems to be determined very much by genetic and physiological factors such as age and stage of lactation. The "let-down" problem in zebu cows means that
it is difficult to obtain a truly representative sample of milk in field studies. The wide variation we have found (2.5 to 70% fat) may reflect this problem, but average figures of about 13.5% to 14.0% total solids, and fat percentage increasing from 4% to 6 or 7% during lactation, suggest that our samples are reasonably representative and consistent and that the Borana cow produces excellent quality milk under pastoral conditions. Milk quality is of great importance not only because of the need for good calf growth rate, but also because pastoral families live on a predominantly milk diet for much of the year. ILCA's nutritional studies include records of weight and height for age of representative groups of pastoralists and their families, together with observations of their food consumption and daily work routine. The very hard work of lifting water from wells for stock comes during the late dry season, when milk production is at its lowest in a seasonally-calving herd, and when last season's grain reserves are getting low. The supply of labour and work capacity per person may limit the possibility of introducing any management changes needing extra work.

Because of the self-evident importance of nutrition in all the pastoral zones, it was decided early in ILCA's work to do more intensive research into this component of the system.

Methods used

Amounts and composition of forage available

Liveweight or body condition measures the response of animals to their nutritional environment integrated over weeks or months. For many purposes it is necessary to know to which component of that environment they are responding or how the factors of feed quantity and quality, grazing, watering and walking are interacting.
Fig 1. Relationship between faecal production (1), digestibility (2), dry matter intake (3) and liveweight (4) of cattle.

Figure 1 shows the annual weight changes of cattle in the agropastoral system of central Mali, and it is easy to distinguish several main periods of the year:

- the wet season, when rapid gains are made on abundant high-quality feed;

- the main dry season, when slow but steady weight losses occur on an initially adequate but diminishing supply of poor quality feed; and

- the late dry/very early wet season, when weight loss is often more rapid. This last period may be so serious in its effects that it is referred to as the 'crise de Juillet'. Several possible causes for ill-thrift at this time have been suggested, including leaching of the remaining forage, mycotoxins produced by fungal
growth following the first rains, excessive energy expenditure in
seeking the fresh grass or diarrhoea causing reduced digestibility
and apparent loss of weight.

Table 1 shows results of quadrat sampling on pastures in the
Fulani agropastoral system of northern Nigeria's subhumid zone, in
which the main rainfall occurs between June and October. Because of
the good growth of tall grasses in this cattle area, the protein and
digestibility figures are generally low, particularly in the dry
period between October and May. Table 2 shows corresponding data
from a grass and browse system grazed by goats and sheep in northern
Kenya. The bimodal rainfall occurs in the period January to March
and in October, and a marked decline in availability and quality of
feed occurs during the intervening dry months of July, August and
September. Because of the high content of browse, the protein content
was notably higher throughout most of the year than shown in Table 1.

Table 1. Composition of forage available to traditionally managed
cattle in northern Nigeria.

<table>
<thead>
<tr>
<th>Month :</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>available DM$^1$ (t/ha)</td>
<td>0.7</td>
<td>1.1</td>
<td>2.0</td>
<td>2.0</td>
<td>2.3</td>
<td>2.5</td>
<td>2.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>CP$^2$ (% of DM)</td>
<td>9.4</td>
<td>9.8</td>
<td>8.5</td>
<td>6.8</td>
<td>6.0</td>
<td>4.8</td>
<td>3.0</td>
<td>4.2</td>
<td>4.5</td>
<td>5.4</td>
<td>5.4</td>
<td>5.1</td>
</tr>
<tr>
<td>digestibility (% DM)</td>
<td>61</td>
<td>60</td>
<td>54</td>
<td>50</td>
<td>48</td>
<td>46</td>
<td>42</td>
<td>52</td>
<td>47</td>
<td>53</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>grazing time (h/d)</td>
<td>9.5</td>
<td>7.6</td>
<td>7.1</td>
<td>7.1</td>
<td>7.0</td>
<td>6.9</td>
<td>7.0</td>
<td>7.9</td>
<td>8.2</td>
<td>8.2</td>
<td>9.3</td>
<td>9.4</td>
</tr>
</tbody>
</table>

$^1$DM = dry matter
$^2$CP = crude protein

Source: Bello Sule, unpublished results, ILCA, Kaduna.
Table 2. Composition of forage and browse available to sheep and goats in northern Kenya.

<table>
<thead>
<tr>
<th>Month</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>available DM(^1) (kg/head)</td>
<td>1.5</td>
<td>1.20</td>
<td>1.50</td>
<td>1.20</td>
<td>0.90</td>
<td>0.80</td>
<td>0.70</td>
<td>0.55</td>
<td>0.70</td>
<td>1.20</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>CP(^2) (% of DM)</td>
<td>17</td>
<td>21</td>
<td>18</td>
<td>14</td>
<td>22</td>
<td>22</td>
<td>17</td>
<td>14</td>
<td>14</td>
<td>21</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>digestibility (% DM)</td>
<td>64</td>
<td>68</td>
<td>64</td>
<td>60</td>
<td>62</td>
<td>55</td>
<td>35</td>
<td>30</td>
<td>40</td>
<td>68</td>
<td>71</td>
<td>67</td>
</tr>
</tbody>
</table>

\(^1\)DM = dry matter
\(^2\)CP = crude protein


Preliminary analysis of the availability and nutritive value of agro-industrial byproducts indicated that, though the oilseed cakes and meals were excellent supplements for the low-protein pastures, the quantities and reliability of supply were altogether inadequate for any widespread use in pastoral areas (Dicko, 1980b). Emphasis was thus placed on better management of pastures and crop residues about which not enough was known, and a detailed study was therefore carried out during 1979-80 of the grazing behaviour and feed intake of cattle in the agropastoral system illustrated in Figure 1. Traditional herders graze animals during the rainy season (July-October) on the natural vegetation of the Sahel, largely composed of annuals like Schoenfeldia gracilis, Loudetia togoensis, and Zornia glochidiata, with Pterocarpus luocens as the principal browse species (Hiernaux, 1978). From November until December, they graze the standing stalks and residues of the millet fields, combined with some grazing of the
regrowth of surrounding fields in fallow. In December in the particular production system under study, they are moved to the residue of the rice fields, with also a substantial regrowth of weeds. If the rice straw and residues are completely grazed the herd is moved about April back to the millet fields, to await the rain in July. Observations presented here were made over one complete year in a locally-owned herd of 90 cattle. During a five day period each month the grazing behaviour of four steers was recorded at 15-minute intervals day and night while simultaneously the total faecal production of four steers was measured with a bagging technique specially developed for free-ranging animals (Dicko, 1980a).

Composition and amount of feed eaten

Forage intake was estimated by the 'indirect' method, in which the output of faeces was first measured (the indigestible part of the feed eaten) by means of a harness and collection bag and this then multiplied by a factor, ratio of total feed eaten to indigestible part, or feed: faeces ratio. This is numerically equal to the ratio 100/100 % digestibility and the digestibility was estimated in several ways.

1. By cutting or plucking by hand samples of forage eaten by the animals. The digestibility of these samples was estimated by chemical analysis. It is difficult to obtain a sample close to that eaten by free-grazing animals. By close observation of the grazing behaviour of each animal, samples could be taken in proportion to the number of bites seen to be taken from each grass or shrub forage type in the hope that the total sample thus obtained would be representative of the day's diet.

2. By allowing the animal itself to select its diet, then taking samples of the material grazed through a large cannula fitted surgically into the rumen. This means physically emptying the contents of the rumen by hand before the animal goes to graze, and then taking samples from the freshly ingested material in the rumen after 1-2 hours of grazing.
3. A technique used in later work in Kenya involves collecting samples of herbage grazed by means of a surgical fistula into oesophagus, which allows feed being swallowed to pass out into a suitable collection bag attached to the neck. This is less time-consuming than the rumen method, and yields a sample which has not been subjected to the fermenting effect of the rumen's active bacterial population.

Two options exist for analysis - either in vitro digestion with rumen liquor or purified enzymes, or else analysis for fibrous fractions closely related to digestibility and the use of a predictive equation such as that of van Soest (1976).

4. In other pastoral countries it has been observed that a close relationship exists between forage digestibility and the composition of the faeces derived from that forage. Data from digestion trials have been analysed so as to predict forage digestibility from either faecal fibre components (which are related negatively to digestibility) or faecal nitrogen concentration (positively related to digestibility). For the Mali study two equations were used, based upon a wide range of native and introduced grasses and legumes grown in northern N.S.W., Australia.

Results obtained

Grazing behaviour

Fig. 1 showed not only the weight changes but also the faecal output, digestibility and estimated feed intake of the cattle studied. The mean observed values are given in Table 3, while Fig. 2 gives grazing times and other details as monthly means.
Table 3. *Intake and performance measurements.*

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean Lwt (kg)</th>
<th>Lwt Gain (kg/d)</th>
<th>DDMI&lt;sup&gt;1&lt;/sup&gt; (kg/d)</th>
<th>DCPI&lt;sup&gt;2&lt;/sup&gt; (kg/d)</th>
<th>MEI&lt;sup&gt;3&lt;/sup&gt; (MJ/d)</th>
<th>Distance (km/d)</th>
<th>Grazing</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>237</td>
<td>0.75</td>
<td>3.91</td>
<td>0.747</td>
<td>57.09</td>
<td>6.01</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>258</td>
<td>0.28</td>
<td>4.29</td>
<td>0.631</td>
<td>60.37</td>
<td>7.84</td>
<td>5.09</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>266</td>
<td>-0.14</td>
<td>2.62</td>
<td>0.213</td>
<td>35.81</td>
<td>7.28</td>
<td>13.07</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>261</td>
<td>-0.52</td>
<td>3.22</td>
<td>0.240</td>
<td>42.98</td>
<td>9.44</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>248</td>
<td>0.13</td>
<td>3.83</td>
<td>0.176</td>
<td>49.17</td>
<td>7.39</td>
<td>3.90</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>251</td>
<td>-0.13</td>
<td>3.54</td>
<td>0.299</td>
<td>43.39</td>
<td>7.77</td>
<td>2.32</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>248</td>
<td>0.08</td>
<td>3.28</td>
<td>0.390</td>
<td>44.92</td>
<td>7.64</td>
<td>3.28</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>242</td>
<td>-0.34</td>
<td>2.44</td>
<td>0.176</td>
<td>29.95</td>
<td>6.93</td>
<td>3.94</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>236</td>
<td>-0.32</td>
<td>2.87</td>
<td>0.127</td>
<td>35.46</td>
<td>7.85</td>
<td>4.84</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>228</td>
<td>-0.12</td>
<td>2.66</td>
<td>0.253</td>
<td>34.04</td>
<td>8.03</td>
<td>3.38</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>224</td>
<td>-0.15</td>
<td>3.74</td>
<td>0.348</td>
<td>48.30</td>
<td>8.62</td>
<td>4.64</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>230</td>
<td>1.15</td>
<td>5.51</td>
<td>1.434</td>
<td>70.72</td>
<td>7.19</td>
<td>6.91</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup>Digestible dry matter intake.

<sup>2</sup>Digestible crude protein intake.

<sup>3</sup>Metabolisable energy intake.

Grazing time was lowest during and after the rainy season (August to October) when pasture is relatively abundant and of good quality. On millet residues and rice straw from November to December grazing time increased steadily until April to June when biomass was much reduced. Both in the rainy season and in the dry season significant negative correlations ($r = -0.85$ and $-0.92$ respectively) were found between standing biomass and grazing time. Covariance analysis showed that grazing time was significantly lower for a given biomass in the period July to October, when forage quality was high. This is shown in Fig. 3.
Fig 2. Relation between biomass availability and grazing behaviour.
Differences in grazing preference are shown in Table 4. The low amount of time spent on millet residues, compared to that on rice straw and fallow regrowth, points to the relative importance of these latter agricultural residue resources particularly for cattle. Sheep and goats spent far more time on fallow regrowth and on browse grazing respectively. The distance walked was about 6 to 9 km during grazing plus 3 to 12 km per day between camp, pasture and water.
Table 4. Estimation of annual grazing time of ruminants on different types of forage.

<table>
<thead>
<tr>
<th></th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours</td>
<td>%</td>
<td>Hours</td>
</tr>
<tr>
<td>Total time</td>
<td>2,883</td>
<td>100</td>
<td>1,948</td>
</tr>
<tr>
<td>Time on browse plants</td>
<td>115</td>
<td>4</td>
<td>669</td>
</tr>
<tr>
<td>on pasture or fallows</td>
<td>1,519</td>
<td>53</td>
<td>1,142</td>
</tr>
<tr>
<td>on millet stems</td>
<td>179</td>
<td>6</td>
<td>135</td>
</tr>
<tr>
<td>on rice straw and regrowth</td>
<td>1,070</td>
<td>37</td>
<td>2</td>
</tr>
</tbody>
</table>

Intake

The monthly mean dry matter (DM) intake figures for cattle are related to the time spent grazing (Fig. 4) in the rainy season, intake was approximately 1 kg D.M. per hour, in the early dry season approximately 0.8 kg DM per hour, whilst in the late dry season this was reduced to 0.5 - 0.6 kg DM per hour. The slightly higher values in December and June appear to be associated with the grazing of rice fallows.

![Fig 4. Relation between voluntary intake and grazing time in different months.](image-url)
The N content of rumen samples was consistently higher than the plucked forage samples (Table 5), perhaps indicating feed selectivity even in the dry season. In the month of July, in the main growth period, both were equally high. Both sets of values showed a similar trend during the year but the difficulties of copying the grazing selection of animals gives greater credibility of the analyses of rumen samples, though these may have been influenced by saliva contamination (Table 8). Seasonal trends in protein content and digestibility (Table 5) were similar to corresponding data from Botswana (APRU, 1978) obtained by use of cattle with oesophageal fistulae.

Table 5. Composition of forage eaten by grazing cattle; (a) Botswana (April, 1978), (b) Mali.

<table>
<thead>
<tr>
<th>Month</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) CP</td>
<td>11.2</td>
<td>9.4</td>
<td>7.1</td>
<td>6.4</td>
<td>6.2</td>
<td>5.8</td>
<td>5.3</td>
<td>6.2</td>
<td>8.3</td>
<td>-</td>
<td>11.6</td>
<td>10.5</td>
</tr>
<tr>
<td>(%) of DM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>56</td>
<td>54</td>
<td>51</td>
<td>48</td>
<td>45</td>
<td>39</td>
<td>46</td>
<td>44</td>
<td>53</td>
<td>-</td>
<td>63</td>
<td>55</td>
</tr>
<tr>
<td>(b) CP %</td>
<td>5.8</td>
<td>3.5</td>
<td>3.7</td>
<td>4.6</td>
<td>7.2</td>
<td>23.1</td>
<td>9.7</td>
<td>8.1</td>
<td>7.7</td>
<td>7.3</td>
<td>6.2</td>
<td>5.2</td>
</tr>
<tr>
<td>(i) 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM %</td>
<td>51</td>
<td>53</td>
<td>53</td>
<td>48</td>
<td>53</td>
<td>62</td>
<td>66</td>
<td>62</td>
<td>48</td>
<td>52</td>
<td>55</td>
<td>55</td>
</tr>
</tbody>
</table>

1 CP = crude protein
2 DM = dry matter percentage
3 (i) = samples plucked by hand
(ii) = samples obtained from rumen

Factors affecting intake

Intake of DM averaged 6.32 kg DM, or 2.6% of the mean cow liveweight of 244 kg. Linear and multiple regression analyses showed that
forage protein (N x 6.25) content had much more influence on DM intake \( (r = 0.68) \) than had forage digestibility alone \( (r = 0.48) \), though the two were closely related.

Weight changes of cattle and their relation to intake

Regression analysis of liveweight changes showed a correlation of 0.68 with digestible dry matter intake (DDMI), 0.89 with crude protein intake (CPI) and 0.89 also as multiple correlation with DDMI and CPI, indicating the major contribution of CP intake to the relationship. Metabolisable energy (ME) intakes were estimated from a formula proposed for tropical grasses (INRA, 1978). The linear

\[
\Delta W = 0.034 ME_{A+P} - 0.450 \\
R = 0.911
\]

Fig 5. Liveweight change as a function of total metabolisable energy intake \( (ME_I) \) and of metabolisable energy intake available for activity and production \( (ME_{A+P}) \).
regression of liveweight change on ME intake (Fig. 5) gave:

\[
\text{Liveweight change (kg/d) = 0.034 } MEI \text{ (MJ/d) - 1.513 } (r = 0.88) \\
= 0.034 (MEI - 44.5)
\]

indicating a total maintenance energy expenditure of 44.5 MJ/d. If the ME intakes are reduced by the estimated minimum maintenance requirements of about 112 kcal/kg or about 31 MJ per day the regression becomes:

\[
\text{Liveweight change (kg/d) = 0.034 (available ME - 13.2) } (r = 0.91)
\]

indicating that in this environment the additional energy expenditure for grazing activities and walking amounted to 13.2 MJ/d, or an additional 42% of the minimum maintenance requirement.

**Evaluation of methods**

Some discrepancies were noted among the various methods of estimating digestibility, upon which this 'indirect' approach depends. Initial comparison of the estimates suggested that the rumen samples gave consistently lower values than the rest, and a mean value was used which excluded the rumen samples, in calculating the values shown in Table 3 earlier (Dicko et al, 1981). A later analysis showed that liveweight changes were most closely correlated with intake estimated via *in vitro* digestibility of rumen samples \((r = 0.80)\), via *in vitro* digestibility of hand-plucked samples \((r = 0.78)\) and via the digestibilities calculated from faecal nitrogen content \((r = 0.75 \text{ for equation 1}; r = 0.68 \text{ for equation 2})\). Estimates are shown in Table 6. All estimates from the rumen samples were markedly lower perhaps because of some initial digestion, and faecal nitrogen regressions gave higher estimates than the rest.
Table 6. Estimates of digestibility by different methods.

<table>
<thead>
<tr>
<th>Month</th>
<th>Faecal nitrogen</th>
<th></th>
<th>Van Soest equation</th>
<th></th>
<th>In vitro digestion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eq. 1 (a)</td>
<td>Eq. 2 (b)</td>
<td>hand (c)</td>
<td>rumen (d)</td>
<td>hand (e)</td>
<td>rumen (f)</td>
</tr>
<tr>
<td>A</td>
<td>63</td>
<td>61</td>
<td>61</td>
<td>46</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>S</td>
<td>66</td>
<td>64</td>
<td>-</td>
<td>-</td>
<td>54</td>
<td>51</td>
</tr>
<tr>
<td>O</td>
<td>56</td>
<td>56</td>
<td>47</td>
<td>42</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>N</td>
<td>53</td>
<td>58</td>
<td>53</td>
<td>43</td>
<td>52</td>
<td>38</td>
</tr>
<tr>
<td>D</td>
<td>54</td>
<td>57</td>
<td>60</td>
<td>44</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>J</td>
<td>54</td>
<td>57</td>
<td>62</td>
<td>47</td>
<td>54</td>
<td>52</td>
</tr>
<tr>
<td>F</td>
<td>54</td>
<td>57</td>
<td>58</td>
<td>53</td>
<td>54</td>
<td>49</td>
</tr>
<tr>
<td>M</td>
<td>54</td>
<td>57</td>
<td>60</td>
<td>57</td>
<td>51</td>
<td>44</td>
</tr>
<tr>
<td>A</td>
<td>57</td>
<td>57</td>
<td>60</td>
<td>58</td>
<td>54</td>
<td>56</td>
</tr>
<tr>
<td>M</td>
<td>54</td>
<td>57</td>
<td>47</td>
<td>51</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>J</td>
<td>55</td>
<td>57</td>
<td>55</td>
<td>50</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>J</td>
<td>77</td>
<td>77</td>
<td>63</td>
<td>61</td>
<td>71</td>
<td>68</td>
</tr>
<tr>
<td>Mean</td>
<td>58.2</td>
<td>59.6</td>
<td>56.7</td>
<td>50.3</td>
<td>54.7</td>
<td>51.2</td>
</tr>
</tbody>
</table>

In later work in Ethiopia and Kenya the oesophageal fistula method has been used. Although this method undoubtedly samples the feed actually selected by the animal, not all food eaten is collected. The proportion which comes out of the fistula depends somewhat on the exact position and size of the opening and therefore differs between cows. Table 7 shows fairly consistent and significant differences among four animals given test feeds in known amounts, but no differences between feeds of different physical types averaged over the four animals. This indicates the need to 'calibrate' animals from time to time, and to use a small group rather than rely on single animals. The total weight of forage collected per hour of grazing time cannot be simply multiplied by the number of hours of grazing per day to calculate total daily intake, unless the percentage feed recovery is known and is used to correct the weights collected.
Table 7. Percentage recovery of different feeds from oesophageal fistulae in four cattle (no. observations in brackets).

<table>
<thead>
<tr>
<th>Feed given</th>
<th>Percentage recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>hay</td>
<td>59</td>
</tr>
<tr>
<td>grass</td>
<td>54</td>
</tr>
<tr>
<td>concentrates</td>
<td>30</td>
</tr>
<tr>
<td>mean</td>
<td>48 (18)</td>
</tr>
</tbody>
</table>

Table 8. Composition of material collected from oesophageal fistula compared with composition of feed eaten.

<table>
<thead>
<tr>
<th>Material</th>
<th>DM(^1) (%)</th>
<th>Nitrogen (%)</th>
<th>Phosphorus (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>hay feed</td>
<td>50</td>
<td>0.87</td>
<td>0.21</td>
</tr>
<tr>
<td>OF(^2) - total</td>
<td>55</td>
<td>1.00</td>
<td>0.52</td>
</tr>
<tr>
<td>- squeezed</td>
<td>51</td>
<td>0.97</td>
<td>0.34</td>
</tr>
<tr>
<td>grass feed</td>
<td>56</td>
<td>1.20</td>
<td>0.24</td>
</tr>
<tr>
<td>OF - total</td>
<td>58</td>
<td>1.32</td>
<td>0.43</td>
</tr>
<tr>
<td>- squeezed</td>
<td>52</td>
<td>1.28</td>
<td>0.33</td>
</tr>
<tr>
<td>concentrates</td>
<td>61</td>
<td>3.45</td>
<td>1.01</td>
</tr>
<tr>
<td>OF - total</td>
<td>68</td>
<td>2.92</td>
<td>1.04</td>
</tr>
<tr>
<td>- squeezed</td>
<td>62</td>
<td>2.97</td>
<td>1.01</td>
</tr>
</tbody>
</table>

\(^1\)DM = dry matter
\(^2\)OF = oesophageal fistula

Table 8 shows the effect of mastication and addition of saliva on chemical composition of samples. More saliva is added to hay than to grass or concentrate samples before swallowing, and the
effect of this on nitrogen and particularly on phosphorus content, is quite clear. The phosphorus content of hay and grass was more than doubled by the phosphorus contained in the saliva, which demonstrates the effectiveness of the recycling process by which ruminants are able to thrive on poor quality feeds for many months.

In current work in Kenya Semenye is using Maasai cattle with fistulae, and this is the method of choice where precise knowledge of botanical, and with less confidence chemical, composition is needed, and where the large amount of work can be justified. For many purposes it is now felt that close observation of grazing behaviour may be sufficient, matched with analyses of forage samples carefully plucked to mimic grazing selectivity. Additional information may be obtained by analysis of faecal samples, which is closely related to the characteristics of the feed eaten, at least in terms of nitrogen, phosphorus and fibre contents.

The collection of faeces by harness and bag, as used here, is much easier with animals which are accustomed to close herding and regular handling than with free-ranging cattle. The standard chromium oxide method would also be relatively easy with herded cattle, and would make it possible to work with larger numbers and with young growing cattle as well as with females. This is now being explored.

An interesting development of this work is the finding that the average amount of forage taken in per 'bite' or per monthful, is fairly constant. This has been calculated from careful recording of the number of mouthfuls taken in a given time; the number of mouthfuls per unit time or the intensity of grazing, is closely related to the rate of walking while grazing. This is illustrated for several conditions in Fig. 6 (Dicko, pers. comm.). At maximum grazing intensity an animal takes a number of monthfuls per minute characteristic of the pasture and when its rate of walking is slowest. As grazing becomes less intense, the number of mouthfuls per minute declines linearly with increase in walking speed. It is hoped that the availability of fistulated cattle may make it possible to test this idea under a wider range of conditions. Number of monthfuls is also being recorded by a simple automatic device (Semenye, pers. comm.).
Conclusions

This component research study amply verified the nutritional limitation to cattle performance during the dry season, and showed that this had several aspects. The main initial constraint appeared to be the low quality of the dry forage which caused the cattle to graze selectively for long periods and expend extra energy in doing so. Samples of forage obtained in various ways confirmed earlier findings that the protein content of the forage was more closely related to animal performance than was its digestibility. The close relationship of forage N content to other quality attributes makes it difficult to assert which one is of primary importance. In tropical pastures it is well known that animal performance depends on maintaining forage protein content above about 8% (Milford and Haydock, 1965). In the present work protein content of forage was below 7.5% for most of the period November to June during which liveweight losses occurred.

These findings emphasize the particular value of protein or non-protein nitrogen supplements for grazing ruminants, and help to explain the better sustained production of animals which browse on high-protein leguminous plants during the dry season. If it is true that protein content is the most valuable single attribute, and is correlated with most other measures of quality, then improvement in protein content should be sought even at the cost of some reduction in gross DM production. Biomass protein content can be increased even within the constraints of climate and soil fertility by management deliberately aimed at increasing the contribution of legumes, herbs and browse plants rather than of lower-quality grasses, however high their DM yield. Where pastoral systems rely on crop residues or stubble grazing in the dry season, as is common, the inclusion of a forage legume with the cereal crop combined with minimum fertilizer input, would both provide supplementary protein to livestock and enhance soil fertility so as to produce better crop yields and better fallow grazing in later years.

Because of the great importance of nitrogen content and digestibility in determining intake and performance of ruminants, ILCA is collating these and other data on a wide range of forage and
browse samples. The widespread practice in Africa of supplying salt in various forms to livestock, suggests that soils and plants may be deficient in particular mineral elements. ILCA has carried out a wide sampling of forage plants on various soils and throughout the year in northern Nigeria, and proposes to extend this survey into the Malian and Niger Sahel and into the Ethiopian and Kenyan rangelands. Analyses are, of course, most informative when they relate to the species and the plant parts actually eaten by grazing animals; this is why ILCA is interested in methods of sampling which mimic the animals' selectivity or, as in O.F. methods use the animal itself to obtain samples for analysis.

Knowledge of the nutritional features for which animals select their forage intake has particular value for ILCA's simulation modelling work. Mathematical descriptions and predictive models have been developed for water use and plant growth (van Keulen et al, 1981) and for animal performance (Konandreas and Anderson, 1982) but a weak point in the sequence is the lack of knowledge about feed intake and selectivity of African livestock under African pastoral conditions.

References


Nutrition animale

Résumé

Les pâturages arides et semi-arides caractérisés par des périodes pluvieuses courtes et irrégulières, assujettissent les animaux et leurs conducteurs à de longues périodes de contraintes nutritionnelles. Les travaux du CIPEA mettent en relief l'interaction de la nutrition et de la santé dans la productivité globale. Des efforts ont été déployés pour diagnostiquer les principales maladies, pour étudier leur épidémiologie et leur impact sur la production et pour tester les mesures de lutte disponibles. Les méthodes utilisées pour enregistrer les données sur la nutrition sont examinées. Elles incluent des méthodes relatives à l'enregistrement de la quantité et de la composition du disponible fourrager et du fourrage consommé.

L'étude a confirmé les contraintes nutritionnelles qui font obstacle aux performances des bovins au cours de la saison sèche et a montré que celles-ci comportaient plusieurs aspects. La contrainte principale semble être la faible qualité du fourrage sec qui oblige les bovins à faire du pâturage sélectif pendant de longues périodes et à dépenser beaucoup d'énergie. Des échantillons de fourrage prélevés de diverses manières ont confirmé des découvertes antérieures selon lesquelles la teneur en protéines du fourrage était plus étroitement liée à la performance animale que ne l'était sa digestibilité.

Ces découvertes mettent en relief la valeur particulière des compléments azotés protéiques ou non protéiques pour les ruminants et contribuent à expliquer la meilleure performance des animaux qui consomment les légumineuses à forte teneur en protéines au cours de la saison sèche. S'il est vrai que la teneur en protéines constitue le facteur déterminant et qu'elle intervient dans la plupart des mesures visant à améliorer la qualité de l'affouragement, alors l'accroissement de la teneur en protéines devrait être recherché, même au prix d'une certaine baisse de la production brute de matière sèche. La teneur en protéines de la biomasse peut être augmentée, même malgré les contraintes relatives au climat et à la fertilité des sols, par une gestion visant délibérément à accroître le rôle des légumineuses, des graminées et des ligneux plutôt que celui des graminées de qualité inférieure, quelle
que soit l'importance de la production de matière sèche. Etant donné le rôle que jouent la teneur en azote et la digestibilité dans la détermination de l'ingestion et de la performance des ruminants, le CIPEA a entrepris de recueillir des données sur celles-ci et sur une vaste gamme d'échantillons de fourrage et de ligneux. La pratique courante en Afrique de donner du sel sous diverses formes au bétail suggère que les sols et les plantes peuvent être déficients en certains éléments minéraux. Le CIPEA a procédé à l'échantillonnage d'une vaste gamme de fourrages sur divers sols pendant toute l'année dans le Nigéria du nord et propose d'étendre cette enquête aux pâturages sahéliens du Mali et du Niger et aux terrains de parcours de l'Ethiopie et du Kenya.

La connaissance des caractéristiques nutritionnelles qui déterminent la sélection par les animaux du fourrage ingéré revêt une importance capitale dans les travaux de modélisation du CIPEA. Des descriptions mathématiques et des modèles de prévision ont été mis au point pour l'utilisation de l'eau et la croissance des plantes ainsi que pour la performance des animaux. Un point faible cependant dans cette série: le manque de connaissances sur l'ingestion fourragère et la sélectivité du bétail dans les conditions pastorales en Afrique.
Summary of Discussion Session 4.
Chairman: Dr Assefa Giorgis (Ethiopia)
Discussion led by Dr Samson Chema (Kenya)

Dr Chema asked what efforts ILCA was making to ensure a systems research discipline by component researchers. He said there did not seem to be a defined role for each component. Dr de Haan pointed out that it was completely legitimate within the systems approach to focus on one of the most critical components in order to understand the basic processes. Animal nutrition was one such critical component.

Dr Ngutter commented that the neglect of small ruminants by the authorities and development agencies stemmed from the condemnation by colonial agricultural officers of the goat as the worst culprit in ecological degradation. He asked what would be the cost of the methodology proposed by Drs Wilson and Semenye in their paper, if this was to be continued for at least three years. Dr Wilson said that this would depend on the salary and benefit levels per senior scientist, otherwise it could be calculated from the data given in the paper plus two observers salaries plus vehicle transport at 5000 km per year.

Dr Diakite commented that many projects did not take sufficient account of small ruminants, donkeys and camels. These animals should be more closely considered in assessing pastoral management. Herdsmen were often ahead of researchers in terms of understanding pastoral systems - this too should be remembered.

Dr Zulberti referred to the information in Wilson and Semenye's paper comparing best vs worst for some of the variables. He thought that these comparisons could be extended to larger numbers of animals. Some other variables which could be included were fertility, mortality, disease control, multiple birth, seasonal breeding control, watering interval and wealth.
Prof. Saka Nuru asked Dr Wilson if he had taken into account the effect of nutrition type and management factors on dental eruption and wear in aging the sheep and goats studied. Dr Wilson said that the main variable was the sheep or goat - the management system had a slight influence on the time of eruption but no other significant effects.

Dr Thomson asked if ILCA had now sufficient information from the descriptive/diagnostic phase in Mali to enable it to concentrate on the experimental/testing phase. Dr Wilson said that there was now enough information from Niger and Kenya as well as Mali to move on to the next phase. Dr Thompson asked Dr Lambourne if he was surprised that protein had a greater effect on intake than digestibility, or was he just confirming other work done in similar regions. Dr Lambourne said that of course he was not surprised, but there was a need to confirm that intake was affected by crude protein under local conditions. This information would allow one to say which forage species were valuable and which useless to the animal.

In referring to Dr Wilson's paper, Dr Grandin stressed that one had to know a lot about an area, its important parameters and production units in order to be able to choose a representative unit.

Dr Rhissa expressed his concern that the discussion on animal nutrition had neglected the contribution of browse to the feed balance of livestock in pastoral areas.
Résumé des débats de la quatrième séance
Président: M. Assefa Giorgis (Ethiopie)
Débats dirigés par le Dr Samson Chema (Kenya)

Le Dr Chema s'est informé des efforts déployés par le CIPEA pour instituer une discipline de recherche sur les systèmes pour les chercheurs sur les composantes. Il a déclaré qu'il ne semblait pas y avoir un rôle défini pour chaque composante. M. de Haan a souligné qu'il était tout à fait légitime, dans le cadre de l'approche par système, de se concentrer sur l'une des composantes les plus importantes en vue de comprendre les mécanismes de base. La nutrition animale faisait partie de ces composantes importantes.

Le Dr Ngutter a souligné que la négligence des responsables et des organismes de développement à l'égard des petits ruminants provenait de l'accusation par les agents de l'agriculture coloniale de la chèvre comme étant le principal responsable de la dégradation écologique. Il a demandé de préciser le coût de la méthodologie proposée par MM. Wilson et Semenye dans leur document, si celle-ci devait se poursuivre pendant au moins 3 ans. M. Wilson a déclaré que cela dépendrait des traitements et prestations dont bénéficierait chaque scientifique de haut niveau et que sinon on pourrait procéder à un calcul sur la base des données fournies dans le document, plus les salaires des deux observateurs et un véhicule parcourant 5000 km par an.

Le Dr Diakité a souligné que plusieurs projets ne prenaient pas suffisamment en considération les petits ruminants, les ânes et les chameaux. Ces animaux devraient être étudiés de manière plus appropriée dans l'évaluation de la gestion pastorale. Les pasteurs dépassaient souvent les chercheurs en ce qui concerne la connaissance des systèmes pastoraux. Il fallait également se rappeler cela.

Le Dr Zulberti a fait allusion aux données contenues dans le document de Wilson et de Semenye, comparant pour certaines variables les meilleures et les pires performances. Il a estimé que ces comparaisons pourraient être étendues à des nombres plus importants d'animaux. Certaines autres variables que l'on aurait pu inclure avaient pour noms,
la fertilité, la mortalité, la lutte contre les maladies, les naissances multiples, le contrôle de la reproduction saisonnière, les intervalles d'abreuvement et la richesse.

Le Prof. Saka Nuru a demandé à M. Wilson s'il avait pris en considération l'effet du type de la nutrition et des facteurs de la gestion sur l'éruption et la chute des dents dans la détermination de l'âge des moutons et des chèvres étudiés. M. Wilson a déclaré que la variable essentielle était le mouton ou la chèvre. Le système de gestion n'avait qu'une influence minime sur le moment de l'éruption et n'avait pas d'autres effets significatifs.

Le Dr Thomson a demandé si le CIPEA disposait actuellement d'informations suffisantes sur la phase de diagnostic/description au Mali pour lui permettre de se concentrer sur la phase d'essai/expérimentation. M. Wilson a déclaré qu'il y avait maintenant suffisamment d'informations sur le Niger, le Kenya et le Mali pour que l'on puisse passer à la phase suivante. M. Thompson a demandé à M. Lambourne s'il était surpris que les protéines aient un effet plus grand sur la gestion que la digestibilité ou bien était-il juste en train de confirmer d'autres travaux effectués dans des régions similaires. M. Lambourne a déclaré qu'il n'était certainement pas surpris mais qu'il était nécessaire de confirmer que l'ingestion était affectée par les protéines brutes dans les conditions locales. Cette information permettra de dire quelles sont les espèces fourragères les plus valables et quelles sont celles qui sont inutiles pour l'animal.

En se référant au document de M. Wilson, Mlle Grandin a déclaré qu'il fallait avoir des connaissances exhaustives sur une zone donnée, sur ses paramètres les plus importants et sur ses unités de production pour être en mesure de choisir une unité représentative.

Le Dr Rhissa a souligné qu'il s'étonnait de constater que les débats sur la nutrition animale avaient négligé la contribution des ligneux à l'équilibre fourragier dans les zones pastorales.
Production strategies and pastoral man

Noel Cossins
Socio-economist and Ethiopia Team Leader, Arid Zones (Eastern and Southern Africa) Programme, ILCA, Ethiopia

Pastoral Man in Africa

One of the main differences between range livestock systems in countries such as America and Australia, and those in Africa, is that in Australia people derive a living from the range while in Africa people depend upon the range for life. In Australia if a grazier loses all his cattle he may go bankrupt, but in Africa if a pastoralist loses all his cattle he may also lose his life.

An African pastoralist may equally lose the capacity to support the life of his family by losing only a portion of the productive capacity of his livestock. Remembering what is at stake to the African pastoralist compared to the Australian grazier, is essential in understanding a pastoralist's reaction to the introduction of change and innovation.

In Africa about 13-16 million km$^2$, or nearly half of the continent south of the Sahara, is desert or arid grassland and savanna where cultivation is a high risk enterprise (Brown, 1971). It is in these areas that almost all of the 20 million or so sub-Saharan pastoralists live, subsisting wholly or almost wholly on the products of their livestock (Helland, 1980).

Of all the secondary users of vegetation through animals, the pastoralist is the only one who depends on milk and not meat. All other secondary users including the advanced capitalist pastoralist or large-scale rancher depend on meat. No Australian rancher in his right mind in fact would attempt to produce milk commercially in the type of semi-arid area in which nomadic pastoralists live.
And yet the African pastoralist has relied on milk and still attempts to do so, except where that system is under pressure or breaking down as is occurring with the Afar of the northeast rangelands of Ethiopia. There is logic behind this reliance on milk for it has created a system independent to an extent of farmer neighbours with whom the pastoral system may have been hostile at times, and which has the capacity to directly support, on a subsistence basis, far more people per unit area than any other arid area production mode. Jahnke (1982) estimates for example that if arid countries like Mauritania and Somalia organised their land use in the form of modern ranching, their pastoral population would have to be reduced by a factor of 50.

Measured in terms of survival, pastoral production systems in Africa have been remarkably effective (Dyson-Hudson, 1982). They have in general achieved their major objective of providing a reliable source of food for the population that actually operated the system, a supply that has been able to be sustained at life support levels throughout the dry stress periods in most years.

The number of people that any area is capable of supporting can be termed the 'human support capacity', and it is this factor that pastoralists seek to optimise. They do so through the production and consumption of milk. The objective is the optimisation of human numbers per unit area of arid land, while the strategy is milk production. This objective is the primary one for all pastoral systems, with the second and equally important objective being to provide as much security as possible for the dependent human population. This is achieved by employing a number of specific strategies. These days under the stimulus of development and change, there is also an increasing interest in productivity and wealth in terms other than livestock numbers.

General relationships between the natural productivity of the land and the human support capacity have been established by various workers for the agro-ecological zones of both East and West Africa. For example, for East Africa they are as follows (Pratt and Gwynne, 1977):
<table>
<thead>
<tr>
<th>Agro-ecological zone</th>
<th>Human support capacity (ha/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual rainfall</td>
</tr>
<tr>
<td></td>
<td>(mm)</td>
</tr>
<tr>
<td>Very arid</td>
<td>189.0</td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>Arid</td>
</tr>
<tr>
<td>500</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>Semi-arid</td>
</tr>
</tbody>
</table>

If the above criteria are applied to the semi-arid Borana area of the Ethiopian southern rangelands a figure of 17.2 ha/person results which indicates that the area has the capacity to support 21% more people than it presently does. The figure for the Afar who live in an arid to very arid area in the northeast rangelands of Ethiopia ranged from 11-50 ha/person which indicates that this pastoral system is under considerable pressure and has more people than it can reasonably support. Other data support these indications.

In all pastoral systems the consumption of milk or blood seems to be steadily dropping, and there are few (if any) which rely almost totally on milk or milk products. In some the reliance is still fairly high. The Borana of the southern rangelands of Ethiopia for example, with some seasonal variations, still consume up to 59% of their diet as milk or milk products with the balance of the diet being increasingly made up of grain. For the Afar, milk now probably constitutes less than 20% of total energy requirements, and grain again is increasingly the main food substitute. This increase of grain and decrease of milk consumption is in fact more and more the pattern in pastoral Africa. Nevertheless the African pastoralist is...
still firmly oriented towards a milk production mode as far as circumstances will allow and has not yet dramatically changed this in favour of selling meat or growing crops.

In the 1960's, some ecologists (e.g. Brown, 1971) argued that the dependence on milk by pastoralists in arid areas was ecologically unsound, placing (as it does) the pastoralists in direct competition with their calves, and in creating a herd population structure where females make up 70% or more of the herd. In the inevitable cycle of good years and drought years this high breeding capacity led to rapid recovery after drought years and a very rapid increase in numbers which spiralled upwards, while environmental degredation increased with each drought period. In each drought, so the argument went, animals did their damage before they died, and as their numbers were great, so was the damage.

This is compelling theory in these times of environmental consciousness but it does tend to simplify the rather complex set of inter-relationships which exist between the pastoralist, his animals and the resources available to these animals in terms of grass or browse and water.

One of the functions of pastoral systems research is to observe and quantify entire pastoral production systems. Given this it is essential to consider pastoralists' objectives and the strategies they employ to attain these objectives. There are many misconceptions about the reasons why pastoralists do the things they do. Almost every study of pastoral systems over the last 30 years has shown however that pastoralists follow observable behaviour patterns which are rational with respect to their objectives, and that these patterns can be described. It is sometimes easier to record the effect (e.g. low weaning weight) first, and then determine the behaviour (e.g. offtake of milk for humans as well as calves), but the two, behaviour and effect, are linked and must be seen as a whole.
Pastoral man and production strategies

Almost everything a pastoralist does is the result of a deliberate decision, from his rain-chasing nomadism to the maximisation of females, which is an obvious strategy for a people one of whose main objectives is to maximise milk production. A similar case exists for breeding practices where the wider the distribution of the calf drop the more chance there may be of high mortality or poor calf growth for those calves dropped in the dry season, and the more likely there is to be a year-round supply of milk.

Nomadic pastoralism presupposes a high degree of organisational and spatial flexibility (Dahl and Hjort, 1979). Households constantly redistribute themselves over the terrain, and membership of households changes as labour is allocated and reallocated between different management units.

In any pastoral system a pastoralist has to construct production strategies to cope with three series of constraints. These are as follows:

1. Normal - the constraints placed upon the system by normal, mostly seasonal, events. A pastoralist's year normally ranges from times of plenty (the rains and post rains period) to times of shortage (the dry seasons). The year is punctuated by a series of high and low periods where disease, parasite burdens, available forage come and go as problems.

2. Disasters - at times some of the normal constraints may assume disastrous proportions. The main disasters are epidemic disease, range fires in the dry season, and drought.

3. Long-term changes - these are often irreversible and consist of such events as the loss of dry-season grazing areas to cultivation, the relative advantages which may accrue to richer pastoralists because of government policies, or loss of revenues from caravans, raiding etc.

Not everything that a pastoralist does can be termed a strategy, and some actions can better be described as tactical decisions. In general, strategies are far less responsive to inter-
ventions than are tactical decisions which can be changed and adjusted fairly readily. In this paper I am using the term 'strategy' to denote the conduct of a campaign or the response to a set of circumstances in its long term and large scale aspects, while 'tactics' are taken to mean the use of resources to the best advantage and with respect to an immediate and short-term solution, generally at the production unit level.

In the pastoral context we can define a strategy as the consumption of milk, or the communal ownership of land, while a tactical decision may concern the movement of animals to specific areas at specific times, or a response to price differentials for different stock types. For example, it generally pays a pastoralist to retain a male animal in his herd until maturity. The reasons are simply economic. The labour expended in herding male stock is small compared to that required for cows and calves, which has to be done in any case, and the returns on keeping a male to maturity are usually worthwhile (Dahl and Hjort, 1979).

In Borana, for example, the average price of an immature male was Birr 198 compared to an average mature male price of Birr 313 (Negussie, 1983). The main labour bottleneck is at the wells in the dry season but there, with a livestock to labour ratio of 50:1, 10% more or less males do not make a great deal of difference. A change of relative immature/mature price ratios might bring about a change of tactics however. Steers are also preferentially retained to full maturity in systems which use blood as a milk substitute, as in the case in the Borana 'dry herds', and a replacement food may also have to be found before immature steers are readily sold.

Perhaps the most important strategy that pastoralists have evolved is the response to the threat of drought. Drought or very dry years are inescapable in most African pastoral systems. In the southern rangelands of Ethiopia, for example, the main rains fail one year in ten and the secondary rains one year in three in the Dolo area. Similar figures can be produced for any rangeland or pastoral system, and as there is no evidence to show that regular cycles of drought occur (Bille, 1983), a pastoralist has to be ready at any time for drought.
Knowing this, a pastoralist adopts several or all of a number of strategies, or traditional forms of insurance against loss. The most important of these (in East Africa) are as follows:

- maintain more than one species of livestock. Camels and goats are for example more resistant to drought than cattle and sheep.

- divide livestock holdings into spatially separate units to minimise the effects of localised drought. This requires a high labour input or more than one household.

- establish and maintain social systems for resource sharing, or for borrowing, lending and gifting.

- maintain large herds, or as large as possible, to maximise the chances of having some left when the drought is over.

- during the drought or disaster minimise the reliant human population by sending away all able-bodied people not required to work the system. People have been most often sent to adjacent agricultural areas (e.g. the Maasai to the Kikuyu areas in the smallpox/rinderpest epidemics of the 1890's), and contrary again to previous opinion, contacts between farmers and pastoralists in East Africa seem to be long established (Hjort, 1981).

