# ILCA ANNUAL REPORT 1983

*Improving livestock and crop-livestock systems in Africa*

**INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA**
P.O. Box 5689, Addis Ababa, Ethiopia

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# *The CGIAR: An international network for agricultural research in the Third World*

*The Consultative Group on International Agricultural Research (CGIAR) was founded in 1971 to finance and coordinate research on the food and agricultural problems confronting the Third World. It consists of governments, international agencies and private foundations. The chairman and secretariat are staff members of the World Bank, while technical guidance and review are provided by a Technical Advisory Committee (TAC) made up of 13 distinguished agricultural and social scientists drawn about equally from developed and developing countries.*

*The origin of the Group lies in the great success of two international research institutes that had been set up by the Ford and Rockefeller Foundations in the 1960s: the International Rice Research Institute (IRRI), established in the Philippines in 1960, and the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico, formally constituted in 1966. Their objective was to breed varieties of rice, maize and wheat that would respond to fertilizer and irrigation. Within 10 years, their breeding programmes had been extremely successful and millions of farmers throughout Latin America and Southeast Asia were adopting the advanced technology of improved varieties and fertilizer. Crop production rose dramatically and the Green Revolution was born.*

*The impact that high-level scientific research could make on food output in the developing world had been amply proven. But more research was necessary in the light of accelerated population growth. It was to promote such research that the Group was set up. Since its establishment a further 11 centres have been created.*

*The main emphasis continues to be on the improvement of food crops. The International Institute of Tropical Agriculture (IITA), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Centre for Agricultural Research in the Dry Areas (ICARDA), the International Centre for Tropical Agriculture (CIAT), the International Potato Centre (CIP) and the West African Rice Development Association (WARDA) all conduct research on the most important cereal, legume, root and tuber crops of the developing world.*

*However, the Group recognized the vital importance of animal production in the Third World, and in the mid-1970s established two centres to conduct research on livestock: the International Livestock Centre for Africa (ILCA) and the International Laboratory for Research on Animal Diseases (ILRAD).*

*In addition, the International Board for Plant Genetic Resources (IBPGR) was founded to collect and conserve germplasm that might otherwise be lost, while the International Food Policy Research Institute (IFPRI) and the International Service for National Agricultural Research (ISNAR) complete the network.*

# Foreword

*ILCA's task is twofold: to apply existing knowledge to improve livestock production in Africa, and to undertake research on major gaps in that knowledge. Achieving these objectives first involves a comprehensive study of selected production systems in the five major ecological zones of sub-Saharan Africa. This diagnostic approach enables ILCA to identify major constraints to output and potentially useful interventions, which are then the basis of detailed research.*

*It is clear that, in the absence of major animal diseases, nutritional stress is the major constraint to increased livestock production in Africa, and that the inadequate phosphorus and nitrogen status of most soils are key limitations to both agricultural output and livestock productivity.*

*Much of Africa's livestock production is associated with cropping. There is consequently a good chance of improving overall food production in Africa by exploiting legumes as a link between cropping and livestock enterprises, thereby stimulating increases in both crop and livestock output. The livestock – legume – cereal crop linkage is the basic theme of many of ILCA's interventions in Africa's major ecological zones. Examples of such interventions include rotating cereals with legume leys, growing cereals in alleys between rows of browse legumes, and intercropping cereals with forage legumes. These systems include the use of both legumes and food crop residues as feed for livestock.*

*Improvements in livestock management appear equally promising. Considerable differences in the performance of individual herds on communal grazing land are apparent, seasonal differences in young stock mortality are striking, and feed supplementation in the dry season clearly improves animal fertility. Genetic changes favouring trypanotolerant breeds in moderately infested tsetse areas and dairy crossbreds in more temperate areas have a notable impact. Draught animal performance can be improved greatly, and simple watershed management and water conservation appear practicable for many smallholders, particularly in the highlands.*

*Drought and rangeland deterioration are topics of immense importance to Africa. To provide a larger and sounder data base for understanding these phenomena more clearly ILCA, in collaboration with NASA, has extended its work on the collection and interpretation of imagery from satellites and from low-level aerial surveys, coupling this with essential ground truthing exercises that include both biological and socio-economic data collection. In this way progress is being made in assisting governments to develop appropriate information systems for areas that are geographically remote and where normal communication systems are deficient.*

*Training, documentation, information and support activities to national research groups provided further key aspects of ILCA's work in Africa in 1983.*

*What is being done by ILCA and by other international research and development agencies, important as it may be, is clearly inadequate. Africa's own food production is stagnating, while cereal and livestock imports are showing an alarming growth. Improvements in food output with lower unit production costs depend largely on the implementation of better production technology, coupled with appropriate organisational structures and food policies. Imports of agricultural products now cost Africa some US$ 16 000 million each year, and with market demand growing by 5% a year, the present expenditure on finding better technology, organisation and policies for increased food production is simply not compatible with the size of the crisis that exists.*

*Africa is a vast land area; it would absorb the land masses of Europe and North America with room to spare; it contains almost as many people and animals as Europe and North America combined; its rate of population increase is three times greater. To suggest that one modest livestock research centre would suffice for Europe and North America would be ludicrous, yet this is not far from the situation prevailing in Africa. If Africa's food crisis is to be tackled effectively, much more research is needed. Without more research, experience tells us that changes in organisation, policy and investment are not likely to suffice.*

P. J. Brumby

Peter J. Brumby
Director General

# ILCA research highlights in 1983

● ILCA's Subhumid Zone Programme in West Africa has paved the way for providing increased feed for livestock without causing grain losses. The team has grown sorghum and the forage legume *Stylosanthes guianensis* cv. Cook on alternate ridges, and by planting the sorghum in two stands per hill rather than one has maintained sorghum grain yields equivalent to those obtained from sole sorghum cropping.

The legume fodder banks developed by ILCA in the subhumid zone are now being adopted by local farmers, and the Federal Livestock Department of Nigeria's Ministry of Agriculture is seeking to extend them further. Twenty-three fodder banks of forage legumes *(Stylosanthes guianensis* and *S. hamata)* have now been established in the main study area and are under close scrutiny by the team.

The team has also found that residual nitrogen in the soil of fodder banks following forage legume cropping produces large increases in subsequent maize yields. Maize following 3 years of *S. hamata* produced 4700 kg grain/ha compared to yields of 2400 kg grain/ha when the maize was grown on land uncropped for several previous years. This shows the potential of sequential crop – forage rotations within a fodder bank.

● The Humid Zone Programme based in Ibada Nigeria, has recorded increases of up to 33% in daily dry matter intake in both sheep and goats through the addition of browse *(Leucaena* and *Gliricidia)* to their grass diet. The animal health package developed by the team is likely to give a 65% rate of return on investment. Vaccination against *peste des petits ruminants* using tissue culture rinderpest vaccine has reduced mortality in goats by 75% at two test sites.

Alley farming has been further developed in 1983. A total of 16 alley farms have now been established. At all these sites leguminous *Gliricidia* and *Leucaena* trees were established from seed. Four new *Gliricidia* accessions from a collection made in Costa Rica have produced fresh weight yields 160% higher than the local control. The Federal Livestock Department of the Nigerian Ministry of Agriculture is starting a pilot development scheme with ILCA in which a further 60 participating farmers will adopt alley farming and an animal health package.