Again these are reasonable strategies given the limitations of the system and the fact that there has never been access to or any reason to trust a formal banking system to build up reserves against bad times, or an insurance policy which will sustain a pastoralist through drought.

Drought effects do not always relate directly to rainfall (Dahl, 1979). The same amount of rain may produce very different subsistence conditions depending not only on the availability of dry season pasture, but also on the number of people needed to make the necessary movements, or raise water, and on the amount of milk, meat or blood needed to feed them, or the amount of grain available for purchase.

Drought effects are thus not solely an ecological phenomenon, and socio-political aspects or market supplies are secondary but important functions. The Afar, for example, are still responding to
the great Wollo drought of 1972-74 by switching from cattle to selling smallstock. Our market figures show however that they bring to market twice as many smallstock as the various markets can absorb, and this inability to sell certainly affects the viability of the system. The Afar response also reflects the fact that mortality rates are markedly differentiated by age during a drought (Dahl, 1979).

Among the Afar Arapta clan during the beginning of the Wollo drought of 1972-74 (Cossins, 1972) there were marked age group gaps in the cattle herd particularly for older cows and heifers. When these gaps were superimposed on the herd composition figures the graph shown in Fig. 1 resulted.

![Graph showing relative numbers of milking age cows](image)

Fig. 1. *Projection of future native milking age cow numbers for the Arapta clan.*
Dahl (1979) found for the Isiolo Boran that there were particular years after a drought that were bad from a reproductive point of view. Fig. 1 shows that while there was likely to be a marked recovery within five years, the worst was still to come for the Arapta clan. Experience in the Afar system has vindicated this prediction, and the Afar are still largely dependent on selling smallstock for their subsistence. Provided another drought does not occur, the Afar could be expected to move back into an increased reliance on cattle from 1983 onwards.

There is a contradiction here, for smallstock are more efficient at converting pasture into consumable meat and milk, and are more easily marketed, so why should the Afar attempt to move back into cattle? There are probably two main reasons. While goats in particular are more resistant to drought and the recovery rate of smallstock is rapid, smallstock are much more susceptible to disease than cattle, and an epizootic can claim high death tolls.

Secondly, the present market system is not able to buy all the smallstock that the Afar need or want to sell at reasonable prices, nor does it provide all the grain the Afar need to buy for subsistence. Unless this is changed, it is a logical production strategy for the Afar to move back, as far as is feasible into milk production from cattle, even though this may not be an ecologically or economically sensible strategy.

Probably the most emotive and contentious issue concerning pastoralists is the numbers game. Range managers and ecologists continually promote the need to destock African rangelands. The pastoralists resist. Why they resist is the root cause of the problem and one that tends to be overlooked. Brown (1971) was among the first to identify the problem as being one of human numbers rather than livestock numbers, and it is important to recognise this distinction for it answers the question of what can be done about this problem and why pastoralists will not destock. It has nothing to do with the 'tragedy of the commons' argument (Harbin, 1968), and has everything to do with common sense.
Let us look at the Borana for example. The Borana live in a 600 mm rainfall rangelands areas, are still oriented to the pastoral mode of production, and seem to be relatively well-off as a people, in that hunger does not feature highly on their list of problems. We know that the average family consists of about 3.5 adult equivalents (it is actually slightly less than this from our household studies) and we can estimate that their total energy requirement per day will be about 33.7 KJ.

We know such a family owns or has access to about 18 head of cattle which, using the herd structures derived from the well studies, means about six lactating cows at any one time. We know also that the average offtake per cow for human consumption over an average ten-to eleven-in month lactation period is 312 litres or 2050 litres per year. In terms of energy this is equivalent to about 7175 KJ.

Our market and household data show that the unit family also sells two mature animals a year, and consumes slightly less than one cull female or an animal about to die (fallen meat). They also keep six sheep and seven goats and the production from these is also sold or consumed. The data also indicates that they consume about 150 kg of smallstock and fallen meat per year, and that part of the income from all livestock sales is used to buy grain, coffee, sugar etc., and that there is also a supplement of bush foods and blood for the boys herding the dry herds. From these sources a total of about 6982 KJ of energy is potentially available 6075 KJ, if no meat is consumed).

Putting the milk, meat, grain, coffee, sugar etc., together gives a total available energy intake of about 14,157 KJ of which milk constitutes about 51%. Based on the combination of adult equivalents and estimated daily energy requirement, the average Borana family requires 12,132 KJ per year. The difference between these two figures suggests that we have either over-estimated the contribution to the diet of other food, particularly meat and grain, or the Borana eat well occasionally. Whatever the case, the above exercise shows that the Borana generally have enough to eat, although
Rainfall
600 mm.

Solar Energy
750 kj cm^2

LAND
81 hectares wet season
48 hectares dry season

150 Ton DM
(excluding browse)

(actual requirements are about 100 T DM, so there is unused potential).

CATTLE (18)
9 Adult F
4-5 Immat. F
3 Immat. M
1 Bull
1 Castrate

WATER
1000 l every
3 days
400 l/day

Ollla Plot Grain
(Milk subs. &
increasing)
Could provide
upwards of 30%
requirements and
replace 2/3 cows)

SMALLSTOCK
(13 - 18)
6 - 10 sheep
7 - 8 goats
(provide 20-30% food
energy requ. by sale
for grain or cons.)

5 to 6 cows in milk
(plus 'fallen meat' or cull
cows and animals which die
also contribute 5% require-
ments)

Offtake for family av.
2050 l/year (or 59% of
required energy intake)

Rest of milk into calves
Minimal sales

SALES OFFTAKE
2 males a year
2 matures or near
mats.
(minimum of 16%
spent on basic ener-
gy requirements)

Horse
3 Camels
(camels provide?
of energy intake.
May be important in
dry season. May
substitute for cows/
smallstock/cash)

Fig. 2. Family resource diagram for the Borana livestock system.
there may be seasonal shortages, with about 200-300 Birr per year left over for clothes, tobacco, talla etc.; but the margins are not great, and even one cow would be missed.

The above information is interesting in its own right, but what we can also conclude from it is that there is no way that the 'average Borana family' can destock without substantially reducing its standard of living, (e.g. no tobacco or talla or clothes etc.), and that stock reductions of over 15% would put that family on the subsistence borderline. Now the Borana are amongst the more fortunate of East Africa's pastoralists, so that it is quite clear that the pastoralists' resistance to destocking is based on a strategy of survival, no matter how foolish it looks to the conservationist.

Jahnke (1982) describes the difference between the human support capacity of African pastoral areas and the actual numbers as about 1:2, or 12 million versus an actual figure of some 20-29 million people.

What is required to precede any destocking policy is not an educational campaign which shows the pastoralist the damage his animals may be doing to the range, but a change of pastoral mode. If the 'average Borana family' as described in the above example were to convert to a mainly grain/bean diet with some milk, and were to maximise sales from all livestock, then that family's net income from the same number of animals would at least double. Conversely, the number of livestock could be reduced by half and the same standard of living maintained.

This applies to most pastoral systems. Jahnke (1982) suggests that the prevailing terms of trade for African pastoral systems in general are 1.7 kg of grain for 1 kg of milk, and 4 kg of grain for 1 kg of meat, so that a pastoralist significantly improves his subsistence basis by trading. Many examples of this can be found in West Africa among the Fulani who trade milk particularly for grain, while in East Africa the volume of this trade is rapidly increasing.

Encampment food grain plots also provide an alternative. A plot which yielded only 4 quintals per year would provide more than
30% of yearly food requirements for that same Borana family, would allow at least a 15% reduction in the average herd size (from 18 to 15 cattle), or would allow an increase in the offtake rate of at least 6% (an increase to 18%) or add an additional 20,000 cattle to the 40,000 presently sold out of the system.

All these figures are very tantalising to the planner and developer, but there are substantial problems of pastoralists' confidence and conservatism to overcome, just as there are for any farmer anywhere when you want him to make a very considerable change in his mode of production. There is also an equally large problem of providing an assured and regular grain supply in a continent where grain deficits prevail, and to provide an assured and regular market outlet for livestock at acceptable prices.

My argument however, is not really about these aspects, but merely uses the above to point out that overstocking is a problem of human numbers, and that the pastoralist knows this and so resists any pressures to destock unless alternative means of supporting his family are available. And he has to have confidence in such alternatives.

The communal use of land is another pastoral strategy, and it makes sense considering the variability and unreliability of rainfall in African rangelands areas. In any one year rainfall may vary within a pastoral system by as much as 200% from the mean, as it may between years. As there also appears to be no cyclical effect involved (Bille, 1983) so that a planned rotational system is not feasible, it pays a pastoralist to have access to as large an area as possible. Individual or group ownership of specific areas of land precludes this strategy, and just so long as a pastoralist continues to have his life at risk rather than his livelihood, and maintains his bankable reserves as livestock, subdivision of land will be counter to the ability of a pastoralist to survive.

Perhaps the last example to consider is that of organisation and cooperation. Pastoral systems generally require a high degree of both if they are to function well. Where neither occurs, and small units compete for resources instead of cooperating in their use, the system begins to break down as is probably happening in the Afar system.
In the Borana system, organisation and cooperation is still high and the system works well. Imagine for example, the degree of organisation and cooperation that is required to work, say, the wells at Bor Bor. There, in 1982 over three days, some 47,000 head of cattle, 22,000 sheep and goats, and 2,000 other stock were watered in groups of 50 to 100 at nearly 300 groups per day, in the same or nearly the same sequence every third day, and some 780 people were organised to work in one of 17 wells also every third day. This was no mean feat under any circumstances. Thus a society which stresses community over the individual, and which stresses common but organised rights to resources, is more likely to succeed in a pastoral context than one which stresses individual rights.

Production strategies and decisions affect almost every part of any pastoral system. The decisions and strategy alternatives facing a pastoralist are no less complex than those facing a western rancher, and because he may have less control over his resources, and the use of these resources involves far more human labour, the organisation and decisions required of a pastoralist may be even more complex.

The idea of the pastoralist as a simple fellow pursuing a simple mode of life is thus a false one. Outwardly, a milk-drinking, cattle-owning pastoralist may appear so, but his system is highly complex and the strategies he has devised to cope with it are equally complex. Unless an intervention is aimed at the cause of the strategy it may not succeed or be adopted, except where the intervention affects a tactical decision rather than a strategy. It is important to understand this when designing a research programme or deciding on research priorities.

**Determining management strategies**

In the above I have discussed pastoral management strategies and tactical decisions. In the past, pastoral management strategies were relatively uniform with respect to a particular climatic zone, and centred on a mobile human population, dispersed in small groups at low overall densities, with an introverted milk-oriented subsistence.
This population experienced major fluctuations in numbers over time, because of the unreliable distribution of rainfall over time and space (Dyson-Hudson, 1982). Livestock numbers were also often limited by the uneven distribution of water resources with respect to grass and browse.

In general, multi-species herding was the norm as a response to the probability of drought and to fully exploit the often mixed grassland-shrubland-woodland of the environment (Dyson-Hudson, 1982). Modifications of the environment or essential resources included the use of fire to control bush, stimulate the regrowth of grass, or to control ticks, and the development of sometimes quite complex wells and ponds. The major strategies however, concerned the dispersal of small production groups over large commonly held areas, and a livestock composite design which included a mix of species and a structure where females predominated. This structure was remarkably uniform for all species and even included horses in Borana.

Pastoral systems are under pressure. Their populations are no longer allowed to adjust naturally to phenomena such as drought or to expand in a traditional territorial sense through force. They are increasingly being brought into the mainstream of development by forces beyond their control, and into situations where traditional pastoral strategies may become less efficient. These strategies then become less useful to pursue, as Dyson-Hudson (1982) writes, and pastoralism then becomes less likely to persist as a plausible pattern of land use.

The strategies pursued by pastoralists are thus changing as pastoral populations respond increasingly to development inputs, political and administrative pressures, and to changing aspirations. The main question to answer for any pastoral system and, by extension, the importance of this question to any pastoral systems research programme, is what strategies are being pursued by the pastoralists under study, and why, and how does one differentiate production strategies from tactical decisions.
Seasonal movements reflect both strategy and tactics. Access to as large a piece of communal land as possible in order to exploit rainfall whenever and wherever it occurs is the strategy, but the tactical decision is the determination of where and when to move for a specific herd or herd group at a specific time. Given the correct intervention, e.g. improved pastures in a specific area, it is relatively easy to induce a change in the tactical decision. It is not so easy to bring about a change in the strategy which is based on the unreliability of rainfall in the arid areas, and the maximisation of opportunity.

If a change from the traditional norm has occurred, it will tell us a great deal about the system and its possible future. The Maasai for example are beginning to countenance individual ranch holdings, which probably signals the beginning of the end for Maasai as traditional pastoralists. The Borana on the other hand still strictly observe the strategy of communal rights to all land in their production sphere, and are still well within the traditional pastoral orbit.

Mode of production is also a strategy and can be determined for example from herd structures. Borana herds consist of 74% females which almost certainly means that the Borana follow a milk production/consumption mode. However the herds also contain about 6% castrated male animals which indicates that animal sales are a secondary strategy.

Pastoralists' drought response strategies can be determined in a variety of ways. Species mix is one indication, and the extent of this is also an indication of the frequency and severity of drought in any area. In the southern rangelands, an area with a relatively good and reliable rainfall (600 mm), the cattle/smallstock/camel ratio is about 3.6/1.3/1, whereas in the much more arid northeast rangelands area, the species ratio is 4.3/11.25/1. Both systems have a species mix, but the Afar's reliance on smallstock indicates a greater and more frequent drought risk.
In general terms the phenomena surrounding a tactical decision respond readily to research inputs, whereas the response to research relating to production strategies is another question. While it is theoretically possible to change the whole production strategy of pastoral reliance on milk for example, and so in the Borana case convert a self-sufficient medium animal offtake (10-12%) system into a self-sufficient higher offtake system (18-20%), this would require considerable organisation and inputs on a supra-system scale, and would also require a national net grain surplus.

Some general rules of thumb regarding pastoralists and the strategies they have evolved to cope with their environment are as follows. If the main national objective remains to use arid areas to support the maximum number of people (maximum human support capacity), then the subdivision of land into discreet units to be owned either by individuals or groups will inevitably reduce the long-term human support capacity of the area; social systems are best left to evolve and look after themselves; removal of land at the fringes of pastoral systems reduces the capacity of the system to survive, as this is usually land whose value to the system far outweighs its physical size (dry-season grazing or strategic area grazing retreats); and it is worth rethinking the ideas of the past which have tended to emphasise the superiority as a production mode of various modified forms of ranching. Ranching cannot compete with pastoralism in terms of human support capacity, and pastoralists can often produce meat nearly as well as any ranch, and much cheaper in the context of the system they already operate.

This paper has addressed strategies and tactical decisions in terms of overall pastoral systems, but the individual producer unit also operates a number of alternative strategies and is responsible for almost all the tactical decisions that have to be made.

Dyson-Hudson (1982) has described East African pastoral systems in terms of a two-tiered structure. The first tier is the division of a region's natural resources into a small number of large units and the second tier being a large number of small units which control and manage the livestock resource in terms of defined herds and flocks. The size of the first tier of units is posed as being
sufficient to accommodate most normal variations in seasonal rainfall, and also to mitigate the effects of all but the most severe disasters.

The second tier of many thousand of small producer units is essentially autonomous in terms of management decisions, and although there is cooperation between these units, this does not, and in fact cannot, extend to guarantees of survival. These small groups may be linked, or controlled and governed to an extent through other bodies which have been evolved as a mechanism to arrange security on a system scale, solve disputes between units, distribute information, and allocate resources. Such bodies may be based on kinship, locality, age sets or other related aspects, but the basic structure remains the two interdependent units which 'put humans into association with livestock and with natural resources' (Dyson-Hudson, 1982).

Strategies and decisions are influenced by a variety of factors at the producer unit level, and it is important to understand what these factors are in terms of identifying constraints, and why there are differences not only between systems and between seasons, but also within a system between producers. For example we have found in Mali marked differences in productivity between herds which can only be attributed to management (Wilson, 1982), and in Kenya we have found that richer Maasai pastoralists have different responses to phenomena and management alternatives than do poor people (Grandin, 1982). The richer pastoralists also have a greater ability to respond to opportunity, and in fact every parameter studied to date in the Kenya programme has had a wealth rank strata.

The strategies and decisions which fall within the realm of the individual producer deserve at least as much attention as those of the pastoral system as a whole, and these are the subject of the following papers.

References


Les stratégies de production et l'éleveur

Résumé

Parmi tous les utilisateurs secondaires de la végétation, l'éleveur est le seul dont la subsistance est assurée par le lait plutôt que par la viande. Le nombre de personnes qu'une zone peut accueillir peut être appelé la "capacité de charge humaine" et c'est ce facteur que les éleveurs cherchent à optimiser. Ils le font par le biais de la production et de la consommation de lait. L'objectif est l'optimisation de la population humaine par unité de surface de zone aride et la stratégie utilisée est la production laitière.

L'une des fonctions de la recherche sur les systèmes pastoraux consiste à observer et à quantifier les systèmes de production pastorale. Il devient donc vital d'examiner les objectifs des éleveurs et les stratégies qu'ils emploient pour atteindre ces objectifs. Dans tout système pastoral, l'éleveur doit mettre au point des stratégies de production pour faire face à trois séries de contraintes:

- les contraintes normales. Il s'agit des contraintes qui pèsent sur le système du fait d'événements normaux, saisonniers la plupart du temps;

- les catastrophes. Quelquefois, certaines des contraintes normales peuvent revêtir des proportions catastrophiques. Les principales catastrophes sont les épidémies, les feux de brousse en saison sèche et la sécheresse;

- les évolutions à long terme. Celles-ci sont souvent irréversibles et se caractérisent par des événements tels que perte de pâturage de saison sèche du fait de l'empâtement de l'agriculture ou perte de revenus du fait de pillage par les caravaniers, etc.

Dans le contexte pastoral, nous pouvons définir la consommation de lait ou la propriété collective de terres comme étant une stratégie alors que les mouvements des animaux dans des zones spécifiques à des moments spécifiques ou en réponse à des variations de prix pour
différents types de bétail peuvent constituer des décisions tactiques. Signalons à cet égard qu'il est possible que la stratégie la plus importante parmi toutes celles que les éleveurs ont mises au point soit la réponse à la menace de sécheresse. La sécheresse est inévitable dans la plupart des systèmes pastoraux africains. Fort de cette connaissance, l'éleveur adopte tout ou partie d'un ensemble de stratégies ou de formes traditionnelles de prévention contre les pertes telles que :

- l'élevage de plusieurs espèces de bétail;
- la division du troupeau en unités spatialement distinctes pour minimiser les effets des sécheresses localisées;
- la mise en place et le maintien de systèmes sociaux de partage des ressources, d'emprunt, de prêts et de dons;
- l'élevage de grands troupeaux pour maximiser les possibilités de survie des individus après la sécheresse;
- la minimisation des risques pour la population humaine au cours de la sécheresse ou pendant la catastrophe en organisant l'exode de tous les bras valides dont la présence dans le système n'est pas indispensable.

Les systèmes pastoraux sont soumis à de fortes pressions. Leurs populations n'ont plus la possibilité de s'adapter à des phénomènes naturels tels que la sécheresse ou d'assurer l'expansion de leur territoire par la force. Elles participent de plus en plus au processus général du développement du fait de l'action de forces qui échappent à leur contrôle et sont plongées dans des situations où les stratégies traditionnelles d'élevage peuvent devenir moins efficaces. Ces stratégies deviennent alors moins utiles à poursuivre et la survie du pastoralisme conçu en tant que mode praticable d'utilisation des terres devient hypothétique. Les stratégies adoptées par les éleveurs changent donc à mesure que s'accroît la sensibilité des populations pastorales aux facteurs de développement, aux pressions politiques et administratives et à de nouvelles aspirations.
Les stratégies et les décisions sont influencées par une variété de facteurs au niveau de l'unité de production et il est important de comprendre ces facteurs en vue de l'identification des contraintes au système ainsi que les différences non seulement entre les systèmes et entre les saisons mais également, au sein d'un système, entre les producteurs. Les stratégies et les décisions adoptées à l'échelon du producteur individuel méritent au moins autant d'intérêt que celles de l'ensemble du système pastoral.
The importance of wealth effects on pastoral production: A rapid method for wealth ranking

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This paper discusses the importance of wealth differences between producers in traditional pastoral production systems. It argues that significant wealth differences exist, that these have a profound effect on production strategies and that pastoral systems research must pay attention to them at several stages from defining a target population or recommendation domain to developing and testing interventions. The paper then describes a rapid method for determining the wealth rank of producers within a given community. Such a ranking is an important tool to stratify a population of producers before sampling to ensure the representativeness of the sample along this important dimension. Alternatively, it may be used post facto for assessing the representativeness of pastoralists already interviewed.

Wealth differences in pastoral production systems
For many years studies of traditional agricultural production systems emphasised the essential homogeneity of producers. While it was recognized that some differences existed, they were though, on the whole, not to be significant, but purely a matter of scale.

In agricultural economics, for example, earlier research results tended to be reported in terms of the average farmer, with his average family, average cropping pattern and average yields. In anthropology, to the extent that economic heterogeneity was researched, emphasis was placed on "levelling mechanisms", which by definition, functioned to counteract trends towards inequality. For example, polygamy has been discussed as having a levelling function, as more wives would mean more children and consequently the eventual fragmentation of the wealthy producers' assets.
In studies of peasant agriculture, there has been increasing recognition of the extent of wealth differences within communities and their effects on production parameters. As Hill (1972) noted in her pioneering work on inequality in a Hausa village in Northern Nigeria, "it is not merely that a few farmers operate on a much larger scale than others... but that there are many rich farmers who have entirely different economic aims from many poorer farmers." She observed that the tendency of scholars to ignore wealth differences among African peasants had hampered our ability to understand their systems of production.

Today, researchers are paying far more attention to intra-community differences between farmers. It is recognized that wealthy farmers have differential access to land, labour, animal inputs (traction and manure) and credit, to name a few important production parameters. In addition with differential savings and investment possibilities, wealthier farmers have different attitudes to risk and innovation (Cancian, 1978) than their poorer counterparts on the survival fringe.

For pastoral systems, recognition of the importance of wealth inequality within communities has lagged behind. Much of the household level research in pastoral production systems has been done (and continues to be done) by anthropologists who have paid insufficient attention to the issue of economic inequality in traditional production systems. The ideology of equality which tends to predominate in pastoral societies as well as the apparent similarities in consumption levels of different households, (coupled with a theoretical tradition which emphasised the homogeneity of traditional communities), have all contributed to this apparent bias of early anthropologists in studying both peasant and pastoral societies.

Unfortunately, as Konezacki (1978) noted in his book entitled The economics of pastoralism: A case study of sub-Saharan Africa, there are few data available on the distribution of livestock ownership within pastoral communities; the little data which are available however indicate that "the prevailing pattern of wealth, and consequently income distribution among African societies dependent on animal husbandry, is one of inequality."
Table 1 presents data from several African pastoral societies on the distribution of livestock holdings between households. These cases were chosen not because they represent extremes of inequality, but rather because they are the few cases for which data were readily available. In each instance there is a marked inequality of livestock holdings, which can be taken as a close approximation of wealth especially in a purely pastoral system where land is communally held.

Table 1. Inequality in livestock distribution: a few African examples.

<table>
<thead>
<tr>
<th>Place</th>
<th>Unit</th>
<th>No. of HH</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tuareg - A</td>
<td>L.U</td>
<td>14</td>
<td>30</td>
<td>34\textsuperscript{e}</td>
<td>0-58</td>
<td>1979</td>
</tr>
<tr>
<td>2. Tuareg - B</td>
<td>Camels</td>
<td>31</td>
<td>21</td>
<td>17\textsuperscript{e}</td>
<td>2-83</td>
<td>1982</td>
</tr>
<tr>
<td>3. Wodaabe</td>
<td>Cattle</td>
<td>75</td>
<td>16</td>
<td>18\textsuperscript{e}</td>
<td>5-45</td>
<td>1982</td>
</tr>
<tr>
<td>4. Somali</td>
<td>L.U</td>
<td>36</td>
<td>132</td>
<td>70</td>
<td>4-660</td>
<td>1950</td>
</tr>
<tr>
<td>5. Sebei</td>
<td>Cattle</td>
<td>42</td>
<td>21</td>
<td>12</td>
<td>0-100+</td>
<td>1960</td>
</tr>
<tr>
<td>6. Maasai</td>
<td>Cattle</td>
<td>41</td>
<td>109</td>
<td>58</td>
<td>4-499</td>
<td>1980</td>
</tr>
</tbody>
</table>

\textsuperscript{e} estimated

Sources: 1. Swift (1979)
3. Lewis (1961)
4. Goldschmidt (1976)

While there are some indications in the literature of the extent of intra-community wealth differences in pastoral societies, there are few, if any, systematic explorations of the effect of wealth differences on production parameters. Intuitively, we would expect differences in wealth to affect production in important ways in a pastoral system. Wealth in the form of animal numbers both enables (and necessitates) a large family which can be garnered through polygamy, adoption, and the incorporation of poor relations as dependents. Greater wealth also means fewer cash flow problems, and
increased possibilities of access to purchased inputs, including drugs and mineral supplements. Clearly a producer with 400 animals will have different management strategies and possibilities than a producer with only 4 animals. Wealthier pastoralists, particularly those with sufficient labour within the household, have more management options in terms of herd-splitting and lending of animals (both for risk avoidance and to maintain useful social networks). They would be likely to have more control over grazing and watering than poorer producers who are not able to herd independently. We would expect breeding to be affected as poor producers might not have sufficient access to a male for servicing whereas wealthy producers might have difficulty with seasonal and other control of breeding in large herds and flocks.

ILCA's research in several rangeland systems, particularly in Kenya, has focused on the effects of wealth on livestock production. Table 2 presents preliminary findings from ILCA's on-going research in Kenya Maasailand. It shows that virtually every important production parameter varies considerably with the wealth rank of the producer. For ease of presentation, the data refer only to the rich and poor (leaving out the middle stratum), and only to one of the three group ranches under study.

Section A of Table 2 provides background information. Of forty households on the ranch, 13 were classed as poor and 12 were classed as rich. Of these, the ILCA sample included seven poor and seven rich households. The poor households owned only 5% of the livestock units on the ranch whereas the rich households owned 48% of them.
Table 2. Production unit heterogeneity: example from a Maasai group ranch.

<table>
<thead>
<tr>
<th>A. Background</th>
<th>Poor</th>
<th>Rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH on ranch</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>HH in sample</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>% of ranches L.U. (total sample) per household</td>
<td>4.9%</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>0.7</td>
<td>6.5</td>
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</table>

<table>
<thead>
<tr>
<th>B. Livestock holdings</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Value of livestock holdings</td>
<td>24,154</td>
<td>234,050</td>
</tr>
<tr>
<td>2. No. of cattle</td>
<td>31</td>
<td>302</td>
</tr>
<tr>
<td>3. No. of smallstock</td>
<td>42</td>
<td>213</td>
</tr>
<tr>
<td>4. SS to cattle ratio</td>
<td>1.3</td>
<td>0.7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Livestock: offtake</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cattle: net offtake %</td>
<td>20</td>
</tr>
<tr>
<td>2. SS : net offtake %</td>
<td>23</td>
</tr>
<tr>
<td>3. Slaughter per capita, Kshs.</td>
<td>33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D. Livestock herding</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. cattle herd alone (%)</td>
<td>0</td>
</tr>
<tr>
<td>2. SS herd alone (%)</td>
<td>29</td>
</tr>
<tr>
<td>3. Cattle herding group size</td>
<td>160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E. Labour inputs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total workers</td>
<td>6.3</td>
</tr>
<tr>
<td>2. No. of adult men</td>
<td>0.9</td>
</tr>
<tr>
<td>3. No. of adult women</td>
<td>1.7</td>
</tr>
<tr>
<td>4. Children in school: %</td>
<td>38</td>
</tr>
<tr>
<td>5. Ratio of cattle/worker</td>
<td>5</td>
</tr>
<tr>
<td>6. HR/day to LS per worker</td>
<td>3.9</td>
</tr>
<tr>
<td>7. HR/day per livestock unit per work</td>
<td>1.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F. Income</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Income from LS/capita (Kshs)</td>
<td>657/=</td>
</tr>
<tr>
<td>2. Mean value of cattle sold</td>
<td>577/=</td>
</tr>
</tbody>
</table>
Table 2 cont.

3. % value of commercial transactions in smallstock

<table>
<thead>
<tr>
<th></th>
<th>18%</th>
<th>7%</th>
</tr>
</thead>
</table>

G. Expenditure

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Per cap. food/drink</td>
<td>195/=</td>
<td>465/=</td>
</tr>
<tr>
<td>2. Per cap. HH</td>
<td>165/=</td>
<td>238/=</td>
</tr>
</tbody>
</table>

Section B presents information on the livestock holdings of the sample households. The figures are all means for the households in that stratum. It shows that rich households have approximately ten times the value of animals, largely accounted for by their having ten times the number of cattle of poorer households. Poorer households have proportionally more smallstock, with a smallstock to cattle ratio of 1.3 as opposed to 0.7 in rich households.

The offtake data presented in Section C continue to show clear wealth differences. (de Haan has already mentioned the finding of Wilson and Wagenaur in Niger that offtake rates are negatively correlated with herd size). The same is true in Maasailand. The rich stratum has net offtake rates of 7% for cattle and 6% for sheep; for poorer households the figures are 20% for cattle and 25% for sheep. Poor Maasai (as poor pastoralists in many areas of Africa) (Wilson, 1980; Little, 1982) place far more emphasis on smallstock than wealthier producers. They own proportionately more smallstock and derive more of their income from smallstock (18% of livestock sales rather than 7%). As we would expect, there is far more slaughter per capita in rich households.

Section D shows that more rich households are able to herd alone, thus having complete autonomy in decision-making with regard to grazing. In addition, whether they herd alone or with others, they benefit from an economy of scale by having very large herd sizes for grazing, watering and dipping.

Section E presents a few data on labour. Again a clear difference emerges; rich households have more members, but because
they have far more animals per worker (25 cattle per worker as opposed to 5 in poor households), they send fewer children to school and work longer hours on livestock management. Looked at from a different perspective, however, we see that they benefit both from economies of scale and also from their ability to marshall non-household labour. Whereas each worker in poor households devotes over an hour a day per livestock unit to livestock work, workers in rich households spend only one quarter of an hour.

Section F shows that rich households have a per capita income from animal sales which is more than twice that of poor households. As rich households do not suffer the same cash flow problems of poor households, they are able to keep steers to maturity, thus fetching higher prices per animal. Again we see that poorer households engage in more smallstock sales and purchases than rich households.

Finally, Section G of Table 2 shows that higher income is reflected in higher per capita expenditures on food, drink, and general domestic goods.

Clearly, as we would expect, producers of different wealth ranks differ considerably in a variety of ways; from their access to the essential elements of production, to their herd/flock structures, offtake rates, and management strategies.

Wealth ranking in pastoral systems research

There are several points in pastoral systems research at which it would be important to take account of the wealth heterogeneity in the area under study. It would be useful in the early stages as part of the identification of the recommendation domain. Interventions which are useful to large herd owners might be unadoptable by poorer producers; in fact, they could intensify and even solidify otherwise transient economic inequalities by, for example, providing differential access to credit. Secondly, during the verification survey, it is important to be sure that the producers interviewed represent a reasonable cross-section of the population for whom interventions are to be designed.
As de Haan mentioned in his introduction, and as I have tried to demonstrate, evidence suggests that the single most important parameter for stratifying within a community is wealth rank. However, among pastoralists wealth is a very difficult parameter on which to obtain accurate data. For pure pastoralists, livestock holdings represent a close approximation of wealth. While livestock holdings can be used as a proxy for wealth in a pastoral production system, animal censuses are often difficult, if not impossible, to carry out. Producers are afraid to have their animals counted, due to fear of taxation, other government interference, or solely on the basis of a cultural taboo on the counting of animals. Even if the pastoralist can be persuaded to have his animals counted, the logistic difficulties of such an operation may be overwhelming. Animals may be scattered into different management units, animals owned and animals kept are not isomorphic categories, frequent movements and large distances add to the costs of such censuses. Some of these logistic problems may be overcome by counting animals at watering points, but young and ill animals are likely to be missed. (For agro-pastoralists or pastoralists, with significant non-pastoral occupational and investment opportunities, the situation can be far more complex).

This paper contends that livestock censuses or other objective measurements are not necessary to establish the wealth rank of producers within a community. The technique of having local informants who rank members of their community according to wealth can yield similar results at a fraction of the time and expense.

The technique of informant wealth ranking

Informant ranking was first used by Silverman in 1966 in a sociological study of prestige hierarchies. It has subsequently been used by myself and several other anthropologists to elicit wealth ranks. Informant ranking uses a card sorting technique in which the name of each producer is written on a small card and several informants are asked to place the cards in piles according to the wealth of each producer. It has three basic requirements which will be discussed in turn: 1. a list of producers to be ranked; 2. a few reliable informants;
3. The elicitation of the word or phrase in the local language according to which the producers are to be ranked (in this case wealth).

**List of producers**

The technique is dependent upon ranking producers in relationship to each other; obviously the ranking will reflect true wealth differences in the population only to the extent that all producers are included. This is not as overwhelming a task as it might first appear. Ways of eliciting the list of producers within the community under study include using censuses, tax roles, and/or voter registration, which can be cross-checked with chiefs, elders or other community members. If there is a known watering regime, names can be elicited at dry-season watering points. With more sedentary populations, air photographs can be used by "walking" informants through them. If, as in Maasailand, producers have an area that they consider "home", whether or not they are present, their names can be elicited on a neighborhood by neighborhood basis. In one of the group ranches under study in Kenya, for which there was no accurate list of resident households, a neighborhood by neighborhood interview elicited the names of 206 household heads who normally use the ranch. This was done in an area of 1350 km² in less than a week.

The necessity of having as complete a list as possible and having all the producers ranked, cannot be overstressed. One recent study in Kenya (White and Meadows, 1981) proposed to examine wealth differences in group and individual ranches in Kenya. The chairman of each group ranch was asked to suggest 12 members for study: four with few livestock, four with an average number of livestock and four with more than average. The researchers were pleased to find significant differences between their wealth cohorts; they assumed that their sampling technique had tapped wealth differences on the ranches. Unfortunately that was not so. One of the ranches they studied is a ranch on which ILCA has been working for two years. In checking the sample households against the population (for which we had complete livestock censuses), it was discovered that the three strata used by White and Meadows represented the middle class, upper middle class and very rich respectively. Poor households were entirely excluded.
This was not through the ignorance of the chairman as we shall see later, but perhaps was due to his assuming that researchers studying animal and especially cattle production would have no interest in households with very few cattle. Table 3 shows the differences between White and Meadows strata and those derived from a census of all ranch households. Whereas their "poor" households owned a mean of 51 cattle, the true population mean is 15. For the "average" households, they show a mean of 218 cattle whereas the population mean is 58. For the "rich" households the Meadows and White mean is 378 cattle while the true mean is 249. For the ranch, they calculate a household mean of 215 cattle, whereas the true mean is only 109. Had White and Meadows used the technique suggested here in which a complete list of households were obtained, and ranked, a much more representative sample and hence a better study would have followed.

Reliable informants

As the degree of inter-informant reliability on wealth ranking tends to be quite high, only a few informants are required. For a small community (i.e. up to 100 producers), where it is likely that everyone knows everyone else fairly well, four or five informants (preferably of different ages) should suffice. Larger communities may need to be divided into smaller sub-areas (defined by the local social structure). Although I have not yet had the opportunity to do this myself, I see no a priori reason why the results from different sub-areas should not be merged, as long as there is sufficient overlap between the rankers. For example if each of three groups of informants rank 250 producers of whom each knows 100, the overlap should be sufficient to make a composite rank.

Despite ideologies of equality, most pastoral producers recognize that there are at least temporary differences in wealth status of the members of their community. They also recognize that people in different wealth strata are in qualitatively different positions with regard to management possibilities. In the two communities where I have done informant wealth ranking, I have had no difficulty in finding a few informants willing to do the task, probably because no precise information (e.g. how many cattle, how many wives) is required.
Table 3. Distortion through poor sampling.

<table>
<thead>
<tr>
<th>Mean household cattle ownership in a Maasai group ranch</th>
<th>Poor</th>
<th>Average</th>
<th>Rich</th>
<th>Ranch mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>51</td>
<td>218</td>
<td>378</td>
<td>215</td>
</tr>
<tr>
<td>Population</td>
<td>15</td>
<td>58</td>
<td>249</td>
<td>109</td>
</tr>
</tbody>
</table>

Table 4. Scoring an informant's ranks.

<table>
<thead>
<tr>
<th>Rank group</th>
<th>No. of men</th>
<th>Men plus dummy case</th>
<th>Final score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (high)</td>
<td>13</td>
<td>13</td>
<td>6.5</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>9</td>
<td>33.5</td>
</tr>
<tr>
<td>4 (low)</td>
<td>13</td>
<td>13</td>
<td>44.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Local concept for wealth

In order to ensure the comparability of the data obtained through the various informants, as well as to ensure that they are ranked according to the criteria the researcher desires, it is important to spend some time, preferably with one or two good interpreters, eliciting the exact local cultural concept to be tapped during the ranking.

Most cultures have a clear concept of wealth. Once the word or phrase is elicited it is useful for the researcher to spend some time determining the various elements that are considered in determining the wealth rank of a producer. Having done this with interpreters, it is also useful to elicit this information from informants after they have completed the ranking. This ensures that
the informant has understood what was required; it also can provide valuable insight into sources of wealth and differential access to local resources.

In Maasailand, the concept used was "emali" a word meaning "property" but most commonly used with specific reference to livestock holdings. Both interpreters and informants felt that the primary indication of a man's wealth was his livestock holding; subsidiary points were smallstock to cattle ratio and family size. I was told that the few Maasai who have been given individual title deeds to land would have had that property included should they have been included among the producers to be ranked.

Computation of the wealth rank

As noted, several informants are asked to rank the producers according to wealth by putting the cards on which their names are written into piles. The informant is allowed to choose the number of piles he wants. Frequently in the course of sorting, the number of piles will be increased as names appear of producers who don't quite fit into existing piles. Informants need not be literate; the names can be read to them after which they will just point to the pile where it belongs. The cards of producers whom the informant is not able to rank are just placed to one side. When the ranking is finished, the names in each pile are read to the informant. This allows for the detection of any errors; it also gives the informant a chance to review the groups he has compiled and make any necessary changes.

On the basis of the sortings, a score is constructed for each producer for each informant. Each producer is assigned a score which is the equivalent of the midpoint value of the category in which he fell. As the number of unknown producers varies between informants a number of dummy cases equal to those of unknown producers are inserted at equidistant intervals. Table 4 shows how the scores for one informant were calculated on a Maasai population of 51 producers. In order to arrive at a composite score for each producer, the scores for that producer are simply averaged together.
Informant wealth ranking in Maasailand: A case example

In order to test the use of informant ranking in a pastoral population (I had previously only used it with mixed farmers), I had four informants rank the 51 producers who live on a single group ranch in Kenya Maasailand. The results of that exercise are reviewed here briefly as a case study.

Table 5 shows the inter-informant rank correlations. The ranking of each informant is compared to the rank of every other informant. Informants 1 and 2 are young men of middle wealth. Informant 3 is an older, poorer man who happens also to be the chairman of the group ranch who had suggested the White and Meadows sample. Informant 4 is middle aged and the richest man in the population. The informants represented the four different neighborhoods on the ranch. Despite the differences in the informants' backgrounds, the inter-informant reliability is quite high (the Spearman's rho correlation coefficients range from 0.87 to 0.91). When the rank of each informant is compared to the composite or average rank, the correlations are even higher 0.95 to 0.98. These are all Spearman's rho and all are significant at P = 001). Clearly, despite age, wealth and neighborhood differences between the informants they were in high agreement about the relative wealth of the members of the ranch. In the Maasai ranking, scores ranged from a high of 3.7 (the richest) to a low of 49.5 (the poorest).

Table 5. Maasai wealth ranks.

<table>
<thead>
<tr>
<th>Inter-informant rank correlation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>0.88</td>
<td>0.87</td>
<td>0.91</td>
<td>0.96</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
<td>0.88</td>
<td>0.91</td>
<td>0.95</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.90</td>
<td>0.96</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.98</td>
</tr>
<tr>
<td>N = 52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6 shows the results of a correlation between the informant wealth rank and a ranking of producers based on an ILCA census about six months previously. It refers to the subset of 22 producers with whom the census had been undertaken. The Spearman's rho is 0.97 (Table 6A). If the two cases for which it is known that there were censusing problems (counting of more than one producer's animals), the correlation rises to 0.99 (Table 6B) (again both with a significance level of $P = 0.001$). Clearly the informant results gave an almost identical ranking of producers as the census. Fig. 1 plots the producers along two axes: livestock units censused and informant wealth rank. It presents graphically what the correlation coefficient has already indicated.

The high correlations are not an artifact of a small size. Fig. 2 depicts the relationship between the wealth ranks (done in late 1982) with livestock units censused in mid-1980 for the 41 households which were then resident on the ranch. Again the relationship is quite clear, although there has not been time to correlate the coefficients. Had the Kenya team stratified it's sample by informant wealth ranks, the results would have been identical to stratifying on the basis of a complete animal census. In fact, in a certain respect the stratification would have been better, as the initial census contained a number of significant errors as one would expect given pastoral resistance to censuses. Census errors are circled in Fig 2. Some of these are minor (e.g. counting a poor relation's animals with a rich man's herd) but others are significant.
Fig 1. Informant vs. census rank.
Fig 2. Informant ranking (1982) vs. initial ILCA census (1980).
Having obtained an informant wealth ranking, the researcher can use stratified sampling to enhance his precision. Informant wealth ranking does not totally replace censusing. After stratifying and sampling it would be critical to do an animal census to know the holdings of the sample and generalize to the holdings of the community.

On the other hand, if data must be collected opportunistically (i.e. with those producers who are amenable or accessible), informant wealth ranking can still be used to gauge the representativeness of the producers interviewed or censused.

Informant ranking techniques need not be limited to wealth. Producers can be ranked on almost any variable including age, family size, management ability etc. The technique, as I hope I have shown, is rapid, simple yet accurate.

References


Importance de l'effet de la richesse sur la production pastorale: Une méthode rapide de stratification de la richesse

Résumé

Cet exposé traite de l'importance des différences de la richesse entre les producteurs dans les systèmes de production pastorale traditionnelle. Il soutient qu'il existe des différences importantes en ce qui concerne la richesse. Que celles-ci ont des effets importants sur les stratégies de production et que la recherche sur les systèmes pastoraux doit en tenir compte à divers niveaux, qu'il s'agisse de la définition de la population-cible ou de la mise au point et de l'expérimentation d'interventions.

Il décrit une méthode rapide de détermination des strates de la richesse auxquelles appartiennent les producteurs dans une collectivité donnée. Chez les pasteurs, la richesse est un paramètre sur lequel il est très difficile d'obtenir des données exactes. Pour les éleveurs purs, la possession de bétail représente une quasi-richesse. Mais les recensements des populations animales sont souvent difficiles, voire impossibles à effectuer. L'étude soutient que les recensements du bétail ou d'autres mesures objectives ne sont pas nécessaires pour établir le rang (en termes de richesse) des producteurs au sein d'une collectivité. L'utilisation d'informateurs locaux pour classer les membres de leur collectivité en fonction de leur richesse peut fournir des résultats similaires en moins de temps et à un moindre coût.

L'informateur utilise une technique de tri de cartes dans laquelle le nom de chaque producteur est écrit sur une petite carte et plusieurs informateurs sont invités à ranger les cartes les unes au dessus des autres en fonction de la richesse des producteurs. La technique requiert l'obtention d'une liste complète des producteurs opérant au sein de la collectivité.

Etant donné que le degré de fiabilité des informateurs pour le classement en fonction de la richesse tend à être élevé, seul un nombre limité de ceux-ci sera nécessaire. Pour une petite collectivité où l'on suppose que tout le monde se connaît assez bien,
quatre ou cinq informateurs devraient suffire. Pour assurer la compara-
rabilité des données obtenues par le biais de divers informateurs et
pour s'assurer que le classement s'effectue selon les critères
souhaités par les chercheurs, il est important de consacrer quelque
temps, de préférence avec un ou deux bons interprètes, à l'étude de
certains concepts culturels locaux à exploiter au cours de la stratification.

Sur la base du tri des cartes, des points sont attribués à chaque
producteur pour chaque informateur. Chaque producteur reçoit des
points qui constituent l'équivalent de la valeur moyenne de la
catégorie à laquelle il appartient. Pour avoir la performance globale
de tels producteurs, on fait simplement la moyenne des points obtenus
par ces producteurs.

Après l'obtention de la stratification des richesses par les
informateurs, le chercheur peut utiliser des échantillons stratifiés
pour plus de précision. La stratification des richesses par les
informateurs ne peut pas remplacer complètement les recensements.
Après la stratification et l'échantillonnage, il convient de
procéder à un recensement des animaux pour déterminer la population
animale détenue dans l'échantillon et pour extrapoler à partir de
celle-ci la structure de la propriété au sein de la collectivité.

Les techniques de classification par informateur ne doivent pas
nécessairement se limiter à la richesse. Les producteurs peuvent être
classés sur la base de presque toutes les variables, y compris l'âge,
la taille de la famille, l'aptitude à gérer, etc. La technique est
rapide, simple et précise.
le regroupement des éleveurs ou des zones rurales selon divers critères. Il a fait allusion au document de M. Cossins qui a mis l'accent sur la tendance des Afars à réduire leurs troupeaux de petits ruminants et a déclaré qu'en Afrique de l'Ouest c'était la tendance contraire. La possession de petits ruminants permettait une plus grande efficacité et une plus grande flexibilité que celle des bovins, notamment parce que :

- la distribution entre les familles était moins concentrée;
- la perte en valeur unitaire était plus faible en cas de vente forcée ou de perte;
- les petits ruminants étaient moins sensibles aux pertes pondérales lorsque l'affouragement est insuffisant;
- la performance du petit bétail en matière de reproduction était meilleure et permettait par conséquent de reconstituer le cheptel beaucoup plus rapidement.

Le Dr Zulberti a mis en doute l'affirmation de M. Cossins selon laquelle "l'éleveur est la seule personne dont l'existence se base sur le lait et non pas sur la viande". M. Cossins a indiqué qu'il faisait allusion aux zones arides et désertiques où (à l'exception des zones irriguées) la laiterie était rare si tant est qu'elle y ait jamais existé. Le Dr Zulberti a exprimé son accord sur l'affirmation selon "laquelle l'éleveur cherche à optimiser le nombre de personnes qu'une superficie donnée est capable d'accueillir". M. Cossins a répondu que si les éleveurs n'avaient pas comme objectif d'optimiser le nombre de personnes par unité de surface, ils n'avaient pas besoin alors de faire du pastoralisme ; le pastoralisme constituait presque toujours un moyen d'accueillir plus de personnes par unité de surface que ne le permettraient les autres modes de production dans les zones arides. Dans ses réflexions sur le document de M. Cossins, le Dr Diakité a souligné que des approches très différentes devaient être adoptées pour étudier le pastoralisme en Australie et en Afrique. M. Cossins a exprimé son accord et a déclaré qu'il espérait que dans son document, cette distinction avait été clairement établie.
Le Dr Timbo a indiqué que dans le contexte du Sahel, les stratégies des éleveurs étaient régies dans une large mesure par la loi du plus grand nombre, afin de combattre les problèmes d'ordre climatique ou de santé animale. L'objectif primordial des éleveurs était la production des jeunes animaux/veaux et non la production de lait. Dans le Sahel, la production de lait n'avait jamais constitué une alternative de production au-delà de l'autosuffisance traditionnelle de la famille pastorale.

Dans les observations qu'il a formulées sur le document de M. Cossins, le Dr Rhissa a déclaré qu'en étudiant les éleveurs et leurs stratégies de production, les conclusions devaient tenir compte des objectifs du bénéficiaire de l'étude. L'objectif du gouvernement peut par exemple être d'aider les éleveurs à mieux s'organiser, d'assurer la sécurité alimentaire d'une zone et d'accroître la part des produits pastoraux dans l'économie nationale. Les objectifs de l'éleveur étaient de fournir du lait, d'assurer sa propre sécurité alimentaire et sociale. Le Dr Rhissa a déclaré qu'à son avis, les objectifs de l'éleveur étaient souvent négligés.

Le Dr Tilahun a fait allusion au document de Mlle Grandin et a indiqué que dans l'étude sur l'inégalité, une distinction devrait être faite entre le revenu du ménage et le revenu du ménage par tête. Mlle Grandin a accepté cette observation et a déclaré que les études devraient se pencher sur cette différence dans leurs analyses, notamment dans les sociétés proches du niveau de la subsistance où une forte proportion des dépenses était consacrée à l'alimentation qui augmentait proportionnellement avec le nombre de personnes dans la famille.
Household studies in pastoral systems research

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Introduction

This section of the workshop deals with household level data collection in pastoral systems research (PSR). It first briefly reviews differences between crop production and pastoral production which affect research possibilities. It then briefly reviews basic types of methods that may be used to collect household level data. Finally, for three important areas of household level data collection in pastoral production systems (i.e. livestock transactions, household budgets, and labour use) it discusses specific problems as well as special techniques which are available for data collection.

Farming vs. pastoral systems research

De Haan briefly mentioned some important differences between cropping systems and pastoral systems of production. Important differences also exist in research for these systems. It would be useful to reiterate some of these, particularly as they affect the collection of household level data.

Pastoral systems are marked by high mobility which causes difficulties in sample selection and long-term survey work. Logistic problems can largely determine possible sampling procedures both in terms of the general location studied and specific households within that location. Many areas are largely inaccessible to researchers on the ground, or would be so at a prohibitive cost. Given the high mobility, it is difficult to ensure that the same families can be followed throughout a long-term study. It will be more cost effective, \textit{aeteris paribus}, to study more households in fewer communities than a few households in a large number of communities.
Pastoral systems are marked by the communal sharing of major resources such that the focus on the household as a unit of production is often more problematic with pastoralists than with farmers. Generally, in order to understand pastoral management practices and strategies, far more attention must be paid to the relationships between households in a system.

Pastoral systems, unlike cropping systems, are marked by the need for continuous inputs as well as the production of at least some continuous outputs. Farming systems research (FSR) studies tend to concentrate on the agricultural growing season, which can be as short as a few months. Thus in a fairly short period of time it is possible to observe all the major inputs to and outputs from crop production. This is not possible with pastoral production systems, which have daily outputs and inputs, the nature of which can change dramatically in the course of an annual cycle. It is not possible to observe these different inputs and outputs in a short period of time. (Parenthetically it might be noted that farming systems based on certain tree crops would resemble pastoral systems in this respect).

If the research suffers from time constraints, these will be far more seriously felt in PSR. In the study of pastoral systems, at least the major seasons and their transitions (Swift, 1982; Grandin, 1982) must be identified and considered. If they cannot be observed more reliance must be put on the ability of the producer to recall and report events.

Pastoral systems are marked by long cycles of drought and post-drought recovery that are much less important in systems of annual cropping. More attention needs to be paid to long-term cycles in PSR, first in order to locate the population under study in a cyclical time frame and subsequently to be able to evaluate the long-term suitability and effects of proposed interventions.

Although it is a research difference rather than a production system difference, it is important to note that testing raises more serious problems in PSR than FSR. Some of these problems are due to factors such as mobility which have already been mentioned. Other relate to the virtual impossibility of simulating pastoral conditions on research stations.
Summary of Discussion Session 5.
Chairman: Prof. Gunnar Sorbo (Norway)
Discussion led by Dr Sitta Barry (Upper Volta)

Dr Barry commented that CILSS (Comité permanent interétats de lutte contre la sécheresse dans le Sahel) was set up in 1973 by six countries (Chad, Niger, Upper Volta, Mali, Senegal and Mauritania) following the drought of 1968 to 1973. Subsequently Gambia and Cape Verde had joined CILSS, whose mission was to

- increase the awareness of the international community to drought and its effects;
- mobilise the necessary resources to combat drought and its effects;
- co-ordinate activities to develop the Sahel and to combat drought and desertification; and
- co-operate with other organisations having similar goals.

In the field of animal husbandry CILSS had established a strategy consisting of six themes:

- increasing livestock feed resources;
- increasing livestock productivity using animal health control methods;
- organising professional channels for livestock production;
- modernising and improving marketing channels;
- recruitment, training and extension work;
- research.

Dr Barry reviewed the papers by Drs Cossins and Grandin and commented that demographic analysis should be carried out over homogeneous environments which may mean the regrouping of pastoralists or rural areas according to different criteria. He referred to Dr Cossins' paper which emphasised the tendency of the Afar to destock small ruminants, and said this was the opposite of the trend in West Africa. The possession of small ruminants could be more flexible and effective
than that of cattle because:

- the distribution between families was less concentrated;
- the loss in value per unit was lower in the case of forced sale or loss;
- smallstock were less sensitive to weight loss in case of insufficient feed;
- the reproductive performance of smallstock was better, therefore capital could be reconsolidated more rapidly.

Dr Zulberti questioned Dr Cossins' statement that 'the pastoralist is the only one who depends on milk and not meat'. Dr Cossins pointed out that he was referring to arid and desert areas where, with the exception of irrigated areas, dairying was rare if existant. Dr Zulberti disagreed with the statement that 'the pastoralist seeks to optimise the number of people that any area is capable of supporting'. Dr Cossins replied that if pastoralists did not have the aim of optimising the number of people per unit area then they would not need to pursue pastoralism; pastoralism almost certainly evolved as a way of supporting more people per unit area than any other production mode in aride areas.

In commenting on Dr Cossins paper, Dr Diakite stressed that very different approaches had to be adopted for Australian and African pastoralists. Dr Cossins agreed and said that he hoped his paper had made that very clear.

Dr Timbo suggested that in the Sahel context, the strategies of pastoralists were governed to a large extent by the law of the greatest number in order to combat climatic or animal health problems. The primary aim of pastoralists was the production of young stock/calves, not milk production. In the Sahel milk production had never been a production alternative beyond the traditional self-sufficiency of the pastoral family.
Dr Rhissa, in commenting on Dr Cossins' paper, said that when studying pastoralists and their production strategies the conclusions needed to be qualified depending on whose behalf one had been carrying out the study. A government's aims may be to help herdsmen organise themselves better, to provide the food security of a zone and to improve the contribution of pastoral products to the national economy. A pastoralist's aims were to provide milk, to attain his own food security and his own social security. Dr Rhissa felt that the pastoralists' aims were often overlooked.

Dr Tilahun referred to Dr Grandin's paper and suggested that in the study of inequality a distinction should be made between household income and household per capita income. Dr Grandin agreed and said that studies should investigate these differences in their analysis, particularly in societies close to the subsistence level where a high proportion of expenditure was on food which increased proportionally with the number of people in the family.
Résumé des débats de la cinquième séance

Président: Prof. Gunnar Sorbo (Norvège)
Débats dirigés par le Dr Sitta Barry (Haute-Volta)

Le Dr Barry a déclaré que le CILSS (Comité permanent inter-États de lutte contre la sécheresse dans le Sahel) avait été créé en 1976 par six pays (le Tchad, le Niger, la Haute-Volta, le Mali, le Sénégal et la Mauritanie) à la suite de la sécheresse 1968 - 1973. Par la suite, la Gambie et le Cap-Vert avaient adhéré à l'organisation dont la mission consistait à :

- amener la communauté internationale à prendre conscience de la sécheresse et de ses effets;
- mobiliser les ressources nécessaires pour combattre la sécheresse et ses effets;
- coordonner les activités pour développer le Sahel et pour lutter contre la sécheresse et la désertification; et
- coopérer avec d'autres organisations ayant des objectifs similaires.

Dans le domaine de l'élevage, le CILSS avait mis en place une stratégie basée sur six thèmes:

- accroître les ressources fourragères;
- accroître la productivité animale en utilisant des méthodes de contrôle de la santé animale;
- organiser des circuits professionnels pour la production animale;
- moderniser et améliorer les circuits de commercialisation;
- recruter et former du personnel et effectuer des travaux de vulgarisation;
- entreprendre des activités de recherche.

Le Dr Barry a fait référence aux documents de M. Cossins et de Mlle Grandin et a déclaré que l'analyse démographique devrait être effectuée sur des environnements homogènes, ce qui pourrait signifier
Lastly, PSR must differ from FSR because it suffers from a dearth of reliable data on which to build. The bulk of research in agricultural production in Africa has been on crop production; even within farming systems little attention has been paid to the livestock sub-sector. Gilbert et al (1980) noted with regard to the initial stages of FSR, "The poorer the data and informational base is, the more research at this stage becomes an art rather than a science and the more on-farm studies are needed to describe and diagnose the areas' characteristics and constraints". Yet as Eicher and Baker (1982) noted, "In summary, research on the behaviour of livestock herders in Africa is about at the same point where research was on the economics of crop production some 20 years ago - many assertions and a sparse supply of facts".

The need for household level data in PSR

PSR is aimed at increasing the productivity of pastoralists and improving their welfare. As much resource management, inputs, and outputs occur on the household level, data must be collected at this level to understand these important production parameters. Additionally, in the final analysis interventions generated by PSR have to be acceptable to and adopted by individual pastoral households. A good understanding of the perceptions, goals, strategies, and decision-making of individual pastoral households is essential if researchers are to effectively identify constraints and design and test interventions which must be implemented at the household level. (This does not negate the need to pay attention to extra-household relationships as noted above).

General methods available for PSR household level data collection

Although PSR will inevitably differ from FSR, there are general methods used in FSR (and generally in survey research) which can be used in a PSR framework. It is not in the scope of this paper to review these methods in detail. A number of excellent texts are available for that purpose (Collinson, 1972; Byerlee et al, 1980; Kearle, 1976; Bernstein, 1979). Nevertheless, it would be useful to list basic techniques for gathering household level data and evaluate some of their advantages.
and disadvantages particularly with respect to criteria used in FSR. Within a pastoral equivalent of FSR, the first questions would be: what exactly do we need to know and what is the most cost-effective way of obtaining the necessary data? The answer to these questions will depend on the nature and phase of the research project itself, and will determine the specific data and methods required.

Types of data collection techniques which might be used in a PSR context can be usefully scaled along two dimensions: formality and frequency. They range from informal, open-ended interviews normally done by the researcher himself, to highly formalised pre-coded questionnaires normally administered by a trained enumerator. In terms of frequency, techniques may require either single visits, limited visits, or multiple visits which may be continuous throughout the study period, or may use seasonal sub-samples. Multiple visit surveys themselves may vary considerably in terms of the frequency with which the data are collected from each producer.

Informal surveys
Informal surveys play a major role in the early stages of FSR. They are conducted by the researchers themselves without the use of enumerators, questionnaires, or random samples, and hence are rapid and qualitative. In the early stages of research, informal surveys provide critical background information on the production system, and form the basis for later, formal questionnaires. Even with the wealth of data available on cropping systems, Byerlee et al (1980) noted: "It is our experience that researchers rarely spend sufficient time on this rewarding and essential task." In PSR, informal surveys will need to play an even more important role.

Although informal techniques are often used primarily in initial surveys, it is important to note that they can be and should be more frequent. As Byerlee et al (1980) noted "(this) type of informal researcher-farmer dialogue... should be a continuous process through all phases of the programme". Informal surveys can elicit types of information that are impossible to collect with formal questionnaires. These include information on producers' strategies, decision-making, and social aspects of the production process. Sen-
sitive information is also more likely to be provided in informal contact with a researcher than with an enumerator. Generally, informal surveys give the researcher the opportunity to interact directly with the producer and explore issues as they arise, rather than in a predetermined way.

Informal surveys by themselves have several disadvantages. Firstly, as the producers are usually chosen opportunistically, the representativeness of the sample may be a problem, especially in an area where there is significant heterogeneity among producers. Secondly, as informal surveys are qualitative, their validity is more likely to be questioned by decision-makers and planners.

Case studies may be seen as a variant of the informal survey in which a carefully selected sample of households are chosen for intensive study, including frequent visits by the researchers themselves. Case studies are particularly valuable in providing data on the full range of production parameters for the sample households, including data on goals and decision making, which are impossible to glean from formal questionnaires. Through case studies, linkages in the system are more likely to be understood.

Formal surveys rely upon the administration of precisely designed questionnaires by enumerators. Formal surveys have the advantage of significantly expanding the number of households which can be included in any study. They provide standardised and quantifiable data, although there are inherent limitations in the type of data that can be collected. While sampling errors are easily decreased through formal surveys, measurement or observation biases inevitably increase. Formal surveys also have the disadvantage of requiring significant inputs for training and supervising enumerators, for coding, data preparation and analysis.

The amount of measurement error in formal surveys depends upon many factors, including the quality of the enumerators and the questionnaires, the type of data to be collected, the frequency of the visits, and the cooperation of the respondents.
Enumerators and questionnaires

The use of enumerators necessarily introduces biases in the data collected. While it is impossible to eliminate the 'enumerator effect', steps should be taken to minimize it through the proper selection, training and supervision of enumerators as well as attention to details of questionnaire design.

In addition to their suitability to conduct interviews, the enumerators selected should, to the extent possible, have the same ethnic background and if possible be known to the target population. This facilitates their acceptance by the latter and enhances their ability to explain the questions in terms and concepts the respondents understand. The latter is very important for standardisation, and will be improved upon even more if the questionnaire format is translated into the local language.

Great attention should be paid to developing the questionnaire, to be sure it taps the precise information required, to phrase it so that it enhances the recall of the respondent, and to standardise it to lessen "enumerator effects". Evidence suggests that the more precise the questions, the more likely the respondent is to recall and relate the answer. On the whole this is more tedious for both the enumerator and respondent, but if fatigue can be avoided, it is far superior in the accuracy of the data produced.

The accuracy of enumerators is enhanced by training them so that their understanding of the terms used in the questionnaires and the procedures for administering them is standardised. In training enumerators, the ILCA Kenya team asked them as a group to translate the proposed questionnaires into the Maa language. Considerable debates followed which were instructive to both the enumerators and the researchers. Once the questionnaires were standardised and pretested, role playing was used for further training, with the researchers trying to approximate all conceivable problems. Lastly enumerators were observed while they administered the questionnaires to non-sample households. If at all possible, one should start training more than the required number of enumerators so that at the end of training one will have a better selection on the basis of their observed performance.
If a questionnaire is at all complicated, the enumerators will still be learning in the initial phases of administration. Close supervision will be required in checking the responses so that errors (either in format design or administration) can be corrected before they are made repeatedly. The first set of data collected by the enumerators should be analysed as quickly as possible to assess its quality.

One cannot over-emphasise the high degree of vigilance required to ensure good quality data in survey work. (For a detailed discussion of quality control and correction of enumerator bias using analysis of variance, see Zarkovich, 1966).

Data type

Not all events are equally well remembered. In terms of probability of good recall, events can be scaled along two dimensions: frequency and regularity. Events which are regular are less likely to be remembered individually, but producer estimates of their occurrence are likely to be adequate. Irregular events which occur rarely (such as livestock transactions) are likely to be remembered individually, but frequently occurring irregular events will pose great difficulty in recall and will necessitate high frequencies of questioning. Labour inputs and expenditures fall in the latter category.

Although this section concentrates on recall, it must be noted that information on certain types of events (e.g. treatment of animals) might best be gathered by actual observation rather than questioning. However, for most data, observation is far more time consuming and consequently far more expensive than recall.

Frequency of visits and end effects

The frequency of visits needed depends to a large extent on the type of event to be recalled (or observed). The frequency will also depend upon the depth of data desired on the event in question. For example, if detailed questioning about decision-making is desired, greater frequency would be helpful.

All surveys based on recall suffer from "end effect", i.e. the difficulty of specifying the limits of the period for which
information is requested and the tendency of respondents to include events from outside this reference period. In multiple-visit surveys, the frequency of the visits will normally define the reference period, which is normally the time lapsed since the last visit of the enumerator. End effect problems occur with the first interview as the end point of the period of reference is often unclear. It is strongly recommended that the data from the first interview be excluded from analysis as it is invariably over-reported. Single-visit surveys suffer particularly from end effect problems unless the period can be clearly specified. Collinson (1972) advocates limited visits for certain data collection and stresses the need to use time frames that fit a local natural or cultural cycle.

Single-visit formal surveys. Single-visit formal surveys form an integral part of FSR methods as currently advocated by CIMMYT (Byerlee et al, 1980). Their primary role is to quantify and verify the hunches which have emerged from the initial informal survey. Single-visit surveys are most appropriate for collecting information on variables (such as herd structure) for which a single objective measurement will suffice. They may also be used to collect general data on a relatively small number of variables particularly when the essential parameters of the production system are already well understood. For well remembered and registered events (e.g. livestock transactions) single-visit surveys may be able to elicit time-depth data on actual events. For non-registered events, single-visit surveys rely more on the producer's ability to estimate, based on general experience, rather than recall actual events; as such, they produce averages rather than indicate variability, and are inadequate when time series data are required.

Multiple-visit formal surveys. Multiple-visit formal surveys have several advantages over single-visit surveys. They provide time series data, are more likely to reflect actual events rather than estimations, benefit from learning on the part of both the enumerator and respondent. However, as the number of visits is increased, given the same amount of resources, the number of households must be de-
creased. Again, careful attention must be paid to the nature of the data required in order to decide between measurement and sampling biases.

In literate societies, it is possible for respondents to keep written records of the variables under study. This is almost impossible in pastoral systems research. However, Swift (1981) believes it may be possible to find, hire, and train local residents to collect time series data, with a minimum input from senior researchers.

When time series data are desired, decisions must be made as to whether the recording will be continuous or non-continuous. For example, rather than recording continuous expenditures, it might be possible with care to subsample within the important seasons.

**Respondent cooperation and bias**

Whatever the information collected, it is necessary to distinguish between the respondent's ability and his willingness to respond. The producer's ability to respond to the questionnaire is largely a function of survey design: whether the questions are well phrased and solicit information which it is possible for him to remember. Multi-visit surveys appear to have a learning component, so that some improvement in recall occurs, provided that it is not offset by respondent fatigue.

A respondent's willingness to respond, however, is a function of his general level of cooperation as well as the sensitivity of the data solicited. FSR researchers frequently note value of early interventions in increasing the general level of cooperation. Nevertheless, there are still likely to be social/psychological factors which encourage inaccurate, and especially selective, reporting. These may be due to a desire for greater prestige, fear of shame, or a cultural taboo on certain topics. Case studies and participant observation are particularly useful to evaluate and adjust for such reporting biases.

Having briefly reviewed types of data collection methods for household level research, this session now turns to specific
topics and methods. We will discuss, in turn, livestock transactions, household budget, and labour studies.

References


Byerlee, D. and Collison, M. 1980. Planning technologies appropriate to farmers - Concepts and procedures. CIMMYT.


Les enquêtes sur les ménages dans la recherche sur les systèmes pastoraux

Résumé

La recherche sur les systèmes pastoraux a pour objectif d'accroître la productivité des éleveurs et d'améliorer la qualité de leur vie. Étant donné que s'effectuent dans le ménage des échanges intersectoriels et des opérations de gestion, il conviendrait de recueillir des données à ce niveau pour comprendre ces importants paramètres de production. Les interventions engendrées par la recherche sur les systèmes pastoraux doivent être acceptables pour les éleveurs et adoptées par les ménages pastoraux. Pour que les chercheurs puissent identifier de manière effective les contraintes et mettent au point puis testent les interventions qui doivent être introduites au niveau du ménage, il faudrait qu'ils acquièrent une connaissance approfondie de l'opinion, des objectifs et de la stratégie des ménages pastoraux ainsi que du mécanisme de prise de décision.

Les types de techniques de collecte de données qui doivent être utilisées dans le cadre d'une recherche sur les systèmes pastoraux peuvent être déterminés selon deux critères: la forme et la fréquence. Ils varient des interviews informelles à bâtons rompus effectuées normalement par le chercheur lui-même, aux questionnaires précodés de type très classique, remplis normalement par un enquêteur qualifié. En ce qui concerne la fréquence, les techniques peuvent faire appel à des visites uniques, à des visites limitées ou multiples qui peuvent être continues pendant toute la période de l'étude ou à des sous-échantillons saisonniers. Les enquêtes à visites multiples peuvent elles-mêmes varier en ce qui concerne la fréquence de la collecte des données auprès de chaque producteur.

Les enquêtes informelles jouent un rôle important dans la phase initiale de la recherche sur les systèmes d'exploitation agricole. Elles sont effectuées par les chercheurs eux-mêmes sans la participation des enquêteurs et sont par conséquent rapides et de qualité élevée. Lors de la phase initiale de la recherche, les enquêtes informelles fournissent des informations importantes sur le système
de production et constituent la base des questionnaires de type classique qui seront élaborés après. Les enquêtes informelles comportent elles-mêmes de nombreux inconvénients. Etant donné que les producteurs sont généralement choisis de manière opportuniste, la représentativité de l'échantillon peut poser un problème, notamment dans un domaine où il y a beaucoup d'hétérogénéité entre les producteurs. Etant donné que les enquêtes informelles sont qualitatives, leur validité est beaucoup plus sujette à caution pour les décideurs et les planificateurs.

Les enquêtes de type classique se fondent sur la distribution de questionnaires conçus de manière précise par les enquêteurs. Les enquêtes de type classique ont l'avantage d'accroître de manière significative le nombre des ménages qui peuvent être inclus dans une étude. Elles fournissent des données harmonisées et quantifiables, quoiqu'il y ait des limites inhérentes aux types de données susceptibles d'être recueillies. S'il est vrai que les erreurs d'échantillonnage diminuent facilement dans les enquêtes de type classique, par contre, les distorsions en ce qui concerne les mesures ou les observations augmentent immanquablement. Les enquêtes de type classique ont également l'inconvénient d'exiger des ressources importantes pour la formation et la supervision des enquêteurs en vue du codage, de la préparation et de l'analyse des données. La quantité des erreurs de mesure dans les enquêtes de type classique est fonction de plusieurs facteurs, y compris la qualité des enquêteurs et des questionnaires, le type des données à rassembler, la fréquence des visites et la coopération des enquêtés.

L'utilisation des enquêteurs introduit des distorsions au niveau des données collectées. S'il est impossible d'éliminer l'effet de l'enquêteur, des mesures doivent être prises quand même en vue de les minimiser grâce à une sélection appropriée, à la formation et à la supervision de l'enquêteur de même qu'à la vigilance dans la conception des divers éléments du questionnaire.

La fréquence des visites nécessaires dépend du type de l'événement dont il faut se rappeler. La fréquence dépend également de la
"profondeur" des données désirées sur les événements en question.

Le rôle primordial des enquêtes de type classique à visite unique consiste à quantifier et à confirmer les impressions qui émergent des enquêtes informelles initiales. Les enquêtes de type classique à visites multiples ont plusieurs avantages sur les enquêtes à visite unique. Elles fournissent des données sur les séries chronologiques et permettent en général de recueillir des informations sur des événements qui ont effectivement eu lieu plutôt que sur des estimations. Ces données permettent d'apprendre beaucoup de choses sur l'enquêteur aussi bien que sur l'enquêté.
Livestock transactions data collection

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Introduction

This paper focuses on livestock transaction data. It discusses the need for data on livestock transactions in pastoral production systems and then considers several methods through which desired data can be collected.

Livestock transactions are defined as all voluntary offtake and acquisition of livestock, whether permanent or temporary. Thus for acquisition they exclude birth, but include purchases and acquiring animals as gifts, on loan, as bride price or by any other "socially mediated" means. For offtake they exclude death but include such transactions as sales, gifts, exchanges of animals (for other animals or any other product), slaughter, loans etc. Although births and deaths are excluded by definition from livestock transactions, methods used to collect data on transactions can frequently be extended to include data on births and deaths.

Need for data on livestock transactions in PSR

Previous studies in pastoral systems have provided little quantitative data on the range of livestock transactions. The anthropological literature contains numerous descriptions of the ranges of livestock transactions open to producers of different societies. On the whole, however, ideal norms rather than actual behaviours are described. In contrast, the economic literature focuses primarily on the "final offtake rate". This is not consistently defined, but normally includes only sales out of the area and in some cases slaughter for home consumption (Eicher and Baker, 1982).

This paper argues that in investigating a pastoral production system it is critical to study all transactions which affect
offtake and acquisition; whether or not they are commercial and whether or not the animal leaves the area (or enters from outside).

Firstly this data is necessary to understand how the producer manipulates his animals to fulfill both short and long-term needs and goals. As Gilbert, Norman and Winch (1980) noted with reference to FSR, "The objectives of the farmer or farming families are directly incorporated into the designing and testing of strategies. An attempt is made to understand the farmers' objective functions in the initial descriptive or diagnostic stage."

Secondly, data on complete transactions, coupled with data on births and deaths, provide a means of assessing livestock productivity which is complementary to the recording of direct production parameters. If overall productivity is defined as the overall offtake rate together with herd increase (or decrease), total offtake as well as total acquisition must be assessed to properly interpret rates of change both in the number of animals and the structure of the herd.

To underline the importance of studying total transactions, Fig. 1 presents data obtained on one group ranch in Kenya. It shows for poor and rich households the mean annual value of permanent offtake. It also shows this value broken down by type of transaction: sale, exchange, gift and slaughter for home consumption. While the actual value of transactions varies greatly between the rich and poor households, the percentage by transaction type does not. For both groups, sales represented only slightly more than half of the transactions. Approximately 45% of the value of transactions was through non-commercial channels. This emphasises the need to study the full range of transactions. This information is critical not only for understanding the producer's goals in herd accumulation, but also for tapping his wider strategies. It is well documented that social transactions of animals are important in African pastoral systems not just as mechanisms of herd accumulation and disposition, but because they serve diverse functions such as risk aversion and development of social networks which may play a critical role in future access to resources.
Specific types of data required

As always in a PSR context, the first questions must be what exactly do we need to know, and what is the most cost-effective way of obtaining the necessary data. The answer to these questions will depend on the nature and phase of the pastoral systems research proj-

Fig. 1. Value of permanent offtake by transaction type: A Maasai example.
ect itself. Thus it is not possible a priori to suggest specific data required nor specific methods for every case. Despite this need for goal-oriented specificity in research, it is nevertheless useful to describe what information about livestock transactions is generally needed especially during descriptive phases of research, as well as possible methods of collecting it.

Important background information for understanding pastoralist's behaviour and strategies which can be obtained by informal surveys include:

1. The general uses of livestock within the society, including both economic and social aspects.
2. Within the economic sphere the general goals of the enterprise (milk/meat; commercial/subsistence).
3. The distribution of rights to animals and their products, which are frequently not exclusive in pastoral systems.
4. Culturally available means of acquisition and offtake of animals.

For individual transactions, data should at least include information on the transaction type, the species, age category and sex of the animal. However, information collected on livestock transaction is easily extended to provide data on a number of other production/consumption parameters. For example, information on price is obviously important for household budget studies. Information on the person with whom the transaction was done (e.g. his residence, relationship) provides important social network data, while information on what precipitated the transaction provides further insights into production strategies.

**Extensive survey methods in livestock transaction studies**

For the more quantitative data on the totality of livestock transactions, the use of some recall techniques is essential unless one can have trained recorders in every household. This paper will briefly discuss multiple-visit techniques, then explore in more detail the single-visit progeny history technique.
As voluntary offtake or acquisition is relatively infrequent, important and discrete, its occurrence is usually well remembered by pastoralists. To my knowledge there has been no study comparing data obtained by enumeration at different intervals in multiple-visit techniques for livestock transaction data. The Kenya team has used twice weekly data collecting. The other Mali team, as part of its continuous livestock productivity studies described earlier in this workshop by Wilson, collects data monthly on a series of tagged herds and flocks. The timing of the visits will depend on resources available and on what other data are being collected. Thus, for example, the high frequency in one Mali sample was chosen to coincide with the collection of labour data rather than because it was felt to be necessary in and of itself. The frequency will also depend on the depth of data desired on the decision-making about livestock transactions. While the more discrete details of transactions etc.) are likely to be remembered for a long time, details on decision making (e.g. why that specific animal at that time) are better elicited at more frequent intervals.

With single-visit techniques the reference period can be quite problematic. As part of its initial survey in the group ranches, the Kenyan team asked producers about their sales for the previous year. The figures on the whole were several times those elicited subsequently by more frequent visiting. It is clear that a major problem was the reference period. As the out-off point "one year ago" was not clearly distinguished in the pastoralists' mind; once they started reporting sales they just kept on until fatigue or memory problems intervened.

With single-visit techniques, it is recommended that the reference be not a period of time. The progeny history technique, which is discussed later, avoids the reference period problem by using individual animals as the focus of questioning.

As livestock transaction events are relatively easy to recall, perhaps the most important factors which encourage inaccurate reporting are social/psychological ones. For example, in Maasailand certain transactions are considered to be more prestigious than others. Generosity is stressed in Maasai culture, whereas it is thought im-
proper to brag about the number of animals you have acquired. As a result, producers tend to report giving more animal gifts than they receive. For the same species/age/sex category, gifts given are also appraised at a higher value than gifts received. In one study site, this resulted in the value of animals reported received being only 43% of the value of animals reported given away.

Similarly, exchanges are probably selectively under-reported. In Maasailand, exchanges of an adult castrate for a young female are quite common. These exchanges are described as being initiated by a person "begging" for the castrate because of some "problem". Female breeding stock are highly valued. It is more prestigious to be able to increase one's breeding stock by acquiring a young female than to have to sacrifice such an animal by exchanging it for a needed castrate. In a parallel fashion, it is more prestigious to have a surplus adult castrate to exchange out than to need such an animal from outside the herd. Given this, it is not surprising that, whereas in one year a random sample of producers reported exchanging in a large number of immatur females (13 cattle, 25 smallstock), they reported exchanging our very few (1 cow and 1 smallstock). This discrepancy is primarily due to selective reporting as partners in exchanges are primarily other Maasai from the same or neighbouring group ranches.

The progeny history technique

A useful method for collecting data on livestock transactions, especially offtake, is the progeny history technique. It was originally developed in Ethiopia by a team from the Ministry of Agriculture and has been used extensively by several ILCA staff, including Cossins in Ethiopia, myself in Nigeria (Grandin, 1981), and most recently by Wilson and Wagenaar (1982) in Niger. It is also currently being used by the ILCA Kenya team, although results from this exercise are not yet available. This section describes the technique, then discusses the extent to which it can be varied and intensified.

In the progeny history technique, with reference to each adult female animal sampled, the producer is asked how it entered the herd, then about the offspring to which it gave birth. Information on the sex and disposition is solicited about each offspring in turn.
The progeny history method essentially depends on the ability of the pastoralist to know, recall and be willing to tell you the life history of his animals. I and other who have used the technique feel that particularly for the major species of animals it is quite accurate.

For a very rapid appraisal, the choice of the animal can be opportunistic. For a more in-depth study, a more systematic sample of animals would be preferable. On the basis of this minimal information, it is possible to calculate roughly what percentage of the animals of each sex leave the herd through death, sales, gifts, or any other socially-mediated means of transacting animals.

A number of intensifications of the technique are possible. These require more a priori knowledge of the system and more time to elicit the information. One important way of intensifying the data is to solicit information on the timing of events. Using local terms for seasons it is frequently possible for the pastoralist to remember at what season the particular animal was born, died or was otherwise disposed of. This is particularly true for recent progeny. Furthermore should a calendar of local events be available, in many cases it is possible to determine the year in question. For cattle, a calendar of 10 to 15 years would be sufficient, for smallstock a shorter one would suffice, while for camels 15 years may be necessary.

Secondly, information about strategies and motivations can be elicited. This may include social data on the party to a transaction, reasons for disposition etc. In Maasailand, for example, pastoralists will readily state what motivated a sale (specific need for money, infertility of the animal etc.). Thirdly, for deaths, the pastoralist's diagnosis can be elicited.

The interview need not necessarily be done with the producer or herd owner. Rather, it is preferable to interview the person who is most likely to know the history of the animals. In pastoral societies in which animals are allocated to women for milking, or other reasons, it may be most useful to interview the women of the household rather than the producer. For example in Maasailand ILCA personnel have successfully interviewed older herd boys for progeny histories. Particularly when herd boys are members of the family,
they tend to know a good deal about the history of the animals under their care. This information is transmitted to them as part of their pastoral training.

The progeny history technique has the distinct advantage of providing time-depth information. Given the cycles of drought and post-drought recovery which typify pastoral systems, this is an important element of information-gathering. Although it is dependent upon the recall ability of pastoralists, pastoral research specialists have often noted that the history of animals and their progeny is well remembered as it is considered critical information for management and selection purposes.

For example, older Maasai women have been able to recall numerous details of the progeny of offspring allocated to them at their weddings 20 to 30 years earlier. Certainly recall will be better for animals still in the herd as well as for more discrete events. Disaster often confuses memory of sequential events. Thus, Maasai at least, have more difficulty in remembering specific events which occurred during the last major drought seven years ago. They will often say, "The dam had several offspring that died in the drought but I don't remember the details."

To the best of my knowledge, however, this technique has never been assessed for its reliability. As part of its ongoing work, the ILCA team in Kenya is concurrently doing progeny history and extensive data collection (by monthly interviews) on livestock offake and acquisition. We will soon be in a position to compare these two methods of collecting data on livestock transactions.

The progeny history technique is not quite as good for collecting data on acquisition as it is for disposal. However, it can be supplemented easily in order to get some time-depth. If the dam was born into the herd, the origin of its mother is recorded. Secondly, particularly if a complete herd enumeration has been made, it is possible to find out the origin of all of the animals currently in the herd. If there is no such enumeration available, it is possible to ask the producer which of his animals were not born into the herd and subsequently ask how and why they were acquired.
References


Collectes de données sur les transactions de bétail

Résumé

Cette étude examine la nécessité de données sur les transactions de bétail dans les systèmes de production pastorale et envisage plusieurs méthodes grâce auxquelles les données souhaitées peuvent être recueillies.

Les transactions de bétail sont définies comme étant l'écoulement et l'acquisition de bétail soit à titre temporaire, soit à titre définitif. Les études précédentes sur les systèmes pastoraux ont fourni très peu de données quantitatives sur les transactions de bétail. Ce document soutient qu'en étudiant un système de production pastoral, il est important d'étudier toutes les transactions relatives à l'écoulement et à l'acquisition, que ce soit à titre commercial ou non, qu'il s'agisse d'entrée d'animaux dans la zone ou de sortie de celle-ci. Ces données sont nécessaires pour comprendre comment le producteur manipule ses animaux pour satisfaire ses besoins et réaliser ses objectifs à court et à long termes. Les données sur les transactions conjuguées avec les données sur les naissances et les décès complètent à merveille les relevés de paramètres directs de production et constituent un moyen adéquat d'évaluer la productivité de l'élevage.

Parmi les informations de base qui permettent de comprendre le comportement et les stratégies des éleveurs figurent les utilisations générales du bétail dans la société, les objectifs généraux de l'exploitation, l'attribution de droits aux animaux et à leur produits et les moyens culturels d'acquisition et d'écoulement des animaux. Ces données peuvent être recueillies grâce aux enquêtes informelles.

Pour les données plus quantitatives sur l'ensemble des transactions de bétail, l'utilisation de certaines techniques de rappel est essentielle à moins qu'on ne dispose d'observateurs qualifiés dans chaque ménage. L'une des méthodes les plus utiles pour la collecte des données sur les transactions de l'élevage, notamment en ce qui
concerne l'écoulement des animaux, est la technique de l'histoire de la progéniture. Celle-ci est née en Éthiopie où elle a été mise au point par une équipe du ministère de l'agriculture. Elle est actuellement utilisée par l'équipe du CIPEA au Kenya. Avec la technique de l'histoire de la progéniture, pour chaque femelle adulte faisant partie de l'échantillonnage, on demande au producteur comment elle est entrée dans le troupeau puis on lui pose des questions sur sa progéniture. Des informations sur le sexe et sur le caractère sont demandées ensuite sur chaque rejeton. La méthode de l'histoire de la progéniture se fonde essentiellement sur la capacité de l'éleveur de retracer l'histoire de ses animaux. La technique a l'avantage distinct de fournir des informations qui remontent à une période reculée. Étant donné les cycles de sécheresse et de reconstitution qui caractérisent les systèmes pastoraux, il s'agit là d'un élément important de la collecte des données. La technique n'est pas aussi bonne pour la collecte des données sur l'acquisition qu'elle l'est pour la collecte des données sur l'écoulement. Toutefois, elle peut être facilement complétée pour obtenir des données qui remontent à une période assez reculée. L'équipe du CIPEA au Kenya effectue en même temps la collecte extensive de données et utilise l'histoire de la progéniture en ce qui concerne l'acquisition et l'écoulement de bétail. L'équipe sera bientôt en mesure de comparer ces deux méthodes de collecte de données sur les transactions de bétail.
Household income and expenditure studies

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Introduction

Very little is known about the economics of household level activities in pastoral production systems (Eicher and Baker, 1982). Despite this, interventions are frequently proposed which call for increased cash expenditures. The implications of this for different groups of households (poor, rich) needs to be assessed. An intervention may require increased labour input. Will there be enough labour and if so will sufficient food be available to sustain the energy requirements of increased effort? An intervention may call for culling of non-productive and old animals from herds and flocks. What is the implication of this for the security and viability of different groups of pastoral households (rich, poor)? What needs of pastoral households can be manipulated to provide incentives for culling? It is in such a context that information on household income and expenditures is required.

Testing and evaluating the impact of interventions as well as assessing the welfare of pastoralists require bench-mark data on income and expenditure patterns of different groups of pastoral households.

Unlike agriculturalists, pastoral households depend more on market transactions to satisfy their subsistence needs. Our own work in Kenya shows that even during the wet season the Maasai obtain up to 50% of their calorie intake from purchased food. This figure can increase to 70% during the dry season. Household income and expenditure data are useful for determining the demand of pastoralists for purchased goods and social services and for assessing the terms of trade between pastoralists and the rest of the economy. A very good example is given by Swift (1979) for Somali pastoralists. He analysed
the barter terms of trade between pastoral products sold by pastoralists and those they purchase by constructing a pastoral cost of living index. He concluded that by the early 1970s their terms of trade had deteriorated and had "led the pastoral economy into a precarious position".

Collection of households income and expenditure data

In addition to producing milk and meat for their own consumption, pastoral households engage in a variety of transactions involving livestock, livestock products, cash and other items (such as crops, handicrafts etc.), to fulfill different goals. Animals and their products are sold to provide cash. They are given or lent to kin and friends to strengthen social ties and ensure long-term security. They may be similarly received. Animals may be exchanged for social reasons or to increase the productive capacity of herds and flocks.

In order to determine the entire household budget, income and expenditure studies should be designed in such a way as to include not only cash income and expenditures but also these important transactions. Usually, the quantities of these transactions are known and their values can be determined by using prices the items would have attracted had they been sold.

Sampling the target population

In any society the most important factor that influences patterns of household income and expenditure is the wealth status of the household. It is self-evident that the consumption of poor and rich households is markedly different. It is therefore essential that study samples adequately represent the gradient of wealth observed in the pastoral group under study. This may not present a problem in situations where a whole village or encampment or target population is studied as done by the ILCA teams in Mali and Kaduna. Even then villages and camps may be formed on the basis of social classes. Care should be taken in selecting sample villages and camps so that results can be generalisable to a known population type. In situations where the coverage in area is more extensive one has to resort to sampling the population as done by the ILCA teams in Kenya and Ethiopia. In that case a
stratification of the population into wealth categories is essential (see Grandin (1983) for a detailed discussion of wealth effects and a rapid method of wealth ranking).

Given such a stratification of the target population, the available resources for collecting data and the time-frame and nature of the study, standard sampling procedures can be employed to determine the size of the sample and choosing them (Cochran, 1963).

Types of data required

Inventory of resources

Once the sample households in the study have been determined, an initial inventory of the human and livestock population needs to be made. Here care should be taken so that animals owned by the household but which are away from the main herd or flock at the time of the inventory are included. Animals not owned by the household but borrowed from others should be identified and recorded as such. Similarly members of the household who are away at the time of the census should be included and temporary visitors excluded. An inventory of major household goods also gives a good indication of investment and consumption patterns.

This information is vital for two reasons. First, it quantifies the wealth status of the sample household. Second, it provides the basic population data to perform per capita computations without which meaningful comparative analysis cannot be made.

Household income and expenditure items

For designing the data collection formats background information is required on the nature of items that form the income and consumption baskets of the pastoral households to be studied as these vary from culture to culture. A comprehensive list of these items should be established from the researcher's personal knowledge or from informal surveys involving a few pastoralists and shopkeepers in the area or a combination of these. In addition to standardising the format for enumeration, it is also a good device to facilitate recall by respondents.
The income items include:-
- livestock and livestock products (animals, milk, ghee, hides and skins, manure etc.)
- agroforestry products (crops, wood, charcoal, honey etc.)
- cottage industry products (handicraft, beer, medicinal herbs etc.)
- other forms of employment (trade)
- other cash inflows (remittance, borrowing)

Cash expenditure items can be grouped as:-
- food
- health and hygiene
- clothing
- transport
- livestock
- livestock inputs
- durable household goods
- others (cash outflows such as loans given).

Frequency of data collection

Extracting information on household budgets, especially expenditures, is extremely difficult because one has to rely on the memory of the respondents to recall such data. Information on pastoral households' income is by far easier to get because most of it is derived from the sale of animals, which they remember very well. The fact that such sales happen very infrequently facilitates recall. On the other hand, expenditures, especially on food items, occur so frequently in irregular amounts that recall becomes difficult.

In collecting household income and expenditure data, the shorter the time span the respondent is requested to recall the more accurate is the information obtained. Researchers have used different frequencies of collecting such data ranging from one-shot surveys asking questions to estimate income and expenditure for a specified period of time (e.g. per month or per week etc.), to continuous daily recording for a long period of time (a year or more). Within ILCA, the Kenya team has used a frequency of once a month, the Kaduna and Mali teams twice weekly. Of course the latter is more reliable but
is, however, very expensive. Unless it is combined with the conduct of other research requiring daily observations, it may not be solely justified on the basis of the precision gained. Even after using this method in Mali, Swift (1983) writes:

'It is likely that enumerators were only partially successful in recording these details of household daily transactions. There was inevitably some resistance to such detailed questioning and at times clearly false information was given or important transactions were forgotten or concealed.'

Our own experience in Kenya using a once-a-month recall method proved that respondents could account only for about 70% of their cash income. In conjunction with a nutrition study, which required food intake data on a daily basis, household expenditures were monitored for a month on a daily basis on selected households. A comparison of the two methods showed that the monthly recall accounted for 73% of the total expenditures recorded on a daily basis.

Table 1. Comparison of monthly and daily recalls on four households in Merueshi Group Ranch, Kenya (October, 1982).