The team also established four intensive feed gardens in 1983 in areas where alley farming is not appropriate to local conditions. Each feed garden, grown with a mixture of two browse and two grass species, should provide the major feed requirements of four to five animals. Twenty more feed gardens are shortly to be established.

● The Highlands Programme has promoted two new techniques during 1983. The single-ox plough, an adaptation of the traditional *maresha* plough for use with a single local ox, had by October 1983 been requested by more than 140 farmers in the Ethiopian highlands. Meanwhile the team is monitoring the performance of 20 farms using the single ox in each of two study areas. This new technique, requiring minimum investment, seems likely to make a major impact with smallholder farmers of the Ethiopian highlands, who are among the world's poorest people.

Another technique introduced by the Programme during 1983 is the use of an ox-drawn scoop to construct surface ponds for water storage. The scoop is a light-weight model (45 kg) suited to local animals, and is drawn by two oxen. A 7000 $m^3$ pond has been constructed at ILCA's Debre Berhan site, and similar ponds are in preparation at Debre Zeit and at ILCA headquarters. Experience so far indicates that a pond of this capacity could be constructed by a group of eight drivers and ox-pairs in just over a month. The water stored in such a pond would support about six households through the dry season, could be stocked with fish to provide an additional protein source and could even be used for small-scale irrigation of food crops during the dry season. Ethiopian government officials and 75 local farmers watched the pond being constructed during a field day at Debre Berhan. Subsequent interest in the introduction of this low-cost technology has been high.

● The Forage Legume Agronomy Group has found dramatic responses to P among native Ethiopian clovers on P-deficient soils. Application of 20 kg P/ha increased yields of *Trifolium tembense* and *T. rueppellianum* by 250%

in 1982 and 562% in 1983 over zero P application. In further trials by ILCA's Highlands Programme 29 kg P/ha gave almost sixfold increases in dry matter production over the non-fertilized control for *T. steudneri* as well as *T. tembense* and *T. rueppellianum*. These findings have important implications for forage cropping in the African highlands.

● The new Livestock Policy Unit began operations in 1983. Two major studies initiated during the year focused on the financing of livestock services in Africa, and the reasons for the varying performance of livestock sectors in different countries.

The first study has shown that governments spend on livestock sectors only a small proportion of the revenue they raise from the same sectors through taxation and fees. An excessive and increasing proportion of the expenditure on livestock services goes to staff costs, and too little money is then available for vaccines, drugs and transport. The study also revealed that the numbers of middle level staff are being increased too fast in relation to the numbers of more junior staff who are active at the field level.

The second study revealed positive correlations between the following:

- growth in livestock population and growth in livestock production;
- growth in cereal production and growth in livestock production; and
- growth in GNP and growth in milk production.

● The Ethiopian Rangelands Programme has improved the efficiency of two test wells in the southern rangelands by around 25% by simply sealing the holding pond, thereby preventing water leaks. The team has shown that surface ponds can be desilted using the ox-drawn scoops introduced by the Highlands Programme. A single scoop can move 9 to 12 $m^3$ of silt daily, and the annual silting up of ponds can thus be prevented by regular maintenance.

● The Kenyan Rangelands Programme has completed its study of the changes taking place in livestock production on Maasai group ranches. In the course of the work the team has developed new methods for evaluating rangelands and pastoral production. Highlights of these new research techniques include the remote sensing of rangeland trends, and the rapid low-cost appraisal of labour allocation and household income and expenditure.

● ILCA's Aerial Survey and Cartography Unit has developed a new technique for surveying cropping activities. Neither traditional aerial photography nor satellite imagery is suited to surveys of cropping practices, mainly because of problems of cloud cover during the growing season. The new technique uses low-altitude aerial surveys and a combination of wide-angle and telephoto photography giving enhanced resolution and good identification of individual crop species.

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# *ILCA's components*

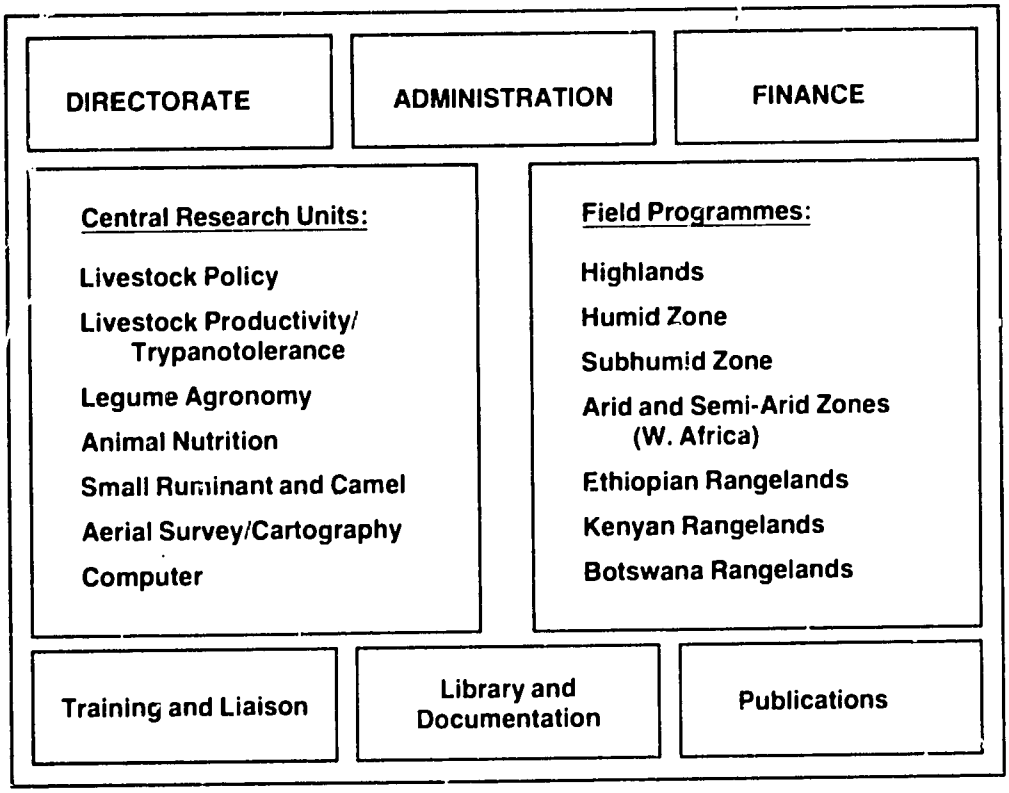
*The components of ILCA have changed substantially over the past 2 years with the strengthening of the research capability at headquarters. The different components are outlined below.*

*The central research units, the Directorate, Administration, the Finance and Information departments and the Liaison and Training Section are located in Addis Ababa. Two of the field programmes are also located in Ethiopia, namely the Highlands Programme and the Ethiopian Rangelands Programme.*