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CASH EXPENDITURES FOR ONE MONTH ON</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food</td>
<td>Livestock</td>
<td>Others</td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monthly recall</td>
<td>Daily recall</td>
<td>Monthly recall</td>
<td>Daily recall</td>
<td>Monthly recall</td>
<td>Monthly recall</td>
<td>Daily recall</td>
</tr>
<tr>
<td>KShs</td>
<td>1308</td>
<td>3047</td>
<td>1905</td>
<td>1980</td>
<td>1188</td>
<td>1015</td>
<td>4401</td>
</tr>
<tr>
<td>Proportion of total</td>
<td>0.30</td>
<td>0.50</td>
<td>0.43</td>
<td>0.33</td>
<td>0.27</td>
<td>0.17</td>
<td>1.0</td>
</tr>
<tr>
<td>Ratio of monthly recall to daily recall</td>
<td>0.43</td>
<td>0.96</td>
<td>1.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: ILCA/Kenya (unpublished data).
However, this percentage varied significantly across different expenditure categories as shown in Table 1. The monthly recall method underestimates food expenditures substantially, proving that frequent but irregular flows are hard to recall during a long period of time. Researchers with wide experience in this field recommend that a three-day span is the most that respondents can recall with a high degree of accuracy (Nestel, pers. comm.)

The frequency of collecting household and income expenditure data should depend on the nature of the research. If a complete understanding of the process is required the highly expensive more frequent methods need to be used. If general orders of magnitude are required the less frequent methods may be used. One may even sample seasonally by concentrating interviews during specific months or weeks in dry and wet seasons. Unfortunately, one may not encounter normal wet and dry seasons, especially in East Africa. One must, therefore, take into account the degree of representativeness of such samples in the analysis of the data (see below).

Quality control in enumerator data collection

Invariably, enumerators are used to advantage to obtain income and expenditure data covering a large number of households in one or more geographic locations simultaneously. The use of enumerators, however, introduces biases in the data collected as noted above. Careful training and supervision is essential.

Analysis of data

Table 2 shows a summary of income and expenditure patterns of Tuareg households in Mali. The dominant source of income is the sale of animals, representing 42% of total income. Salaries earned are a close second accounting for 35%. Income from cereals, other food and consumption items and clothing is not from the sale of these items as such, but represents the value of these items obtained in exchange. The purchase of food items accounts for 49% of total expenditures, the most prominent item being cereals (22%). Expenditure on the purchase of livestock and livestock inputs is also high (32%) followed by expenditures on clothing (10%).

- 294 -
Table 2. Mean annual household income and expenditure of 16 Tuareg households in Mali.

<table>
<thead>
<tr>
<th></th>
<th>Income Amount (MF)</th>
<th>Income %</th>
<th>Expenditure Amount (MF)</th>
<th>Expenditure %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals</td>
<td>92,350</td>
<td>42</td>
<td>66,194</td>
<td>32</td>
</tr>
<tr>
<td>Milk</td>
<td>1,069</td>
<td>-</td>
<td>6,600</td>
<td>3</td>
</tr>
<tr>
<td>Cereals</td>
<td>16,038</td>
<td>7</td>
<td>46,919</td>
<td>22</td>
</tr>
<tr>
<td>Other food and consumption</td>
<td>15,963</td>
<td>7</td>
<td>51,319</td>
<td>24</td>
</tr>
<tr>
<td>Clothing</td>
<td>1,813</td>
<td>1</td>
<td>21,506</td>
<td>10</td>
</tr>
<tr>
<td>Equipment and artisan work</td>
<td>15,150</td>
<td>7</td>
<td>9,556</td>
<td>5</td>
</tr>
<tr>
<td>Salaries etc.</td>
<td>78,250</td>
<td>35</td>
<td>9,425</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>220,656</strong></td>
<td><strong>100</strong></td>
<td><strong>209,519</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Swift (1982).

Tables 3 and 4 give a summary of per capita income and expenditures of Maasai households in Mbirikani Group Ranch in Kenya. In this case opportunities to earn income from employment outside the pastoral sector are restricted. Livestock sales (mainly cattle) represent a very high proportion (83%) of total cash income. The only other significant source of cash income is trading in livestock, which provides 11% of total cash income.
Table 3. Sources of cash income of Maasai pastoralists in Mbirikani Group Ranch (July 1981 to June 1982)

<table>
<thead>
<tr>
<th>Source</th>
<th>KShs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cattle</td>
<td>1523</td>
<td>83</td>
</tr>
<tr>
<td>smallstock</td>
<td>1474</td>
<td>81</td>
</tr>
<tr>
<td>milk sales</td>
<td>49</td>
<td>2</td>
</tr>
<tr>
<td>hides &amp; skins</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trading</td>
<td>205</td>
<td>11</td>
</tr>
<tr>
<td>Remittance</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Borrowing</td>
<td>42</td>
<td>2</td>
</tr>
<tr>
<td>OTHERS</td>
<td>38</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1821</td>
<td>100</td>
</tr>
</tbody>
</table>


Table 4 gives a more disaggregated picture of mean per capita cash expenditure for food and non food items excluding purchases of livestock and livestock inputs. Cereals, sugar (consumed in tea with milk) and fats/oils, which provide a substantial portion of the calorie requirements of the Maasai, are the major items of cash expenditure, followed by clothing.

From the above it is clear that the pastoral households studied both in Mali and Kenya spend a very high proportion of their income on food and livestock. The income elasticity of food expenditure is very low.
Table 4. Annual per capita expenditure on food and non-food items by Maasai households in Mbirikani Group Ranch (July 1981 to June 1982).

<table>
<thead>
<tr>
<th>Food items</th>
<th>Expenditure</th>
<th>% of total food items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>222*</td>
<td>49</td>
</tr>
<tr>
<td>Wheat</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Sugar</td>
<td>55</td>
<td>14</td>
</tr>
<tr>
<td>Tea</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Fat/oils</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>Potatoes</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Meat</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Other food</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>387</strong></td>
<td><strong>86</strong></td>
</tr>
<tr>
<td>Hotel food</td>
<td>28</td>
<td>6</td>
</tr>
<tr>
<td>Hotel drink</td>
<td>36</td>
<td>8</td>
</tr>
<tr>
<td><strong>Subtotal food items</strong></td>
<td><strong>451</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-food items</th>
<th>% of total non-food items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>3</td>
</tr>
<tr>
<td>Kerosine</td>
<td>2</td>
</tr>
<tr>
<td>Soap/Omo</td>
<td>5</td>
</tr>
<tr>
<td>Transport</td>
<td>13</td>
</tr>
<tr>
<td>Medical</td>
<td>9</td>
</tr>
<tr>
<td>Clothing</td>
<td>47</td>
</tr>
<tr>
<td>Household items</td>
<td>3</td>
</tr>
<tr>
<td>Beads</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal non-food items</strong></td>
<td><strong>84</strong></td>
</tr>
</tbody>
</table>


*74 kg per capita per annum.
Since the consumption of other items is almost negligible, the implication is that any increased income will be largely spent on the purchase of breeding stock unless attempts are made to increase pastoralists' demands for other consumption and investment items.

A more sophisticated analysis of household income and expenditure data can be performed using regression techniques. A common representation of this is given as:

\[ E_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_m X_m \]

where \( E_i \) = Expenditure on the ith commodity or group of commodities

\( \beta_0 \) = least square mean

\( \beta_j (j=1,2,\ldots,m) \) = coefficients of the independent variables

\( X_j (j=1,2,\ldots,m) \) = independent variables specified as determinants of expenditure e.g. \( X_1 \) = household size

\( X_2 \) = wealth or income group

\( X_3 \) = season of the year etc.

Usually, the log form of the above function is preferred as the coefficients specified directly produce elasticities of expenditure.

The main determinants of expenditures of pastoral households are: (a) household size, (b) income or wealth status and (c) seasons of the year.

Ceteris paribus, the larger the household size the higher the expenditure, the higher the wealth status of the household the bigger the expenditure, and the drier the season the larger the expenditure, especially on food. Table 5 shows how the cash income and expenditures on cereals of the Tuareg in Mali is affected by the different seasons.
Table 5. *Seasonal cash income and expenditures on cereals of 16 Tuareg households in Mali (1971-1981).*

<table>
<thead>
<tr>
<th>Season</th>
<th>Cash income excluding salaries</th>
<th>Cash expenditure on cereals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MF</td>
<td>%</td>
</tr>
<tr>
<td>Hot (March-June)</td>
<td>39,100</td>
<td>38</td>
</tr>
<tr>
<td>Rains (July-October)</td>
<td>44,206</td>
<td>42</td>
</tr>
<tr>
<td>Cold (November-February)</td>
<td>20,088</td>
<td>20</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>103,394</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Swift, 1982.

The use of expenditure baskets of pastoralists to calculate terms of trade for pastoral products as calculated by Swift (1979) is shown in Table 6.
Table 6. Barter terms of trade for pastoral products in southern Somalia

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barter value of 1 adult male camel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rice (kg)</td>
<td>140</td>
<td>204</td>
<td>71</td>
<td>108</td>
<td>159</td>
<td>192</td>
</tr>
<tr>
<td>maize (kg)</td>
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References


Etudes sur les revenus et les dépenses monétaires des ménages

Résumé

On dispose de peu de renseignements sur l'économie des ménages dans les systèmes de production pastorale. En dépit de cela, des interventions qui impliquent l'accroissement des dépenses monétaires sont fréquemment proposées. L'expérimentation et l'évaluation des interventions et de leurs effets de même que l'évaluation de la qualité de la vie des éleveurs nécessitent des données de base sur la structure du revenu et des dépenses de différents groupes de ménages pastoraux.

Outre la production de lait et de viande auto-consommée, les ménages pastoraux participent à diverses transactions de bétail, de produits animaux, de cultures commerciales, d'objets artisanaux etc., en vue de réaliser leurs différents objectifs. Pour déterminer la totalité du budget du ménage, les études sur le revenu et les dépenses doivent être conçues de sorte à refléter non seulement le revenu et les dépenses monétaires mais aussi d'autres transactions importantes.

Dans toute société, le facteur le plus important qui influence la structure des revenus et des dépenses du ménage est la richesse du ménage. Il est évident que la consommation est différente selon qu'il s'agit d'un ménage riche ou pauvre. Il est par conséquent essentiel que les échantillons de l'étude représentent adéquatement le gradient de richesse observé dans le groupe pastoral étudié. Une fois que les ménages-échantillons de l'étude auront été déterminés, il faudra entreprendre un inventaire initial de la population humaine et animale. Un inventaire des biens essentiels du ménage donne également une image fidèle de la structure des investissements et de la consommation. Cette information est vitale pour deux raisons: elle quantifie la richesse du ménage - échantillon et fournit des données de base sur la production pour effectuer les calculs par tête d'habitants sans lesquels aucune analyse comparative significative ne peut être effectuée.
Pour la conception des formulaires de collecte de données, il convient de rassembler des informations sur la nature des éléments qui forment le revenu et la consommation des ménages pastoraux à étudier, étant donné que ceux-ci varient d'un cadre culturel à l'autre.

Dans la collecte des données sur le revenu et les dépenses du ménage, l'information recueillie est d'autant plus exacte que la période de rappel est courte. La fréquence de la collecte des données sur les dépenses et les revenus des ménages devrait être fonction de la nature de la recherche entreprise. Si une compréhension approfondie du processus est requise, ce sont les méthodes fréquentes, très coûteuses qui doivent être utilisées. Par contre, si les ordres de grandeur requis sont généraux, il convient d'utiliser les méthodes les moins fréquentes.

Les enquêtes effectuées au Kenya et au Mali ont clairement montré que les ménages pastoraux observés dépensaient une très forte proportion de leur revenu pour acquérir des produits alimentaires et du bétail. Puisque la consommation des autres produits était presque insignifiante, on peut en déduire que tout accroissement du revenu sera en grande partie consacrée à l'acquisition de reproductrices, à moins que des efforts ne soient déployés pour accroître la demande pour d'autres biens de consommation et d'investissement.

Une analyse plus sophistiquée des données sur les dépenses et les revenus des ménages peut être effectuée en utilisant les techniques de régression.
Labour data collection

Barbara E. Grandin

Anthropologist, Arid Zones (Eastern and Southern Africa) Programme, ILCA, Kenya,

Introduction

Labour plays a crucial role in any agricultural production system. In a pastoral system where grazing and water are theoretically of free access within a resource-sharing group, capital (in the form of animals) and labour power are the essential means of production which must be acquired and managed for a successful operation. This paper addresses issues regarding the collection of data on labour inputs for pastoral production. First it briefly considers the utility of data on labour as part of pastoral systems research, and then discusses research methods for data collection.

The need for labour data in pastoral systems research

We have already noted that unlike FSR, PSR on the whole suffers from a paucity of baseline information and understanding of system dynamics. This is perhaps more true of labour than of any other input to production. Anthropological studies, which comprise the bulk of the research done on pastoral societies, have tended to focus on the social organisation of labour while paying little attention to the actual labour demands of the system. However, a proper understanding of labour as a system component must pay attention to both its social and technical aspects.

The energy demands of many tasks necessary for pastoral production are much less than the energy demands for crop production. A myth has arisen about the idle pastoralist, because inputs in energy were confused with inputs in time. It has been assumed on the basis of little evidence that labour rarely if ever constitutes a constraint to pastoral production. Hence, traditionally, little attention has been paid to the labour demands of pastoral production.Labour data
gathered by several ILCA teams, as well as other researchers, however, are beginning to demonstrate that in fact there can be large demands for labour time in pastoral production.

As labour is a critical input into pastoral production, it is necessary to understand both the labour demands of the households and the labour supply available. In the descriptive and diagnostic phase of PSR informal surveys can be used to gather information on the following aspects of labour:

1. The critical production tasks, their timing and seasonality.
2. The culturally accepted age and sex division of labour.
3. The possible recruitment pathways for labour.
4. Labour demand/supply variations between households and social mechanisms for adjusting these.
5. The constraints due to insufficient labour including its effect on productivity.

Ideally there should be sufficient information to make some estimation of the economic returns to labour.

Through the use of a labour profile which details the time and amount of labour inputs into production activities by category of worker and season, it may be possible to determine whether there are labour constraints to production. It is also possible to determine what the opportunity cost of proposed interventions might be in terms of the shifting of time allocation from one activity to another.

These factors must be considered for designing interventions. If proposed interventions require significant changes in labour inputs or patterns, it is essential to know: Is labour available and/or can it be obtained at the required time? What would be the opportunity costs forgone with the desired changes of labour input? Will the age/sex group normally responsible for a task or group of tasks be willing or able to undertake a proposed intervention?

Occasionally, proposed interventions cross the accepted age/sex division of labour. For example among Maasai, women have the responsibility for fetching water: although they occasionally bring
water to the dwelling site for young or ill animals, their primary responsibility is to fetch water for domestic use. It is the responsibility of the men to see to the watering of animals. Thus an intervention which suggests or recommends the carrying of water to the dwelling site on a regular basis for young animals would most likely meet with resistance on the part of women because they do not see it as their responsibility to water animals except in extreme instances, and on the part of men who do not see it as their responsibility to bring water to the dwelling site.

In determining labour availability (particularly with a view to introducing a new technology) it is important to collect data on the household level. Households vary significantly in labour needs, labour availability as well as in their labour need/supply ratio.

In one Maasai group ranch, poor and rich families have a total work force of 6.3 and 9.8 people respectively. (Workers are defined as all adults and children over the age of six years). However, although richer households are much larger, their livestock holdings are also much larger, and consequently the ratio of livestock units per worker is much higher. For example in Olkarkar, whereas rich households average 26 livestock units per worker, poor households average only 6 livestock units per worker. These different ratios of livestock units per worker affect the management strategies and time allocation between rich and poor households, although they may be offset by social and market mechanisms for acquiring labour.

With the ideas of building up a repertoire of methods for gathering labour data, this section will briefly review some of the more traditional methods available, and provide more in-depth information on a relatively new technique. The better-known methods include: critical task analysis (which may include some direct observation) and recall; the emerging technique is called the random visiting or time allocation technique. The critical task technique involves specifying the most important production tasks and trying to quantify the time necessary for them. Recall techniques involve interviewing various workers and asking them how much time they have spent on a certain activity for a certain specified period. Recall techniques range in intensity from seasonal to daily interviews. (In
the case of the seasonal interviews they are more like critical task specification as it is impossible for the worker to remember actual hours worked). Lastly, the time allocation technique is based on random visits at which time the current activities of all workers in the household are recorded. These methods are not mutually exclusive; as appropriate, they can enhance one another.

Critical task analysis

There is a particular dearth of labour input data for pastoral systems. Swift (1979), Torry (1977) and Dahl (1979) have applied the critical task technique to pastoral systems of the Tuareg of Mali and the Gabra and the Borana of Kenya respectively. In critical task analysis, through observations and interviews, the researcher develops a list of the most important production tasks and the approximate amount of time that it takes to complete these tasks. The quantification may be done by direct observation (parallelling the work study approach used in farm management studies). Dahl describes a fairly large number of both the minimum livestock and domestic tasks necessary to sustain a Borana household, but she does not attempt to quantify the time involved. Torry, on the other hand, estimates only labour time required for herding, milking, and watering the major species kept by the Gabra, as well as labour needed to collect water for domestic consumption. Using these species specific task estimates, he then estimates the labour that would be required for an independent Gabra household. He estimates that a total of 2,494 hours are required each month for these critical tasks, and suggests that this labour intensive system necessitates the pooling of the labour of several households and thus joint herding. Swift also pays primary attention to labour inputs to livestock management but he refines the technique by estimating necessary inputs by season as well as by management unit size.

These critical task approaches to livestock production provide useful and interesting data in a cost-effective way. They are similar in many respects to Collinson (1972)'s limited-visit survey. As Collinson notes, "The same type of pattern is formed for components of the labour profile by repetition from season to season...
limited visit techniques deliberately seek to exploit this pattern in eliciting answers based on experience rather than on historical recall of labour use for that particular season." They suffer, however, from limitations inherent in the method. They deal only with general descriptions of major tasks and provide no information on the actual inputs of labour by various workers and variations in allocation of labour which might be related to season, skill or wealth.

Cossins (personal communication) uses a variation of the critical task technique in his on-going study among the Borana of Ethiopia. Preliminary survey results indicated that labour necessary for watering animals in traditional Borana wells might be a key constraint to productivity. All animals are watered from wells for four to six weeks each year; thus the amount of water that can be extracted from wells at this time is a limiting factor of production.

He is dealing with this particular labour input on several levels. At the first level, for the whole production system, he sought to determine in gross terms whether there is sufficient labour available to work the wells, i.e. whether labour is a constraint to water production in the dry season.

In the Borana study site, of the 30 or so major well groups, 24 were studied in detail and sufficient information was gathered on the remaining wells to allow extrapolation. Data on total numbers of workers required for each task (by age/sex category) were obtained. This was compared with the size of the population for these age/sex categories which had been obtained from a demographic survey. This showed that in overall terms labour was not likely to be a limiting factor. The second level, now underway, is to look at labour demand/supply for each well group and then each well.

Extensive recall methods

Multi-visit recall techniques for collecting labour data are currently being used by Swift in Mali and White in Niger. They use resident enumerators to collect labour input data from all workers in sample camps at twice-weekly intervals. As Swift (1982) notes, "The notion of elapsed time created some difficulties." The use of watches was
not successful, so that the local concepts of time (broken into seven categories) were used to estimate time spent on various activities. Both Swift and White collect the labour data with a battery of other data as part of a much broader study, so that the enumerator costs were not high.

In designing a multi-visit recall study for labour data, perhaps the two most important decisions are the frequency of the visits, and whom to interview.

1. Frequency

Collison (1972) stated that "where work organisation is complex and highly irregular even from day to day,... information for two or three days previous may be too much to ask and liable to heavy transfers." This is likely to be less of a problem in pastoral societies where the bulk of the labour inputs are regular. However, if detailed information is required, especially on tasks other than herding and watering, twice-weekly recall is probably as necessary with pastoralists as it is with farmers. This is the frequency being used by Swift and White. As noted earlier, however, high frequencies can lead to problems with respondent and enumerator fatigue.

2. Respondents

The decision on whom to interview depends both on the breadth of data that is required and the cultural practices in the area under study. The herd owner at least should be interviewed. He would probably be able to say which people looked after each group of animals for the previous few days, and in what major management tasks they engaged. The researcher would have to be particularly wary of reporting biases, e.g. if the herder really doesn't know, but won't admit the fact, or if due to labour shortages, the household has non-conventional patterns of labour input to which the herder would not want to admit. For more precise information, each worker would need to be interviewed separately as Swift and White have done. This greatly increases the costs of the survey (both in data collection and analysis), but would significantly increase accuracy.
Either limited-visit or extensive recall data may be able to yield sufficient data for determining labour bottlenecks. However, these methods have several drawbacks related to the fact that they tap only major inputs into productive, and possibly domestic, activities. First, as many smaller inputs are missed, it is not possible to calculate returns on labour in pastoralism (about which we know very little as Eicher and Baker have noted). Secondly, the researcher is not likely to know what other activities the workers are engaged in. He will thus not be in a position to understand what activities would have to be forgone should labour intensive innovations be suggested.

**The time allocation technique**

Because of these felt difficulties with critical task and recall methods of labour data collection, in the Kenya Maasai study, the ILCA human science team used a data collection technique called "time allocation" recently developed by American anthropologists. The method relies on randomly timed visits to a household during which descriptions of the activities of all its members are recorded. These records produce a series of verbal snap-shots sufficient in number to provide a thorough description of activities by such parameters as age, sex and season. The time devoted to a particular task is extrapolated from the percentage of all activities devoted to that task (see Grandin, 1982 for more details).

The requirements of the time allocation technique are the following:

1. Sample households which are included in the study must be censused so that the name, age and sex of all the workers in the household can be determined.

2. Enumerators must stay near the homesteads so that all the important hours of the day might be covered. Thus the technique is difficult with a highly nomadic population in which encampments or households split seasonally.

3. A computer is needed for analysis as the number of snap-shots or records is quite large. Although the Kenya team has used a main-frame computer, a micro computer would be sufficient.
The time allocation technique has one disadvantage in addition to its basic requirements. It is not adequate for specifying time spent on certain activities away from the home. For this category of activity it is useful if it can be implemented by some specific observations or at least interviews as is done in critical task analysis. For example in the watering of livestock, if a producer leaves the household in the morning with animals to water, it would be useful to know how much time he spent walking to the water, how much time he spent waiting for the animals to be watered, how much time the animals spent watering and how much time the man spent socialising or gathering information. The time allocation technique in and of itself cannot supply these data.

The advantages of the time allocation technique, however, are numerous.

1. It easily covers all potential workers.

2. It is not plagued by the problems of recall since activities are recorded on the spot.

3. There is little respondent fatigue; in fact almost any person in the household can be interviewed. There is no requirement for uniformity of respondents as long as one can be sure, within the context of the specific society, that the person interviewed is likely to know the whereabouts and activities of the various members of the household. Recording of the information does not take very long. Five to ten minutes is normally sufficient for a household of 10 people.

4. Apart from a household census, little pre-survey labour data is required. It is not necessary to specify critical tasks beforehand, and little needs to be known on the age and sex division of labour.

5. The time allocation technique covers the complete range of tasks whereas critical task techniques depend on the specification of just the few most important tasks. Time allocation will record minor but important tasks, the cumulative effect of which can be very important for the production system. For example where critical task techniques tend to concentrate on time to herding and watering, in our
Maasai study 70% of the time devoted to livestock management (excluding milking) was devoted to herding and watering. This critical task specification would have missed 30% of livestock management tasks.

6. Although we have not done so in the Kenya study, it is possible with time allocation to record multiple simultaneous activities. Thus a woman who was sitting outside, watching a child while making butter and keeping an eye on smallstock can be recorded as doing all those tasks. Were she to be interviewed on what she had done at that period of time, it is likely she would have said "making butter" as that is the most discrete, least regular activity.

7. Lastly, and perhaps most important, the time allocation technique provides critical information on production unit variation. If the sample size is sufficient, households can be compared according to their labour supply, wealth, neighbourhood or any other parameter which is thought to affect labour input.

Although the time allocation technique used by the Kenya team was continuous for a period of just over a year, we see no a priori reason why the technique could not be adopted to more limited periods of time. With the help of the biometrician at ILCA's headquarters, the team is doing retrospective analysis to determine the minimum number of visits deemed to be necessary in a season in order to provide a labour profile for that season. Preliminary results suggest that little precision is gained by having more than 10 visits per household per season. On the other hand, whereas a minimum of 10 people per person category desired for analysis would be required, precision would be increased by increasing the number of people studied. We suspect that frequent visits to a number of households (for example two weeks of visits to each household four times a day) should provide the necessary quantity of data to estimate production inputs and other activities. Of course, in order to use seasonal sub-sampling more background information on labour inputs and especially constraints would be required to determine the optimal timing.

Sample results of the time allocation technique

This section presents a few preliminary results from the time allocation study by the ILCA team in Kenya. Visits were made to each
sample household twice a month at randomly chosen times between the hours of 6 a.m. and 8 p.m. during which period the activities of every member of the household were noted. Table 1 shows how the observations were used to calculate the percentage of livestock management tasks done by each age/sex category of worker. For example, there were 1,121 observations of livestock management activities out of a total of 3,530 observations. Thus 41% of all the observations were of livestock management (representing approximately 4.3 hours per worker per day). For watering, there were 123 observations, of which 15% were male children, 5% were female children, 75% were adult males and 6% were adult females. While this table presents data on the percentage of specific tasks done by various age/sex categories, the time allocation data can also be used to calculate hours per day spent on these tasks, either in total or by age, sex, season etc...

Table 1. Age/sex roles in livestock management at Olkarkar.

<table>
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<td>42</td>
<td>47</td>
</tr>
</tbody>
</table>

N.B. There were no differences in task percentages between wet and dry months.

1. Children 6 years and above.
2. Percentage errors due to rounding.
3. N = number of observations of livestock management activities.
Table 2 shows the time devoted to livestock management by age/sex of worker, for all workers and finally by livestock unit. The data demonstrate that whereas each worker in a rich household spends more time on livestock management than a worker in a poorer household, richer households devote far much less time per livestock unit held. This is because rich households herd their animals in much larger groups, thus benefitting from economies of scale; they also are able to marshall labour from poorer households with whom they frequently herd.

Table 2. Labour devoted to livestock management at Olkarkar.

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Mean number of hours of labour per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Children</td>
</tr>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>1</td>
<td>5.0^2</td>
</tr>
<tr>
<td>2</td>
<td>5.7^2</td>
</tr>
<tr>
<td>3</td>
<td>6.4^2</td>
</tr>
</tbody>
</table>

^1 Children 6 years and above.

^2 Children spent a mean of approximately 2 hours a day at school.

These examples indicate just a few of the analyses possible with the data gathered by the time allocation technique. Although the time allocation technique is being increasingly used, to date there are not, to my knowledge, any studies available comparing results gained from this technique to those gained from recall or critical task analysis. The Kenya team is in the process of designing a brief study which will involve concurrent collection of recall and time allocation data from a sample of households in the Maasailand. It is hoped that the results produced will aid in assessing the validity and reliability of the two methods under pastoral conditions.
References


Collecte de données sur la main-d'œuvre

Résumé

La main-d'œuvre joue un rôle très important dans tout système de production agricole. Dans un système pastoral à caractère collectiviste où les pâturages et l'eau sont théoriquement d'accès libre, le capital (sous forme d'animaux) et la main-d'œuvre constituent les moyens essentiels de production à acquérir et à gérer pour une exploitation productive.

Pour bien comprendre la main-d'œuvre conçue comme une composante des systèmes, il faudrait se pencher sur ses aspects sociaux et techniques. Etant donné l'importance de la main-d'œuvre dans la production pastorale, il est nécessaire de bien connaître la demande et l'offre de main-d'œuvre des ménages. Dans la phase de la description et du diagnostic de la recherche sur les systèmes pastoraux, des enquêtes informelles peuvent être utilisées pour la collecte de données sur les tâches de production les plus importantes, sur le moment de leur exécution et leur caractère saisonnier, sur la division culturellement acceptée du travail par âge et par sexe, sur les divers modes de recrutement des travailleurs, sur les variations offre/demande de main-d'œuvre entre les ménages et sur les mécanismes sociaux d'ajustement de celles-ci et les contraintes dues à l'insuffisance de la main-d'œuvre, y compris ses effets sur la productivité.

Il y a une indigence particulière de données sur la main-d'œuvre des systèmes pastoraux. Par le biais de l'analyse, d'observations et d'interrogations, le chercheur dresse une liste des tâches de production les plus importantes et du temps approximatif nécessaire pour les mener à bien. La quantification peut s'effectuer par l'observation directe tout comme pour l'approche sur l'étude de la main-d'œuvre utilisée dans les études sur la gestion de l'exploitation agricole.

L'analyse des tâches les plus importantes de la production pastorale fournit des données utiles et intéressantes à un prix abordable.
Cette approche souffre cependant de limites inhérentes à la méthode. Elle se contente de descriptions générales des tâches les plus importantes et ne fournit pas d'informations sur les travaux effectués par divers travailleurs et sur les variations de la répartition du travail qui peuvent être liées à la saison, à la compétence ou à la richesse. Cossins utilise une variante de la technique de l'analyse des tâches les plus importantes dans ses études sur les Borana d'Ethiopie.

La technique de rappel fondée sur les visites multiples, telle que celle utilisée par Swift au Mali et White au Niger se fonde sur l'utilisation d'observateurs résidents pour collecter des données sur le travail effectué par tous les travailleurs dans des campements-échantillons deux fois par semaine. Dans la conception d'une étude de rappel à visites multiples pour l'obtention de données sur la main-d'œuvre, les deux aspects les plus importants ont certainement trait à la fréquence des visites et au choix des personnes à interroger. Le rappel extensif ou les visites limitées pourraient fournir suffisamment de données pour déterminer les goulets d'étranglement en matière de main-d'œuvre. Toutefois, ces méthodes comportent plusieurs inconvénients étant donné qu'elles n'exploitent que les facteurs les plus importants dans les activités de production et éventuellement dans les activités domestiques.

La méthode de la répartition du temps se fonde sur des visites programmées de manière aléatoire dans un ménage, au cours desquelles, les activités de tous ses membres sont enregistrées. Ces enregistrements produisent une série de tableaux verbaux suffisants en nombre pour fournir une description complète des activités par des paramètres tels que l'âge, le sexe et la saison. Le temps consacré à une tâche particulière est extrapolé sur la base du pourcentage de l'ensemble des activités consacrées à cette tâche.

Les ménages-échantillons inclus dans l'étude doivent être recensés de sorte que le nom, l'âge et le sexe de tous les travailleurs du ménage puissent être déterminés. Les enquêteurs doivent rester à proximité des ménages de sorte que les heures importantes du jour puissent être couvertes. Une ordinateur est nécessaire pour
l'analyse, étant donné que le nombre d'entrées est assez important.

La technique de la répartition du temps comporte un inconvénient en ce sens qu'elle ne permet pas de déterminer avec précision le temps consacré à certaines activités effectuées loin de la maison. De telles activités peuvent être couvertes par des observations ou par des interrogations spécifiques comme dans l'analyse des tâches les plus importantes. Les avantages de la technique de la répartition du temps sont multiples. Elle couvre tous les travailleurs potentiels et n'est pas limitée par les problèmes que pose le rappel; les enquêtés ne sont pas agacés et seul un nombre limité de données de pré-enquête sur la main-d'œuvre s'avère nécessaire; elle couvre toute la gamme des tâches; elle permet d'enregistrer des activités multiples et simultanées et fournit une information vitale sur les variations au niveau des unités de production.

Certains résultats préliminaires de l'étude sur la répartition du temps effectuée par le Groupe du CIPEA au Kenya ont été présentés. Ils mettent l'accent sur quelques unes seulement des analyses possibles avec les données collectées sur la base de cette technique. L'équipe du Kenya est sur le point d'élaborer une courte étude qui portera à la fois sur la collecte de données basées sur le rappel et sur la répartition du temps dans un échantillonnage de ménages vivant en pays Maasaï. On espère que les résultats contribueront à évaluer la validité et la fiabilité des deux méthodes dans les conditions pastorales.
Summary of Discussion Session 6.
Chairman: Prof. Gunnar Sorbo (Norway)
Discussion led by Dr Befekadu Degefe (Ethiopia)

In referring to Dr Grandin's paper on Livestock Transactions, Dr Wilson pointed out that off-take data are taken by animal scientists as a matter of course. Indications of off-take and deaths can be got from initial surveys, as was done in Niger.

Mr Sandford pointed out that labour intensity was different from labour energy intensity, and both were different from the question of whether labour was a constraint on pastoral production. Even if people were totally idle for 11½ months of the year, if labour was in short supply for just ½ month, e.g. for watering livestock from wells, then labour shortage may be the critical constraint on the system. Dr Grandin agreed and said that people might not work hard but in fact were not idle as they may have to work long hours. If a labour constraint was only for a short period of time, understanding the dynamics of this would come from a critical task/season specification and an analysis of the detailed labour input information. Mr Sandford said that he suspected that the technique of the 'time allocation study' might overestimate the labour requirements of a system by failing to distinguish between those tasks which were truly essential and those which were just undertaken to fill in time. In the 'recall' technique, respondents were more likely to indicate priorities by not mentioning the time spent on tasks which were inessential.

Dr Zulberti warned that it was very easy for scientists to become data addicts and to try to collect everything from everyone. Anyone could look at his or her own work and recognise many occasions on which data was collected and never used. Such data collection could postpone real action in the field and could be an expensive endeavour providing little or no effect on the well-being of the pastoralist. He said that the final objective was not to know the pastoralist but to know how one could be useful to him. Mr Sandford agreed that it was important to be cost effective in research, but he pointed out
that there was a great danger in restricting one's collection of data exclusively to those items which before the research started were thought to be the most important. He said that sometimes breakthroughs in knowledge occurred through the analysis of data which was collected in a much more open-minded way. In project preparation, for example, one may need to prioritise much more strictly. But in research one needed to be much more open-minded. This was the essence of the systems approach - to find out what was important, not to pre-determine it.

Dr Zakary referred to Dr Solomon's observations that the expenditure of pastoralists was mainly devoted to buying food and very little was spent on systems inputs, and that perhaps parameters of development should increase the demand so that pastoralists could sell their cattle. Dr Zakary felt that although the latter might improve the pastoral sector's contribution to the national economy, at the same time pastoralists might then become slaves to demand - this could be very dangerous during a drought. Dr Zakary felt that the present system of using pastoral areas was good - developers should above all allow pastoralists to organise themselves. Dr Solomon agreed.

Dr Tilahun stated that the usual economic contention was that low income households spent a large proportion of their income on food and that this ratio declined as household income increased. But he didn't think one could see such a relationship in pastoral societies. Dr Solomon said that he had evidence from the Kenya study that the wealth status of pastoral households greatly influenced the per capita expenditure on food. Dr Solomon agreed with Dr Tilahun when he said that information on decision making responsibilities of household members on the use and disposal of livestock was important for household income and expenditure studies. The analysis of such information gave an insight into the extent to which management and marketing practices varied due to household size and composition.

Dr Thompson said that the controversy regarding the need to understand the complete system as opposed to part of the system in the descriptive/diagnostic phase was resolved if one remembered that the
systems approach was iterative. This allowed one to return to the initial phase to study either another well-defined aspect of the system or to gather further information needed for designing and testing solutions to a constraint previously identified. But the time-span of an iteration must be short; thus a narrowly focused, short duration diagnostic/descriptive survey was preferable to a complete systems survey.
Résumé des débats de la sixième séance
Président: Prof. Gunmar Sorbo (Norvège)
Débats dirigé par le Dr Befekadu Degefe (Ethiopie)

Faisant allusion au document de Mlle Grandin sur les transactions de bétail, M. Wilson a mis l'accent sur le fait que les relevés des données sur l'écoulement sont effectuées par les zootechniciens de manière systématique. Des données relatives à l'écoulement et aux décès peuvent être obtenues à partir d'enquêtes initiales comme ce fut le cas au Niger.

M. Sandford a souligné que l'intensité de main-d'oeuvre était différente de l'intensité d'énergie de la main-d'oeuvre et que ces deux éléments n'intervenaient pas dans la question de savoir si oui ou non le travail constituait une contrainte à la production pastorale. Même si les travailleurs étaient totalement oisifs pendant 11 mois et demi et qu'au cours de la dernière quinzaine de l'année il y ait carence de main-d'oeuvre, par exemple, pour l'abreuvement du bétail au puits, la carence en main-d'oeuvre constituerait la contrainte la plus grave sur le système. Mlle Grandin a accepté cette idée et a déclaré que la main-d'oeuvre ne travaillait peut-être pas dur mais en fait qu'elle n'était pas oisive étant donné qu'elle pouvait avoir des journées de travail très longues. Si une contrainte en matière de travail était pour une courte durée seulement, on pourrait en saisir la dynamique par une spécification saison/tâche vitale et par l'analyse des données détaillées du facteur travail. M. Sandford a déclaré qu'il avait l'impression que la technique de la répartition du temps pourrait surestimer les besoins en travail d'un système, notamment parce qu'elle ne permet pas de distinguer les tâches réellement essentielles de celles qui sont effectuées pour meubler le temps. Dans la technique du rappel, il était probable que les enquêtes mettent l'accent sur leurs priorités et qu'ils passent sous silence le temps consacré à des tâches qui n'étaient pas essentielles.

Le Dr Zulberti a fait savoir qu'il était très facile pour qu'un chercheur devienne un maniaque des données et qu'il essaie de collecter tout ce qui est possible et imaginable. Nous pouvons tous trouver dans nos travaux plusieurs exemples où nous avons collecté des données que nous n'avons jamais utilisées. Une telle collecte de données pourrait retarder l'action
sur le terrain et pourrait constituer une entreprise coûteuse ayant un effet limité ou nul sur la qualité de la vie de l'éleveur. Le Dr Zulberti a déclaré que l'objectif final n'était pas de connaître l'éleveur mais de savoir comment on pouvait lui être utile, M. Sandford a reconnu que le rapport coût-efficacité était important en matière de recherche mais il a souligné qu'il était très dangereux de limiter la collecte de données aux informations que l'on pensait être les plus importantes avant le démarrage des activités de recherche.

Il a déclaré que quelquefois les progrès scientifiques intervenaient à la suite de l'analyse de données qui avaient été collectées de manière beaucoup plus générale. Dans l'élaboration des projets, il est possible de fixer les priorités de manière beaucoup plus stricte. Mais dans la recherche, il fallait être beaucoup plus ouvert. C'était là l'essence de l'approche par système: trouver ce qui était important et non pas le prédéterminer.

Le Dr Zakary a fait allusion aux observations de M. Solomon selon lesquelles les dépenses des éleveurs étaient essentiellement consacrées à l'achat de produits alimentaires, que très peu de ressources étaient affectées à l'achat de facteurs de production et que, peut-être, les paramètres de développement devraient accroître la demande afin que les éleveurs puissent vendre leurs bovins. Le Dr Zakary estimait que quoiqu'une telle démarche puisse augmenter la part du secteur pastoral dans l'économie nationale, elle pouvait en retour transformer les éleveurs en esclaves de la demande et cela pouvait être très dangereux en période de sécheresse. Le Dr Zakary a déclaré que le système actuel d'utilisation des zones pastorales était bon, que les responsables du développement devraient par dessus tout permettre aux éleveurs de s'organiser. M. Solomon a exprimé son accord sur cette idée.

Le Dr Tilahun a déclaré que l'hypothèse économique habituelle était que les ménages à faible revenu consacraient une proportion importante de leurs revenus à l'achat de produits alimentaires et que ce rapport diminuait avec l'accroissement du revenu du ménage. Mais il ne pensait pas qu'on puisse observer une telle relation dans les sociétés pastorales. M. Solomon a déclaré qu'il avait des preuves émanant de l'étude,
selon lesquelles la richesse des ménages pastoraux influençait considérablement les dépenses alimentaires par habitant. M. Solomon a accepté le point de vue du Dr Tilahun lorsque celui-ci a déclaré que les informations sur les membres du ménage investis du pouvoir de décision sur l'utilisation et la disposition du bétail étaient importantes pour les études sur les revenus et les dépenses des ménages. L'analyse de telles informations donnait une idée de la manière dont la gestion et les pratiques de commercialisation variaient en fonction de la taille et de la composition du ménage.

Le Dr Thomson a déclaré que la controverse concernant la nécessité de connaître l'ensemble et non pas une partie seulement du système comme c'est le cas dans la phase de description/diagnostic était dépassée dès lors que l'on se rappelait que l'approche par système était itérative. Cela permettait de retourner à la phase initiale soit pour étudier un autre aspect bien défini du système, soit pour收集er d'autres informations nécessaires pour la conception et l'essai de l'élimination d'une contrainte entièrement identifiée. Mais la durée d'une itération doit être courte; ainsi, une enquête de diagnostic/description bien délimitée et de courte durée était préférable à une enquête complète sur les systèmes.
Livestock marketing studies

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Introduction

Marketing is an important aspect of any livestock system. It provides the mechanism whereby producers exchange their livestock and livestock products for cash. The cash is used for acquiring goods and services which they do not produce themselves, in order to satisfy a variety of needs ranging from food items, clothing, medication and schooling to the purchase of breeding stock and other production inputs and supplies.

A major objective of pastoral systems research (PSR) is to increase productivity and improve the standard of living of pastoralists. Interventions for increasing productivity generated by PSR will have costs and returns associated with their adoption. It is therefore essential that such interventions are not only technically feasible and socially acceptable, but also economically feasible. In other words, the incremental returns of the interventions must out-weigh the additional costs incurred in adopting them. Both input and output prices fluctuate over time. Researchers must, therefore, establish the sensitivity of interventions by establishing within what range of input and output prices they are stable. Time series data on prices pastoralists are paid for their livestock and livestock products as well as prices they pay for inputs are essential for such analysis. Unfortunately, in most African countries while time series data on input prices may be available, they are almost non-existent for livestock prices.

The collection of time series data on product and input prices, however, is not a function of PSR scientists. This should be the responsibility of the ministries servicing the livestock and agricultural sector. The purpose of this paper is to underscore the
necessity of studying livestock markets and routinely collecting time series data on prices of livestock at local, regional and terminal markets. Based upon the experience of ILCA economists and other researchers in Africa it outlines a methodology, which can be easily adopted by the relevant ministries of African countries in setting up a systematic collection and analysis of livestock market information. The second section provides the rationale for undertaking livestock marketing studies. A simplified livestock marketing system model is presented in the third section. A methodology for regularly collecting time series data and for conducting in-depth studies on livestock marketing is then given, followed by illustrated suggestions for the analysis of data. A suggested national organizational framework for collecting and analysing livestock market data is presented in the last section.

Why study livestock markets?

As already stated, in most African countries there is a severe paucity of time series data on livestock prices as well as on the performance and efficiency of the livestock marketing system. Ironically, livestock marketing happens to be a favourite sector, where African governments choose to intervene in a variety of ways. These interventions range from outright fixing of wholesale and retail meat (e.g. Benin, Ethiopia, Togo) to monopolising the export market (e.g. Botswana, Kenya). Yet in many instances policy decisions on livestock marketing are taken in the absence of vital information on how they affect livestock producers, traders, slaughter-houses, butchers and consumers. Very often price fixing at unrealistic levels leads to open black markets, where the real prices substantially differ from those officially listed. In spite of this the official prices constitute the price series data, which clearly distort any analysis based on them.

Even when governments pursue price stabilisation policies it is difficult, in the absence of livestock market data, to establish to what degree their effects are transmitted to the level of producers.

The absence of data on the magnitude and seasonality of supply as well as prices can frustrate the success of development
projects. The closure of the meat packing plant at Kotsi in Sudan after a few months of operation is a case in point (Abbot, 1979).

It is often argued that the stratification of the beef industry into areas of breeding, growing out and fattening should be pursued; this is often included in livestock development projects without much success. The comparative advantage of such a proposal cannot be fully assessed without determining the long-term stable price margins between the areas of stratification.

An important use of time series data is in assessing over time the terms of trade between livestock producers and the rest of the economy. This assessment can be made using weighted price indices of a pastoralists' consumption basket and comparing it to the weighted price indices of their sales basket (Swift, 1979). Such an analysis should be made from time to time to gauge and temper the effect of price policies on pastoralists, who depend on the market for subsistence much more than agricultural households.

Thus in any country, livestock marketing studies are essential to provide vital information on the operations and efficiency of the livestock marketing system for effective research, planning and policy formulation in the livestock sector.

A livestock marketing system model

A schematic representation of a livestock marketing system is shown in Fig 1. The bottom part shows the flow of livestock from producers to secondary (regional) and terminal (national) markets through one or more primary collection markets. Livestock markets can easily be differentiated by the type of sellers and buyers operating in the market and the purpose for which livestock are purchased. Table 1 summarises these attributes for three types of livestock markets (Ariza Nino et al, 1980).
Table 1. Characteristics of livestock markets.

<table>
<thead>
<tr>
<th>Type of market</th>
<th>Main sellers</th>
<th>Main buyers</th>
<th>Purpose of purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Primary collection</td>
<td>Producers</td>
<td>Other producers</td>
<td>For stock replacement or fattening</td>
</tr>
<tr>
<td>markets</td>
<td>Local butchers</td>
<td>Slaughter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>Collection for resale in larger regional markets</td>
<td></td>
</tr>
<tr>
<td>2. Secondary distribution markets</td>
<td>Traders</td>
<td>Local butchers</td>
<td>Slaughter</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>For resale in terminal markets</td>
<td></td>
</tr>
<tr>
<td>3. Terminal markets</td>
<td>Traders</td>
<td>Local slaughter-houses</td>
<td>Slaughter</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>Export</td>
<td></td>
</tr>
</tbody>
</table>

The top of Fig. 1 shows the external and internal factors that influence the livestock marketing system. First on the supply side the cash needs of producers, the strength of demand for their livestock, and pastoralists' expectation of the nature and length of the dry and wet seasons influence the volume of the different species of livestock on offer at any time. The higher the cash needs of the pastoralists the greater the volume of livestock on offer. Their response to market demand has been a subject of controversy in the literature (Carlisle and Randag, 1970; Hill, 1970; Khalifa and Simpson, 1972; Low et al, 1979; Jarvis, 1980). However, there is growing evidence that pastoralists in fact dispose of their marketable animals in a manner consistent with sound economic behaviour (Ariza Nino et al, 1980). In other words the stronger the effective market demand as expressed by high prices, the greater the volume of livestock supplied. Finally, pastoralists' perception of the climate influences supply and hence the price of livestock. Anticipation and

- 330 -
occurrence of prolonged dry seasons induce more sales. The poor condition of the animals plus the greater numbers supplied during such times depress livestock prices. On the other hand the anticipation and occurrence of good rains causes pastoralists to withhold animals from the market so that they can put more weight and fetch better prices later on.

Second, government policy through fiscal, regulatory and development intervention affects the volume, flow and prices of livestock in the marketing system. Favourable fiscal policies that encourage livestock production and reduce costs to producers increase the supply of livestock, e.g. subsidies, and price stabilisation policies. On the other hand taxes and levies of all kinds tend to restrict the volume supplied. The control of epidemic diseases, the proper development of range areas and the development of trek routes and livestock market facilities tend to increase the volume supplied and reduce marketing costs. In general government monopolistic tendencies and the fixing of artificially low prices stifle market supply and demand.

Finally, market demand as expressed by the volume and prices buyers are willing to pay for livestock influences the behaviour of the markets at all links in the system. The efficiency of the market as reflected by the marketing costs of the system and to what extent price changes are transmitted through the marketing system strongly influence the operation of the markets. The less efficient the market the less responsive will supply be to changes in market demand.

Livestock market research methodology

Livestock marketing systems research involves a two-pronged approach. The first involves the regular collection of time series data from a network of selected livestock markets. The second deals with in-depth studies of the performance efficiency of the livestock marketing system at the various links of the chain as livestock move from producers to the consumers.
Figure 1. Livestock marketing system model.
Collection of time series data

Identification and selection of livestock markets

The first consideration in setting up a livestock market data collection network is the identification of livestock markets and the selection of those markets to be included in the network.

Livestock markets in each administrative unit of a country, classified in the manner described in previous section, can be put on a map with arrows indicating the direction of flow of livestock by species. Extension staff can be effectively used to provide information for such classification and estimating roughly the volume of different species of livestock offered for sale on each market day. Fig. 2 provides an example using cattle markets in Upper Volta.

The selection of which markets to include in the network, like any sampling problem, is a function of the coverage desired and the resources available for collecting the information. If there are several primary collection markets feeding a secondary redistribution market, it is not necessary to regularly collect data from all of them. A few can be selected on the basis of location, distance from the secondary market and the volume of supply. Seasonal observations can then be used to correlate those left out from the network with the secondary market in order to estimate their supply and prices.

Types of livestock market data to be collected

The volume of livestock on offer at the market is important as it gives a picture of the supply as well as its influence on prices. If possible the volume should be recorded by species, sex and age. Such information is easier to obtain in fenced markets where there are controlled gates. It may be difficult in open areas where livestock are bunched together in mobs. In such cases number by species is sufficient. The sex and age structure can be estimated by sampling the mobs seasonally.

The number of sellers and buyers participating in the market should be recorded to indicate the degree of concentration and hence influence on the price of livestock and offtake.
Fig 2. Major cattle markets and flows in Upper Volta.

The price of livestock transacted should be recorded by breed, sex and age either on a census or sampling basis depending on the volume and the number of enumerators available. For large markets where there are more than 200 animals sold per species a 25-30% sample is desirable. In a market where one expects two breeds and their crosses this yields a minimum of three to six observations per class of animal by breed, sex and age.

A survey of prices producers receive should be made periodically to establish their relationships with market prices.

The weight of traded animals in the sample if possible, should be recorded. However, it may be difficult to weigh livestock in unorganised markets, where there is no auctioning on a weight and grade basis. In such cases visual assessment of body size (large, medium, small) and body condition (good, fair, poor) coupled with the age category of the animal can give a good indication. Weight correlations with body size and body condition can be established from the nearest abbatoirs.

The destination and purpose of traded animals should be recorded as such information will give a good picture of the direction and magnitude of flow and the purpose for which animals are purchased.

The mode of transport should be recorded as it will show the importance of trekking, railing and trucking over time.

All of the above information should be recorded by field officers or enumerators from the selected markets on the market days predetermined by the market research officers. In addition to this they should comment on conditions that influence the supply and demand situation for that market day.

Frequency of data collection

Once the livestock markets from which data will be regularly collected are determined, the next question is at what frequency should the data be collected? This depends on the type of livestock market in question and the frequency of market days. In primary livestock
markets livestock are usually traded once or twice a week. Market
days of secondary or regional livestock markets do occur more
frequently. The frequency of a terminal market-day may be as much
as six times a week.

It is desirable for time series analysis to have weekly
data but it is not necessary to collect data at each market day. It
can be collected on a sampling basis after establishing the represen-
tativeness of the market days with respect to the week. Are all
market days held during the week similar or are some market days more
important than others in terms of volume offered and volume traded?
For instance if in a secondary livestock market both Wednesdays and
Fridays are market days and Fridays tend to be more important, one
can establish the factor (X) by which the volume supplied and the
volume traded is greater than on Wednesdays by conducting an initial
survey of the market as well as crosschecking the information by
interviewing buyers and sellers in the market. This factor can then
be used to estimate the market parameters that pertain to the
Wednesday markets from data collected on Friday markets.

In livestock markets where there is only one market day per
week a similar approach can be taken in sampling one week or two weeks
per month. However, one has to be cautious and take into account that
seasonal changes will be captured by such sampling.

In many African countries (e.g. Ethiopia and Nigeria) the
occurrence of major religious (Christian and Muslim) holidays has a
market effect on supply, demand and prices of livestock, especially
those of smallstock. Demand is high during these holidays and prices
can be 80% more than the annual average price (Okali and Obi, 1982).
It is therefore essential to intensify livestock market data collec-
tion during such holidays in order to accurately assess their impact
on the various market parameters.
Studies of market performance and efficiency

Studies of the performance and efficiency of the livestock marketing system at the various links of the chain as livestock move from producers to consumers (including the wholesale and retail trade of meat) have to be conducted by a senior livestock market analyst who is in charge of the entire livestock market data collection and analysis with assistance in the field by his colleagues at headquarters and the provincial livestock marketing officers (see Section 6). The reason for this is two-fold. First the observations and probings necessary to get the information require a high degree of skill and experience. Secondly, the senior market analyst has to acquire a first-hand insight into how the livestock market operates in order to properly analyse and interpret the time series data being collected by the field officers.

Studies of market performance and efficiency include two major aspects of the livestock marketing system. The first is an assessment of the degree of buyer concentration in the markets selected for time series data collection and how livestock prices are arrived at and purchasing is financed. Although the number of buyers and how many animals they bought in the market can be recorded by field enumerators, assessing the manner in which they operate, whom they represent, in how many other livestock markets they trade, and how they finance their purchase requires a considerable degree of skill and market knowledge to elicit.

The second study involves establishing the cost of livestock and meat marketing as animals change hands from the producer to the primary markets, to the secondary markets and finally to the terminal markets, where they are slaughtered for domestic consumption and/or are exported live.

These marketing costs can be distinguished as costs of:-

(i) transporting (trekking, trucking and/or railing);
(ii) feeding (including grazing);
(iii) marketing levies and taxes imposed by local and national authorities;
(iv) mortality or loss (some animals die during transit because of diseases or other physical stress; some might stray and not be recovered);

(v) slaughtering and processing costs;

(vi) capital as represented by the interest on the money tied up by the livestock from the point of purchase to the point of sale; and

(vii) the opportunity cost or salary of the operator (trader, butcher etc.).

The above information can be established by interviewing livestock traders and managers of slaughterhouses and spot checking the information by actual observation on their operations. Livestock marketing margins can be defined as the difference between the sales price of the animal (meat) and the costs incurred by the seller including the acquisition price of the animal (meat). The less the margins the more efficient the marketing system.

Analysis of livestock market data

The types of analysis of livestock market data are categorised under four major headings:-

(i) supply of livestock;

(ii) destination of livestock;

(iii) price movements; and

(iv) market performance and efficiency

Supply of livestock

The sources of livestock supplying the particular market can be analysed using frequencies of traded animals by area of origin by breed, sex, age and total volume. This indicates what types of animals are supplied by each area and the frequencies can be used to estimate marketed offtake from the hinterland of the market.

A problem which frequently arises in such analysis is to what detail origins of livestock need to be specified. One can a priori section the hinterland by a functional criterion (geographic, type of producer or source) and instruct enumerators to categorise...
origins of livestock into the specified sections. Alternatively, one can instruct them to record place names of the origins of livestock and decide later how to categorise them. Table 2 shows an example of such an analysis by type of producers.

Table 2. Source of cattle supply to the Emali market.

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of cattle</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group ranches in Kajiado district</td>
<td>1143</td>
<td>77.9</td>
</tr>
<tr>
<td>Trading centres serving group ranches in Kajiado district</td>
<td>292</td>
<td>19.9</td>
</tr>
<tr>
<td>Individual, ranches Kajiado district</td>
<td>23</td>
<td>1.6</td>
</tr>
<tr>
<td>Farms in Machakos district</td>
<td>9</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1467</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Destination of traded livestock

The frequencies of traded livestock by breed, sex, age and purpose of purchase for major destinations reveals the relationships between various livestock markets as well as the trade in livestock between pastoralists, agro-pastoralists and agriculturalists. Tables 3 and 4 show such an analysis for selected destinations.
Table 3. Destination of cattle trade at Emali.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Destination</th>
<th>No.</th>
<th>% of slaughter</th>
<th>% of production</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slaughter</td>
<td>Ong‘ata Rongai</td>
<td>510</td>
<td>32</td>
<td>n.a.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Dagoretti</td>
<td>214</td>
<td>13</td>
<td>n.a.</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>KMC - Athi River</td>
<td>242</td>
<td>15</td>
<td>n.a.</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>- Mombasa</td>
<td>9</td>
<td>1</td>
<td>n.a.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mariakani</td>
<td>211</td>
<td>13</td>
<td>n.a.</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Emali</td>
<td>25</td>
<td>2</td>
<td>n.a.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>380</td>
<td>24</td>
<td>n.a.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal slaughter</strong></td>
<td>1591</td>
<td><strong>100</strong></td>
<td><strong>n.a.</strong></td>
<td><strong>61</strong></td>
</tr>
<tr>
<td>Production</td>
<td>Machakos district</td>
<td>612</td>
<td>n.a.</td>
<td>62</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Group ranches Kajiado</td>
<td>341</td>
<td>n.a.</td>
<td>34</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Individual &quot; &quot;</td>
<td>40</td>
<td>n.a.</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal production</strong></td>
<td>993</td>
<td><strong>n.a.</strong></td>
<td><strong>100</strong></td>
<td><strong>39</strong></td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>2584</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>


The total volume and fluctuation of livestock supply are of major interest as they show the degree of seasonality of supply. This can be easily seen by plotting weekly or monthly supplies (e.g. see Fig.3). For long-term determination of seasonality several years' time series data is essential. A standard statistical technique for establishing seasonality is the method of moving averages(Yamane, 1967; Croxton et al, 1969).
Table 4. Characteristics of cattle bought at Emali for destination to Machakos and Kajiado group and individual ranches.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Machakos</th>
<th>Kajiado group and individual ranches</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>castrate</td>
<td>female</td>
</tr>
<tr>
<td>Maasai zebu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature</td>
<td>404</td>
<td>88</td>
<td>2</td>
</tr>
<tr>
<td>Adult</td>
<td>26</td>
<td>51</td>
<td>35</td>
</tr>
<tr>
<td>Subtotal</td>
<td>430</td>
<td>139</td>
<td>37</td>
</tr>
<tr>
<td>Sahiwal cross</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Adult</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Subtotal</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Boran cross</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature</td>
<td>–</td>
<td>6</td>
<td>–</td>
</tr>
<tr>
<td>Adult</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Subtotal</td>
<td>–</td>
<td>6</td>
<td>–</td>
</tr>
<tr>
<td>TOTAL</td>
<td>430</td>
<td>145</td>
<td>37</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig 3. Mean monthly supply and price per head at Emali market.

Livestock prices

The most important single parameter in collecting time series data on livestock marketing is livestock price. For a given market and a given period (week, month, year) mean livestock prices per head and liveweight can be analysed by breed, sex and age. Table 5 gives an example of such analysis.

The next analysis is that of determining whether there are seasonalities in livestock prices. Seasonality of prices can be determined by type of animals sold. The methodology is similar to that of determining seasonality in supply of livestock. Fig. 3 illustrates an example. However, several years' data are required to establish long-term seasonality.

Finally, a stepwise multiple regression analysis can be used to fit a demand model for a given market relating price to breed, sex, age, season, volume of supply and number of buyers in the market as well as the interactions between these independent variables (Draper and Smith, 1966). The longer the time series data the better the specification of the demand function. The value of the demand function does not lie so much in its ability to predict future prices but in its usefulness in quantifying the relationships between livestock prices and breed, sex, age, season of the year, type of market and other variables one may specify. Shapiro (1979) analysed price of cattle in Upper Volta as a function of age, sex, season of the year, region of the market, type of seller etc. The results of the regression are summarised as follows:

- Prices for males increase at an increasing rate with age, up to 5.7 years (average 5,000 CFA F per year overall); they increase at a decreasing rate to age 11.4, where they begin to fall.

- No strong age-price relation was found for females.

- A premium of 1,500 CFA F was paid for steers over bulls at all ages.

- Only slight evidence of higher prices was found for sales closer to major consumption and export centres.
- No difference was found between ethnic groups as sellers.

- Higher prices occur during the rainy season, lowest during the dry season; males hold their prices better than females during the dry season.

- The amount of seller market information had no significant effect on prices.

- Higher prices were paid for males when they were sold to butchers and traders; females brought higher prices when sold to herders and farmers.

- The type of market had no significant effect on prices.

The foregoing analysis on time series data of livestock markets can be done on district, province and national levels to give information at various levels of aggregation.

Market performance and efficiency

Analysis of the studies of the operations of livestock markets yield in the first instance qualitative and quantitative information on the operations of the markets that is useful in analysing and interpreting the time series data generated. There is no set way of analysing such data. Market analysts have their own approach which is acquired through experience. Two examples of calculations of marketing margins are given in Tables 6 and 7. Studies of the well established traditional marketing systems in West Africa, which also deal with exporting live cattle from the northern pastoral areas to the coastal zone, show that they perform efficiently (with gross margins of 15-20%) despite their traditional base and complexity (Herman, 1979; Staatz, 1979). Our own work (Bekure et al, 1982) and that of Matthes (1979) in Kenya show that marketing margins are much higher (25-35%).
Table 5. Mean prices of cattle at Emali by breed, sex and age -

<table>
<thead>
<tr>
<th>Breed</th>
<th>Sex</th>
<th>Immature</th>
<th>Adult</th>
<th>All ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>per head</td>
<td>per kg</td>
<td>per head</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small E.A. zebu</td>
<td>male</td>
<td>645</td>
<td>3.70</td>
<td>1478</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(761)</td>
<td>(15)</td>
<td>(364)</td>
</tr>
<tr>
<td></td>
<td>castrate</td>
<td>866</td>
<td>4.76</td>
<td>1603</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(660)</td>
<td>(26)</td>
<td>(714)</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>886</td>
<td>4.83</td>
<td>998</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(62)</td>
<td>(2)</td>
<td>(446)</td>
</tr>
<tr>
<td></td>
<td>All sexes</td>
<td>753</td>
<td>4.39</td>
<td>1396</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(1483)</td>
<td>(43)</td>
<td>(1524)</td>
</tr>
<tr>
<td></td>
<td>% Grand total</td>
<td>48.5%</td>
<td>50%</td>
<td>98.5%</td>
</tr>
<tr>
<td>Sahiwal cross</td>
<td>male</td>
<td>1284</td>
<td>-</td>
<td>2150</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(5)</td>
<td>-</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>castrate</td>
<td>1378</td>
<td>-</td>
<td>2159</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(9)</td>
<td>-</td>
<td>(19)</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>-</td>
<td>-</td>
<td>1683</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>-</td>
<td>-</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>all sexes</td>
<td>1337</td>
<td>-</td>
<td>2099</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(14)</td>
<td>-</td>
<td>(24)</td>
</tr>
<tr>
<td></td>
<td>% Grand total</td>
<td>-</td>
<td>1%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Boran cross</td>
<td>castrate</td>
<td>600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(6)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% Grand total</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>all breeds</td>
<td>males</td>
<td>649</td>
<td>3.70</td>
<td>1482</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(766)</td>
<td>(15)</td>
<td>(366)</td>
</tr>
<tr>
<td></td>
<td>% Grand total</td>
<td>25%</td>
<td>12%</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>castrates</td>
<td>870</td>
<td>4.76</td>
<td>1617</td>
</tr>
<tr>
<td></td>
<td>(N)</td>
<td>(675)</td>
<td>(26)</td>
<td>(733)</td>
</tr>
<tr>
<td></td>
<td>% Grand total</td>
<td>22%</td>
<td>24%</td>
<td>46%</td>
</tr>
</tbody>
</table>
Table 5 cont.

<table>
<thead>
<tr>
<th>females: KSh</th>
<th>886 (62)</th>
<th>4.83</th>
<th>1,002 (449)</th>
<th>4.87</th>
<th>908 (511)</th>
<th>4.87</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Grand total</td>
<td>2%</td>
<td>15%</td>
<td>17%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grand total:

<table>
<thead>
<tr>
<th>KSh</th>
<th>758 (1503)</th>
<th>4.39</th>
<th>1,407 (1,548)</th>
<th>5.50</th>
<th>1,087 (3,051)</th>
<th>5.27</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Grand total</td>
<td>49%</td>
<td>51%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Wholesale butchers' margins in Ouagadougou (in CFA F per head).

<table>
<thead>
<tr>
<th>Costs</th>
<th>CFA F per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediary's commission</td>
<td>250</td>
</tr>
<tr>
<td>Holding fee</td>
<td>100</td>
</tr>
<tr>
<td>Slaughter tax</td>
<td>1,000</td>
</tr>
<tr>
<td>Condemnation loss a</td>
<td>150</td>
</tr>
<tr>
<td>Apprentices' salaries b</td>
<td>200</td>
</tr>
<tr>
<td>Purchase price</td>
<td>31,250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revenues</th>
<th>CFA F per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale of meat d</td>
<td>31,250</td>
</tr>
<tr>
<td>Sale of fifth quarter e</td>
<td>5,250</td>
</tr>
</tbody>
</table>

| Margin | 3,550 |


a One half percent of meat was condemned in Ouagadougou in 1976.
b Average apprentice's salary 8,000 CFA F per month.
c Carcass weight 125 kg, 250 CFA per kg.
d Meat sold at purchase price of animal.
e Sales value of fifth quarter is 42 CFA F per kg carcass weight.
Table 7. *Cattle marketing costs at Emali and Ong'ata Rongai.*

<table>
<thead>
<tr>
<th></th>
<th>KShs per head</th>
<th>Kshs per kg liveweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean purchase price from producers</td>
<td>1 012</td>
<td>3.97</td>
</tr>
<tr>
<td>Market costs up to Emali</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- trekking</td>
<td>KSh 20.00</td>
<td></td>
</tr>
<tr>
<td>- watering fee</td>
<td>KSh 2.00</td>
<td></td>
</tr>
<tr>
<td>- food and lodging</td>
<td>KSh 12.00</td>
<td></td>
</tr>
<tr>
<td>- transport</td>
<td>KSh 4.00</td>
<td></td>
</tr>
<tr>
<td>- loss - trading</td>
<td>KSh 10.00</td>
<td></td>
</tr>
<tr>
<td>- death(1/60)</td>
<td>KSh 17.00</td>
<td></td>
</tr>
<tr>
<td>Mean sales price at Emali</td>
<td>1 396</td>
<td>5.48</td>
</tr>
<tr>
<td>Trader's mean gross margin at Emali</td>
<td>319</td>
<td>1.29</td>
</tr>
<tr>
<td>Mean purchase price at Emali</td>
<td>1 396</td>
<td>5.48</td>
</tr>
<tr>
<td>Market costs up to Ong'ata Rongai</td>
<td>119</td>
<td>0.47</td>
</tr>
<tr>
<td>- County Council fees</td>
<td>KSh 7.00</td>
<td></td>
</tr>
<tr>
<td>- trekking fee</td>
<td>KSh 20.00</td>
<td></td>
</tr>
<tr>
<td>- watering fee</td>
<td>KSh 2.00</td>
<td></td>
</tr>
<tr>
<td>- food &amp; lodging</td>
<td>KSh 20.00</td>
<td></td>
</tr>
<tr>
<td>- transport</td>
<td>KSh 12.00</td>
<td></td>
</tr>
<tr>
<td>- miscellaneous costs</td>
<td>KSh 12.00</td>
<td></td>
</tr>
<tr>
<td>- loss - trading</td>
<td>KSh 14.00</td>
<td></td>
</tr>
<tr>
<td>- death(1/60)</td>
<td>KSh 32.00</td>
<td></td>
</tr>
<tr>
<td>Mean sales price at Ong'ata Rongai</td>
<td>1 919</td>
<td>7.6</td>
</tr>
<tr>
<td>Trader's mean gross margin at Ong'ata Rongai</td>
<td>394</td>
<td>1.55</td>
</tr>
</tbody>
</table>

Organisation for collection and analysis of livestock market data

There cannot be a set way of organising a national livestock marketing data collection and analysis. One can only make a general suggestion which elaborates the main features. In the end the organisation to be adopted in a given country will have to take into account the prevailing conditions. What is suggested here is a flexible organisational framework which can be easily adopted with modification.

Figure 4 presents a schematic representation of a general organisational framework for the collection and analysis of livestock market data. It is based on the hierarchical structure most common to ministries of livestock, or agriculture in many African countries. Their field offices are usually hierarchically organized in conformity with administrative units of their respective countries. Thus, the ministries have field offices at provincial, district and occasionally at locational levels, where field officers with secondary school education are posted.

It is suggested that the organisation for the collection and supervision of livestock market data follows the same structure. At the headquarters of the ministry a Livestock Marketing Analysis Section should be responsible for organising the collection, supervising and analysing all data on the livestock market system of the country. This section should be located within the Livestock Marketing Department so that it falls under the responsibility of a department with a functional commitment to the task. In ministries where there is no such department it may be placed under the Planning Unit. The section should be headed by a competent senior livestock market analyst with access to a statistician and data processing facilities. How big and permanent the staffing of the section should be is a function of the size and the importance of the livestock sector in the country. It should therefore be tailored to the needs of the country in question.

At the provincial level, it is suggested that a full-time junior market analyst be made responsible for supervising and partially analysing the data collected in the province. This will enable prompt supervision of data collection as well as facilitate
Fig 4. Suggested organisational chart for setting up national marketing data collection and analysis system.
feed-back of market data to market participants at the local level. For instance average weekly prices of important categories of livestock in major district markets can be compiled at the provincial office and promptly reported to the public by the mass media. This in itself may increase the efficiency of the livestock marketing system.

In addition to supervising and ensuring good quality data collection at the district level, the provincial livestock market analyst will be responsible for conducting in-depth livestock market studies under the direction and supervision of the senior livestock market analyst at the headquarters of the ministry.

At the district level, it is suggested that one of the already existing personnel of the ministry be made responsible for supervising data collection and passing the information to the provincial livestock market analyst. In many African countries district level personnel are university graduates with sufficient background to handle the task provided they are given adequate orientation and on the job training. In cases where the district is located in a major livestock trading region a full-time supervisor may be warranted.

At the market level it is our contention that most of the time series data collection on livestock markets can be conducted and supervised by existing personnel, who in many instances have offices a few yards from these markets. In case livestock markets, where no ministry officers are posted, are selected, other enumerators (e.g. teachers, businessmen etc.) may be contracted on a part-time basis, provided they are adequately supervised with unannounced spot checking. We have used this approach at Ong'ata Rongai, Kenya with good success.

In conclusion, we would like to reiterate that the above organisation is suggested only as a framework for consideration. In small countries or in countries where the network of livestock markets is small and caters for only one terminal market, as in Botswana, the whole organisation may mean one senior and two junior analysts being assisted by field enumerators.
References


Etudes sur la commercialisation du bétail

Résumé

L'un des principaux objectifs de la recherche sur les systèmes pastoraux consiste à accroître la productivité et à améliorer le niveau de vie des éleveurs. L'adoption d'interventions engendrées par la recherche sur les systèmes pastoraux en vue de l'accroissement de la productivité implique à la fois des coûts et des gains. Il est par conséquent essentiel que ces interventions soient non seulement techniquement réalisables et socialement acceptables, mais aussi économiquement rentables. L'objectif du présent document est de souligner la nécessité d'étudier les marchés de bétail et de procéder à la collecte systématique de données chronologiques sur les prix du bétail, sur les marchés locaux, régionaux et finals.

Dans la plupart des pays africains sévit une grave carence de données chronologiques sur les prix du bétail de même que sur la performance et sur l'efficacité du système de commercialisation du bétail. Une représentation schématique d'un tel système qui montre le flux de bétail du producteur au marché secondaire (régional) et final (national) à travers un ou plusieurs marchés primaires est donnée. Les marchés de bétail peuvent être facilement différenciés par le type de vendeurs et d'acheteurs opérant sur le marché et par l'objectif de l'achat du bétail.

La recherche sur les systèmes de commercialisation du bétail implique une approche bi-directionnelle. La première fait appel à la collecte régulière de données chronologiques sur un réseau de marchés de bétail sélectionnés. La deuxième a trait à une étude approfondie de la performance et de l'efficacité du système de commercialisation du bétail aux diverses étapes de la chaîne qui conduit le bétail du stade de la production à celui de la consommation.

Dans la collecte de données chronologiques, la première chose à faire est de procéder à la mise en place d'un réseau de recueil de l'information sur les marchés de l'élevage qui permette d'identifier les marchés de bétail et de sélectionner les marchés à inclure dans
les réseaux. Les types de données des marchés de bétail à collecter incluent le volume du bétail disponible, le nombre de vendeurs et d'acheteurs, le poids des animaux échangés, la destination des animaux échangés et le mode de transport utilisé. La fréquence de la collecte des données dépend du type de marché de bétail en question et de la fréquence des jours de marché. Dans les marchés de bétail primaires, le bétail est généralement échangé une ou deux fois par semaine. Les jours de marché sont beaucoup plus fréquents sur les marchés secondaires ou régionaux de bétail. Sur les marchés finals, la fréquence des jours de marché peut atteindre six par semaine.

Les études sur la performance et l'efficacité du système de commercialisation du bétail aux diverses étapes de la chaîne production-consommation doivent être effectuées par un expert-analyste des marchés de bétail chargé de la totalité des opérations de collecte et d'analyse de données sur les marchés de bétail avec l'assistance sur le terrain de ses collègues du siège et d'agents provinciaux chargés de la commercialisation du bétail. Les études sur la performance et l'efficacité des marchés portent sur deux aspects essentiels du système de commercialisation du bétail. Le premier a trait à une évaluation du degré de concentration des acheteurs dans les marchés sélectionnés en vue de la collecte de données chronologiques ainsi que sur la manière dont les prix du bétail sont déterminés et sur le mode de financement des achats. La deuxième étude fait appel à l'établissement des coûts de la commercialisation du bétail et de la viande à mesure que les animaux passent des mains du producteur au marché final, où ils sont abattus pour la consommation locale et/ou exportés sur pied, après avoir transité par les marchés primaires et secondaires.

Les types d'analyse des données sur les marchés de bétail sont catégorisés comme suit: offre de bétail; destination du bétail; fluctuation des prix; et performance et efficacité des marchés. Le paramètre le plus important dans la collecte de données chronologiques sur la commercialisation du bétail est le prix du bétail. Pour une période et pour un marché donné, le prix par tête et par poids viv
peut être analysé par race, sexe et âge.

Un cadre organisationnel souple pour la collecte et l'analyse des données du marché est suggéré. Il se fonde sur la structure hiérarchisée qui est si commune aux ministères de l'élevage ou de l'agriculture dans plusieurs pays africains.
Summary of Discussion Session 7.
Chairman: Dr Jackson Kategile (IDRC, Kenya)
Discussion led by Mr Larry Ngutter (Kenya)

Dr Barry observed that marketing channels had developed since 1979 due to Nigeria's decision to supplement its meat imports from outside Africa by purchasing Sahel meat. However, to get to Nigeria, animals had to go through Niger or Upper Volta. In 1975 a national organisation was set up in Upper Volta - ONERA (Office national d'exploitation des ressources animales). ONERA's headquarters in Ouagadougou regularly gathered information on prices and numbers of animals. This had resulted in a map of stock movements in 1980.

In reference to Dr Bekure's paper, Dr Chema pointed out that although it was true that there was government control of meat prices in Kenya, there was no government monopoly on the export of livestock, provided that such exports were sanctioned by the government.

Prof. Saka Nuru suggested to Dr Bekure that the threat of epidemic diseases (e.g. rinderpest) could be added to the list of factors inducing the sale of livestock. Dr Bekure agreed, but said that epidemics could not be considered a permanent feature of the system. The model referred to was a simple one and was not expected to incorporate everything.

Dr Tilahun referred to the ILCA/RDP livestock marketing study carried out in Ethiopia in which the degree of responsiveness of buyers and suppliers to price changes was measured. This could give an indication of the market potential for additional livestock. The study revealed that for cows the percentage change in quantity demand was 1.7 times larger than the percentage change in price that brought it about. The change in the price of female sheep and goats on the other hand had little effect on the quantity demanded. For male goats and sheep the quantity demanded was more responsive to change in price. For small ruminants increases in price resulted in decreases in supply, but for cows a 1% increase in price resulted in a 0.8% increase in quantity supplied. The study also illustrated the effects of religious
festivals on livestock sales. Both Moslem and Christian festivals influenced the sale of small ruminants in most of the studied markets and Christian festivals influenced the sale of cattle.
Résumé des débats de la septième séance

Président: M. Jackson Kategile (CRDI, Kenya)
Débats dirigés par M. Larry Ngutter (Kenya)

Le Dr Barry a souligné que les circuits de commercialisation s'étaient développés depuis 1979, notamment en raison de la décision du Nigéria de compléter ses importations de viande en provenance de pays non africains par l'achat de viande dans les pays sahéliens. Toutefois, pour arriver au Nigéria, les animaux doivent traverser soit le Niger, soit la Haute-Volta. En 1975, une organisation nationale, l'ONERA (Office national d'exploitation des ressources nationales) avait été mise en place en Haute-Volta. Le siège de l'ONERA à Ouagadougou rassemble généralement les données sur les prix et sur les nombres des animaux. Ces activités de collecte ont donné lieu à une carte des mouvements du bétail en 1980.

Se référant au document de M. Bekuré, le Dr Chema a souligné que certes le Gouvernement contrôlait le prix de la viande au Kenya, mais il n'exerçait pas de monopole sur l'exportation du bétail qui était toutefois soumise à son autorisation.

Le Prof. Saka Nuru a suggéré à M. Bekuré d'ajouter la menace de maladies épidémiques (par exemple la peste bovine) à la liste des facteurs à la base des ventes de bétail. M. Bekuré a accepté ce point de vue mais a déclaré que les épidémies ne pouvaient pas être considérées comme une caractéristique permanente du système. Le modèle auquel il avait été fait référence était très simple et ne pouvait donc pas tout inclure.

M. Tilahun a fait allusion à l'étude CIPEA/RDP sur la commercialisation du bétail effectuée en Ethiopie, dans laquelle l'impact du changement de prix sur les acheteurs et les producteurs avait été évalué. Cela pouvait donner une idée de la capacité du marché d'accueillir de nouvelles têtes. L'étude a révélé que pour les vaches, l'évolution du pourcentage de la demande quantitative était de 1,7 fois plus importante que le changement de pourcentage du prix qui en avait été à la base. Le changement du prix des ovins et caprins femelles, d'autre part, avait eu très peu d'effet sur la demande.
quantitative. Pour les caprins et pour les ovins mâles, la quantité demandée avait été beaucoup plus influencée par le changement du prix. Pour les petits ruminants, l'accroissement du prix s'était traduit par une baisse de la production mais pour les vaches, un accroissement du prix de 1% a donné lieu à un accroissement de 0,3 de la quantité offerte. L'étude illustre également les effets des fêtes religieuses sur les ventes de bétail. Les fêtes musulmanes, tout comme les fêtes chrétiennes, ont influencé la vente des petits ruminants sur la plupart des marchés étudiés et les fêtes chrétiennes ont influencé les ventes de bovins.
FEATURES AND CONSTRAINTS IDENTIFIED IN PSR AT ILCA
Summary of Discussion Session 8.
Chairman and discussion leader: Dr Barry Nestel (U.K.)

Dr Rhissa said that in PSR he felt it was not only a question of identifying constraints but it was also necessary to put forward a package of solutions to governments. It was up to the governments to analyse and adopt solutions relevant to their aspirations and potential.

Dr Nestel asked Dr Cossins what were the time factors in a program of work needed to reach the diagnostic phase. Dr Cossins said that this would vary from system to system. In the case of the Ethiopian rangelands study, an initial survey took three weeks in the field, and an additional month and a half to prepare a research proposal. Descriptive and diagnostic study programmes were then initiated and only eighteen months later were the team at the point where they were initiating some specific or component research programmes. Dr Wilson said that his team produced systems studies in 3½ years in Mali and then initiated component research on identified constraints. Some component research on agronomy was however carried out from the beginning. He felt it should be possible to identify some constraints more quickly in zones of similar ecology and social organisation. Prof. Saka Nuru thought that such a time-frame would very much depend on the availability of the required information from the national institutions and the government. With such information available, the descriptive phase should not take more than a year to confirm or amend what was known. Where such information was lacking then the descriptive/diagnostic phase would take much longer. He felt that the active co-operation of the national institutions, the government and the pastoralists themselves was essential.

Dr Diakite, in referring to the situation in Mali, said that researchers should not just leave the results of research to be applied - one had also to ensure against poor use and interpretation of data.
Dr Barry felt that the discussion was disturbing – surely the main aim was to be useful to pastoral people? One constraint was that the state did not help the pastoralist by instituting systems or technologies which allowed the pastoralist to be exploited. National priorities usually concentrated on grain production rather than pastoral production.
Résumé des débats de la huitième séance
Président et directeur des débats: M. Barry Nestel (R.-U.)

Le Dr Rhissa a déclaré que dans la RSP, il pensait qu'il ne s'agissait pas seulement de l'identification des contraintes et qu'il fallait également proposer des solutions aux gouvernements. Il incombait aux gouvernements d'analyser et d'adopter les solutions conformes à leurs aspirations et adaptées à leurs capacités.

M. Nestel a demandé à M. Cossins quels étaient les facteurs temps nécessaires dans un programme de travail pour atteindre la phase de diagnostic. M. Cossins a répondu que cela variait d'un système à l'autre. Dans le cas de l'étude sur les parcours éthiopiens, une enquête initiale avait duré trois semaines sur le terrain et il avait fallu 45 jours supplémentaires pour préparer une proposition de recherche. Les programmes d'étude de diagnostic et de description avaient ensuite été lancés et ce n'est que 18 mois plus tard que l'équipe a pu démarrer certains programmes spécifiques de recherche sur les composantes. M. Wilson a déclaré que son équipe avait produit des études sur les systèmes en 3 ans et demi au Mali et qu'elle avait ensuite commencé des recherches sur les composantes sur des contraintes identifiées. Des activités de recherche sur les composantes dans le domaine de l'agronomie avaient toutefois été entreprises dès le début. Il pensait qu'il devrait être possible d'identifier certaines contraintes plus rapidement dans des zones où l'écologie et l'organisation sociale étaient similaires.

Le Prof. Saka Nuru estimait qu'un tel cadre temporel devrait être fortement tributaire de la disponibilité des données requises dans les institutions nationales et gouvernementales. Avec de telles informations, la base descriptive ne devrait pas prendre plus d'un an pour confirmer ou infirmer ce qui était connu. Là où une telle information faisait défaut, la phase description/diagnostic prendrait beaucoup de temps. Il estimait que la coopération des instituts nationaux, du Gouvernement et des éleveurs eux-mêmes revêtait une importance capitale.
Se référant à la situation qui prévaut au Mali, le Dr Diakité a déclaré que les chercheurs ne devraient pas simplement se contenter de donner les résultats de leur recherche pour application. Il fallait également veiller à se prémunir contre l'utilisation et l'interprétation inadéquates des données.

Pour le Dr Barry, ce débat était gênant. L'objectif essentiel était certainement d'être utile aux populations pastorales. L'une des contraintes était que l'État n'aidait pas l'éleveur en mettant en place des systèmes ou des techniques qui favorisaient l'exploitation de celui-ci. En général, la priorité nationale était la production de céréales plutôt que la production pastorale.
IDENTIFYING THE SCOPE FOR IMPROVEMENT IN PASTORAL PRODUCTION
The scope for improvement

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Introduction

This paper takes as its starting point that in the cycle of pastoral systems research (PSR) the existing system has been adequately investigated, described, and analysed and that the constraints on the further development of the existing system have been identified. The next stage in the cycle is to identify the scope for improvement.

Identifying the scope for improvement may imply different things. To some people in some situations, there seems to be almost no scope for improvement. Although the present system is one of low productivity, it seems that nothing can be done to improve it except at a cost which is far in excess of potential benefits. In such circumstances identifying a possible improvement is a most challenging task and enormous effort is spent in designing and redesigning research and development work in order to try to reduce costs and increase benefits.

To other people in other situations there seems to be a wide range of improvements, each of which offers promise. Identifying the scope for improvement then appears to be more a case of selecting from among the many alternatives those options which offer the greatest promise. In such cases the main task is estimating the likely consequences of alternatives.

Although this paper is relevant to both sets of circumstances, it has a number of different alternatives primarily in mind. In both cases decisions in principle are made on possibilities for improvement and the ideas about the improvements are refined to the point where they can be the subject of on-farm/range, on-research station,
component research, or the subject of further study of some other appropriate kind. This paper is concerned with the social and economic aspects of the identification and assessment of improvements.

In particular situations potential improvements are likely to induce some combination of changes in technology (technological change) and in organisations, institutions, or in other economic, administrative or social conditions (hereinafter collectively termed "social change"). One extreme example, involving no change in technology but substantial social change, would be the expropriation of individually-owned and managed water points (on communally grazed land) and the substitution of group-ownership and management by an elected committee of pastoralists. Such a change could lead to improvement both in overall productivity, through the establishment of a mechanism to control the number of livestock permitted to graze an area of land, and in the equity of distribution (between members of a pastoral society) of access to water and so to grazing. At the other extreme there may be a potential for substantial changes in technology, e.g. by the introduction of an effective vaccination against contagious bovine pleuropneumonia conferring immunity for life, which will require no direct social change but which can be applied through, for example, existing arrangements for anti-rinderpest vaccinations.

Most potential improvements will require some combination of substantial amounts of both new technology and social change. Both the technological and the social changes required will usually be of two sorts; firstly the direct intended change, which is a fundamental part of the improvement, and secondly the indirect changes, often unintended, unforseen and, sometimes, unwanted, which are brought about by the direct changes. Direct technological changes may lead to indirect social (as well as technological) changes, and vice versa. The indirect changes may be as important, in both their costs and benefits, as the direct.
Tasks in identifying the scope for improvement

This paper will discuss the tasks to be done principally from the point of view of ILCA. However other organisations carrying out PSR are faced with essentially the same obligations and constraints and so, with minor amendments, what is written here about ILCA is applicable to other organisations.

In order to fulfill its mandate, ILCA needs not only to identify potential improvements but also to make some assessment of ILCA's mandate states that it should seek to increase livestock production and to improve the quality of life in sub-Saharan tropical Africa. In assessing potential improvements it needs to look at their likely impact in terms of these two criteria. It also, in order to prevent resources being wasted on research whose results are not implemented, needs to assess the chances of adoption of potential improvements. Partly this is a matter of looking at the objectives of the other parties involved in development, e.g. of the host government or of the pastoralists of the area concerned, to see whether what seem to be improvements in terms of ILCA's criteria will also seem to these other parties to be improvements that they should encourage rather than frustrate. Partly it is a question of assessing whether, with the best will in the world, the parties and institutions concerned are capable of introducing the improvements within a reasonable period of time. Finally ILCA needs to ensure that at least some of the improvements that it develops will bear fruit rapidly. Host governments, pastoralists and donors will all need early reassurance of the capacity of PSR to yield useful results if their initial enthusiasm and support is not to wane. Some improvements are not only important but also, because of their very nature, have very long pay-off periods. They need to be complemented by others which even if not inherently so important can serve to sustain interest.

There are, then, four things to be done: to identify potential improvements, to assess the probable impact of each, to assess the probability that an improvement will be adopted and to estimate how rapidly an improvement will bear fruit. It is convenient for analytical purposes to classify them as separate activities
although in practice they will often be carried out more or less simultaneously and by a single person, sometimes through a series of iterations that modify initial ideas into something more appropriate and feasible.

In some cases the next step in the development of improvements lies with ILCA (or other organisations carrying out PSR) alone, e.g. where a new technology has to be devised or adapted for a specific location and where ILCA can itself carry out the necessary technical component research. In other cases some specific social change, which can only be brought about by someone else, normally a part of the host government, is required, either on its own or as a necessary concomitant to an ILCA derived change in technology. Even where someone else must take the next step ILCA needs to assess the likely impact and chances of adoption of the improvement, and the probable rapidity of its fruition so as to provide that someone with adequate information on which to base their own decision. In some cases what is required is research by someone else; in other cases further research will not be useful and what is needed is the implementation of development forthwith.

Identifying potential improvements

If, for example, an initial analysis of the system indicates that marketing is a constraint then this signposts the need for an improvement in marketing. "Identifying a potential improvement" is the process of looking at the critical stage or steps in the marketing process and tentatively selecting things which could be done, in the way for example that Bekure, Evangelou and Chabari (1982) have identified supply of credit, weighing and grading, and sale by auction, as potential improvements in livestock marketing in Kajiado, Kenya.

Assessing the impact of potential improvements

The assessment of impact of an improvement merits some further consideration. Essentially this is a predictive activity, or an attempt to forecast something which may follow on from research; it is not
monitoring or evaluating something which is already taking place. Assessment of impact has so far been described in terms of the likely direct and derived technological and social changes which will be associated with an improvement, but at this stage it is necessary to go further and evaluate the changes according to ILCA's criteria, i.e. in terms of their consequences on production and on the quality of life. ILCA will not be interested, of course, in improvements which simply maximize output regardless of cost. ILCA's mandate to increase output implies the rider "at reasonable cost". On the other hand at this stage in the PSR cycle precise prediction of costs of improvements in relation to benefits is impossible. The same is true of other kinds of impacts. Since research has not yet taken place the quantity of the potential benefits (yields) is not yet known and the volume of costs (inputs) is equally obscure. Moreover, since the improvement is still some way off in time from introduction to pastoralists, the relative prices of outputs and inputs will probably be subject to considerable changes, but ones which are largely unpredictable in direction or size. Analyses of various degrees of sophistication and complexity can, and should, be done to explore the combinations of yields, inputs, prices and other factors which give rise to impacts which are on balance favourable or unfavourable. These should permit an assessment of the probable long-term average overall impact. Another element in the assessment of the increased production is the extent to which increases in average (over different sites or different periods) production is matched by increased risk (variation).

ILCA's mandate also requires it to improve the "quality of life" - an expression which is in some ILCA documents rephrased as "standard of living", although in common usage there are important differences between the way the terms are used. The latter usually implies much more emphasis on material welfare, particularly on the consumption of goods and services, whereas the former embraces not only material welfare (clean air, low infant mortality) but also satisfaction of a less material kind, e.g. harmonious social relations.
In practical terms, ILCA can assess the probable impact of potential improvements on the quality of life in a number of important ways. The impact on the natural environment is one of these; a second is to assess to what extent the potential improvements proposed will benefit all sections of the community, i.e. all kinds of households - "kinds" in terms, for example, of wealth and power, occupation or ethnicity. Certain kinds of both technological and social changes, even if their benefits are not intended to be restricted to particular socio-economic classes, are in practice more likely to benefit or be adopted by some classes and this may positively injure others. ILCA, both out of a proper concern for social equity, and from a need to avoid the resentment against itself which will arise if it is thought to favour only certain groups, should aim to avoid developing improvements which are likely to benefit only certain ethnic groups in an ethnically mixed region, or the strong at the expense of the weak. Thus, as far as is practicable, ILCA should develop a package of improvements at least some of which should offer benefit to every kind of household. An early assessment is required of the likely impact on relative welfare of different groups, since once research has been successfully carried out it will not be possible to suppress its results even if their impact is inequitable. A third important respect in which the impact of a potential improvement on the quality of life can be assessed is in terms of the way it affects the distribution of benefits and burdens within households - in particular its effect on the nutrition of children and on the work pattern of women. There are, of course, a number of other aspects to the quality of life which may be relevant to particular potential improvements, but those mentioned here deserve consideration in respect of every improvement.

Assessing the chances of adoption of potential improvements

ILCA needs not only to assess the probable impact of improvements if adopted, but also to assess the chances of desirable improvements being adopted. It is not a sufficient condition for an improvement to be adopted that it has desirable impacts in terms of output and quality of life. There may be difficulties involved, for example
difficulties in the procurement and distribution of high technology inputs, which are unlikely to be solved even if ILCA convinces everyone concerned about the urgency of their solution. Social constraints, in the form of traditional institutions and value systems, have often been cited as causes of the failure to adopt new technological improvements. The possibility of such social constraints can not be denied, possibly in the form of fundamental divergencies in values between, for example, ILCA and a progressive government on the one hand and a traditionally-oriented pastoral society on the other. But in many cases in the past where agricultural researchers and extension personnel have blamed such social factors, the real problem has subsequently been found to be that the researchers were advocating unprofitable technology or had failed to grasp the full complexity, e.g. in respect of risk, of their clients' decision-making process.