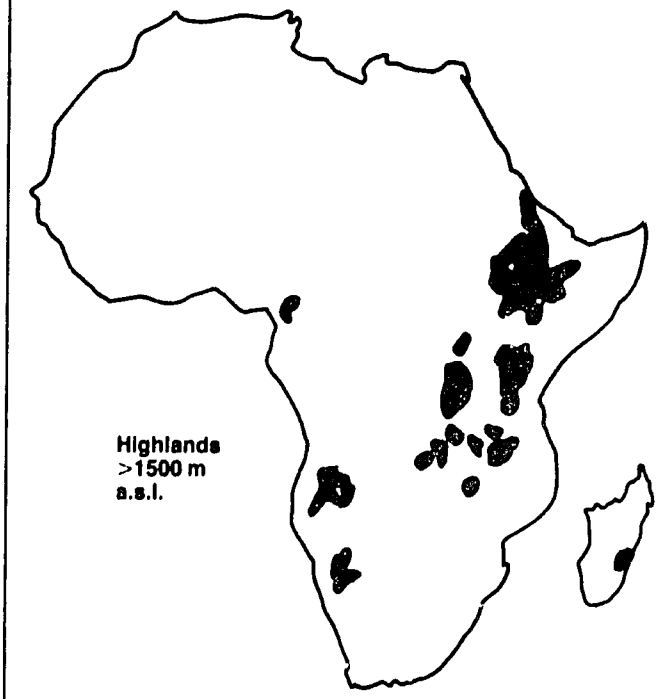
*The structure of ILCA reflects the complementarity between the work of the field programmes and that of the research units at headquarters. The central research units interact with the field programmes in a number of ways. They perform a service function (Computer, Aerial Survey/Cartography, Laboratory), they conduct research common to more than one field programme (Livestock Productivity, Forage Legume Agronomy, Small Ruminant and Camel) and help provide a regional context for the research of the whole Centre (Livestock Policy).*

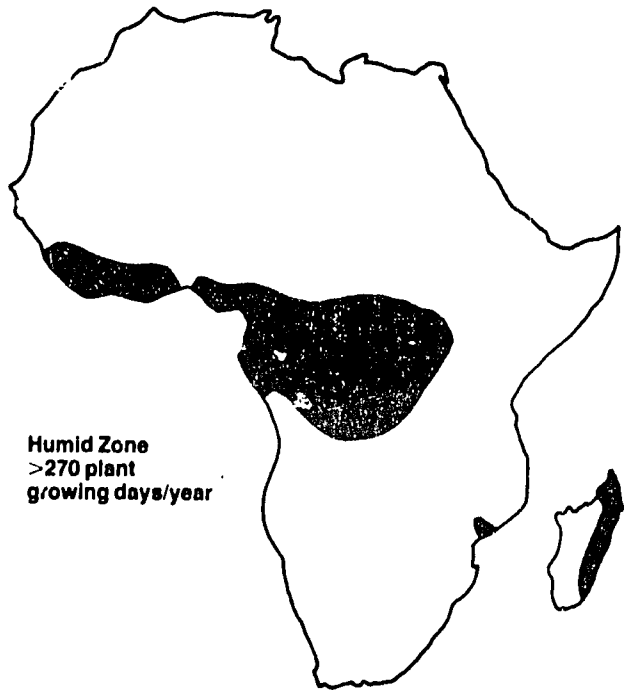
*The field programmes are located in the major agroclimatic zones of sub-Saharan Africa. Three are in West Africa – the Arid and Semi-arid Zones Programme in Mali and the Humid and Subhumid Zones Programmes in Nigeria. The Ethiopian, Kenyan and Botswana Rangelands Programmes study and aim to improve livestock production by pastoralists in East and southern Africa. The work of the Highlands Programme is carried out in the Ethiopian highlands.*

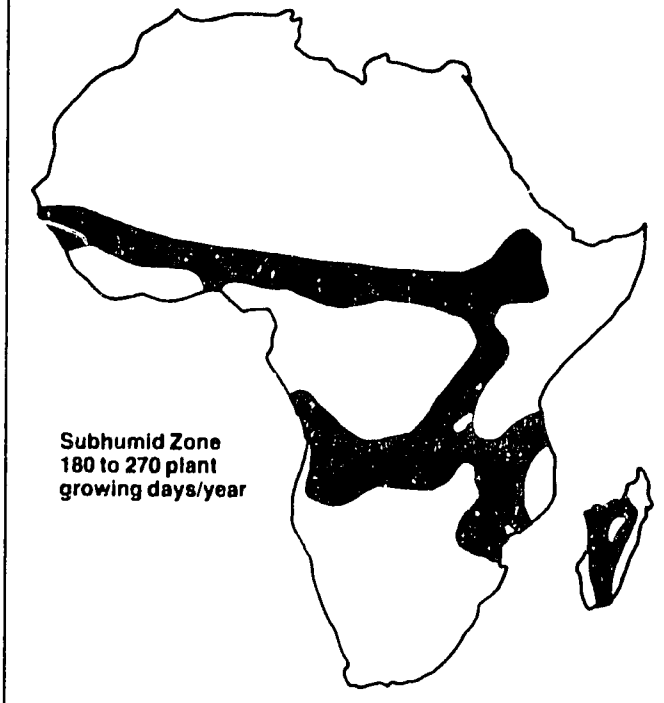
*The organisation of ILCA's research groups reflects the Centre's commitment to systems research. Base studies of the different livestock systems of sub-Saharan Africa have been carried out primarily by the field programmes, while the recent shift of emphasis in strengthening the research capability at headquarters is a result of ILCA's increased concentration on component research and the design and adaptation of new technology. The testing of improvements to different systems is carried out by the field programmes, which are also responsible for the application of these improvements. Any feedback from producers is recorded so that designs of interventions can be modified accordingly and future research be made appropriate and effective.*

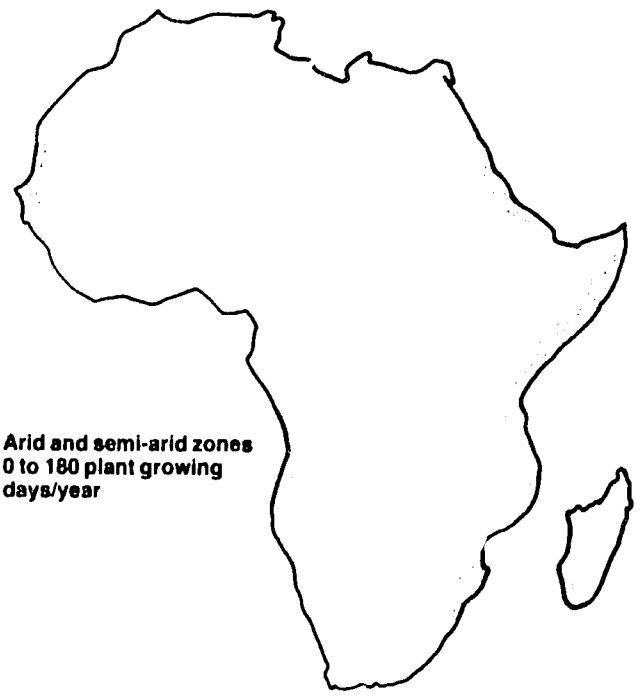


# Environmental zones of sub-Saharan Africa



# Field programmes

# The Highlands Programme

## Introduction

The work of ILCA's Highlands Programme is aimed at improving livestock and food production in the highland areas of Africa lying above 1500 m a.s.l. Although these highland areas cover only 4% of the continent's surface area, they constitute a particularly important zone for livestock production. Around 20% of Africa's cattle and sheep and 10% of its goats are found in the highlands, where smallholder farming systems predominate.

Until 1983 the Programme's research was concentrated at ILCA's headquarters (2380 m a.s.l.) and at two research stations in the Ethiopian highlands: Debre Berhan (2850 m a.s.l.) and Debre Zeit (1800 m a.s.l.). These stations are 110 and 45 km respectively from Addis Ababa. The Programme now conducts additional forage and soils trials on a vertisol at Mulo Farm (2400 m a.s.l.), 70 km north of Addis Ababa. The locations of these four sites are given in Figure 1.