Assessing the rapidity of fruition

As already noted, ILCA needs to include in its package of improvements some which will yield early evidence of the usefulness of PSR, even if these are of only modest importance. Otherwise there is a danger that essential support by other parties, i.e. host governments, pastoralists and donors, will be withdrawn prematurely from more important improvements which can be developed and yield results only over a longer term. The early development and introduction of some improvements, even if only modest ones, can help to sustain interest and support while the more long-term, and possibly more important, improvements are still being worked on.

Who should identify the scope for improvement?

The techniques for assessing the impact, probability of adoption, and speed of fruition of potential improvements are overviewed in a later section. This section examines who should do the identification and assessment. A "natural" solution appears to be that as far as improvements implying primarily technological change are concerned the first task of identifying the potential improvements should be by the natural scientist in that specialist field (e.g. soil science,
forage agronomy, genetics) most concerned, and that in the subsequent task of predicting the indirect changes and the impact on production and the quality of life, social scientists (including economists) should also play a substantial part. The implication of this approach is that it is primarily the staff and consultants of the PSR organisation itself (e.g. ILCA) who will be involved.

However there are two shortcomings in this point of view. Firstly the probability that a host government will take the necessary steps that will allow a successfully tested improvement to be adopted subsequently will be directly proportional to the degree of its own involvement early in the process of decision making that led to the development of the improvement. Such early involvement by the host government will not only lead to its greater sense of commitment to the introduction of the improvement and to an earlier awareness of the institutional changes it may subsequently have to make, but also to its providing ILCA earlier with information about the host government's own intentions that may affect the chances of adoption. That is the positive aspect. The negative aspect is that unless the host government's involvement in decision making on the improvements to be designed and tested is to be merely token window-dressing, then ILCA risks being prevented from developing improvements, which could be highly beneficial, by host government officials who may not have the training or time to be able to appreciate an improvement's real potential. Host government involvement may be either a help or a hindrance.

The other shortcoming is that an important argument raised in favour of a systems research (FSR/PSR) approach is that it more closely considers small farmers' /pastoralists' point of views and is more influenced by their values and opinions than are other research approaches. Clearly this "advantage" is in danger of being lost if, at a critical stage when decisions are being made about the improvements to be tested or studied, farmers' /pastoralists' opinions are not directly canvassed but are only "represented" by what natural or social scientists think farmers ought or are likely to think. Consideration needs to be given as to how the opinion of pastoralists might be incorporated into the selection of improvements for testing.
The "literature" on FSR is somewhat silent or opaque on this subject. Most of the discussion in the literature about farmer's participation in FSR is about their involvement in identifying constraints, in carrying out on-farm trials, and in subsequent adoption of innovations. Literature dealing specifically with the issues of the institutional devices required to incorporate farmers'/pastoralists' opinions into the process of identifying improvements cannot be identified.

Three points are worth making here. First the staff of many government services for implementing development are unlikely to represent farmers'/pastoralists' opinions any better than research scientists. In many countries, indeed, especially where FSR/PSR has been willingly adopted as an approach by the research services, the researchers are more likely than are the agents of the often 'top-down' oriented extension services to be able to understand farmers' points of view. Secondly, in seeking pastoralists' opinions care has to be taken to obtain an adequate cross-section. It is not enough to consult political leaders, or leaders of pastoralists' associations, or "prominent" or "progressive" pastoralists. Such people are likely to be drawn from among the better-off and are likely neither to understand well the problems of the less well-off, nor, if they understand them, to represent them if such views are contrary to their own interests. Nor is it enough just to call a public meeting to discuss selection of improvements. At such public meetings the interests of the less well-off, even though they attend, are unlikely to be strongly defended.

The third main point is that if pastoralists are to make the contribution to identification of improvements that is needed of them, then time and care has to be devoted to discussing with them what the different improvements may involve. Of course, if asked "would you like a new kind of livestock feed which will make your animals give more milk?" the response will be affirmative. That sort of consultation is mere window-dressing. What needs to be done is to thrash out in some detail what the innovation may mean (including any alternative options) in respect of, for example, cash cost, labour-use profiles, risk, land tenure, loss of pastoralists' independence etc.
This is inevitably time-consuming and will not lead to published articles in internationally refereed journals in the way that conventional disciplinary research (even if subsequently ignored by pastoralists) will yield. But it is more likely to lead to the design and testing of innovations which will subsequently be adopted. The point is that pastoralists cannot be expected to grasp immediately all the implications for their pastoral system of a potential technological change. Little in their own experience will have fitted them to know what sort of questions one needs to ask about new technology. But if scientists and pastoralists will sit down together to thrash some of the issues out, from the union of their past, separately inadequate, experience something useful may emerge. In the case of the participation in decision making by both pastoralists and officials of the host government's service for implementing development, care has to be taken to establish a proper institutional framework for that participation and to ensure that participants are adequately oriented and briefed so that their participation is both genuine and has positive results.

Techniques for assessing potential improvements

This section of the paper deals briefly with the kind of techniques available for assessing the relative merits of different potential improvements once these have been identified.

Early on in the preparation of this paper the idea was discussed that it ought to be possible to make generalisations, about impact, about probability of adoption, about rapidity of fruition, based on broad categorisations of, on the one hand, "types of improvement" and on the other "kinds of situations" in which the improvements are to be introduced: for example, "individual land tenure" areas would be one kind of situation, "communal tenure" areas would be another. Categorisation of improvements could be by a number of different criteria. One of these would be in terms of western concepts of disciplinary boundaries, and would lead to a categorisation as follows.
1. Improvements to the primary productivity of the natural vegetation leading to better animal nutrition.

2. The growing of introduced grass, browse and other forage.

3. The supply of supplementary feed (minerals, protein, energy etc.) from non-rangeland sources.

4. Improvements in animal health.

5. Genetic improvements (whether from imported genes or by intra-area selection).

6. Improvement in water supplies - leading to more frequent watering, with higher quality water at less energy cost in watering.

7. Improvement in animal husbandry (e.g. breeding seasons, weaning practices, housing etc.); i.e. improvements in the care of individual livestock kept not subsumed under 1 to 5 above.

8. Improvements in marketing that lead to greater market efficiency, convenience and equity.

Categorisation by disciplinary boundaries did not lead to many useful generalisations. Possibly the only important one was about rapidity of fruition. In many pastoral areas the full scope of available animal health technology has not yet been exploited and quite short periods of survey, followed by short trials on pastoralists' herds, can lead to rapid results on a wide scale. Although improvements on the health side may not substantially affect the overall productivity of the pastoral system unless the nutrition constraint is also overcome, they can provide early and dramatic evidence of the efficacy of PSR as far as the productivity of individual animals is concerned.

A possible categorisation of improvements in terms of those which are susceptible to testing by standard experimental techniques and those which are not was also considered. The distinction is not absolute but one of degree (more or less). Most technological changes are susceptible to standard experimental techniques when tested on a research station, and some of these, for example, forage crop trials on individually owned fields, weight gains of individual animals due
to supplementary feeding, can also be tested in this way "on-farm" ("on-range"). In other cases, however, because of difficulty of measurement, e.g. in the case of milk yields of cows with calves at foot, or because of difficulty of experimental control, e.g. with different range management techniques on communally grazed land, even technological improvements are barely testable in "on-farm" experimentation. Most social changes are not susceptible to standard experimental techniques of the kind applied to technological innovations because it is simply not possible to conduct a controlled experiment with them. However, it should not be concluded that experimentally testable improvements are legitimate and important and that untestable ones are not. On the contrary, many experimentally testable improvements may offer only trivial advantages whereas the major scope for improvement may be through untestable innovation.

Although it cannot be concluded that improvements which are experimentally testable are, ipso facto, likely to be more or less important than those which are not, they have some advantages when it comes to reducing the risk of failure in large-scale implementation. With improvements that are experimentally testable there will be some points, short of full-scale implementation, at which the impact of an improvement on increased production can be verified. Of course, even in this case what will be measured, when doing experiments, are changes in output under conditions of experimental control or of supervision or guidance by scientists. These may comprise rather different conditions than would be the case in the event of large-scale adoption by pastoralists at a later time. On-farm testing, if done for long enough and on a large enough scale, can also in theory involve assessments of risk and the inter-class and inter-household distribution of costs and benefits. In practice it seldom can be done for long enough or on a large enough scale to achieve this.

However the scope for success in the introduction of improvements will be determined more by the characteristics of the particular situation (in time and space) on which PSR and development are focused rather than by the category of improvement. Particular situations differ from each other in so many different ways (environ-
mental, economic, social, political etc.) that useful categorisations and generalisations are not possible here. Categorisation by one criterion (e.g. rainfall) cuts across categorisations by another (e.g. social structure) in a way that yields a myriad of sub-categories. In other words, the assessment of potential improvements cannot be done simply by reference to simple rules of thumb (generalisations applied to broad categories of improvements and situations) but will require specific analysis in each instance.

Thus, in assessing potential improvements, broad generalisations based on categories of improvements and of situations cannot be relied upon to predict likely impact and probability of adoption. Rather reliance will need to be wholly on case-specific predictive models. In a few cases, if it is decided to select that improvement for subsequent component research, some experimental evidence will subsequently become available to shed light on the validity of the original models.

The models can be of varying degrees of complexity depending on the time and resources available to construct and test them and on the input data available. At one extreme of simplicity, the model may be no more than a "back-of-the-envelope" calculation (simple "partial budgeting") to decide whether the average cash cost of, say, a mineral block is likely to be exceeded by the average value of extra liveweight gained as a result of using it.

A first step improvement on the "back-of-the-enveloppe calculations model would be one which:

1. estimated probabilities of different values of net cash returns, thereby taking at least partial account of the substantial impact of variability in pastoral systems on the pay-off from an improvement.

2. included a cash flow exercise which estimated how the period and financial deficit between the time at which cash costs are incurred and cash returns are received might be bridged by different classes of pastoralists.
3. showed the impact of a potential improvement on the labour-use profile of different classes of pastoralists. In many pastoral (and farm) systems, labour is as critical a limiting resource as cash. It is, therefore, important to calculate whether the extra labour demand generated by an improvement can be accommodated solely by sacrificing leisure (and if so whether the net returns per extra man hour are comparable to those obtained by other activities currently carried on), or whether it will require the displacement of some other productive activity, and if so with what result. Such calculations are equivalent to the "gross margin" kind of calculations carried out for conventional cropping enterprises which show which activity is likely to yield the highest margin per hectare and which activities are likely to be displaced by the more profitable new one. Models that deal with labour-use are more complex than "gross margin per hectare" analyses. For example in the case of irrigated land whereas land can be allocated at most to three different crops in succession each year, i.e. once every four months, competition between activities for labour occurs on a much more frequent basis.

The types of models discussed so far are extremely simple and for the most part are economic models. If time and data allow far more complex models can be used. In agropastoral enterprises, linear programming maximizing models have already been used (e.g. by Eddy (1979) and Delgado (1979)) but not yet for purely pastoral enterprises except at an excessively aggregate scale, e.g. it has been done for the Sahel as a whole (Picardi, 1974). Konandreas and Anderson (1982), building on work by others, have devised a simulation model which can be used to forecast some of the changes in livestock systems which will spring from changes in technical parameters. Both these kinds of models are essentially economic ones, are expressed in mathematical terms, can be computerised, and deal with rather few relations and variables at a time (the Konandreas and Anderson model contains some 25 key equations). On the whole, the economic models developed so far are best at predicting the impact of improvements on net output (production less costs) and are not directly concerned with the probability of adoption or the effect on the quality of life as spelt
out in this paper. Most anthropological models are verbal, not mathematical, and are much more complex but correspondingly less precise. They are much more concerned with questions of adoption and of interpersonal equity. A feature of all complex models is that they require considerable time and effort not only to collect data but also to manipulate the model and consider its results.

Concluding summary

There are four main tasks to be carried out when identifying the scope for improvement: identification of potential improvements and then, in respect of each of those identified, prediction of the likely impact in terms of at least two criteria (increase in net production, change in the quality of life), prediction of the probability of adoption and of the rapidity with which the improvement will bear fruit if adopted. These are not very radical suggestions but they are seldom practised. Furthermore it has been suggested that when identifying scope for improvement not only should the natural and social scientists of the organisation practising PSR itself be involved, but also pastoralists and officials of the implementing agencies of the host government should participate as well. For such participation to be fruitful, however, thought, trouble and time have to be devoted to ensure that their participation is genuine and properly structured and informed. In making predictions, generalisations based on categories of improvements and categories of situations in which the improvements are to be introduced are of very limited use. Case-specific analysis will be required which will use predictive models of varying complexity and from different professional disciplines. Because the predictions are being made in advance even of on-station research, they cannot be precise but can only be estimates of probabilities concerning the balance between benefits and costs or between positive and negative factors.
References


Envergure des innovations

Résumé

Cette étude prend comme point de départ que le système existant a été étudié, décrit et analysé de manière adéquate dans le cadre de la recherche sur les systèmes pastoraux et que les contraintes relatives au développement futur du système ont été identifiées. La phase suivante dans le cycle consiste à identifier l'envergure des innovations.

Il y a quatre tâches essentielles à effectuer dans l'identification de l'envergure des innovations: l'identification des améliorations potentielles et ensuite, par rapport à chacune des innovations identifiées, la prévision des effets potentiels, compte tenu tout au moins de deux critères (accroissement de la production nette, changement de la qualité de la vie), la prévision de l'adaptabilité de l'innovation et de la rapidité avec laquelle celle-ci portera des fruits si elle est adoptée. Le CIPEA peut évaluer l'impact probable des améliorations potentielles sur la qualité de la vie de plusieurs manières. L'impact sur l'environnement fait partie de celles-ci. Le CIPEA peut également évaluer la mesure dans laquelle les améliorations potentielles profiteront à toutes les composantes de la collectivité. Troisième aspect non moins important: la manière dont une amélioration influe sur la distribution des avantages et des inconvénients au sein des ménages.

En identifiant l'envergure de l'amélioration, il faudrait faire appel non seulement aux chercheurs spécialisés en sciences sociales et naturelles participant à la RSP mais également aux éleveurs et aux responsables des organismes d'exécution du Gouvernement du pays hôte. Pour qu'une telle contribution soit fructueuse cependant, il faudra faire en sorte qu'elle soit bien structurée et que les participants à cette recherche concertée disposent des informations requises.

Dans les prévisions, les généralisations basées sur des catégories d'innovations et des catégories de situations dans lesquelles les
améliorations doivent être introduites sont d'une portée limitée.
Des analyses de cas spécifiques, fondées sur des modèles de prévision de complexité diverse effectuées dans diverses disciplines seront nécessaires.

Les modèles peuvent être de complexité diverse, compte tenu du temps et des ressources disponibles pour les mettre au point et les tester et compte tenu des données disponibles. Il peut être très simple mais il peut également être assez complexe et estimer par exemple les probabilités de différentes valeurs de revenus monétaires nets, inclure des calculs sur la marge brute d'auto-financement déterminant la manière dont le déficit financier qui intervient entre le moment auquel les dépenses monétaires sont effectuées et celui où les revenus monétaires sont perçus peut être comblé par les différentes classes d'éleveurs et montrant l'impact d'une amélioration potentielle et le profil de l'utilisation de la main-d'œuvre de différentes classes d'éleveurs. Si le temps et les données le permettent, des modèles beaucoup plus complexes peuvent être utilisés.

Etant donné que les prévisions de tels modèles se font à l'avance (même avant d'entreprendre la recherche au niveau de la station), elles ne peuvent être précises. Toutefois, elles peuvent constituer des estimations plausibles sur l'équilibre entre les coûts et les bénéfices ou entre les facteurs positifs et négatifs.
Biotechnical options

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Introduction

Let me begin by reminding you that ILCA is one of the International Agricultural Research Centres with a mandate to carry out a programme of research supported and extended by documentation and training "to assist national efforts which aim to effect a change in production and marketing systems in tropical Africa ..."

Let me quote also Baker (1977)'s selection from the ILCA prospectus (1974). "The system approach is valuable in research planning not so much in identifying problems, which are often self-evident, as in selecting what are likely to be the most profitable approaches to problem solving. This is especially relevant to livestock production in Africa where improvement in yield or output is as likely to come from social change or from range improvement as it is from genetic change in the animals themselves."

The truth of this has been shown in the constraints to production and opportunities for improvement identified by the leaders of our pastoral research teams in their papers to this workshop. One might well argue that most, if not all, of the problems they have specified could have been listed before ILCA's systems research programmes began - indeed most of these problems were already identified or identifiable from the large amount of research information then available. What was lacking was knowledge of the best ways of solving the evident problems, given that many optimistic attempts to introduce new methods based on improved Western models had been dismal failures. It was not clear whether the technology had been wrong, and just did not work in the different physical environments of Africa, or whether the social and economic conditions in which the technology had been
used had prevented it from being applied in such a way as to effect the improvements of which it was potentially capable.

Sandford has outlined the considerations which seem to be most important from the social and economic viewpoints in identifying the scope for improvement in pastoral production. We must also consider the biological or technical possibilities which are available for pastoral systems, and try to sort these into some ranking of applicability considering not only the likelihood of technical success but also their relevance and feasibility.

Technical features of pastoral systems

African pastoral systems are subsistence-oriented, and based on milk production — milk, not only to rear the calves which will ensure long-term continuity of the system, but also to form the mainstay of human nutrition. These systems are not easily forced into the mould of conventional Western beef production and many earlier attempts to develop such enterprises have failed.

The zebu-type cow in these extensive grazing areas may appear unproductive, indeed the milk yields recorded in ILCA pastoral studies are quite modest. Consider a cow giving an offtake of 1 l/day; in terms of human nutrition she is producing as much as a castrate gaining 1 kg/day*. Her biological efficiency is high judged by the value of her output of high quality food in relation to the amount and value of the forage she has eaten.

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* 1 000 ml milk at 14% total solids = 140 g nutrients
1 000 Lwt gain = 600 g bodywt (30% skin, bone, inedible tissues)
   = 600 x 0.70 edible tissues (70% water)
   = 600 x 0.70 x 0.30 g edible DM
   = 126 g nutrients
Table 1. Estimated yield (ml/day) of cows in ILCA pastoral programmes.

<table>
<thead>
<tr>
<th>Country</th>
<th>Milk offtake for human use (measured) (ml/day)</th>
<th>Milk intake by calf estimated from weight gains (ml/day)</th>
<th>Total (ml/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>1140</td>
<td>2560</td>
<td>3700</td>
</tr>
<tr>
<td>Kenya</td>
<td>720</td>
<td>(2500)</td>
<td>(3220)</td>
</tr>
<tr>
<td>Mali</td>
<td>730</td>
<td>1620</td>
<td>2350</td>
</tr>
</tbody>
</table>

Considering the harsh conditions under which they live, small ruminants too reach high levels of individual production. Even though individual production may be high, cattle herd productivity could be raised substantially if:

- fewer calves died, and more were reared to sell or to milk;
- calves grew faster and matured earlier;
- cows calved first at an earlier age; and/or
- cows calved more frequently thereafter.

Table 2. Reproductive performance of sheep and goats in semi-arid Africa.

<table>
<thead>
<tr>
<th>Country</th>
<th>Age at 1st parturition (d)</th>
<th>Parturition interval (d)</th>
<th>Litter size</th>
<th>No. of young/female/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goat Sheep</td>
<td>Goat Sheep</td>
<td></td>
<td>Goat Sheep</td>
</tr>
<tr>
<td>Mali</td>
<td>470 270 250</td>
<td>1.21 1.05</td>
<td>1.63 1.51</td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td>550 320 320</td>
<td>1.25 1.04</td>
<td>1.42 1.19</td>
<td></td>
</tr>
<tr>
<td>Sudan</td>
<td>- 230 280</td>
<td>1.52 1.13</td>
<td>2.37 1.49</td>
<td></td>
</tr>
</tbody>
</table>

If more calves were reared better and either sold earlier or calved earlier, lactating cows could form a higher proportion of the herd, giving higher efficiency of production per unit of forage eaten, or per unit area of grazing land used.

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Milk yield is the key to most improvements since increases in yield would make it possible to reduce calf losses, improve growth rate of calves and thus to meet the implicit objectives of the pastoralist while also making possible an increase in the turnoff of surplus male cattle to meet national development needs.

The results of ILCA's systems analysis have shown the importance also of smallstock - particularly their role as a rapidly renewable liquid asset, easily converted into cash or exchanged to meet short-term needs, and of a convenient size to provide meat for domestic, religious or social celebrations. Their shorter gestation and high fecundity provides valuable flexibility and their behaviour makes it possible to exploit types of pasture or browse not eaten by cattle. The almost universal use of young males for slaughter sale or exchange has shown up clearly in ILCA surveys.

Table 3. Age and sex structure of flocks in Sahel transhumant systems.

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Sheep (a)</th>
<th>Sheep (b)</th>
<th>Goats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>0 - 6</td>
<td>11</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>7 - 14</td>
<td>6</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>15 - 21</td>
<td>4</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>over 21</td>
<td>7</td>
<td>36</td>
<td>7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28</td>
<td>72</td>
<td>25</td>
</tr>
</tbody>
</table>

Just as the type of livestock kept and their role has strong common features, so too the constraints identified can be grouped into those which are common to most pastoral systems and some more specific to a particular region or system. This distinction depends largely on the overriding influence of climate, mainly rainfall and its seasonal distribution; we shall examine how this dominates the husbandry of cattle and small ruminants and contributes, directly and indirectly, to many of our problems.
The effect of climate on nutrition

The ILCA team in Mali has recorded the amount and quality of forage available, and the liveweight changes of cattle and small ruminants in the systems relying on the Niger delta (Dicko et al, 1981).

Fig 1. Seasonal trends in liveweight (1) and metabolisable energy intake (2).
Fig. 1 shows the seasonal pattern of changes in liveweight in cattle in Mali. Similar patterns have been found in many other tropical climates, and it is evident that the annual weight increase made during the short wet season when feed is abundant and of good quality is partly lost over the following months of the dry season, particularly in the few weeks immediately preceding the following season's green growth. This means that yearly net gains are low, maturity is delayed, and first calving is at four or five years of age. Cows, which usually conceive towards the end of the wet season, calve after a long period of under-nutrition during the following dry season. It means also that cows which calve a little late and do not conceive again before the dry season begins are likely to enter a long period of lactational/nutritional anoestrus and will not conceive until their calf has been weaned or until the following year's wet season. Thus the herd will include too many cows which calve only every second or even third year.

The classical solution to this predictable yearly problem of feed shortage is to move, either between wet and dry-season grazing areas where land is still plentiful, or to arable areas where crop residues are available. Lack of water means that grazing areas within reach of dry-season wells or ponds soon become overgrazed; the high concentrations of livestock may help the spread of diseases, and poor nutrition is made worse by the need to walk long distances each day or two.

Options available for improvements

Problems arising from aridity

Not only mean annual rainfall and its variation, but also its distribution, greatly influences pasture growth and therefore secondary productivity of livestock. Unreliable early rains can cause repeated sequences of germination and seedling death; very heavy rains cause massive runoff and fill surface ponds and streams, but poor infiltration into the soil means that pasture growth is poorly sustained. Rainfall distribution may be so unreliable that there is no possibility of permanent use of land by livestock - Bille (1983) has suggested
that a monthly rainfall of less than 60 mm gives very little or no
grass growth (in the Ethiopian rangelands) and the probability that
rainfall will reach this minimum figure in any one month is the best
biological distinction between wet and dry months. Judged by this
criterion some areas of the northeastern Ethiopian rangelands, for
example, will have no effective primary production at least one year
out of ten except in natural hollows. Baker (1975) pointed out that
the Karamoja area of Uganda could expect one year in four to be so
dry as to seriously reduce crop and pasture growth and cause losses
of animals. This problem cannot be solved by the creation of more
watering points, and such areas can be exploited in the long term
only under a nomadic system permitting emergency access to areas which
have more reliable pasture growth. If this becomes impossible, it
will be necessary for governments to organise emergency drought
relief in the form of livestock or human food, or emergency purchase
of excess stock.

Areas with a well-defined but erratic bimodal rainfall are
better suited to livestock grazing than to introduction of cropping.
Loss of browse through land clearing might even harm livestock
production more than it would benefit from the dry-season crop residue
grazing.

Rainfall cannot be controlled, but by systematic recording
over the pastoral area it is possible to arrive at valuable estimates
of reliability of monthly rainfall. This, in the long run, may make
it possible to plan more stable systems of utilisation and development.
This is clearly an option requiring governmental or regional projects'
initiative, and might well be linked to modern methods of satellite
remote sensing, to give advanced warning of failure of rainfall, and
to provide long-term and large-scale monitoring of rangeland con-
ditions.

Problems of undernutrition

Inadequate nutrition in the dry season may occur as a long-term
problem because of progressive loss of dry-season grazing areas,
associated with increasing pressure of populations or with ethnic
or political rivalries. For such cases the options lie with govern-
ments, through development planning or market and pricing structures aimed at increasing the sale of surplus stock and thus reducing the pressure on grazing resources.

Undernutrition occurs in normal years in most pastoral areas, and many options are available to pastoralists for reducing or avoiding its effects.

1. If it is not too serious, its effects can be minimized as far as possible by sale of stock and by careful management, relying upon the following wet season's gains to restore livestock to normal weight and productivity. This depends on the reliability of the compensatory growth phase and is the laissez-faire strategy adopted in many areas in Africa and overseas. It fails if the rains fail, particularly in areas where lack of marketing facilities makes it difficult or financially catastrophic to sell animals in a period of widespread feed shortage.

2. Provide additional feed by improvement of grazing resources. Pasture improvement by fertilizing and oversowing legumes is a well proven technique. Success depends on selection of suitable seeds and provision, by pelleting or otherwise, of any necessary plant nutrients and rhizobial inocula. Technically it is an attractive option, but success depends also on restricting first-season grazing so that seedlings can establish, grow to maturity and set seed. This cannot be done on communally grazed land and this option, while technically feasible, is therefore not applicable in most African pastoral areas. It has been shown, however, that some systems recognize the right of a person to reserve an area for his own use – as the olepolole reserved for calves or milking cows in the Kenyan Maasailand. In northern Nigeria it has been found that pastoralist Fulani may fence off an area of several hectares by agreement with landholding sedentary farmers and that productive pastures of Stylosanthes species can be grown on this to provide good quality forage for the dry season. While this will not be possible for truly nomadic pastoralists it may become possible for transhumant herders with a recognized main camp, particularly under some form of herders' association or similar form of regulation of grazing rights.
3. Supplementary feeding. The technology of using protein concentrates (peanut or cotton-seed meal) or a cheaper non-protein nitrogen source (urea) is well established in developed pastoral countries. Compounded grain/molasses/urea supplements are easily made by appropriately simple village or small-scale industry. These are used in northern Nigeria, and the widespread practise of giving salt to animals in the Sahel suggests that, after a brief research study to define the nutrients most needed, herders might quickly adopt an improved type of nutrient supplement particularly if its cost of production or transport were subsidized by the government, as is the case with fertilizers in many countries.

In Mali considerable use is made of cowpea and groundnut haulms as supplementary feed, and ILCA has active programmes in both Mali and northern Nigeria developing improved methods and testing new varieties of legumes for use as an intercrop or in rotation with the traditional sorghum or millet. Whatever supplement proves to be best, economics require that it should be given to the animals most likely to benefit and not wasted where no response is to be had. This means that young females mating, calving or lactating for the first time should be given preference, as also cows whose poor condition might prevent their conceiving or rearing a vigorous calf. Newly weaned calves may well repay extra feeding. This is an intervention available to the individual herder when supplementary feed is available.

4. Modify grazing management. ILCA has shown that heavier grazing in the early wet season will make more feed available in the early dry season. This requires agreement or control over livestock numbers and some right of exclusive use of the extra pasture thus produced. The revival of earlier forms of social/territorial organisations, or the creation of new herders' associations may make this option possible.

In many areas valuable browse species could be encouraged by selective clearing of others. Browse could be used more efficiently by careful selective cutting of branches to encourage regrowth, or by judicious use of fruit in the dry season (Cissé, 1982). This, too, might require some form of agreement among herders using a particular area - there are precedents for such rational utilisation methods.
5. Modify livestock management. Where pasture is inadequate, particularly if this is associated with bush encroachment it may be better to reduce numbers of sheep or cattle and increase camels or goats, which are better able to subsist on browse. The association of goats with degenerated pasture land does not necessarily mean that goats cause degeneration. Their selectivity in browsing enables them to produce on land where sheep and cattle, mainly grazers, cannot thrive. Their higher quality intake is obtained only at the cost of lower quantity - Schwarz and Said (1981) found that nutrient intake of goats in the dry season was only 1/4 to 1/9 their nutrient intake in the wet season, but protein intake was 1/3 of the wet-season level. Further research is needed to study grazing and browsing habits and the effects of different methods of stocking on browse production and regeneration.

More dry-season forage could be made available by the establishment of more water points, ponds or wells to extend the pastoral area available for grazing in the dry season. This requires government or regional action, combined with careful assessment of the probable effects on the vegetation of increased or more prolonged grazing pressure. Where no great harm is to be expected and where some communal control of livestock numbers can be assured this is perhaps one of the most attractive options.

In agropastoral areas sedentary farmers have available new short-cycle varieties of cereals which generally require reasonable soil fertility. This can be maintained best by animal manuring, and farmers are putting in extra wells in order to attract pastoralists to bring their cattle to the farmers' fields in the dry season (Fulton and Toulmin, 1982). This interdependence between farmers and herders will become more and more important in the future.

Within the power of individual pastoralists is the possibility of better matching feed requirements to feed supply by controlling the times of mating and of weaning. To some degree conception in cows is dependent on their response to improved nutrition during the two to three months of the wet season and calvings tend to cluster in the late dry season following. The need of pastoralists for a year-round supply of milk probably accounts
for a more even spread of calvings seen for example in Wilson (1982). Whether it is possible to reduce neonatal and later deaths, and to improve overall productivity by control of mating times or by supplementary feeding of bulls or of cows calving out-of-season needs study in different systems.

Stock numbers could certainly be reduced by large-scale sale of surplus animals in the late wet or early dry seasons. This is a common feature of "stratified" or more highly developed pastoral industries but depends on the existence of marketing, transport and either abattoir or fattening facilities commensurate with the annual surplus cattle turnoff. This needs attention by government or development project planners but in the long run is essential to a rational exploitation of extensive pastoral regions.

The individual pastoralist could well be encouraged to cull the least productive of his stock, rather than keep cows indefinitely in the hope of getting a calf some day. This is logical if keeping extra cattle is felt to be at no cost to the individual since the land is communally owned but, in the longer term, pastoralists must be persuaded that a chronically diseased cow or one of genetically poor productivity is a liability and not an asset.

Separate management of different classes of cattle is already widely practised and has some advantages in both nutritional and health terms. It facilitates the gathering and holding for vaccination or sampling of large numbers of stock, particularly if combined with government establishment of dipping and similar facilities in the vicinity of the wells near which animals congregate in the early dry season. Dry stock could be grazed far from water in this season, allowing pregnant and lactating cows and calves to be given closer attention. Developments such as this call for some organisation of pastoralists as well as government policy initiatives.

Specific problems of particular systems

Young stock mortality

Young stock mortality is a problem in Ethiopia and in the Sahel with a two-year average of 28% deaths in calves. Research is needed to
establish to what extent this is due to undernutrition because of high milk offtake for human consumption, particularly from cows rearing male calves which are considered to be less valuable than female calves. In small ruminants mortality was 32% before weaning. The extent to which this was the result of disease or of other causes is not known. This represents an important field of potential improvement but requires further research. Losses in smallstock are similarly high in Kenya, but losses of calves are much lower. In Ethiopia and Mali the death rate in male calves is higher than in females, substantially because of competition with humans for limited milk supplies and preferential treatment of heifer calves. Improved nutrition and milk production would lead to a substantial increase in the number of surplus male calves reared for sale.

Bush encroachment on grazing lands

Research is needed into the long-term stability of grazing resources in relation to grazing pressure, stocking rate and type of stock used. Growth of productive browse shrubs and trees does not mean a reduction in total primary production, and the spread of browse species that may be used in the dry season should help to correct the lack of feed that usually occurs then. Again, the fact that land is common-owned means that no pastoralist is prepared to spend his time and effort to selectively clear undesirable species, or to safeguard young browse seedlings during their vulnerable years by reduced grazing pressure. Creation of pastoralists' associations is a very necessary first step in the better husbandry of grazing resources.

Epidemic diseases

Vaccines are available for some of the infectious or tick-borne diseases that have in the past wiped out herds and flocks. Research is continuing at ILRAD and there may one day be vaccines for East Coast fever and trypanosomiasis. There is an urgent need for more dipping or spraying and injection yards, better distributed over major pastoral areas. In the absence of any regulation or control of grazing, the development of rotational systems to reduce the number of tick or helminth larvae is impossible. In other countries it has been possible to introduce more resistant breeds of livestock, but
zebu-based cattle and local breeds of smallstock are probably the most resistant livestock available. Apart from manual removal of ticks no management or genetic means seem to be available, and pastoralists must rely on veterinary and chemical methods of control, which in turn depend on active, well motivated extension, advisory and veterinary services in the zone affected.

Good versus poor herdsmen

Apart from identifiable single causes of production losses, evidence from ILCA's studies in Mali and in Kenya shows that there are large differences between herds and flocks, within the same general type of husbandry.

Table 4. Production indices* for (a) Mbirikani group ranch, Kenya and (b) two agropastoral systems in Mali (goats and sheep combined).

<table>
<thead>
<tr>
<th>Production index</th>
<th>(a)</th>
<th>(b)</th>
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<tbody>
<tr>
<td>Goats</td>
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<td>Rice</td>
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<tr>
<td>Best flock</td>
<td>676</td>
<td>692</td>
</tr>
<tr>
<td>Worst flock</td>
<td>101</td>
<td>257</td>
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</table>

* Average litter size x survival to weaning x 150 day weight Ewe weight postpartum

Research is needed to identify the features of individual herd or flock management responsible for these large differences. In Kenya Grandin has shown that productivity is associated with the wealth of the "owner" or with herd or flock size, but it is claimed that great skill is involved in grazing management in the early wet season and that this has great influence on yearly productivity (Swift, 1982). If these special skills can be described and understood, it might be possible to raise poorer managers to near the
level of the best, without introduction of any alien technology. Wilson (1982) proposed an intervention pathway for small ruminants combining many of these ideas. The series of improvements proposed merits careful study, since it is based on many years' experience in several countries.

Fig 2. Intervention pathways for small ruminants in the agropastoral system.
Conclusions

The argument that a systems approach is valuable, not just in identifying problems but in deciding the most effective means of problem-solving, is amply borne out by ILCA's experience. The examples quoted here all show the value of understanding the interrelationships among the causes of lowered livestock productivity. This makes it possible to direct attention to the root of the trouble, rather than to be misled by superficial symptoms. Thus, calf deaths result from the interplay of human needs and milk production, determined by level of nutrition, which is itself the complex result of primary forage production and its exploitation by individually managed herds and flocks.

Increased numbers of water sources may solve an immediate feed problem by making large areas available for dry-season grazing, but this may be harmful in the long run to the stability of some fragile plant associations.

Improvement of grazing resources by proven technology of legume oversowing depends on the prior creation of some form of associations of herders with an interest in regulation of livestock numbers and grazing pressures on the area of land for which they are responsible.

Because of the overriding influence of aridity, and the communal use of land not many of the options of technology are applicable in purely pastoral systems. Those that are relevant often depend on prior government initiative or some form of social-territorial organisation, but there are some ways in which pastoralists could help themselves. More possibilities exist in agropastoral systems, and in forms of transhumance which allow pastoralists to become responsible for, and to benefit from, a defined area of land.

References


Options bio-techniques

Résumé

Dans le document précédent, il a été procédé à l'examen des questions les plus importantes aux plans social et économique en ce qui concerne l'identification de l'envergure des améliorations de la production pastorale. Il est également important de considérer les possibilités biologiques ou techniques d'amélioration des systèmes pastoraux et d'essayer de classer celles-ci par ordre d'applicabilité, en tenant compte non seulement des possibilités de succès au plan technique mais aussi de l'opportunité et de la factibilité des techniques en question.

Le document passe en revue certains des aspects techniques des systèmes pastoraux d'Afrique. Ces systèmes visent à assurer la subsistance des éleveurs et se fondent sur la production de lait. La productivité du troupeau bovin pourrait être augmentée de manière substantielle si la mortalité chez les veaux régressait, si on élevait plus de veaux et de génisses pour la vente que pour la production de lait, si la croissance des veaux était plus rapide et s'ils atteignaient la maturité plus tôt, si le premier vêlage des vaches intervenait à un âge plus précoce et si les vêlages subséquents étaient plus fréquents.

L'équipe du CIPEA au Mali a enregistré la quantité et la qualité du fourrage disponible et les changements de poids vif des bovins et des petits ruminants du système du delta du Niger. Il est évident que l'accroissement pondéral annuel enregistré au cours de la petite saison des pluies lorsque le fourrage est abondant et de bonne qualité se perd partiellement lors des mois de la saison sèche suivante, particulièrement pendant les semaines qui précèdent immédiatement la prochaine saison de croissance. La solution classique de ce problème prévisible chaque année consiste à effectuer des déplacements soit entre les zones de pâturage de saison sèche et de saison des pluies, dans des zones où les ressources en pâturages sont abondantes, soit dans des zones de culture où des sous-produits agricoles sont disponibles.
Les variations et la distribution de la pluviosité moyenne annuelle influencent considérablement la croissance des ressources pastorales et partant, la production secondaire de bétail. Des pluies précoces irrégulières peuvent être à la base de séquences répétées de germination de courte durée; les grosses averse peuvent entraîner un ruissellement abondant et remplir les mares et les cours d'eau de surface; mais une infiltration insuffisante dans le sol signifie une croissance inadéquate des pâturages. Les zones à pluviométrie clairement définie mais irrégulière sont plus adaptées aux pâturages qu'à l'introduction de cultures. La perte de ligneux par le défrichage pourrait causer au bétail un préjudice que ne pourrait compenser le pâturage des sous-produits agricoles en saison sèche.

Une nutrition inadéquate pendant la saison sèche peut constituer un problème à long terme à cause de la perte progressive de zones de pâturage de saison sèche associée à l'accroissement de la pression de la population ou aux rivalités ethniques et politiques. La malnutrition sévit dans les années normales dans la plupart des zones pastorales et les éleveurs disposent de plusieurs solutions pour en réduire ou éviter les effets. Ceux-ci peuvent être minimisés par la vente de bétail et par une gestion appropriée, basée sur les gains de la saison des pluies suivante pour restaurer la productivité du bétail et améliorer ses performances pondérales. Du fourrage supplémentaire peut être fourni par l'amélioration des ressources pâturables – fertilisation et ensemencement de légumineuses par exemple. La complémentation fourragère peut être pratiquée: la technique qui consiste à utiliser des concentrés de protéines ou une source non protéique d'azote moins coûteuse est bien établie dans les pays à élevage développé. Le CIPEA a également démontré que l'intensification du pâturage au début de la saison des pluies produit plus de fourrage au début de la saison sèche. Lorsque les pâturages sont inadéquats, en particulier lorsque cette insuffisance est liée à l'empâtement des broussailles, il serait peut-être plus approprié de réduire le nombre des ovins et des bovins et d'augmenter ceux des chameaux ou des chèvres qui supportent mieux un régime basé sur la consommation de ligneux. On pourrait développer la quantité de fourrage en mettant en place beaucoup plus de points d'eau, de mares.
ou de puits en vue de l'extension de la zone pastorale disponible pour les pâturages de saison sèche.

La mortalité des jeunes animaux constitue un problème en Éthiopie et au Sahel où, en deux ans, on a enregistré 28% des décès chez les veaux. Il conviendrait d'entreprendre des recherches en vue de déterminer le rôle joué par la malnutrition du fait des taux élevés de prélèvement de lait pour la consommation humaine, en particulier pour ce qui est des vaches ayant mis bas des veaux auxquels on attribue une valeur inférieure à celle des génisses. Il est nécessaire d'entreprendre des recherches sur la stabilité à long terme des ressources pâturables, eu égard aux pressions sur les pâturages, aux taux de charge et aux types de bétail utilisés. La nécessité d'aménager des périmètres où pourraient s'effectuer des bains détiqueurs, des pulvérisations et des injections devient urgente, de même que celle d'une meilleure distribution de ces périmètres dans les zones pastorales. Il est nécessaire d'entreprendre des recherches pour identifier les caractéristiques de la gestion des troupeaux de bovins ou de petits ruminants qui expliquent les grandes différences entre les troupeaux de bovins et les troupeaux de petits ruminants élevés dans la même zone.
Summary of Discussion Session 9.
Chairman: Dr Samson Chema (Kenya)

Dr Rhissa felt that the discussion on the identification of possibilities for improving pastoral production had neglected the fundamental point - the organisation of the pastoralists themselves. The herdsmen were the principal agents of improvement and their contribution could be better secured through training, information and meetings.

Dr Abel said that Mr Sandford was not encouraging about the possibility of communicating effectively with pastoralists over the introduction of new technology. He asked was there not scope for using traditional pastoral institutions for this purpose. Mr Sandford said that some traditional organisations were not well structured for carrying out this kind of dialogue - in most traditional organisations it was an elite class who carried on the dialogue. They were probably not representative of all groups e.g. the poor, women, subordinate ethnic groups etc. In discussing new technological improvements they would need to be adequately briefed on what the new technology implied. They did not have adequate experience of introducing technology to be able to spot the critical issues unless they were adequately briefed. Dr Abel suggested that technology assessment ought to include an appraisal of the ability of a new technology to survive a drought, and the contribution it could make to a recovery from drought. Mr Sandford agreed.

Dr von Kaufmann said that maximising milk production was not always the pastoralist's objective. If there were many people to feed with few cattle then milk production was vital. But as herd size grew or milk production increased then the percentage of milk off-take decreased.

Prof. Saka Nuru said that the meeting had been informed that pastoralists disposed of young male animals, particularly goats and sheep, in favour of female ones. Yet the previous day the meeting had been told that pastoralists sold male cattle at a later age to get higher financial returns. There appeared to be a contradiction.
Dr Lambourne said that the decision by smallstock owners in the Sahel to sell young males early was based on the fact that their growth rate slowed down after 9 to 12 months. It was therefore good business to sell them before this. On the other hand, the main cost of rearing a small calf was the milk it had consumed. To keep a few males an extra year cost little.

Prof. Saka Nuru pointed out that ILCA researchers in the field seemed to neglect goat's milk - a vital livestock product. Dr Lambourne said that goat's milk was used in the Sahel for family use by smallstock herders, but this was not generally the case if cow's milk was available. ILCA has considered the possibility of encouraging studies of goat milk production, but lacked the staff to do it.

Dr Kalusa said that there seemed to be very little attention paid to the role of donkeys in regions of e.g. Ethiopia. Yet the donkey clearly affected the lives of the indigenous people. Dr Lambourne replied that ILCA had a research programme on animal traction, including cultivation and transport. Dr Wilson had worked on donkeys in the past, and it was hoped that ILCA would do some more research on this subject as resources permitted.

Dr Thomson illustrated the dangers of introducing supplementary feeding policies into a livestock system with an example from Syria. This was one of the reasons why sheep numbers in Syria were today about double the number in the late 1950s, with consequent deleterious effects on the natural grazing lands.
Résumé des débats de la neuvième séance
Président: Dr Samson Chema (Kenya)

Le Dr Rhissa a souligné que les débats sur l'identification des possibilités d'amélioration de la production pastorale avaient négligé un point fondamental: l'organisation des éleveurs eux-mêmes. Les éleveurs étaient les principaux agents de l'amélioration du système et leur contribution pouvait être plus positive par le biais de la formation, de l'information et de réunions.

Le Dr Abel a déclaré que M. Sandford n'était pas optimiste en ce qui concerne la possibilité de communiquer de manière efficace avec les éleveurs sur l'introduction de nouvelles techniques. Il a demandé s'il n'était pas possible d'utiliser les institutions pastorales traditionnelles à cet effet. M. Sandford a déclaré que certaines organisations traditionnelles n'étaient pas assez bien structurées pour servir de cadre à ce type de dialogue. Dans la plupart des organisations traditionnelles, c'était à une élite que s'adressait ce dialogue. Celle-ci n'était certainement pas représentative de tous les groupes, par exemple, les pauvres, les femmes, les groupes ethniques de caste inférieure, etc. Dans l'examen des innovations technologiques, il faudrait que ces éleveurs soient correctement informés sur les conséquences de l'introduction des nouvelles techniques. Ils ne disposaient pas de l'expérience adéquate en matière d'introduction de techniques nouvelles pour être à même de détecter, sans être correctement informés, les questions cruciales. Le Dr Abel a suggéré que l'évaluation technologique devrait inclure une évaluation de la capacité d'une nouvelle technique de survivre à la sécheresse et de sa contribution éventuelle à l'élimination des effets de la sécheresse. M. Sandford a exprimé son accord.

M. von Kauffman a déclaré que la maximisation de la production laitière n'était pas toujours l'objectif de l'éleveur. Lorsqu'il y avait beaucoup de personnes à nourrir avec peu de bovins, la production laitière était vitale. Mais à mesure que la taille du troupeau ou la production laitière augmentait, le pourcentage de prélèvement de lait diminuait.
Le Prof. Saka Nuru a déclaré que les participants à la réunion avaient été informés que les éleveurs disposaient des jeunes animaux mâles, en particulier des chèvres et des moutons pour garder les femelles. Toutefois, le jour précédent, les mêmes participants s’étaient entendu dire que les éleveurs vendaient les bovins mâles à un âge plus avancé pour avoir des rentées de fonds plus importantes. Il semble y avoir ici une contradiction. M. Lambourne a déclaré que la décision des propriétaires de petit bétail du Sahel de vendre tôt les jeunes mâles était basée sur le fait que leur taux de croissance se ralentissait après 9 à 12 mois. Il était par conséquent rentable de les vendre avant cela. D’autre part, le coût essentiel de l’élevage d’un petit veau était le lait qu’il consommait. Garder quelques mâles une année de plus n’était pas coûteux du tout.

Le Prof. Saka Nuru a souligné que les chercheurs du CIPEA sur le terrain semblaient négliger le lait de chèvre qui est portant un produit animal vital. M. Lambourne a déclaré que le lait de chèvre était consommé dans le Sahel par les familles des éleveurs de petit bétail mais que ce n’était pas le cas en général lorsque le lait de vache était disponible. Le CIPEA a envisagé la possibilité d’encourager des études sur la production de lait de chèvre mais ne disposait pas du personnel requis pour le faire.

Le Dr Kalusa a déclaré qu’il semble y avoir très peu d’intérêt pour le rôle joué par l’âne dans les provinces de l’Ethiopie par exemple. Pourtant, il ne faisait aucun doute que l’âne contribuait à la vie des populations locales.

M. Lambourne a répondu que le CIPEA avait un programme sur la traction animale, y compris le labour et le transport. M. Wilson avait travaillé sur les ânes auparavant et l’on espérait que le CIPEA entreprendrait d’autres activités de recherche sur le thème lorsque les moyens le permettraient. M. Thompson a souligné les dangers inhérents à l’introduction de politiques de complémentation dans un système d’élevage sur la base d’un exemple syrien. C’était là l’une des raisons pour lesquelles le nombre des ovins était aujourd’hui sur le point d’atteindre le double de son niveau vers la fin des années 50 avec comme conséquence, la dégradation des pâturages naturels.
CASE STUDIES IN PSR
Design and testing procedures in livestock systems research: An agro-pastoral example

R. von Kaufmann

Agricultural Economist and Team Leader, Subhumid Zone Programme, ILCA, Nigeria

Introduction

Farming systems research (FSR) seeks to employ the skills of scientists most directly in the service of improving the welfare of small farmers. Livestock systems research (LSR) is no different except that livestock systems are two stage systems that necessarily demand different approaches to some of the problems of research in the field.

Rohrbach (1980) introduced a paper on FSR by stating that 'farming systems research is a philosophy and methodology of agricultural research for the development of improved technologies appropriate to small farmer needs and circumstances'. He claimed that there are very few controversial issues in farming systems research (due to a degree of agreement over the basic value and character of this type of research. Those issues which remain most significant to practitioners cannot be resolved in the process of debate per se. 'These issues, which primarily relate to questions of methodology, organisation and implementation, are in the process of being resolved by experience.' In concurrence with that opinion, and in view of the innumerable texts on farming systems research that already exist, this paper will avoid repetition of argument and rather concentrate on lessons drawn from the experience of the ILCA Subhumid Programme in the practice of LSR. In order to keep the paper to a manageable length it will concentrate on issues on which FSR and LSR differ.

Another author who is particularly appropriate to discussions of ILCA's work is John Dillon because he reviewed systems research for the Consultative Group on International Agricultural Research (CGIAR). He has stated 'that man, not cations or nodules or rumen flora of crop varieties or livestock species or dollars,'
consumates the system must be a basic text' (Dillon, 1973). He stresses the need 'to take a theological view that effects may be due to the purposes they serve and only a holistic approach, with openness and teamness through interdisciplinary endeavour, can lead to the capturing of adequate understanding of a system for purposes of improving performance.' He points out 'the need for a structure which will facilitate a synthesising, integrative, team-oriented outlook rather than one that is analytical, compartmentalising and disciplinary and that the agricultural system is a purposive one involving physical, biological and social parts and that it operates within an environment having significant purposive components.' He also notes that 'adoption in the real world is a crucial factor and hence implies consideration of communication and extension.'

Background to source of the case examples

ILCA subhumid programme

The subhumid programme is charged with a responsibility for researching ways and means of enhancing the welfare of sedentary livestock producers through increased cattle and small ruminant production.

The programme is based in Kaduna in northern Nigeria in an ecological zone delineated by the 1,000 mm and 1,500 mm isohyets. With its good rainfall and radiation (180 - 270 growing days) it is an area of high potential production. However it is relatively under-utilised because of tsetse-borne sleeping sickness and trypanosomiasis, though this situation is changing at a rapid pace. Farmers are moving in, extending arable cultivation and at the same time reducing tsetse habitats. Hard on their heels the formerly nomadic Fulani cattle-men are settling and becoming mixed crop-livestock producers. Whilst the settled agropastoral Fulani are the prime clients of the LSR they are so closely interlinked with the arable farmers that both communities have to be included in the research.

The 'pre-research model' adapted by Kaufmann (ILCA, 1979) from Johnson et al (1971), indicated that malnutrition is the single most important constraint to range livestock production. It is also the factor that is most sensitive to correction with available tech-
nology. Thus improving the nutritional status of the herds is the paramount objective of the programme. Since there is an inadequate supply of purchasable feedstuffs, the improved nutrition must come from forage production.

Livestock systems research

The differences between LSR and FSR are brought about by practical problems in conducting research rather than by differences in intent and scope. The following schematic outline of an integrated research programme drawn up by Harrington (1980) fits as well to LSR as it does to FSR and is a suitable framework on which to hang the particular aspects of LSR discussed in this paper.

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Fig. 1. Overview of an integrated research programme.
Considerations in designing improved technology

Complementarity

LSR should freely use the research results and experiences of other research and development organisations. LSR should also call on these other institutions to carry out back-up work. The research institutes can help overcome problems that require detailed on-station experimentation. That does not, however, preclude LSR teams from doing their own experiments which can not be done elsewhere for, say, ecological or cultural reasons.

The development agencies are essential to LSR as vehicles for testing the proposed interventions and procedures in the real world. There is no other way for LSR to test the adoptability of its products.

Case example

ILCA's subhumid programme is closely associated with the National Animal Production Research Institute (NAPRI) of Ahmadu Bello University. NAPRI has been conducting research on animal production in Nigeria for about 30 years and has a wealth of results, information and scientific expertise on which ILCA has relied very heavily.

The programme is also linked to the Livestock Project Unit (LPU) of the Federal Livestock Department. The LPU is responsible for implementing a World Bank-assisted livestock development project. The staff of the LPU provide an ever-present audience from the development community which is necessary in the selection of priorities and for the quick uptake of interventions. The association with LPU will enable ILCA to assess the uptake, effectiveness and persistence of its innovations in 'real life'.

An example of this three-way cooperation can be taken from the nutrition trials conducted in the LSR programme.

On station. The rations were developed from data on feed requirements, and forage and agro-industrial by-product nutritional values determined by NAPRI scientists.
Researcher managed trials. Carefully controlled trials confirmed the predictions and the Fulani appeared to accept the principle of feeding certain animals certain amounts at certain times.

Farmer managed trials. The LPU then incorporated ILCA's findings into a pilot smallholder dairy scheme that is now being actively promoted. ILCA is continuing to obtain all the necessary records to assess the uptake, success and persistence of the innovation through its close association with LPU field staff.

Policy oriented

Being complementary also means that FSR must be policy oriented 'with decisions relative to national research goals being fed downwards' (Dillon, 1973). This is essential to the cohesiveness of the above three steps.

Case example

The Director of the Federal Livestock Department, who is also on the Board of ILCA, has appointed a technical advisory committee of distinguished Nigerian agriculturalists to assist the team with advice and guidance on both technical and policy matters. This committee is chaired by the Director of NAPRI and has other members from federal, state and University circles. Their input, both formal and informal, is essential to keeping the team's work consistent with national policy. If the team did not have this advice it not only could lose vital support but it would also be much less likely to come up with adoptable interventions.

Social responsibility

In most basic research the purposes and advantages to the end users are not a major concern of the scientist. LSR, however, has a social responsibility. For example technologies that may aid larger farmers to the disadvantage of smaller farmers should be avoided lest they defeat the prime objective of LSR, which is to conduct research for development that does not exacerbate inequalities. That is not meant to exclude interventions that may help both rich and poor alike or even help rich without any effect on poorer farmers, since production and paid employment are usually within government objectives.
Case example

Despite accusations of being patronising and attempting to keep farmers backward ILCA has assiduously avoided the use of tractors in the preparation of fodder banks because the extent of cultivation is limited by the amount of available family labour, and tractors could drastically alter the status quo to the disadvantage of the poor.

Reviewing priority problems and opportunities

Once the objective of the LSR effort has been defined the LSR programmes still need to be carefully focused or else the scientists will tend to take on too much and, as a result, individuals may work hard at appropriate but inadequately co-ordinated tasks. Each discipline must be clear as to the contribution expected of it. If, for example, livestock nutrition is the focus of the programme only those disciplines necessary for resolving the nutritional constraints should be employed. However, this will inevitably require a multi-disciplinary team because the economic and social factors are likely to be as problematic as the agronomic ones.

Case example

As indicated above the subhumid programme has focussed on the alleviation of malnutrition in domestic ruminants with forage agronomy at the hub. The social scientists helped make it possible to grow forages by determining how pastoralists could obtain the right to use and fence fallow land belonging to arable farmers. There are a myriad of other possible examples from all disciplines. For instance, of all the possible diseases the veterinarian first concentrated on internal parasites in young stock because it was reasoned that with sedentarisation and cattle continuously returning to the same spot the worm burden in calves was likely to build up. This is likely to be even more of a problem with the establishment of more or less permanent fodder banks and, if true, will tend to negate the advantages of better feeding.

Later it was argued that the establishment of fodder banks might be more profitable if they were used by more productive animals.
such as dairy crosses, but these animals are known to be more prone to diseases. Thus the veterinarian is now studying the disease patterns in a small number of experimental crossbred animals attached to Fulani herds with fodder banks.

Appraising present techniques

This subject is possibly more difficult in livestock research because there is typically even less contact between research stations and pastoralists than with their farming counterparts. However, the LSR scientists should still try and discover all the approaches that have been attempted and how they fared. Then when considering alternative ideas generated from within the team they should go back to the local scientists and extension workers for advice. More often than not there will be good reason why these ideas have not been tried successfully before. Ultimately, however, the interventions will have to be proven in the prevailing ecological and socio-economic environments.

Case example

The subhumid programme took all available advice before commencing trials with undersown legumes but even then the results were somewhat embarrassing; the seeds were washed out of the ridges, drowned in the ridge bottoms, were weeded out in a 'surprise' third weeding and so on. Ultimately it was found that the time of undersowing relative to the planting of the main crop is very critical. If this is done too early the crop is damaged if too late the yield of stylosanthes is also suppressed.

Similarly when crossbreds were first introduced they were not tame enough for the traditional manual de-ticking and they contracted a range of diseases not prevalent in local Fulani cattle but which are endemic to the area. Appropriate chemo-immunisation and acaricide spraying regimes had to be instituted.

Setting assumptions about near-term conditions

The team must take into account not only the present circumstances but both recent past and immediate future trends. If it does not it is likely that it will test interventions that will no longer be relevant by the time they are proven.
Case example

The subhumid programme is aware of the trend towards increased areas under cultivation and increased stock numbers. Both these factors weaken the relative bargaining position of the pastoralists. There will be more competition between them for less grazing. In these circumstances it would be unwise to concentrate wholly on forage production and the team is devoting considerable resources towards crop-livestock interactions. This involves research into crop residue production, storage and utilisation as well as growing food crops in fodder banks by judicious rotation or by transplanting into rows hoe-cut through the stylo.

Testing improved technology

The testing of improved technology is difficult to write up in the form of an overview because so many of the details vary according to the particular techniques employed by the different disciplines. For instance the veterinarian will use quite different methods from the agronomist. This section will, therefore, concentrate on discussing problems of technology testing for improving livestock production. The normal sequence used in explaining the phases of FSR work is from researcher managed, researcher executed, through research managed, farmer executed, to farmer managed, farmer executed trials. In effect this means that the scientists first conduct their own experiments to prove and explain scientifically how the technology actually works. Then they run the experiment with the farmers' participation to see if farmers have the technological resources to cope with the innovation and that it can work in their circumstances. Finally the researcher takes a back seat and observes whether or not the farmers actually adopt the innovation. If ultimately the farmers do not adopt the innovation, or only with drastic alterations, the innovation must be dropped or returned to the drawing board for further adaptation.

In practice this is a somewhat simplified scheme of things because there is constant feedback at all stages. Whenever problems arise the whole or part of the trial can be returned to an earlier phase or occasionally leap-frogged forward. Generally speaking the earlier the phase the greater the control and detail and the more
certain the science. The later the phase the greater the influence of the 'real world' and the greater the assurance of relevance to the system in question.

This tidy format is by no means automatic. For instance the unwary scientist can very easily enter a farmer managed, researcher executed phase when the farmers apply their considerable ethnoscience in dealing with intruders with the objective of getting all they can out of the researchers without any real commitment to the researchers' objectives.

Researcher managed, researcher executed trials

When innovations are too uncertain and risky to try on farmers' fields or they require examination under strictly controlled conditions they should be tested in fields and herds wholly controlled by scientists. These trials are usually carried out at national research institutes or on sites controlled by the LSR teams in their case study areas. The research at the national research centres will usually have been done in the past and not specially for the LSR programme. Great care must, therefore, be taken in extrapolating the results. The difference between the circumstances of the original research and of LSR must be identified and their effects determined. Occasionally they will have to be repeated in the case study area.

Case example

NAPRI had considerable data on the productivity of Bunaji (White Fulani) cattle. In view of the long generation interval it was extremely valuable to the team to find the data already existent. However the data had been gathered from government livestock improvement and breeding centres and not from traditional pastoralists' herds. It provided potential production parameters rather than baseline data.

NAPRI also had data on natural forage quality but it related to the semi-arid border of the subhumid zone. The extrapolations have to be validated with local data. NAPRI has data on legume cultivation and Friesian-Bunaji crossbred productivity but both were supported by mechanised farming which is not replicable in pastoral livestock situations.
Researcher managed, farmer executed trials

Once the LSR team has designed an intervention and completed successful on-station trials it can set an hypothesis that it will be beneficial for livestock production in the selected district or region. The next phase in the LSR cycle is to let the pastoralists try out the intervention under the guidance of the LSR team: researcher managed, farmer executed.

Sample size

This is where LSR starts to diverge most sharply from normal research station experimentation. It is the point where data collection becomes extremely problematic because of the mobility of the stock, their large unit sizes and the owners' emotional involvement with their animals. Moreover, because of the long generation intervals it is absolutely essential that records are kept of the same animals for a number of years. The sample size has, therefore, to be large enough to cope with losses and drop-outs over a long period.

Sample size is also determined by the need to have enough farmers involved to eliminate effects of differences between individual farmers. The effect of individual abilities, ambitions and circumstances is likely to be stronger on livestock production than on crop production because of the daily need for decisions over the herd and the competition between herders for favourable grazing. At the same time LSR can easily become too unwieldy and costly. For instance a sample of only 20 herds may involve over 1,000 animals. Sampling is also constrained by the need to work with pastoralists who are willing to cooperate almost on a first come, first served basis. There are too few herds within serviceable areas and too much communication between pastoralists for the team to pick and choose between them.

The subhumid programme was able to get over these conflicting demands in the early researcher managed phase by keeping control animals in every herd. For instance only half the eligible animals from any one herd would be included in any trial. The owners were amenable to this because they preferred to have half the animals better off rather than none at all. This technique could not,
however, be continued into later trials because once the farmers saw
the benefits, there was no way of preventing them employing the
innovation on the control animals at their own expense.

The question of cost effectiveness is dealt with below. As for unwieldiness, it is true that all the catalysts for Murphy's Law (remoteness, poor communications, almost illiterate enumerators and huge amounts of data) are present in force. If it can go wrong it surely will. This can, however, be considerably alleviated by integrating the LSR programme so that, as far as possible, a single pool of data is used. This optimises the use of available staff since, for example, a calf is only weighed once, be it for the breeder, feeder, vet, economist or whoever else needs calf weight data. It also means that the various disciplines have to bargain with each other and justify their use of resources in terms of the team's overall objectives. The sample size is then determined by the purposes of the survey.

Household economic studies are perhaps the most contentious. Some economists argue for large random samples in order to achieve statistical reliability but there appears to be a growing school of thought, very evident in the criticism of earlier drafts of this paper, that, in view of all the problem in supervising enumerators and processing data in field programmes, small select samples may be preferable. Innovations will only be adopted by herd owners if they have marked effects on their welfare so it should be sufficient to just know the major items of income, expenditure and time budgets of a small representative selection of the various categories of producers in the target population. Another advantage of the small sample is that it can be done at the same time as the in-depth study of household decision making processes that is an essential part of most LSR studies.

Frequency of data collection

The frequency of data collection is perhaps most contentious in this phase of the LSR cycle. In the previous researcher managed phase the fact that the researchers are 'in charge' allows for smaller sample size and greater reliability and fewer hidden factors. In the
next phase of farmer managed—farmer executed trials the technical possibilities have already been determined and explained. The LSR team is by then more concerned in determining to what degree the farmers can cope with the innovations and what benefits they obtain from following the recommendations.

In the researcher managed, farmer executed phase scientific technical understanding and explanation is still required but the researcher must allow for the farmer's independence. That means the frequency of recording must take into account such factors as the farmers' natural reluctance to reveal sensitive information such as sales prices. The farmers also have, deliberately and unavoidably, very variable powers of memory recall. The more sensitive the topic or the more aware the farmer is of the official, correct or expected answer the less accurate his memory. To combat these factors it is often better to observe the event rather than to ask about it. Some degree of apparent over-kill in data collection may be necessary. For instance since sales, purchases, deaths, births, slaughters and losses can occur on any day it is probably as well to have an enumerator visit the herd daily. To avoid irritation at his presence and because firm routines are essential to the management of staff who are not expected to fully understand the reason or importance of diligence, it may be as well for the enumerators to record milk offtake daily. This gives them defendable purposes to be in the herd whilst recording all the other activities.

Case example

The subhumid programme adopted all the above principles reasonably effectively. Local school children were employed as enumerators to record milk offtake, deaths, sales etc. on a daily basis. However, difficulties did arise in data processing because the team had no in-house computer and attempted to run all its data once a year on the central computer at head office. This meant that the scientists had the greatest difficulty in ensuring adequate supervision. Nor did they have any way of doing preliminary or interim analysis to test the reliability or suitability of the data. When finally processing the data the remoteness of the computer meant that they had no access to original records even for simple items like checking
eartag numbers. These problems led ultimately to an inefficient use of computer and staff time. There is little doubt that systems research teams ought to have their own micro-computer facilities from the outset.

**Duration of data collection**

There can not be any hard fast rule about the duration of data collection except that data collection should always be for a purpose and once that purpose has been accomplished the data collection should stop.

**Case example.** The subhumid programme found it necessary to study the grazing behaviour of pastoral herds as a means of determining the type and quantity of feed available to the cattle throughout the year. This was intended as a one year study but the extent of burning and time spent on burn-regrowth had not been anticipated and was only appreciated after regrowth had been a significant part of the diet for a few weeks. The study had, therefore, to be continued for a second year.

The basic herd productivity recording started at the outset of the programme yet it is still continuing because after three years there are too few data on calving intervals and age at first calving. More time is, therefore, needed for the team to acquire data on such basic parameters as age and weight at first calving in traditionally managed herds, let alone what effect improved nutrition may have on those parameters.

**Farmer managed, farmer executed trials**

Once farmers have successfully executed the procedures, or implemented the interventions under LSR guidance, and the indications are that they are happy with the design and wish to adopt it as part of their normal husbandry practices, then the trials can move into the final phase of the LSR cycle. The LSR team members must then stand back and become passive observers so that they can test whether their brain-child can survive without them. The team needs to know if the intervention is adopted at all and at what rate (i.e. what is its acceptability index), how closely the farmers adhere to the original
design, what modifications they introduce, how successful the intervention is in terms of the goals it was designed to achieve, how persistent it is and what side effects it has.

This phase of the cycle can only be accomplished in cooperation with the extension and development agencies. It cannot be done very convincingly by the team trying to simulate extension officers. They can not be that uncommitted to their own concept. It is essential, therefore, that the team develop a sufficiently close relationship with an agency that will allow them access to the necessary data both of extension inputs and from the participating farmers.

The frequency of data collection can be very much less than in earlier phases because it is no longer necessary to try and explain what is happening at a micro-level. It is the macro-effect on farm output and profitability that is important. The duration of the experiment should be at least five to seven years in trials involving large ruminants such as cattle but may be less for smaller species with shorter generation intervals.

**Case example**

The cordial relationship ILCA has with the Federal Livestock Department and the Kaduna State Ministry of Animal and Forest Resources provides ideal facilities for this phase of the LSR cycle. Indeed the only problem is that some innovations are being adopted before ILCA would normally be ready to move on from the researcher managed phase.

By working through the livestock service centres ILCA hopes in 1984 to have, in effect, a network of testing sites spread throughout the zone in Nigeria. These will provide ideal conditions because they will be created under differing circumstances and well away from the present sites in Kaduna State where ILCA's own influence cannot be eliminated.

**Applicability of LSR to national authorities**

The advantage of the international teams, which must always include a number of nationals and have close links with local institutions, is that there can always be injections of fresh ideas and cross ferti-
lization from innumerable sources. There is no way, however, that the tiny teams from international agricultural research centres (IARC's) such as ILCA can do much more than scratch the surface of the problems of livestock production, though they may help significantly in developing new research methodologies, and in assisting the establishment of national LSR teams and possibly in setting goals and standards for LSR.

National LSR teams should be established at all the major research stations where they would help orientate their research programmes towards existing field problems and speed the transference of research results to the producers. The teams may be comprised of scientists wholly engaged in LSR or it may form just part of research scientists' duties. CIMMYT tried attaching one FSR economist per research station to lead the FSR work and encourage the participation of other scientists. It was hoped that this would improve the problem solving relevance of the work of the stations. However, this was not effective as it might have been because not all the resident scientists had been persuaded of the advantages to them of FSR.

Case example

Having actively encouraged the ILCA subhumid programme for a number of years NAPRI is now setting up its own LSR team that will be able to capitalise on ILCA's experience and move into different ecological zones. It will be able to focus more directly on Nigerian problems and with access to the substantial research capability at NAPRI and other departments of Ahmadu Bello University it is potentially a very effective unit.

Cost effectiveness

LSR has the immediate appeal of not requiring the massive investments in land, buildings, stock or equipment that is necessary for establishing a research station. LSR is also adept at exploiting past on-station research without further cost. LSR also has the advantage that, with an appropriate inclusion of rapid 'down-stream' elements, there is an almost immediate response in productivity. In other words the benefit stream can be turned on certainly earlier than from on-
station research and even earlier than from most development projects that tend to concentrate on infra-structural developments in the first years.

Nevertheless, the outline of the problems connected with livestock systems given above gives plenty of scope for very expensive research. If each discipline expects to work with the same support it would command in specialised research departments the costs of LSR would be quite unreasonable. However, provided that those problems that require very detailed research with, for example, expensive laboratory equipment are referred to the appropriate institutions and the LSR scientists are prepared to adhere to the goals of the LSR programme and make the necessary compromises, LSR is not overly expensive. In the ILCA subhumid programme it is estimated that it will require only 120 herd-owners to adopt the proposed packages in order to justify US $1 m of research. With a recommendation domain of several hundred thousand livestock owners it should not be difficult to defend the expenditure on LSR in social cost benefit terms provided that the innovations really do catch on.

It is of course very rewarding when, as with the fodder banks, producers in the vicinity of the LSR adopt the innovations for themselves. It is also encouraging when pastoral organisations such as the Myetti Allah Cattle Fulani Society follow the LSR and spread the word. These actions will go a long way to justify the expenditure on LSR but, especially for an IARC like ILCA, the prime clients for the research results must be the extension and development agencies in the host countries across the zone. It is their function to take the innovations to the producers. If the LSR programmes can improve the rate of return on the investments in development and extension schemes there will be no question of the cost effectiveness of LSR.

Apart from the obvious need for thorough technical accounts of the success and failures of interventions under test, the extension workers require critical reviews of the circumstances and the back-up support necessary to the success of the innovation. With this addition the recommendations will be very much more useful than the jargon-loaded reports in scientific journals or the limited instructions presented in typical appraisal reports.
Case example

The LPU Smallholder Dairy Scheme grew out of the ILCA nutrition trials where the Fulani had demonstrated that, with adequate guidance and assurance of supplies, they would selectively ration their cows. By doing so they improved the returns to the scarce resource of purchasable feedstuffs. ILCA did not just hand over reports on the trials but worked closely with the LPU staff in the design of a Livestock Service Centre which could deliver the necessary advice, credit and material provisions necessary to the success of the scheme. The pilot Livestock Service Centre and its successors will serve as vehicles for the dissemination of future proven innovations and research findings as well. This will hopefully ensure that:

1. the producers get the proper advice;
2. the producers can obtain the necessary inputs as and when they require them;
3. ILCA will have access to the records and the contact with the producers that it needs to determine the uptake, adoptability and persistence of its innovations in the final farmer managed, farmer executed phase of the LSR cycle. This is particularly important in range livestock work because, as noted above, there is tendency for innovations to be picked up before they are proven. Thus it is essential that a watchful eye be kept on them so that faults can be detected quickly and timely corrective action taken.

Extension into development projects

As indicated earlier LSR can help bridge the gap between research institutions and development projects firstly by establishing that the innovations are acceptable to the producers and then by carefully detailing when, where and how best to encourage the uptake of the innovations. For instance, varieties, planting dates, seed and fertiliser rates etc. are only part of what an extension officer needs to know in order to encourage farmers to produce forages. He also needs to know which category of farmer is most likely to respond, which arguments are most effective in eliciting the response of the farmer (i.e. those that are most closely allied to the needs and
interests of the farmer) and what back-up services the farmer will require. The planners and decision-makers would also like to have some idea about the likely rate of up-take, the optimum extension officer to farmer ratios, the availability of inputs and the marketability of the increased production. Obviously LSR can not provide such a service to each and every project but a thorough analysis of these factors in the process of conducting the trials will be of immense benefit to those carrying out feasibility studies in other areas. Instead of using blind hunches, project preparation teams can look for similarities and variances and assess the consequences of those factors that have been shown to be important to the success of the innovations.

Naturally the closer the link between the LSR teams and development project staff the smoother will be the transference of innovations from research to development. This will apply to all development projects, not just the ones physically associated with the research, because of the establishment of an empathy with the problems of development. As indicated above this can best be promoted by cooperation at the farmer managed, farmer executed phase of LSR.

References


Conception et essais en matière de recherche sur les systèmes d'élevage: un exemple agro-pastoral

Résumé

La recherche sur les systèmes pastoraux devrait s'inspirer largement des résultats et des expériences des autres organisations de recherche et de développement. La recherche sur les systèmes pastoraux devrait également faire appel à de telles institutions pour effectuer des travaux d'appui. Les institutions de recherche peuvent contribuer à résoudre des problèmes qui requièrent une expérimentation poussée au niveau de la station. Les organismes de développement sont essentiels à la recherche sur les systèmes pastoraux en ce sens qu'ils représentent des moyens de tester dans les conditions de l'exploitation les interventions et les méthodes proposées.

La recherche sur les systèmes pastoraux doit s'inspirer de politiques clairement définies qui tiennent compte des implications sociales de ses résultats. Par exemple, des techniques susceptibles d'aider les grands exploitants agricoles au détriment des petits exploitants agricoles devraient être écartées pour ne pas contrecarrer l'objectif primordial de la recherche sur les systèmes pastoraux qui est de mener à bien des travaux de recherche en vue d'un développement qui n'entraîne pas l'aggravation des inégalités.

Dès que l'objectif des activités de recherche sur les systèmes pastoraux d'élevage aura été défini, des programmes de recherche sur les systèmes d'élevage devront alors être clairement définis pour éviter de disperser les efforts des chercheurs par manque de coordination. En examinant les idées nouvelles proposées par un ou plusieurs membres de l'équipe, les scientifiques participant à la recherche sur les systèmes pastoraux devraient retourner auprès des chercheurs locaux et des vulgarisateurs en vue de recueillir leur opinion. L'équipe doit non seulement prendre en considération la situation actuelle mais également l'évolution récente et les tendances futures immédiates, faute de quoi il est vraisemblable qu'elle sera amenée à tester des innovations qui ne seront plus appropriées au moment où leur validité sera confirmée.
La chronologie normale utilisée pour décrire les diverses phases de la recherche sur les systèmes se présente comme suit : a) essai dirigé et exécuté par les chercheurs; b) essai dirigé par le chercheur mais exécuté par l'exploitant; c) essai dirigé et exécuté par l'exploitant. Cela signifie que le scientifique effectue d'abord ses propres expériences pour prouver et expliquer scientifiquement le mode de fonctionnement de la technique. Puis il effectue l'expérience avec la participation de l'exploitant pour voir si celui-ci dispose des ressources techniques nécessaires pour assimiler l'innovation et si celle-ci peut s'adapter à la situation. Pour terminer, le chercheur se retire et observe l'exploitant pour voir si celui-ci adopte oui ou non l'innovation.

Lorsque les innovations ne sont pas du tout sûres et qu'il s'avère risqué de les essayer sur les champs des exploitants agricoles ou qu'elles requièrent un examen dans des conditions soumises à un contrôle strict, elles doivent être testées dans des champs et dans des troupeaux entièrement contrôlés par les chercheurs. Ces essais sont en général effectués par les équipes de la RSP dans la zone d'étude.

Une fois que l'équipe de la RSP a conçu une intervention et effectué des essais fructueux au niveau de la station, elle peut poser comme hypothèse qu'elle sera profitable à la production animale dans le district ou la région sélectionnées. La phase suivante de la RSP consiste à laisser les éleveurs tester l'intervention sous la direction de l'équipe de la RSP dans le cadre d'essais dirigés par les chercheurs et exécutés par l'exploitant agricole.

La fréquence de la collecte de données est peut-être très aléatoire lors de cette phase du cycle de la RSP. Dans la phase précédente gérée par le chercheur, le fait que les chercheurs soient responsables permet d'avoir un échantillonnage plus petit, une fiabilité accrue et un nombre plus limité de facteurs cachés. Dans la phase suivante gérée et exécutée par l'exploitant, les possibilités techniques ont déjà été déterminées et expliquées. L'équipe de la recherche sur les systèmes pastoraux se préoccupe alors de déterminer le degré auquel
les éleveurs peuvent assimiler les innovations et les avantages qu'ils peuvent tirer de la mise en œuvre des recommandations. Dans la phase gérée par les chercheurs et exécutée par l'exploitant, la compréhension et l'explication techniques sont encore requises. Mais le chercheur doit donner à l'exploitant une certaine indépendance. La fréquence de l'enregistrement des données doit donc tenir compte de facteurs tels que la réticence naturelle de l'exploitant lorsqu'il s'agit de révéler des informations aussi névralgiques que le prix de vente.

Une fois que les exploitants ont suivi les recommandations comme il se doit ou mis en œuvre les interventions sous la direction d'éléments de la RSP, qu'ils sont satisfaits des innovations et qu'ils souhaitent les adopter comme éléments de leur pratique quotidienne en matière d'élevage, on peut passer à la phase finale du cycle de la RSP. Le cycle gestion et exécution des essais par l'exploitant ne peut être accompli sans la coopération des organismes de vulgarisation et de développement. Les activités de collecte de données peuvent être nettement moins fréquentes que lors des phases précédentes parce qu'il n'est plus nécessaire d'expliquer les paramètres de manière intensive.

La RSP est intéressante parce qu'elle ne fait pas appel à des investissements importants pour l'acquisition des terres, des bâtiments, du bétail ou du matériel nécessaires pour la mise en place d'une station de recherche. La RSP fait également appel à l'exploitation de la recherche passée au niveau de la station, ce qui n'implique pas des coûts supplémentaires. La RSP a également l'avantage de contribuer à un accroissement immédiat de la productivité en cas d'inclusion appropriée d'éléments rapides en aval.

La RSP peut contribuer à combler le fossé entre les institutions de recherche et les projets de développement, tout d'abord en établissant que les innovations sont acceptables pour les producteurs puis en déterminant clairement la manière, le lieu et le moment les plus appropriés pour encourager l'adoption des innovations.
Des exemples qui s'inspirent des travaux du programme du CIPEA/zone sub-humide basé à Kaduna dans le nord du Nigéria ont été donnés.
Summary of Discussion Session 10.
Chairman: Dr Samson Chema (Kenya)
Discussion led by Prof. Saka Nuru (Nigeria)

Prof. Saka Nuru questioned the use of the term 'agro-pastoral' by Dr von Kaufmann as applied to people deriving most of their revenue from livestock. Dr von Kaufmann said that the term suited his purposes in the paper because it indicated the crop-livestock interaction that existed. Prof. Saka Nuru asked how could the ILCA team continue to record performance (five to seven years had been suggested), and did this include researcher managed, farmer executed trials? Dr von Kaufmann said that the various research activities ran concurrently - there was no need to wait for the study of basic production parameters to finish before testing interventions.

Dr von Kaufmann agreed with Prof. Saka Nuru when he said that LSR was not to be regarded as a 'water-tight' concept that had to be executed as it had been thought of initially. It was a dynamic process and one corrected one's mistakes as one went along. Prof. Saka Nuru then suggested that the terms 'researcher postulated/proposed' and 'farmer initiated' could be used to replace 'researcher managed' and 'farmer managed'. Dr Kaufmann said that the term 'farmer initiated' appealed to him, but explained that ILCA was relatively new to the field of systems research, and had suffered in the past from trying to develop its own terminology. Only by understanding terminology use could one influence the development of definitions. Prof. Saka Nuru said that it was difficult to compare the cost-effectiveness of LSR and traditional research findings. Dr von Kaufmann agreed and said that he had only wished to point out that LSR could be very cost-effective - in fact each form of research could help to increase the cost-effectiveness of the other.

Dr Bekure stressed that case studies could not take the place of extensive surveys. Without extensive surveys, case studies remained unique without wide applicability to the population. Dr von Kaufmann agreed in principle with this and explained that he had only been commenting on the situation in his own area of work, where he had
found oral data to be very unreliable — he therefore preferred to record actual observations.

Dr Okali said that the categorisation of producers in the areas the meeting was concerned with was not important. Regardless of the terms used there was a continuum along which producers lay, and it was not essential to have strictly defined categories.

Dr Diakite, commenting on Dr von Kaufmann's paper, said that the exchange of information between ILCA's team in Nigeria and ODEM was worthwhile and could be strengthened.
Résumé des débats de la dixième séance

Président: M. Samson Chema (Kenya)
Débats dirigés par le Prof. Saka Nuru (Nigéria)

Le Prof. Saka Nuru s'est interrogé sur le bien-fondé de l'utilisation de l'expression "agro-pastoral" par M. von Kauffman en référence à des populations dont la majeure partie du revenu provient de l'élevage. M. von Kauffman a déclaré que le terme était utilisé de manière appropriée dans le document parce qu'il indiquait l'interaction élevage-agriculture qui existait. Le Prof. Saka Nuru a demandé comment l'équipe du CIPEA entendait continuer à enregistrer les performances (5 à 7 ans ont été suggérés) et si cela incluait les essais dirigés par les chercheurs et exécutés par l'exploitant. M. von Kauffman a déclaré que les diverses activités de recherche s'effectuaient simultanément et qu'il n'était pas nécessaire d'attendre la fin des études sur les paramètres de production de base avant de tester les interventions. M. von Kauffman a reconnu avec le Prof. Saka Nuru que la RSP ne devait pas être considérée comme un concept rigide. Elle ne devait pas nécessairement être exécutée comme elle avait été initialement conçue. Il s'agissait d'un processus dynamique et l'on corrigeait ses erreurs au fur et à mesure qu'on les commettait.

Le Prof. Saka Nuru a alors suggéré que l'expression "proposée/avancée par le chercheur et démarrée par l'exploitant" soit utilisée pour remplacer les expressions "dirigée par les chercheurs" et "dirigée par l'exploitant". M. von Kauffman a déclaré que l'expression "démarrée par l'exploitant" lui plaisait mais que le CIPEA était, toutes proportions gardées, un nouveau venu dans le domaine de la recherche sur les systèmes et qu'en outre, il avait souffert par le passé de la tentative de mise au point de sa propre terminologie. Ce n'est qu'en comprenant l'utilisation de la terminologie qu'on pourra influer sur la conception de définitions. Le Prof. Saka Nuru a déclaré qu'il était difficile de comparer l'efficacité-coût de la RSP et les découvertes de la recherche traditionnelle. M. von Kauffman a exprimé son accord et a déclaré qu'il souhaitait simplement indiquer que la RSP pouvait avoir un caractère efficacité-coût et qu'en fait, toute forme de recherche pouvait contribuer à accroître l'efficacité des autres formes de recherche.
M. Bekuré a souligné que les études de cas ne pouvaient pas remplacer les enquêtes à grande échelle. Sans les enquêtes à grande échelle, les études de cas n'étaient pas tellement applicables à la population. M. von Kauffmann a exprimé son accord de principe avec cette idée et a fait savoir qu'il n'avait fait que formuler des observations sur la situation dans sa propre zone d'étude, où il s'est rendu compte que les données orales n'étaient pas fiables. Il a par conséquent préféré enregistrer des observations ou bien des faits réellement observés.

Le Dr Okali a déclaré que la catégorisation des producteurs dans les zones qui préoccupait tant les participants à la réunion n'était pas importante. Quels que soient les termes utilisés, il y avait une continuité qui s'imposait aux producteurs et il n'était pas essentiel d'avoir des catégories strictement définies.

Dans ses réflexions sur le document de M. von Kauffmann, le Dr Diakité a déclaré que l'échange d'informations entre l'équipe du CIPEA au Nigéria et l'ODEM revêtait une grande importance et qu'il pourrait être renforcé.
A proposal for pastoral development
in the Republic of Niger

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\textsuperscript{2}Deputy Director General, ILCA, Ethiopia

Introduction

For several years there has been a growing tendency to consider a pastoral production system as one of the least rewarding targets for development. Although many pastoral development projects have been launched, they appear to have failed to come to grips with the intricate problems posed by this mode of production: the end results of such efforts have been frustrating and the final returns of input have been usually low or negative. Several analyses of the reasons behind the high failure rate of pastoral development projects have been published (Ferguson, 1976; Horowitch, 1979; Goldschmidt, 1980) and their conclusions need not be repeated here. However, some positive thinking to offset the negative balance sheet of \textit{ex post} pastoral project appraisal may be worthwhile. Thus, it may be useful to focus on a defined area, e.g. the pastoral zone of the Niger Republic, for which a well thought-out development programme has been formulated and proposed for funding.

USAID-supported research and preliminary development work in the pastoral zone started in 1979. The first phase of the Niger Range and Livestock (NRL) Project will be completed in June 1983 and be followed by a development project termed the Niger Integrated Livestock Production (NILP) Project. The contract for the design and implementation of NILP was awarded to Tufts University as the prime contractor, with ILCA, North Carolina A & T University, New Mexico State University as sub-contractors.

The design team (also called the joint enterprise group) assembled in Niamey in early January 1983 and submitted their first
draft in early February. Several design sub-teams were created to write the various components for the project paper. C. de Haan (ILCA) and A. E. Sollod (Tufts School of Veterinary Medicine) were responsible for the animal production component, including animal nutrition and health, while P. N. de Leeuw (ILCA) and G. Greenwood were charged with ecology, range and water resources and their management. G. Greenwood was a consultant representing New Mexico State University.

This paper presents a summary of the design team's findings and proposals in the fields of range management and animal production. However, it should be realized that the development of these technical components are part of an integrated developmental strategy aimed at increased food production, income and security for Niger herders. Thus the project will promote the participation of pastoralists in the development process by interweaving the activities of herdsmen, herders' associations and the services provided by the Government.

The primary objective of creating local "institutions" is that development should serve human needs and must therefore be defined in terms of human objectives. The goals in the technical sector are intermediary objectives, by which the primary objectives can be attained.

At the time of writing, the authors had not yet received the final project papers on the other components of the design (on "institution building" and associated socio-economic research, human health and education and training). However, for an overview of the integrated approach that underlies the proposed development strategy, reference can be made to a draft discussion paper on strategy by Swift (1982), who is the coordinator of the socio-economic unit of the NRL phase, and to a summary of this paper (de Leeuw and Swift, 1983).

The authors wish to acknowledge the contributions of their colleagues A. E. Sollod and G. Greenwood without which this paper could not have been written and wish to thank J. Swift for providing the necessary background on the NRL project.

Description of the production systems

The target area is 80,000 km$^2$ in size and lies within the pastoral zone of the Niger Republic. It has a population of some 170,000 pastoralists, the majority of which are Tuareg, the minority tribes
being Wodaabe and Arabs. The area supports about 330,000 cattle, 930,000 sheep and goats and 100,000 camels (Table 4). Mean annual rainfall varies from 200 mm in the north to 400 mm in the south, most of which falls in the two- to three-month long rains between July and September. Inter-annual variations in total amount, distribution and length of the growing season are great (Table 1).

Table 1. Annual rainfall (mm) distribution over 60 years (1920 - 1981) for Agadez (16°40'N, 8°00'E) and Tahoua (14°40'N, 5°30'E).

<table>
<thead>
<tr>
<th>Region</th>
<th>100 mm</th>
<th>100-200 mm</th>
<th>200-300 mm</th>
<th>300-400 mm</th>
<th>400-500 mm</th>
<th>500 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agadez</td>
<td>22</td>
<td>57</td>
<td>22</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tahoua</td>
<td>-</td>
<td>-</td>
<td>17</td>
<td>37</td>
<td>34</td>
<td>12</td>
</tr>
</tbody>
</table>


Range resources vary with annual rainfall and its distribution. End-of-season standing biomass ranges from 200 to 500 kg DM/ha in the north to 500 - 1 500 kg DM/ha in the south and consists mainly of short-lived annual grasses and herbs (Table 2). Woody cover is variable but on average is low (Milligan, 1982a). Herbage crude content rises to 10 - 15% in August, dropping to low values of 3 to 5% towards the end of the dry season. The greatest variation in herbage quality occurs during the transition period (from late May to early August, its duration varying between years), when there is a mixture of scattered new growth and old standing forage and litter. The same seasonal trends occur for herbage digestibility (Fig. 1).
Figure 1a. Range of crude protein content (% DM) in annual grass herbage.

Figure 1b. Range of digestibility (% DM) in annual grass herbage.
Table 2. Total annual rainfall and maximum standing biomass on four sites in the pastoral zone of the Niger Republic

<table>
<thead>
<tr>
<th>Site</th>
<th>Year</th>
<th>Total annual rainfall (mm)</th>
<th>Maximum standing (kg/ha)</th>
<th>Ratio kg/ha/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aderbissanat</td>
<td>1980</td>
<td>108</td>
<td>660</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>153</td>
<td>500</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>151</td>
<td>730</td>
<td>4.9</td>
</tr>
<tr>
<td>Gadabeji</td>
<td>1980</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>159</td>
<td>190</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>150</td>
<td>1130</td>
<td>7.5</td>
</tr>
<tr>
<td>Ibeceten</td>
<td>1980</td>
<td>192</td>
<td>970</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>210</td>
<td>640</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>160</td>
<td>590</td>
<td>3.7</td>
</tr>
<tr>
<td>Dakoro</td>
<td>1980</td>
<td>238</td>
<td>1500</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>236</td>
<td>750</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>240</td>
<td>1200</td>
<td>5.0</td>
</tr>
</tbody>
</table>


The question arises whether range resources within the area are adequate to sustain the 500,000 TLU (1 TLU = 250 kg) in particular during periods of drought. To answer this question, theoretical carrying capacity calculations have been made based on the assumed relationship that 1 mm rainfall produces 2.5 kg of dry matter. From Table 2, it is clear that this relationship is poor and actually ranges from 1.2 to 7.5 kg DM/mm rain, because of differences in rainfall distribution and intensity, and soil characteristics. Depending on rainfall, the estimated carrying capacity ranges from 400,000 to 700,000 TLU (Table 3), which demonstrates that in average years the existing population can be sustained, but a serious fodder shortage may develop when in the north the rains are below 100 mm and in the south below 300 mm, events that occur during one year out of five (Table 1).
Table 3. Carrying capacity (CC) estimates of the NRL zone in relation to rainfall and biomass production.

<table>
<thead>
<tr>
<th></th>
<th>Northern part (40,000 km²)</th>
<th>Southern part (40,000 km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rainfall (mm)</td>
<td>Biomass (kg/ha)</td>
</tr>
<tr>
<td>100</td>
<td>250</td>
<td>36</td>
</tr>
<tr>
<td>150</td>
<td>375</td>
<td>24</td>
</tr>
<tr>
<td>250</td>
<td>625</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: Penning, Vries and Djiteye (1982).

Livestock density increases from north to south in line with range productivity, from about 4 TLU/km² to 7.5 TLU/km² (Table 5). During the rainy season there is an influx of cattle and camels into the northern part of the area, which return to the south from late September onwards (Table 4). Although the Tuareg have a much more diverse species mix (Wilson and Wagenaar, 1982), they appear less mobile than the cattle-owning WoDaaBe. The greater mobility of the latter is reflected in the much greater seasonal fluctuation in WoDaaBe herds (Table 3). Within this general context of movement, differing goals and constraints lead to different production strategies which involve different breeds and species of animals maintained in herds, reliance on different types of dry-season water sources, attachments to particular dry-season geographic zones, and the use of different salt cure zones.
Table 4. Livestock populations in the NRL zone.