The principal thrust of the Highlands Programme is to develop and test ways of increasing the contribution of livestock to farm production for resource-poor African smallholders. Opportunities exist in most areas to make more efficient use of harvest residues in livestock production, and of manure and draught power in crop production. In addition to finding ways of exploiting these links between crop and livestock enterprises, the Programme is exploring the many possibilities for increasing the production of traditional livestock products such as meat and milk. Increased production and sales of meat and milk can provide the working capital needed to purchase modern inputs to boost crop yields in a continent where increased grain production is an absolute necessity.

While the research is being undertaken first in the traditional dryland farming systems of the Ethiopian highlands, the research approach and the results achieved will have ready application to many other production systems in the continent where smallholder farmers grow crops and keep livestock.

The Programme continued to emphasise the farming systems approach to research during 1983. Studies of traditional farming systems have been complemented by on-station and on-farm trials on various topics. The on-farm testing of improved technology is an essential part of the Programme's research approach. This testing provides in-depth information on adoption problems at the farm level and on the social and economic impact of innovations, and thus gives feedback for further component research. During the year some 300 farmers were involved in the Programme's research, either as sources of data for the studies in the traditional system or as cooperators for testing a range of innovations.

## Diagnostic studies

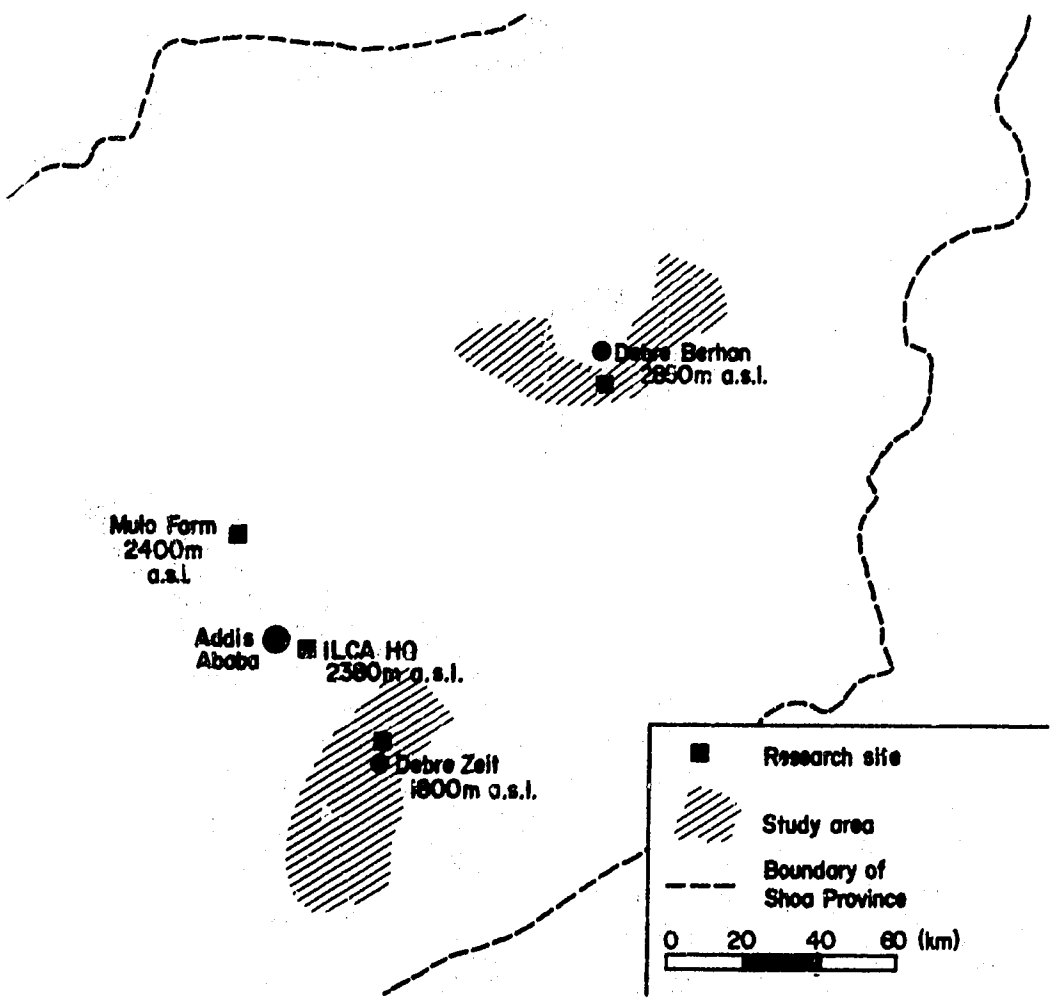
Inadequate total feed supply for the existing livestock populations, marked seasonality of feed supply and low feed quality are major constraints to increasing animal productivity throughout the African highlands, and especially in Ethiopia. In Ethiopia, native pasture on non-arable uplands, volunteer pastures on crop fallows and crop stovers account for virtually all animal feed resources. The supply of commercial feed concentrates is very limited.

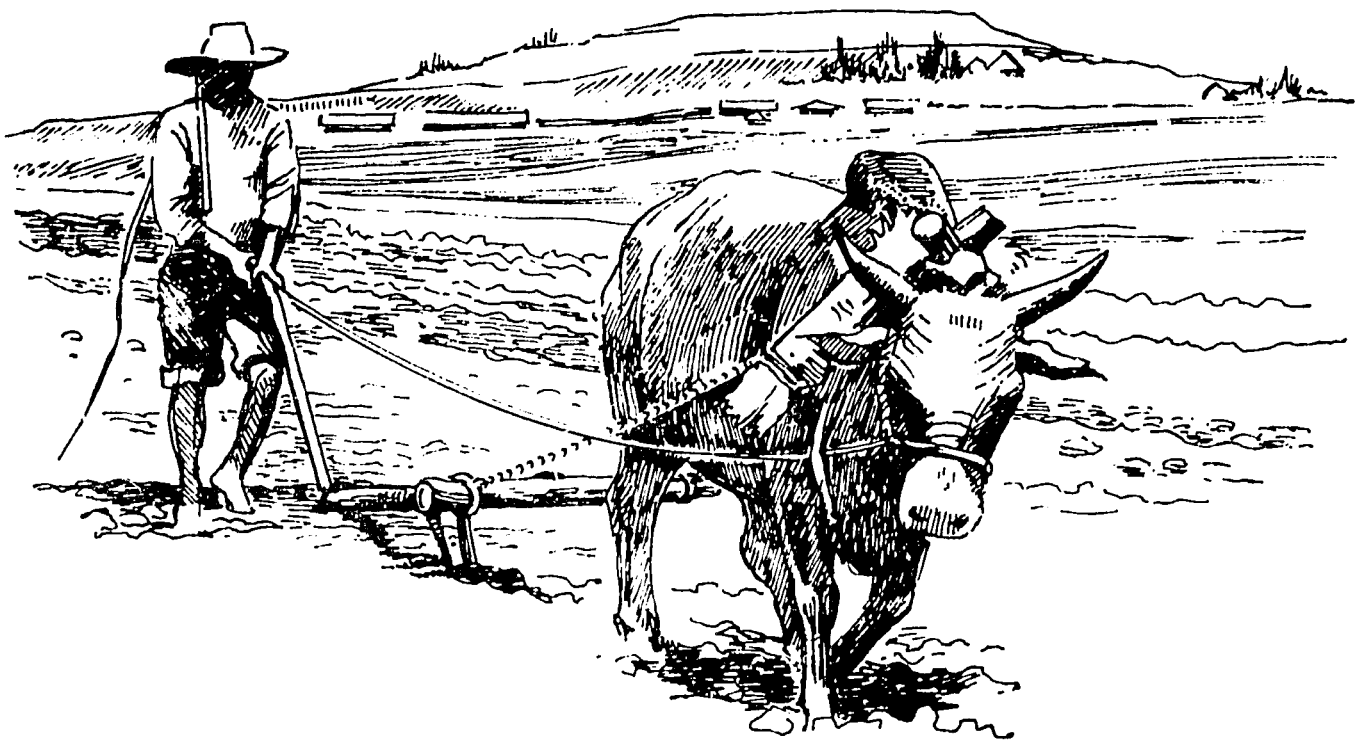
Because of population growth and pressure on land, the average length of the fallow