<table>
<thead>
<tr>
<th>Livestock population (x 1000)</th>
<th>May 1981</th>
<th>Sept 1982</th>
<th>Oct. 1982</th>
<th>Mean¹</th>
<th>TLU² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>289</td>
<td>331</td>
<td>376</td>
<td>332</td>
<td>249 (50)</td>
</tr>
<tr>
<td>Bororo</td>
<td>(153)</td>
<td>(192)</td>
<td>(247)</td>
<td>(198)</td>
<td>(148) (30)</td>
</tr>
<tr>
<td>Azawak</td>
<td>(136)</td>
<td>(139)</td>
<td>(130)</td>
<td>(133)</td>
<td>(101) (20)</td>
</tr>
<tr>
<td>Smallstock</td>
<td>780</td>
<td>831</td>
<td>1148</td>
<td>930</td>
<td>140 (28)</td>
</tr>
<tr>
<td>Camels</td>
<td>70</td>
<td>156</td>
<td>89</td>
<td>98</td>
<td>99 (20)</td>
</tr>
<tr>
<td>Donkeys</td>
<td>13</td>
<td>23</td>
<td>20</td>
<td>18</td>
<td>9 (2)</td>
</tr>
<tr>
<td>TOTAL TLU</td>
<td>410</td>
<td>540</td>
<td>554</td>
<td>497</td>
<td>497 (100.0)</td>
</tr>
</tbody>
</table>

¹ Weighted annual mean.
² Cattle = 0.75, smallstock 0.15, camel 1.0, donkeys = 0.50, TLU (250 kg LW).

Compiled from Milligan 1982a, 1982b.

Table 5. Seasonal livestock densities (no./km²) in the NRL zone (1981-82).

<table>
<thead>
<tr>
<th>Livestock density (no./km²)</th>
<th>cattle</th>
<th>smallstock</th>
<th>camels</th>
<th>donkeys</th>
<th>Total TLU</th>
<th>ha/TLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern part</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet season</td>
<td>1.5</td>
<td>6.5</td>
<td>2.5</td>
<td>0.4</td>
<td>4.8</td>
<td>20</td>
</tr>
<tr>
<td>Dry season</td>
<td>1.1</td>
<td>6.7</td>
<td>1.2</td>
<td>0.2</td>
<td>3.2</td>
<td>31</td>
</tr>
<tr>
<td>Southern part</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet season</td>
<td>6.4</td>
<td>10.2</td>
<td>0.6</td>
<td>0.3</td>
<td>7.1</td>
<td>14</td>
</tr>
<tr>
<td>Dry season</td>
<td>5.5</td>
<td>13.6</td>
<td>1.3</td>
<td>0.4</td>
<td>7.7</td>
<td>13</td>
</tr>
</tbody>
</table>

Constraint diagnosis

Range resources

The single major constraint to which all producers within the zone are subject is that of a unimodal range resource base. This implies that the productivity of the system hinges on a two- to four-month rainy season during which nutrient supply is sufficient for maintenance and production in terms of incremental herd growth (liveweight gain plus reproduction). Once the growing season is over, the range resource may remain adequate in quantity but it deteriorates gradually in quality over the nine-month long dry season. This situation is in contrast to many other West African production systems that are capable of breaking the deteriorating fodder situation through short or long-distance movement to perennial floodplain grasslands (e.g. the inner delta of the Niger River, the shores of Lake Tchad, the floodplains of Benin or Nigeria), to crop residue resources or to burned savanna woodlands. None of these options are available to the WoDaaBe and Tuareg pastoralists in the ILP zone, at least not for those with cattle herds, while for small flocks and camels, the options are somewhat greater through the exploitation of browse.

Animal nutrition

Protein

It appears that protein deficiency is the most limiting dry-season factor in grazing animals (cattle and sheep). Early in the rainy season the protein level (nitrogen) of grasses is at its highest (8 - 12% digestible protein). As the rainy season ends and the dry season progresses, this level drops steadily until the end of the dry season when it averages 1% (Louis, 1982). Selective grazing may result in an actual intake slightly higher than this, but the protein intake would still be well below maintenance requirements for cattle and sheep. In cases of severe protein deficiency subcutaneous edema (bottle jaw) develops due to hypo-proteinemia; this has been observed in sheep in the project zone (Glazier, pers. comm.).
Microminerals, vitamin A and phosphorus

Research completed late in the NRL project has demonstrated the soil to be severely deficient in cobalt (Co), copper (Cu), and selenium (Se). Critical points of soil mineral concentrations where deficiency starts in pastured ruminants are four times that found in the NRL soil for Co, 22 times that for Cu, and ten times the critical soil concentration for Se. Local salts from Bilma and Tigguidan Tessoum do not contain adequate concentrations of these elements to be useful as supplemental sources. Striking clinical features of these deficiencies have been observed in animals in the zone. The deficiencies appear to be significant constraints to animal production and health, but the production responses to supplementation must still be tested since the zone's slow-growing animals may respond only minimally; however, as general nutrition is improved through other project interventions, the animals' requirements for microminerals will increase.

Empirical observations of clinical signs and responses to treatment, both in the project zone and elsewhere in the Sahel, have demonstrated severe vitamin A deficiencies at the end of the dry season; therefore, dry season vitamin A supplementation will be one of the first large-scale interventions in the ILP project.

Forage analysis for phosphorus is presently unreported, but it is anticipated that some deficiencies do exist.

Water points

Uneven water point distribution may result in underutilisation of some areas while there is overgrazing in other areas which have an abundance of water points. Dry-season water points with very high output, such as bore holes, may attract more herds than the localised biomass might be expected to support; however, the degree to which these negative effects may occur in the project zone has not been adequately quantified. In an intensive study on a single WoDaaBe herd, Glazier (1983) found evidence that the time required to draw water from a well detracted from the potential foraging time for the herd, and it may have adversely affected the animals' feed intake.
Infectious diseases

In the past, the single most important infectious disease hindering increases in animal production was rinderpest. The JP-15 rinderpest campaign conducted in the 1960s failed to eradicate this disease but greatly reduced its incidence, and today it continues to be controlled by widespread vaccination. However, knowledge of other important animal diseases prevalent in the region is limited and, except for contagious bovine pleuropneumonia, no efforts have been undertaken to systematically control them.

The NRL project conducted two forms of animal health research. A veterinary consultant made several trips into the project zone and through extensive interviews, herd examinations, and necropsies was able to assess the animal health status of the herds and to formulate a tentative list of disease constraints based on their relative economic importance (Sollod, 1981).

Field research on animal health was also done by some members of the socio-economic team. Their work emphasised herder perceptions of diseases, specific causes, approaches to treatment and control, and their relative economic importance. It was found that the herders had a fairly sophisticated understanding of diseases and epidemiological relationships (Maliki, 1982).

Production indices

Sahelian pastoral systems generally utilise their range resources as efficiently as other production systems in similar arid environments; however, because of the constraints described above, production is
very slow as reflected in low growth, maturation and reproductive rates. There are also high young stock mortality rates and low offtake rates which reflect both the selective use of milk for human consumption and uncontrolled infectious diseases. Table 6 gives the main production parameters of the existing systems.

Table 6. Estimates of important production parameters in the zone.

<table>
<thead>
<tr>
<th>Species</th>
<th>Net animal reproduction rate (%)</th>
<th>Mortality</th>
<th>Age at first parturition (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>birth to weaning (%)</td>
<td>weaning to first parturition (%)</td>
<td>adults (%)</td>
</tr>
<tr>
<td>Cattle</td>
<td>50</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sheep</td>
<td>100</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Goats</td>
<td>110</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td>Camels</td>
<td>40</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Donkeys</td>
<td>40</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>


Project output

Testing and extension of range management strategies

The programme involves three phases:

- the technical and economic evaluation of proposed strategies under controlled conditions;

- on-herd trials of strategies shown to be effective under controlled conditions (contingent upon the removal of watering constraints and the formation of experimental herding units);

- the extension of proven strategies through the herders' association (HA) network through trained HA range management auxiliaries chosen on the basis of their traditional range skills.
Deferred dry-season grazing

Deferred dry-season use trials will be conducted at two ranches during the 1982-83 and 1983-84 dry seasons. Every day and every other day watering regimes will be investigated, in part to simulate local conditions. The animal performance will be followed after the end of the experiments until the end of the following rainy season to investigate compensatory gain.

Centripetal grazing

Experimental work on the Ekrafane ranch has shown that centripetal herd management can reduce weight losses in immature steers (Klein, 1981). Centripetal grazing is in fact a more elaborate system of deferred dry-season use, coupled to a variable watering regime. The advantages of the outside-in system are thought to be 1. maintenance of higher quality feed through deferred use, 2. reduction of animal energy expenditures in walking at the moment of greatest stress, and 3. higher intake and digestibility due to more frequent late dry-season watering. As with deferred dry-season use, this technique could result in better animal condition and lower calf mortality in the late dry season.

Under the project it is proposed that:

1. A modelling exercise be performed in order to estimate the effect of centripetal grazing on cattle.

2. One on-ranch trial of the centripetal system be established during the dry season 1983-84. The trial will include two stocking rates plus a control herd with a total of 60 cattle. Daily and alternate day watering during the hot season will be superimposed on the stocking rates.

The question of watering frequency and the allocation of labour to animal herding versus watering is considerably more complex. According to the only animal behaviour survey conducted by NRL (Glazier, pers. comm.), such a system may be precluded by a lack of labour to simultaneously water the animals and herd them away from forage that is to be conserved for later use. Furthermore, given the present watering technology, the imposition of daily watering would so
reduce the time available to the animals for grazing that herd productivity would fall rapidly.

Thus, the feasibility of applying centripetal grazing in the project depends on:

- a reasonable degree of control of a water point;
- the allocation of a certain amount of additional labour to herding the animals to the desired ranges;
- a reduction in the time spent watering the animals;
- the effects of increased water frequency on animal performance, on the rate of forage disappearance, and on the stocking and movement strategies of the herder.

Watering technology studies

That the provision of water during the dry season is an important component in the production system has been recognized early during the NRL phase. Several studies have been conducted but have not been, or have been only partially, published. Data from the waterpoint survey are currently being analysed, while labour inputs on a household basis are incorporated in socio-economic studies, the report on which is in preparation.

For the quantification of the effects of current watering technology on herd and labour productivity, the sample used is the same as for the animal production studies (see below) and is stratified to distinguish between Tuareg and WoDaaBe and between households with low and high ratios of animals to people.

Particular attention will be paid to the relationship between the amount of time spent watering, the quantity of water consumed per head, the time and resources available for grazing, and herd productivity. With this information, a better prediction can be made of the effects of changing the watering regimes in the project zone.

This project consists of a follow-up to the NRL water point survey (Knight, 1981) that aimed to carry out the following within selected HA areas:
- the preparation of accurate water point maps;
- the delineation of water deficit and surplus zones through measuring water point outputs and requirements by season; and
- labour inputs and efficiency for water extraction.

During the survey, the constraints and limitations of existing technology will become evident, while more efficient innovations and techniques will be identified. Potential innovations include:

- well mouth reinforcement (already tested by NRL);
- better harnesses for draft animals;
- installation of concrete screens in the aquifer to prevent slumping of aquifer material, to increase the volume of water present at any moment and to facilitate recharge;
- development of well covers to permit temporary closure of wells;
- methods of directing water into traditional watering basins without detaching the tire d'eau; and
- development of water-trapping structures in sandy areas.

Animal production and health

Introduction

Objectives. The objectives of the animal production and health component of the ILP project will be:

1. to identify economically feasible and socially acceptable production increases in the cattle, sheep, camel and goat production systems of the pastoral zone through:

   - improvements in per animal productivity by increasing milk production and by reducing mortality with strategic feeding practices;
   - improvements in production efficiency with herd health programmes.
2. to develop, with the assistance of the government of Niger, animal production and health input delivery systems to the herders' associations and Veterinary centres through:

- the training and continuing education of one veterinary auxiliary for each herders' association;

- support to the annual livestock service vaccination campaigns;

- the construction of veterinary posts at pastoral centres and the provision of animal restraint facilities in the zone; and

- introduction of a process approach to field research in the livestock service.

It is expected that the ILP project will have its greatest impact on animal production by introducing strategic inputs of protein and animal health commodities.

**Institutional framework**

Animal production and health activities will be undertaken within the institutional framework of the HA and the government livestock service with the support of private markets and the national veterinary pharmacy. In an effort to extend animal health care to a grassroots level, training of veterinary auxiliaries was initiated by the livestock service and the NRL project in 1981.

The animal health study of NRL (Sollod, 1981) pointed out that herders were often not using the optimal combination of commodities in animal care. Under ILP it is anticipated that a more cost-effective population approach to animal health may be carried out by utilising a better selection of animal care commodities and by working through veterinary auxiliaries who are members of the HA. Animal production inputs, mainly protein supplements and nutritional counselling will also be introduced through the system of auxiliaries.

The ILP project will begin to develop a process approach, or an "evolutionary operational programme", to field research whereby the results of research are rapidly tested through field trials and socio-economic evaluation, and they are then extended and monitored under the supervision of the researchers themselves. It will be a
major objective of the ILP project to introduce and begin to institutionalise the evolutionary operational programme in the livestock service.

Output

The project will produce three major outputs, all of which will focus on improving per animal production in the production systems of the zone. Emphasis will be placed on solving the most severe, and the most easily addressed of the constraints described in the previous section, namely, seasonal protein deficiency, vitamin/mineral deficiencies and infectious diseases. Improvements will also be made in environmental hygiene (such as water point decontamination) and animal reproduction (through early pregnancy diagnosis and the identification and treatment of causes of infertility in cattle and goats.

The first output, the evolutionary operational programme, is a management system in which new technology is gradually introduced through a logical sequence of research and implementation activities. New inputs are carefully evaluated for their technical, economic and social impact before being extended on a broader scale.

The evolutionary operational programme has five stages which will carry the project activities through a logical sequence. These stages include field research, field trials, socio-economic evaluation (under partial implementation), full implementation and monitoring.

Field research. Interdisciplinary research will be carried out to provide base-line data on herd productivity, animal nutrition, habitat utilisation, epidemiology and reproduction. The frequency of data collection, which can be accomplished by single visits to each herd, will be limited to four times per year in order to reduce costs and to minimize disruption to herders and their livestock. Visits will coincide with the key seasons which modulate pastoral production, that is early wet, full wet, early dry and late dry.

Herd productivity. Except for a retrospective survey (Wilson and Wagenaar, 1982) no animal production data are available from the traditional systems of the project zone. The project will therefore
implement a data collection system for the two production systems: WoDaaBe and Tuareg. The following parameters will be collected:

1. herd/flock composition, covering the main categories by species, age, and sex. Through interviews, information will be collected on animal births, deaths, sales, gifts and transfers;

2. milk offtake per individual animal;

3. calf growth (long bone growth and body weight) up to approximately 50 kg liveweight and small ruminants up to approximately one year of age;

4. condition of all cattle in the herd, through the establishment of a simple system of condition scoring.

Animal nutrition. The methodology in determining feed quality will be to select from one herd in each of the sub-samples two to four matched sentinel animals and observe at regular intervals the composition of vegetation being eaten. Samples will be collected for food analysis. This method of grab sampling or simulated grazing has given good representative results of the quality of ingested feed (Dicko et al, 1981).

Habitat utilisation. Habitat utilisation by sample households and their herds will be monitored in a seasonal time-frame through periodic recall enquiries on herd movement, grazing and watering strategies and labour force. Behaviour recording will be done on the same sub-sample as mentioned in animal nutrition to determine the 24-hour activity profiles and grazing conditions of the diurnal cycle. These habitat utilisation observations and measurements will be made within the same sample framework as the productivity and nutrition studies described above.

Epidemiological studies. Rigorous epidemiological data collection and analysis system will be integrated with the studies described above and will therefore have an ecological perspective which takes full cognisance of environmental and socio-economic factors as determinants of disease. Animal health monitoring will be done on:
1. the herd productivity groups;

2. geographically selected samples throughout the project zone - retrospective studies will combine animal production data and case-control methodology;

3. site-specific investigative field epidemiology where problems occur, including water point and environmental contamination.

Livestock reproduction. Research will be directed to identify and determine the relative significance of factors which cause such high infertility and reproductive failure. Particular emphasis will be on the non-nutritional causes of lowered reproductivity. By utilizing retrospective herd studies and prospective cohort studies, a detailed herd reproductive history will be obtained in an on-going manner with the present and continuing herd reproductive status being assessed. This data base will be used to determine reproductive indicators. Determination of the infectious causes of infertility and reproductive failure will also be done. This will be accomplished largely by the epidemiological disease determination surveys.

The application of the techniques of early pregnancy diagnosis will be examined in cattle, camels, sheep and goats. Internal palpation and external ballotment will be performed on the various species. This knowledge may be used to assist herders to make more informed decisions concerning the sale and/or selective feed supplementation of their animals.

Field trials. These trials will be carried out in simple with/without comparisons of matched pairs of animals of similar characteristics in order to reduce numbers and costs. They will be conducted in the same production units as the field research, with the control animals providing the data for the parameters of the existing system. Field trials on individual vitamin or mineral inputs and certain combinations will be carried out on 10 to 20 pairs of animals for each input. Two classes of sheep and cattle (newborn animals and reproductive females) will be tested for two years.

The ILP project will gradually test the technical and economic feasibility, and the social acceptability, of limited
concentrated feeding (1 kg of cottonseed or 0.5 kg of groundnut cake) to one or two lactating cows from each of 10 herds for two months in the late dry/early wet season. Their performance will be compared to 10 to 20 control animals of similar characteristics through bi-weekly milk recording (offtake) and measurements of calf growth; the technical and economic coefficients will be estimated.

The ILP project will also establish the feasibility of calf supplementation using locally produced groundnut cake/maizemeal and a vitamin/mineral mixture. On the basis of differences in calf mortality and daily gain, a cost-benefit ratio will be calculated in order to make a decision on possible extension.

**Socio-economic evaluation**

Results from the field trials will be evaluated to determine whether full implementation is warranted. Evaluations will be made of costs and benefits, feasibility, sustainability, social acceptability and environmental impact. Pilot interventions will be carried out at the level of the total production unit and will comprise two categories:

1. Those interventions which need to be tested on a herding unit (e.g. grazing management, protection from flies in the late rainy season, vaccinations against contagious diseases), and are not yet sufficiently tested to establish economic viability.

2. Those interventions which have already proven their economic viability, but for which it is necessary to establish their social acceptability. In such cases, consumer demand for products - those paid for by the herders themselves - will be the basis of evaluation.

**References:**


Ferguson, D.S. 1976. *A conceptual framework for the evaluation of livestock production development projects and programs in sub-Saharan Africa.* CRED, Univ. of Michigan, Ann Harbor.


Knight, J. NRL water point survey. USAID, Niamey.


Maliki, A.B. 1982. NGAYNAAKA: Herding according to the WoDaaBe. USAID/NRL, Niamey.


Wilson, R.T. and Wagenaar 1982. An introduction survey of livestock population demography and reproductive performance in the
area of the Niger Range and Livestock Project. USAID/NRL, Niamey.

**Proposition de développement pastoral en République du Niger**

**Résumé**

La région-cible qui s'étend dans la zone pastorale de la République du Niger a une superficie de 80 000 km². Sa population est de quelque 170 000 éleveurs composés pour la majorité de Touaregs et d'autres ethnies minoritaires, à savoir les Wodaabes et les Arabes. On trouve dans la zone environ 330 000 bovins, 930 000 ovins et caprins et 100 000 camélidés. La pluviométrie annuelle varie de 200 mm dans le nord à 400 mm dans le sud et la plupart des précipitations se produisent lors des deux à trois mois de saison des pluies entre juillet et septembre.

La contrainte essentielle à laquelle les producteurs de la zone ont à faire face est le caractère unimodal de la base des ressources pastorales. Cela implique que la productivité du système est tributaire de deux à quatre mois de saisons des pluies au cours desquelles la production d'éléments nutritifs est suffisante pour l'entretien de la production en termes de croissance du troupeau. Il apparaît que le manque de protéines soit le facteur limitant de saison sèche le plus important pour les ruminants. La recherche a démontré que le sol est très pauvre en cobalt, en cuivre et en sélénium. La distribution inadéquate des points d'eau peut se traduire par une sous-utilisation de certaines zones et par le surpâturage d'autres zones où l'eau est abondante. La qualité de l'eau varie considérablement à l'intérieur de la zone. Dans le passé, la maladie infectieuse qui constituait l'obstacle le plus sérieux à la production animale était la peste bovine. Toutefois, on ne dispose que de connaissances limitées sur d'autres maladies animales graves dans la région et peu d'efforts ont été déployés pour lutter systématiquement contre celles-ci. A cause de ces contraintes, la production est insuffisante. Cette situation se reflète dans la faiblesse des taux de croissance et de reproduction ou dans le caractère tardif de la maturité.

La phase d'expérimentation et de vulgarisation du projet proposé fait appel à l'évaluation technique et économique de stratégies proposées dans des situations contrôlées, à des essais au niveau du troupeau, à des
stratégies dont l'efficacité a été prouvée dans des situations contrôlées, et à la vulgarisation de stratégies confirmées au niveau de l'association des éleveurs.

Au cours de l'exécution du projet proposé, les contraintes et les limites relatives aux techniques disponibles de mise en valeur des ressources en eau deviendront plus évidentes, alors que des innovations plus efficaces seront identifiées.

Les innovations potentielles portent notamment sur :

- le renforcement de la margelle des puits;
- l'amélioration des harnais des animaux de trait;
- l'installation de panneaux de béton dans la couche aquifère pour éviter l'effondrement de portions de celle-ci en vue d'accroître le volume d'eau disponible à n'importe quel moment et de faciliter la reconstitution de la nappe;
- la construction de couvercles de puits pour permettre la fermeture temporaire des puits;
- la mise au point de méthodes de canalisation de l'eau en direction de bassins d'abreuvement traditionnels sans réduire le tirant d'eau;
- la mise au point de procédés de captage des eaux dans les zones sableuses.

Les objectifs de la composante production et santé animales sont les suivants :

- identification d'accroissements économiquement réalisables et socialement acceptables de la production de bovins, d'ovins, de camélidés et de caprins dans les systèmes de la zone pastorale, par le biais de l'amélioration de la productivité par animal et de l'efficacité de la production grâce à des programmes vétérinaires destinés au troupeau;
- développement avec l'aide du Gouvernement du Niger des systèmes de production et de santé animales, des associations d'éleveurs et de centres vétérinaires notamment par:

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- la formation suivie d'un auxiliaire vétérinaire pour chaque association d'éleveurs;
- l'appui aux campagnes de vaccination annuelle du service de l'élevage;
- la construction de postes vétérinaires dans les zones pastorales et l'installation de matériel de contention dans la zone;
- l'introduction d'une approche à la recherche de terrain dans le service de l'élevage.
Summary of Discussion Session 11.
Chairman: Dr Samson Chema (Kenya)
Discussion led by Dr Rhissa (Niger)

In response to a question by Dr Wilson on the importance of Vitamin A, Dr de Haan said that Vit. A had been identified by the pastoralists as a major constraint to night grazing in the late dry season. This was subsequently confirmed by a consultant veterinarian who identified between 10 and 20% of the herd in question with night-blindness. The main cause was the very low proportion of browse trees in the region, especially following drought. When asked by Dr Wilson why donkeys had not been included in the studies described, Dr de Haan said that donkeys were not an obvious constraint in the system, and therefore did not command a high priority at the stage. Dr Akilu commented that there were also problems of Vitamin A deficiency which had been diagnosed and described by herdsmen and vets. As regards camels, discussions were taking place with IEMVT to identify constraints, the most important being parasites (helminthesises) and Salmonella diseases.

Dr Suleiman observed that the discussion had concentrated on animal management - why were not range monitoring studies, such as biomass production, composition changes and vigour, not incorporated into the plan for trend analysis described by Dr de Leeuw? Dr de Leeuw explained that such parameters would indeed be monitored in Niger. Ground truth would be collected on species composition, biomass growth during the rainy season and during the dry season in specific areas of the zone. These areas would be repeatedly visited during each ground survey. This was part of an integrated space (satellite), aircraft and ground inventory of grazing resources in time and space for the zone.

Dr Diakite stressed the importance of quantity and quality of water, and felt it was important to continue with the chemical and bacteriological analysis of water. A problem was that of tapping deep water resources without spending too much money. Yet no development was possible in these areas of Niger without water.
Résumé des débats de la onzième séance
Président: Dr Samson Chema (Kenya)
Débats dirigés par le Dr Rhissa (Niger)

En réponse à la question de M. Wilson sur l'importance de la vitamine A, M. de Haan a déclaré que la vitamine A avait été identifiée par les éleveurs comme la contrainte essentielle au pâturage de nuit à la fin de la saison sèche. Cela avait été par la suite confirmé par un vétérinaire consultant qui a identifié entre 10 et 20% des animaux du troupeau en question frappés de cécité nocturne. La cause essentielle en était la très faible proportion de ligneux dans la région en particulier après la sécheresse. Lorsque M. Wilson a demandé pourquoi les ânes n'avaient pas été inclus dans les études décrites, M. de Haan a déclaré que les ânes ne constituaient pas une contrainte évidente dans le système et que par conséquent on ne leur avait pas accordé un rang élevé de priorité à ce niveau.

M. Aklilu a déclaré qu'il y avait également d'autres problèmes de carence de vitamine A qui avaient été démontrés et décrits par les éleveurs et par les vétérinaires. En ce qui concerne les chameaux, des discussions étaient en cours avec l'IEMVT pour identifier les contraintes, les plus importantes de celles-ci étant les maladies parasitaires (l'helminthiase et la salmonellose).

M. Suleiman a fait remarquer que les débats avaient été axés sur la gestion des animaux et s'est posé la question de savoir pourquoi les études de suivi continu sur des thèmes tels que la production, la composition, l'évolution et la vigueur de la biomasse des terrains de parcours n'avaient pas été incorporées dans le plan utilisé pour l'analyse de l'évolution décrite par M. de Leeuw. M. de Leeuw a expliqué que de tels paramètres seraient étudiés au Niger. Des données seraient recueillies au sol sur la composition des espèces et la croissance de la biomasse pendant les saisons pluvieuse et sèche dans des zones spécifiques de la région. Ces zones feraient l'objet de plusieurs visites pendant chaque enquête au sol. Ces activités s'inscriraient dans le cadre d'un recensement aérien (par satellite et par avion) et terrestre des pâturages de la zone échelonné dans le temps et dans l'espace.
Le Dr Diakité a souligné l'importance de l'eau aux plans qualitatif et quantitatif et a déclaré qu'il était important de poursuivre son analyse chimique et bactériologique. L'un des problèmes à résoudre était celui de l'exploitation des eaux souterraines sans dépenser trop d'argent. Et pourtant, aucun type de développement n'était possible dans ces régions du Niger sans l'eau.
STRENGTHS AND WEAKNESSES OF PSR
Summary of Discussion Session 12.
The strengths and weaknesses of pastoral systems research with particular reference to ILCA's programmes.
Chairman: Mr Stephen Sandford (ILCA)
Discussion Panel: Mr Larry Ngutter (Kenya)
Dr Noumou Diakite (Mali)
Dr Jackson Kategile (IDRC, Kenya)
Dr Zakari Rhissa (Niger)
Prof. Saka Nuru (Nigeria)
Dr Assefa W. Giorgis (Ethiopia)

Mr Ngutter felt that the following should be ILCA's priorities in the future:

1. ILCA should continue its present efforts and programmes in
   - micro-economic household level data collection;
   - marketing studies;
   - resource inventory, including livestock census;
   - insistence on cost-effectiveness of proposed intervention packages;
   - aiming to influence traditional research from research stations to the field in pastoral systems research, and produce usable results at the earliest possible time.

2. ILCA should modify its present approaches to
   - dovetail with national policies, objectives and strategies;
   - integrate its work with national and international research, policy, extension, training and other institutions;
   - expand the scope and area coverage of its on-going programmes.

3. ILCA should explore new horizons in the areas of
   - public policy formulation/analysis, particularly as policy is affected by or affects research efforts;
   - land issues in PSR, specifically
Dr Diakite referred to ILCA's work in Mali and said that ILCA's co-operation there in the future could focus on:

- support for training;
- support for the initiation of extension methodology or pre-extension work;
- financial support for costs of offices, garages, accommodation, etc.

ILCA could have an important role in the negotiations for obtaining finance. ILCA's image was in general good. But there was a Fulani proverb which said that 'the kid licks whoever licks the kid'. ILCA's good image required that those responsible for ILCA keep 'licking' it in order to maintain it.

Dr Kategile said that in view of the fact that ILCA was not in a position to cover all African countries directly in its PSR activities due to financial constraints and that PSR results were applicable within only one socio-economic situation, ILCA should adopt a different strategy. He felt that ILCA could play a leading role in PSR in Africa. This could be done by co-operating with other research institutions in Africa. ILCA's roles could be:

1. popularisation of PSR among research institutions in Africa;
2. development of research methodology in PSR. Methodologies should preferably be applicable to African institutions. Methods should continue to be reviewed;
3. if methods were agreed upon, data collection and analysis could be centralised where necessary;
4. ILCA should form cohesive PSR teams that can set an example;
5. the training of African research scientists in PSR;
6. to visit and advise PSR teams in Africa;
7. to collect and disseminate PSR activities in Africa - to foster exchange of information;
8. to act as a source of germplasm, specifically for pastures;
9. to co-operate directly with PSR teams in African institutions.

Dr Kategile also questioned whether or not ILCA should get involved into agroforestry and intensive livestock systems, rather than concentrate solely on pastoral systems.

Dr Rhissa said that it was important that any collaboration between ILCA and other organisations should pass through the correct administrative channels. Once collaboration had been set up with national institutions this should be open and sincere. Agreement must first be reached on the objectives of the work and there should be joint effective exploration of the existing potential in terms of documentation, technical methods etc. Subsequently ILCA should regularly inform the national institutions of the results of its activities. ILCA should encourage the training of technical staff by organising seminars on pertinent subjects. ILCA should also hold meetings at the request of national governments.

Prof. Saka Nuru said that co-operation with national research and development agencies was a top priority for ILCA. Such co-operation involving universities, state, local and federal government etc. had several advantages:

- pooling of technical expertise towards a common goal;
- the determination of national priorities relevant to national needs;
- use of local knowledge to shorten the descriptive/diagnostic phase;
- financial benefits from national governments; and
- easier dissemination of results.

He advocated the siting of ILCA team offices in national research institutions. Prof. Saka Nuru said he thought that ILCA's techniques
were in general good, but stressed that local pastoralists should be actively involved in the planning and execution of the research work. He felt that the failure of many national and international projects had been due to the lack of such a grass-roots involvement. He thought that ILCA could have achieved more if its research had been extended beyond the 'case study area' concept and had involved local development agencies to a greater extent.
Résumé des débats de la douzième séance

Forces et faiblesses de la recherche sur les systèmes pastoraux à la lumière des programmes du CIPEA.

Président: M. Stephen Sandford (CIPEA)
Participants: M. Larry Ngutter (Kenya)
Dr Nounou Diakité (Mali)
M. Jackson Kategile (CRDI, Kenya)
Dr Zakari Rhissa (Niger)
Prof. Saka Nuru (Nigéria)
M. Assefa W. Giorgis (Ethiopie)

M. Ngutter a déclaré qu'il estimait que les futures priorités du CIPEA devraient se présenter comme suit :

1. Le CIPEA devrait poursuivre ses efforts et programmes actuels dans:
   - la collecte des données micro-économiques au niveau du ménage;
   - les études de marché;
   - l'inventaire des ressources, y compris le recensement du bétail;
   - la proposition de programmes d'intervention économiquement efficaces et susceptibles d'inciter la recherche traditionnelle sur les systèmes pastoraux à quitter la station de recherche pour aller sur le terrain ainsi que la production de résultats utilisables, le plus tôt possible.

2. Le CIPEA devrait modifier sa philosophie actuelle pour :
   - harmoniser ses politiques, objectifs et stratégies avec ceux des pays africains;
   - intégrer ses travaux à ceux des institutions nationales et internationales de recherche, de planification, de vulgarisation, de formation et autres;
   - élargir ses programmes en cours et ses zones d'étude.

3. Le CIPEA devrait explorer de nouvelles perspectives dans les domaines suivants:
- formulation/analyse de politiques gouvernementales, notamment lorsque les activités de recherche influent sur la politique ou vice-versa;

- questions foncières dans la RSP et notamment:
  - l'impact de l'individualisation de la propriété foncière sur le pastoralisme;
  - l'impact des cultures des zones arides sur le pastoralisme;
  - les voies et moyens à mettre en œuvre pour conserver les ressources foncières;
  - la prévision des sécheresses.

Parlant des travaux du CIPEA au Mali, le Dr Diakité a déclaré que la coopération du CIPEA avec son pays devrait à l'avenir être axée sur:

- l'assistance en matière de formation;
- l'assistance en matière de mise au point de méthodologies de vulgarisation ou de pré-vulgarisation;
- l'assistance financière par la prise en charge des coûts de bureaux, de garages, de logements etc... Le CIPEA pourrait jouer un rôle important dans les négociations en vue de l'obtention de financements. L'image du CIPEA était en général bonne. Mais il y a un proverbe peul qui dit que le "petit lèche celui qui le lèche". Pour les besoins de la cause, il fallait que les responsables du CIPEA continuent à lécher le Centre.

M. Kategile a déclaré qu'étant donné que le CIPEA n'était pas en mesure de couvrir directement tous les pays africains dans ses activités de RSP, notamment en raison des restrictions budgétaires, et que les résultats de la RSP n'étaient applicables que dans un contexte socio-économique seulement, le CIPEA devrait adopter une stratégie différente. Il estimait que le CIPEA pourrait jouer un rôle de premier plan dans la RSP en Afrique. Cela pouvait se faire grâce à la coopération avec d'autres institutions de recherche en Afrique. Le CIPEA pourrait avoir pour rôle:
1. La vulgarisation de la RSP au niveau des institutions de recherche de l'Afrique.

2. La mise au point de méthodologies de recherche dans le domaine de la RSP. Les méthodologies devraient de préférence être utilisables par les institutions africaines, et les méthodes devraient faire l'objet d'une révision permanente.

3. La centralisation de la collecte et de l'analyse des données là où cela s'avérera nécessaire, si des méthodes sont conjointement adoptées.

4. La formation par le CIPEA d'équipes homogènes de RSP susceptibles de servir de modèles.

5. La formation de chercheurs africains spécialisés dans la RSP.

6. La fourniture de services consultatifs aux équipes de RSP en Afrique, dans le cadre de visites périodiques.

7. La collecte et la diffusion de données sur la RSP en Afrique et l'intensification des échanges d'informations.

8. La fourniture de matériel génétique, notamment pour les pâturages.

9. La coopération directe avec les équipes de RSP dans les institutions africaines. M. Kategile s'est également demandé si oui ou non le CIPEA devait toucher à l'agro-foresterie et au système d'élevage intensif au lieu de se limiter aux systèmes pastoraux.

Le Dr Rhissa a déclaré qu'il était important que toute collaboration entre le CIPEA et d'autres organisations passe par les circuits administratifs appropriés. Dès la mise en place des mécanismes de coopération avec les institutions nationales, la collaboration devrait être franche et sincère. Un accord doit d'abord être conclu sur les objectifs des travaux et il devrait y avoir une exploration commune du potentiel existant en termes de documentation, de méthodes,
techniques, etc. Par la suite, le CIPEA devra régulièrement informer les institutions nationales des résultats de ses activités. Le CIPEA devra encourager la formation du personnel technique en organisant des séminaires sur des sujets pertinents. Le CIPEA devrait également tenir des réunions à la demande des gouvernements nationaux.

Le Prof. Saka Nuru a déclaré que la coopération avec les organismes nationaux de recherche et de développement était une priorité essentielle pour le CIPEA. Une telle coopération avec les universités, les administrations nationales, municipales et fédérales comportait plusieurs avantages :

- la mise en commun des connaissances techniques vers la réalisation d'un objectif commun;
- la détermination de priorités nationales conformes aux besoins nationaux;
- l'utilisation des connaissances locales pour raccourcir la phase diagnostic/description;
- des gains financiers pour les gouvernements; et
- une diffusion plus facile des résultats.

Il a préconisé l'installation des bureaux des équipes du CIPEA au sein des institutions nationales de recherche. Le Prof. Saka Nuru a déclaré qu'il pensait que les techniques du CIPEA étaient généralement bonnes. Mais il a souligné que les éleveurs locaux devraient participer plus activement à la planification et à l'exécution des travaux de recherche. Il a déclaré que l'échec de plusieurs projets nationaux et internationaux était dû à la non-participation de ces éleveurs à ces entreprises. Il estimait que le CIPEA aurait pu avoir des résultats plus probants si sa recherche avait été poursuivie au-delà de sa zone d'étude et s'il avait collaboré de manière plus suivie avec les organismes locaux de développement.
FINAL DISCUSSION ON PSR
Summary of Discussion Session 13.

Pastoral Systems Research

Chairman: Mr Stephen Sandford (ILCA)

Dr Chema suggested that in order to sell the systems approach further, ILCA might make a systems film, describing the kind of personnel involved in such work and what methodologies they follow. Sets of slides might also be helpful in supplementing specific areas of research. He also cautioned that ILCA's Programme Committee would need to consider national commitments to joint activities when considering changes in ILCA's in-country research programmes.

Dr de Haan pointed out to the meeting that there was no pastoral systems research methodology available when ILCA started its operations. He felt that ILCA was getting near to developing that capability now. He cited the examples of the joint projects under negotiation in Mali and in the Cameroons, both of which would be housed with national programmes.

Dr El Kaluba stated that in any livestock production system there were two factors, namely genetic material and the environment, that influenced the productivity and efficiency of the system. He felt that most of the presentations in the workshop had dealt extensively with environmental effects, but had paid little attention to genetic material. He felt there had been a tendency by most development agencies to overlook the importance of local livestock breeds in favour of exotic breeds, often very unsuited to African conditions. ILCA should consider the importance of the local breeds in the areas in which it is working.

Dr Zulberti noted that the comments of participants, particularly those of national representatives, indicated the broad acceptance of the concepts of pastoral systems research. As Prof. Saka Nuru had put it, this represented a major shift from the traditional approach to research. However, Dr Zulberti felt that some of the workshop presentations did not follow the lines of PSR too closely. But he said that a workshop such as this one could not have taken place 10 years ago. The systems research concept was not a crazy idea any more.
He proposed that the philosophy of systems research imposed the following conditions on those pursuing such an approach:

- a commitment to development;
- a commitment to recognise one's mistakes, from which one can learn;
- a commitment to a well-defined purpose;
- a commitment of ILCA professionals to work with local professionals and vice versa;
- a commitment to multi-disciplinarity;
- a commitment to work with pastoralists;
- a commitment to be useful to pastoralists, to generate action programmes to serve pastoralists as mentioned in de Haan's paper.

Dr Abel referred to the adverse effects on pastoralists of rural-urban and arable-pastoral terms of trade, and thus felt that if technical research was to have any relevance it must incorporate policy analysis into a systems approach. He also thought that a historical analysis of the origins of the present pastoral problems was lacking from the systems framework of the workshop. It was necessary to search for historical explanations of why, how and when people once politically and economically strong and ecologically secure had become dependant, impoverished and devastated by droughts.

Dr Grandin agreed with Mr Sandford that systems analysis was a continuing process. She felt that ILCA needed to develop a data base from their research which could be made available to other African researchers. The raw data should be made available in this way.

Dr Barry took the opportunity to thank ILCA's Director General and his colleagues for having made the participants' stay possible. The problems of livestock production formed a major part of the preoccupations of he and his colleagues from the Sahel. The desire to improve the income of pastoralists and to maintain the Sahel countries as exporters of livestock and meat had shown itself soon after
independence. This was the reason the economic community of meat and livestock was set up in 1971 as part of the development programme in the member countries concerned with this agreement. For the same reasons the member countries of CILSS had set up a unit responsible for the problems of livestock production following the great drought. In the Sahel sub-region there were several organisations such as CEBV, CILSS, CEAO and ECOWAS working in a co-ordinated way. The information provided during the workshop would certainly complement the data already possessed by the countries of the Sahel. However, the problem was to succeed in implementing concrete measures to improve the lives of the herdsmen and their communities. These measures should include all types of production system. Research should not be carried out for research's sake. There was not much time to spare - development had to be rapid. In this respect ILCA had a very important role to play.
Résumé des débats de la treizième séance sur la recherche sur les systèmes pastoraux
Président: M. Stephen Sandford (CIPEA)

Le Dr Chema a suggéré que pour mieux promouvoir l'approche par système, le CIPEA pourrait faire un film sur le système décrivant le type d'agents participant à de tels travaux et les méthodologies appliquées. Des séries de diapositives pourraient également être utilisées pour expliciter certains domaines spécifiques de recherche. Il a également souigné qu'en examinant les modifications à apporter aux programmes de recherches zonaux du CIPEA, le Comité de programme du CIPEA devrait envisager la participation du Centre à des activités nationales dans un cadre coopératif.

M. de Haan a signalé aux participants que lorsque le CIPEA démarrait ses activités, il n'y avait pas de méthodologie de recherche sur les systèmes pastoraux disponible. Il estimait que le CIPEA était sur le point d'acquérir une telle méthodologie. Il a cité l'exemple de projets en cours de négociation au Mali et au Cameroun qui auront pour siège des programmes nationaux.

Le Dr El Kaluba a déclaré que dans tout système de production animale, il y avait deux facteurs, notamment le matériel génétique et l'environnement qui influençaient la productivité et l'efficacité du système. Il pensait que la plupart des documents présentés au cours du séminaire avaient traité de manière extensive des effets de l'environnement, mais avaient négligé le matériel génétique. Il pensait que la plupart des organismes de développement avaient tendance à négliger les races locales et à privilégier les races exotiques souvent mal adaptées aux conditions de l'Afrique. Le CIPEA devait tenir compte des races locales dans les zones dans lesquelles il travaillait.

M. Zulberti a noté que les observations des participants, particulièrement celles des représentants des pays, indiquaient qu'ils acceptaient en général les concepts de la recherche sur les systèmes pastoraux. Comme l'avait souligné le Prof. Saka Nuru, cela représentait une évolution majeure par rapport à l'approche traditionnelle en matière de recherche. Toutefois, M. Zulberti estimait que certains des exposés
ne suivaient pas de très près les lignes de la RSP. Mais il a déclaré qu'un séminaire tel que celui-ci ne pouvait pas avoir lieu dix ans auparavant. Le concept de la recherche sur les systèmes n'était plus une idée absurde. Il a soutenu que la philosophie de la recherche sur les systèmes imposait les contraintes suivantes à ceux qui l'adoptaient:

- une volonté de développement;
- l'engagement de reconnaître ses erreurs, démarche qui permet d'aller de l'avant;
- l'engagement de bien définir les objectifs;
- l'engagement des scientifiques du CIPEA à travailler avec les scientifiques locaux et vice-versa;
- l'engagement à travailler dans un cadre multidisciplinaire;
- l'engagement à travailler avec les éleveurs;
- l'engagement à servir les éleveurs et à mettre au point des programmes d'action au service des éleveurs comme l'a mentionné M. de Haan dans son étude.

Le Dr Abel a fait allusion aux effets négatifs de la détérioration des termes de l'échange rural/urbain et agricole/pastoral sur l'éleveur et a estimé que pour être applicable, la recherche technique doit incorporer l'analyse des politiques dans l'approche par système. Il pensait également que dans le cadre du séminaire, on avait omis de procéder à l'analyse historique des origines des problèmes pastoraux. Il était nécessaire de rechercher les explications historiques qui permettraient de savoir pourquoi, comment et quand des peuples jadis politiquement et économiquement forts, vivant dans un cadre écologique sûr, ont été appauvris et affaiblis par la sécheresse. Mlle Grandin a reconnu avec M. Sandford que l'analyse des systèmes était un processus continu. Elle pensait que le CIPEA devait développer une base de données à partir de sa recherche, base qui pourrait être mise à la disposition des autres chercheurs africains. Les données brutes devraient être mises à la disposition des utilisateurs éventuels de cette manière.
Le Dr Barry a saisi cette occasion pour remercier le Directeur général du CIPEA et ses collègues pour avoir rendu possible le séjour des participants à Addis. Les problèmes de production animale constituaient une partie importante de ses préoccupations et de celles de ses collègues du Sahel. Le désir d'améliorer le revenu des éleveurs et de permettre aux pays du Sahel de continuer à exporter du bétail et de la viande s'est manifesté dès le lendemain des indépendances. C'était là la justification de la Communauté économique du bétail et de la viande qui a été mise sur pied en 1971 en tant que partie intégrante des programmes de développement des pays membres signataires de cet accord. Pour les mêmes raisons, les pays membres de CILSS avaient mis en place un service chargé des problèmes de production animale à la suite de la grande sécheresse. Dans la sous-région du Sahel, il y avait plusieurs organisations telles que la CEBV, le CILSS, la CEAO, et la CEDEAO qui travaillaient de concert. Les informations fournies au cours du séminaire compléteraient certainement les données déjà disponibles dans les pays du Sahel. Toutefois, le problème était de réussir à mettre en œuvre des mesures concrètes pour améliorer la qualité de la vie du pasteur et de sa collectivité. Ces mesures devraient porter sur tous les types de systèmes de production. La recherche ne devrait pas être entreprise simplement pour l'amour de la recherche. Il n'y avait pas de temps à perdre. Le développement devait être rapide. A cet égard, le CIPEA avait un rôle très important à jouer.
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