phase in the crop – fallow cycle is decreasing in many African countries. As a result average crop yields will decline unless low-cost means are available for farmers to maintain, or even increase, soil fertility. The Debre Berhan area was selected by the Programme for its studies of methods for improving the productivity of fallow land. Soils cropped in this area are comparatively infertile, with available P levels of 1 to 3 ppm, less than 2% organic matter and a pH of 4 to 5. They are usually cropped for 2 to 3 years and then fallowed for up to 15 years. Yields of less than 1 t DM/ha have been recorded on fallows ranging from 2 to 11 years. The legume content was consistently lower on older fallows, accounting for 14% of DM in fallows of less than 5 years and 7% in older fallows. These fallows compare unfavourably with nearby seasonally waterlogged bottomlands, where pastures yield 5 to 7 t DM/ha. ILCA's team is examining the opportunities for strategic use of fertilizers to allow more intensive cropping of the arable lands. The key to this is expected to be the contribution of the legume in the fallow or ley phase; and indigenous legumes are highly responsive to phosphate fertilizers.

An important aspect of the work is the continuous monitoring of the target farming systems in order to obtain basic agricultural data and to identify possible constraints and development opportunities. During 1983, 42 farmers participated in monitoring surveys around Debre Berhan and 20 around Debre Zeit. Data were collected on farm inputs and outputs, household economics, farm inventories and market prices. This information revealed traditional production levels against which the effect of new technology under test by ILCA could be evaluated. This survey information has been complemented by a study of changes in livestock ownership by smallholders around Debre Berhan.

**Figure 1. Location of the research sites and study areas of ILCA's Highlands Programme in Ethiopia.**





A field study on the nutrition of draught animals over two full cropping seasons in the Debre Berhan area was completed in late 1983. Detailed information was collected on the use of draught animals and on their contribution to agricultural production in the subsistence farming system. This study should help identify interventions likely to improve the efficiency of use of draught animals.

Difficulties in marketing liquid milk have been confirmed as a major impediment to smallholder dairy development. The team is therefore studying ways of processing milk at the farm level in order to produce storable, transportable and marketable dairy products. The facilities for this dairy technology research were prepared in 1983, and a small dairy was constructed at the Debre Berhan station. During the year the number of farmers around the station with a crossbred dairy animal increased to 40, and these farmers will be the initial target group for the products and processing methods developed by ILCA.

The productivity of improved smallholder dairy enterprises depends also on whether these enterprises fulfil household objectives, and on who in the household takes decisions relating to the inputs and outputs of such enterprises. This complex of factors was closely examined in a series of intra-household studies during 1983.

Farmers generally were pleased with the dairy enterprise, although they found it difficult to obtain annual yields above 1800 litres/cow, due especially to the shortage of high-quality feeds during the long dry season. Women were observed to be more influential than men in decision-making for the dairy enterprise.

## Designing and testing improvements

*Pond construction*

Water supplies for both livestock and the household are often considered to be major problems only in the arid and semi-arid pastoral areas of Africa. However, water is also in short supply for smallholder farmers in many other areas of the continent which experience long dry seasons. Development of surface water supplies in small dams or ponds is usually a capital- or labour-intensive activity.

The soils and topography of much of the Ethiopian highlands are suited to small-scale dam and pond construction. Farmers in these highland areas own some 6 million working oxen which are used on average for only 60 working days each year for land cultivation and threshing. The combination of a rural water shortage, sites suitable for pond construction and a readily available source

of draught power was considered to be ideal for the development of water supplies for smallholders, based on the use of draught animals as a source of power for pond excavation.

During 1983 a 7000 $m^3$ pond was excavated at the Debre Berhan research station to determine the technical performance of simple metal scoops drawn by indigenous oxen. The scoops have a nominal capacity of 0.15 $m^3$, a size matched to the draught power available from paired working oxen of 300 kg LW each. The excavation was also intended as a demonstration site to encourage similar work by farmers on their own land. An analysis of the work showed that ponds of a similar size should be within the capacity of local farmers. The oxen working on ILCA's site excavated approximately 1 $m^3$ earth/pair/day. At this rate of work, the oxen owned by a group of 50 farm families should be able to excavate a 6000 $m^3$ pond during a single dry season. Farmers have now confirmed their interest in this technique by undertaking to cooperate with government agencies and ILCA in a pilot programme of pond construction in the Debre Berhan area in 1984. Shell (Ethiopia) Ltd is providing a capital grant to purchase the equipment needed for the pilot programme. This technique is likely to have wide applicability in Ethiopia and in many other areas of Africa.

*Dairy development*

During 1983 the operations of 40 smallholder dairy farmers in both the Debre Berhan and Debre Zeit areas were studied. Milk yields averaged around 1800 litres/cow/year at Debre Zeit and 1600 litres/cow/year at Debre Berhan, levels which compare favourably with yields of similar *Bos taurus* x *Bos indicus* crosses elsewhere in Africa. Furthermore, these yields were obtained with little use of purchased concentrates. At these yield levels the smallholder dairy enterprise is profitable.

During 1983 ILCA made preliminary tests at Debre Zeit on the use of cows as draught animals. As reported below, this option is being evaluated in a formal trial at the Debre Berhan station. As a consequence of ILCA's work at Debre Zeit, five smallholders owning crossbred cows have, on their own initiative, begun to use their Friesian x Boran cows as draught animals. They have sold their oxen and thereby have more feedstuffs available per cow than farmers keeping both oxen and crossbred cows. This development is being closely monitored.

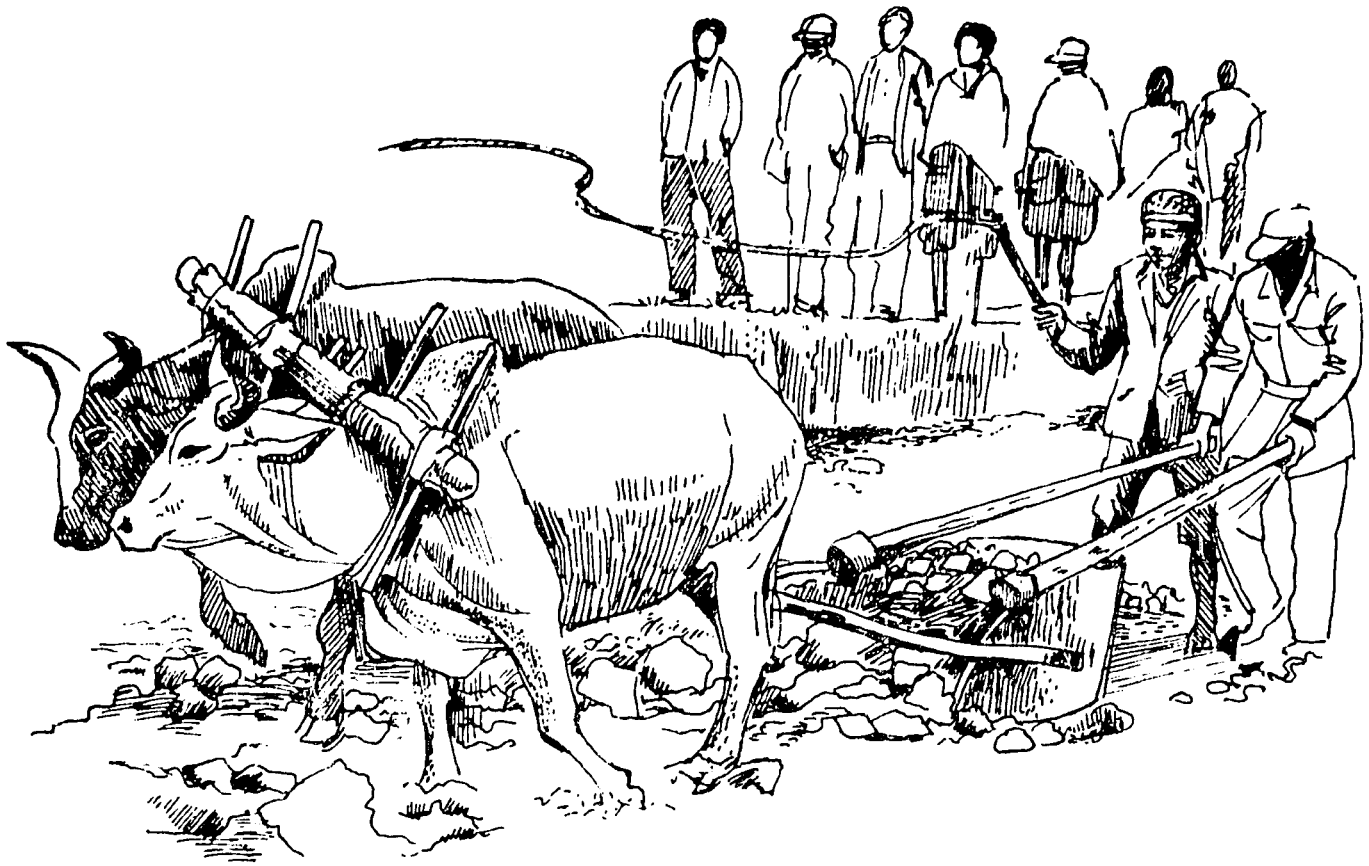
*Biogas digesters*

Most of the household energy in the Ethiopian highlands is provided by burning cattle dung. This leads to substantial nutrient losses from the land each year, especially of N. This problem is being tackled through comparative studies of various types of biogas digesters, including the so-called Indian and Chinese types. A new type of digester which originated in Asia is also being evaluated. It consists of an inflatable vinyl container which can be easily fabricated in developing countries. The low capital cost of this new type makes it potentially more attractive for tropical climates than either the Indian or Chinese types. Two farm families at Debre Zeit are now sharing a methane digester producing around 2 $m^3$ of gas a day and sufficient residue to topdress around 1 ha of farm land each year.

*Forage and pasture experiments*

Experiments on soil fertility and plant nutrition and on forage agronomy were conducted at the four research sites in the Ethiopian highlands during 1983. In this way warm, intermediate and cool highland ecosystems and the major soil types of the highlands were included. Low soil fertility has already been cited as a major constraint to forage and crop growth. An important research effort is thus the quantification of the N contribution by legumes to the growth of subsequent cereal crops. Experiments were initiated on two soil types, an alfisol at Debre Zeit and a vertisol at Mulo, on which vetch, lentils, peas and horse beans *(Vicia faba)* were grown. Intercropping of legumes and cereals is an alternative way of improving soil fertility and the quality and quantity of crop residues. Experiments at both Debre Zeit and Mulo using horse beans in pure stands and in various mixtures were undertaken to evaluate this alternative.

Fallowing of cropped fields for up to 15 years is a common practice in the Debre Berhan area. At the end of the fallow phase soil is raked into heaps, mixed with sod and



manure, and burned to mineralise plant nutrients (mainly P). Nitrogen losses resulting from soil burning are high. The volunteer fallow vegetation, although low in productivity especially in the first years after the crop phase, responded dramatically to N and P fertilization in ILCA's trials. Increases in DM yields of up to 450% were observed.

Phosphorus is deficient in most arable soils of Ethiopia. Table 1 shows how phosphate application increased DM yields of three native clovers up to sixfold on a typical arable, non-flooded vertisol. Root and nodule weights increased by 400%. However, P deficiency appears to be less marked on flat, frequently flooded vertisols where the bulk of the native pasture grows.

**Table 1. The effect of P and N application on the growth of three African clovers[a] 12 weeks after planting on a vertisol at Addis Ababa, 1983.**

| Fertilizer | | | Plant weight | Root weight | Nodule weight | No.of nodules/plant | No. of leaves/plant | %P in aerial parts[b] | No. of inflorescences/ plant[c] |
|---|---|---|---|---|---|---|---|---|---|
| | P (kg/ha) | N (kg/ha) | (g) | (g) | (mg) | | | | |
| | 0 | 0 | 1.43 | 0.34 | 31 | 12.24 | 11.21 | 0.20 | 7.37 |
| DAP[d] | 10 | 9 | 4.32 | 0.61 | 77 | 18.81 | 15.93 | 0.26 | 10.19 |
| | 30 | 27 | 8.05 | 0.90 | 108 | 27.44 | 15.33 | 0.39 | 13.10 |
| TDP[e] | 10 | 0 | 3.85 | 0.56 | 69 | 20.36 | 15.34 | 0.29 | 9.76 |
| | 30 | 0 | 8.28 | 0.93 | 124 | 29.19 | 18.74 | 0.34 | 16.29 |
| | LSD (0.05) | | 2.34 | 0.41 | 31 | 6.71 | 5.66 | 0.04 | 2.15 |

[a] Each figure in the table is an average value from measurements on *Trifolium tembense*, *T. rueppellianum* and *T. steudneri*.
[b] 6 weeks after planting.
[c] At harvest.
[d] DAP = diammonium phosphate.
[e] TSP = triple superphosphate.

Pasture legume oversowing increased both the legume proportion in the sward and the DM yield, provided the soil was not excessively waterlogged. Only the native legumes *(Trifolium tembense, T. rueppellianum* and *T. steudneri)* established themselves successfully after oversowing. Soil ripping improved the establishment of the oversown legumes, and increased DM production by 69 to 90% over the control at Debre Berhan. This may have been due to mineralisation of N, P and S from organic matter and to the better aeration of ripped soil.

The native pasture species, which are predominantly annuals, tend to dry off after the rains with the first frost at the higher altitudes. Rooted tillers of cold- and drought-tolerant perennial grasses *(Phalaris arundinacea, Festuca arundinacea* and *Echinochloa* spp.) were interplanted into the native pasture with the objective of extending pasture growth into the dry and cold period of the year. Two years appear to be required for successful establishment of sown permanent pastures in the cooler highland ecosystem at Debre Berhan. Promising perennial grass species are available for the Debre Berhan area, including the genera *Dactylis, Festula, Phalaris* and *Lolium* spp. However, no suitable perennial legume has so far been identified for this location, and it may be necessary to use free-seeding native annual legumes in improved permanent pastures. Examples of such species are *Trifolium cytopodium, T. schimperi, T. tembense* and *T. rueppellianum.* However, no cultivated permanent pasture has so far outyielded the native bottomland pasture.

The success of the above strategies in improving the quality and quantity of annual and perennial pastures in Ethiopian and similar environments will depend directly upon low-cost production of domestic seed. For this reason, various cultural practices were investigated in 1983 in relation to their effect on seed set and seed yield of *Vicia villosa* and *V. dasycarpa.* A simple wooden support of crossed sticks increased vetch seed yield by 37% over a control yield of 640 kg/ha without supports.

### *Animal traction*

Research on various aspects of draught animal use continued in 1983. On-station tests with zebu oxen worked as singles drawing a modification of the local Ethiopian plough, the *maresha,* were completed during the year. The favourable results of this work led to on-farm trials with local farmers in both the Debre Zeit and Debre Berhan areas. Some 30 traditional farmers used the technique during the main 1983 crop season. Crop yields of plots cultivated with a single ox were no less than yields on plots cultivated in the traditional manner.

This modification to the plough is particularly relevant to those farmers cultivating areas of up to 1.5 ha. These farmers are unlikely to be able to provide the feed required for a pair of oxen. Many millions of other African smallholder farmers are confronted with this problem of needing oxen to cultivate their fields but being unable to feed them adequately. The low-power single-ox option being investigated by ILCA is potentially applicable in many of these situations. Engineering aspects of the draught animal work in the Programme were contributed by staff from the National Institute of Agricultural Engineering, UK.

Ethiopia has some 10 million ha of vertisols, which tend to be substantially more fertile than lands now being cropped. However, water management is necessary to allow cropping on these vertisols. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed and tested a broadbed and furrow system to allow such soils to be cropped. The potential importance of these soils to grain production in Ethiopia led the Programme to undertake a preliminary trial with the ICRISAT method in Ethiopia. The work was done at ILCA headquarters and confirmed that water management is advantageous for crops such as wheat, oats and horse beans. Yield increases of up to 45% for these crops over the control plots using traditional land preparation methods were recorded. For example, an average wheat yield of 1474 kg/ha was recorded on the broadbed and furrow, compared with a yield of 1130 kg/ha using traditional methods of cultivation. This work on the application of the ICRISAT methods to the Ethiopian situation will be expanded in 1984.

During 1983 ILCA published a major bibliography on animal traction research prepared jointly by ILCA's Documentation Section and a PhD student working with the Highlands Programme.

### *Crossbreed productivity*

During 1983 an analysis was carried out on data collected for a study by the Arsi Rural Development Unit (ARDU) on the comparative productivity of local and crossbred cows. The results were published as *ILCA Research Report* 11. This exercise was undertaken as part of ILCA's work in supporting the analysis of production data acquired by national agencies. The results highlight the value of using productivity indices combining a number of production traits when making comparisons of interbreed productivity. The analysis showed the clear superiority of a range of crossbreds over indigenous *Bos indicus* breeds, the similarity in productivity of 50% and 75% *Bos taurus* crosses, the minimal productivity differences between Friesian and Jersey crosses with local breeds, and the clear advantage of wet-season calving over alternative breeding schemes.

## *ILCA's single-ox plough*

*Some 70% of the human population of Ethiopia (total 32 million) live in the highlands above 1500 m altitude. Ethiopia has the largest livestock population in sub-Saharan Africa, with the majority of cattle, sheep and equines being found in the highland areas. The highlands are generally temperate and suitable for both crop and livestock production.*

*Cattle are kept mainly as a source of draught power and manure. Milk, meat and hides are subsidiary products. Livestock are owned by individuals and are an important form of investment and financial security.*

*Surveys carried out by ILCA's Highlands Programme show that animal power used for crop-related work averages more than 1000 hr/farm/year. Most of this power is supplied by oxen. The land is tilled with the traditional cultivation tool known as the maresha, drawn by a pair of oxen of the indigenous Zebu breed. The land is often cultivated up to six times before planting.*

*According to Ethiopia's Ministry of Agriculture, about 29% of Ethiopian farmers have no oxen, while 34% have only one, 29% have two and 8% three or more. Farmers owning either one ox or none have to hire or borrow oxen for field cultivation. Some of them have to hire handlers as well. As a result, cultivation often cannot be done at the optimum time, and crop production suffers.*

*However, ILCA has found that a farmer does not need to have two oxen for cultivation. By developing a suitable yoke and harness and by modifying the local wooden maresha plough ILCA's team has shown that cultivation can be done using a single ox. The work output of oxen used singly was found to be 40% higher than that using the double-ox plough.*

*Field days were organised for farmers from the areas around the Highlands Programme's two research stations at Debre Berhan and Debre Zeit. These were attended by 80 farmers as well as local government officials and extension workers. Many farmers tried ploughing with the single ox themselves, and subsequently were invited to use the technology on their own farms, at their own risk and expense. ILCA sold some of the modified implements for US$ 5 each. Twenty-two farmers tested the single-ox maresha on their own farms in this way.*

*Test farmers were then visited twice weekly and the status of their farms and the success of the new technology was recorded. By July 1983 ILCA's team were monitoring 40 test farmers and by October 1983 more than 150 farmers had approached ILCA for assistance in ploughing with single oxen.*

*Widespread use of the single-ox plough could dramatically reduce the number of oxen needed to support crop production, thereby increasing the feed resources available for each working animal. Grazing pressures could be reduced and the nutritional status of the remaining oxen should improve. The single-ox technique does not put subsistence crops at risk and it requires only minimum investment. The new yoke and harness can be made cheaply from local materials, while the modification to the maresha can be carried out by the village blacksmith.*

*The single-ox technique has far-reaching implications for the smallholder farmers of the African highlands, many of whom are among the world's poorest people.*

# The Humid Zone Programme

## Introduction

The humid zone of West Africa covers around 2 million km$^2$. The high rainfall (more than 1500 mm/year) and the high mean temperatures (27–30°C) result in a relative humidity of 80–90%.

The entire zone is infested with tsetse fly, and livestock survival and production is limited by the blood parasite *Trypanosoma*, spread by the bite of the tsetse fly. Cattle production is of minor importance compared to sheep and goat production because of the greater susceptibility to trypanosomiasis of most cattle breeds. Even so, when ILCA established its Humid Zone Programme to focus on the improvement of small ruminant production, little information was available on the productivity of sheep and goats in the local farming systems.

ILCA's team is based at Ibadan in southwest Nigeria. Offices, laboratory and computer facilities are located at the International Institute of Tropical Agriculture (IITA), where the team also has a 16-ha experimental plot. Field work in southwest Nigeria during 1983 centred on villages in the Badeku and Fashola areas, and in the southeast on the villages of Mgbawku and Okwe (Figure 2).

During 1983 the Programme continued its study of the components of the major sheep and goat production systems in the humid zone of West Africa. Appropriate technical interventions to improve the productivity of these systems were tested. The team now has 12-month records of the performance and productivity of free-roaming animals in southwest Nigeria and of confined animals in the southeast. Major health screening programmes in both areas are providing a better understanding of the prevalent diseases, and will provide base data for future veterinary research.

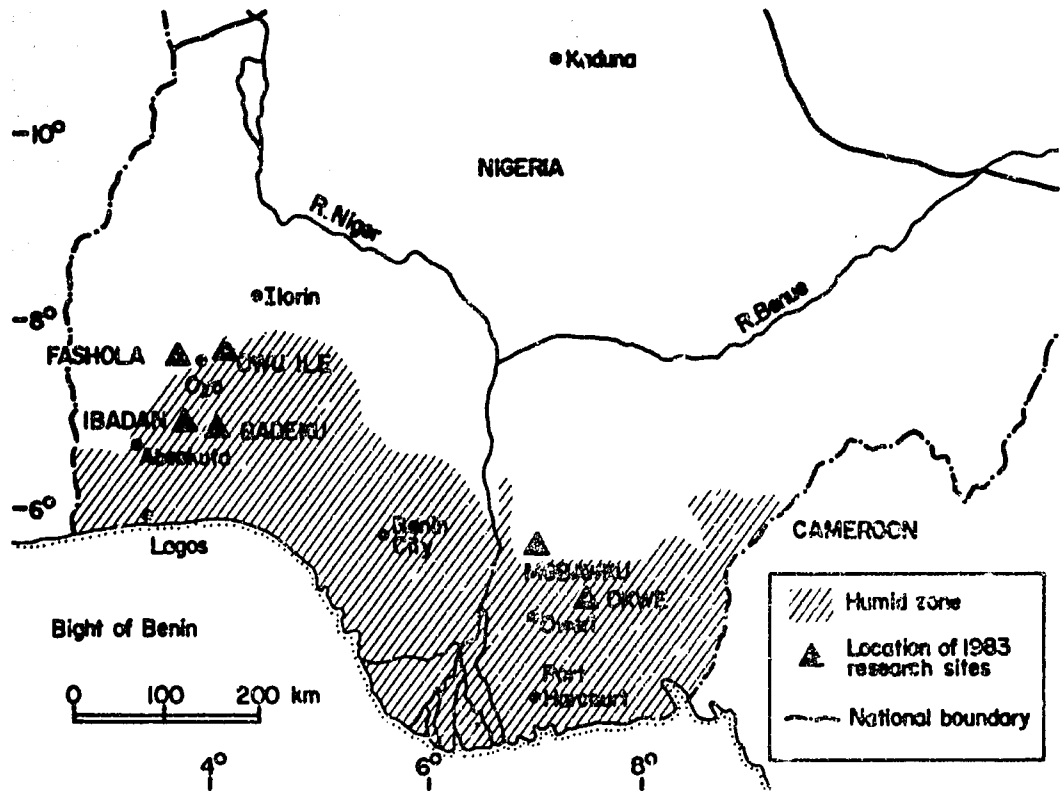
Leguminous browse dominated the feed and nutrition work during 1983. Continued progress with the establishment of *Gliricidia sepium* from seed facilitated the planting of an additional 12 mixed-browse alley plots on farms in the southwest. Four prototype 'intensive feed gardens' containing highly productive grass and browse species were established in the southeast as a first step towards providing forage for the cut-and-carry feeding of confined animals.

An alley farming model for smallholders which will form the basis of a pilot development programme was developed jointly with the Livestock Project Unit of the Nigerian Federal Livestock Department. ILCA will play a major role in coordinating the technical aspects of the programme and monitoring the biological and economic impact of alley farming and of the control of *peste des petits ruminants* (PPR). Similar models using intensive gardens are planned for the confinement systems in the southeast.

The Fashola substation was closed in May 1983 and breeding flocks were transferred to the IITA campus in Ibadan. This move facilitated better control of experimental animals and a tighter integration of the agronomy and nutrition work. The team's presence in the Badeku villages ended in November 1983 with the completion of the Badeku/Ikire animal health study. The Programme's strong commitment to village-based research continues, however, with an expanded presence in southeast Nigeria, a central role in the new programme of the Livestock Project Unit in Nigeria, and a new cooperative training and research programme in the Republic of Benin.

The Programme continued to receive financial support from the International

**Figure 2. The research sites of ILCA's Humid Zone Programme in southern Nigeria, 1983.**




Development Research Centre (IDRC), Ottawa, for its work on alley farming, from the Ford Foundation for consultant economists and for research on the role of women, and from the Federal Government of Nigeria for the research in southeast Nigeria.

## Diagnostic studies

### *Trypanotolerance*

In conjunction with ILCA's Livestock Productivity and Trypanotolerance Group new work on trypanosomiasis was initiated in 1983. The objectives of this research are to determine the incidence of trypanosomiasis in indigenous 'trypanotolerant' dwarf sheep and goats and to measure its effect on their productivity. This research will contribute to an understanding of the genetic and physiological basis of trypanotolerance. An important aspect of this work involves tsetse fly trapping to relate the incidence of the disease to tsetse challenge.

Between May 1982 and September 1983 an average of 3.5% of the animals sampled in the Fashola area were diagnosed as positive for trypanosomes. While the incidence of trypanosomiasis appeared to be fairly constant over this period, the fly trap data indicated that tsetse challenge was distinctly seasonal.

### *Disease screening*

Until 1983 the Programme's veterinary work focused largely on PPR and ectoparasites. Results from three major disease surveys within two management systems are now available. One objective of this work was to clarify the overall disease picture and indicate what further veterinary research might be justified. Another objective was to elucidate the complex interactions between animal health, management and productivity.

A random sample of animals included in production monitoring exercises was subjected to monthly clinical examination at two sites in southwest Nigeria (free-roaming animals) and quarterly at two sites in southeast Nigeria (tethered/confined animals). Preliminary results suggest that apart from PPR there are no major diseases occurring on a scale large enough to seriously constrain animal productivity at these sites.

*Management and animal productivity studies*

During the initial work of the Humid Zone Programme emphasis was placed on comparing animal health and productivity in 'forest' and 'derived savanna' areas of the humid zone. Because much of the humid zone is transitional between forest and savanna, and little difference between the two has been recorded, ILCA's team is now documenting animal productivity under the various management systems found in the zone regardless of ecosystem.

One of the basic features of management is the extent of restriction on animal movement, which affects the ability of animals to make full use of available forage at all times of the year. In August 1982 health and productivity monitoring was started in southeast Nigeria, where animal movement is restricted by tethering and/or total confinement, a system which has arisen in response to increased human population density and intensification of land use. Southeast Nigeria provides a valuable location for studying the potentials and limitations of this type of smallstock husbandry.

Household flocks at the southeastern sites are approximately half the size of those in the southwest, with an average of 3 to 4 adults compared to 6 to 7. The animals in the southeast are also 20% lighter than those in the southwest, with does of 17 months and above weighing on average 15 kg at Mgbakwu and Okwe and 20 kg at Ikire and Fashola.

Mortality of confined animals in the southeast (4% per month) is twice as high as that of free-roaming animals in the southwest. While PPR is the suspected cause, the epidemic nature of the disease and infrequent screening has made detection difficult. In January 1984 animals in half of the households at Mgbakwu will be vaccinated with tissue culture rinderpest vaccine (TCRV).

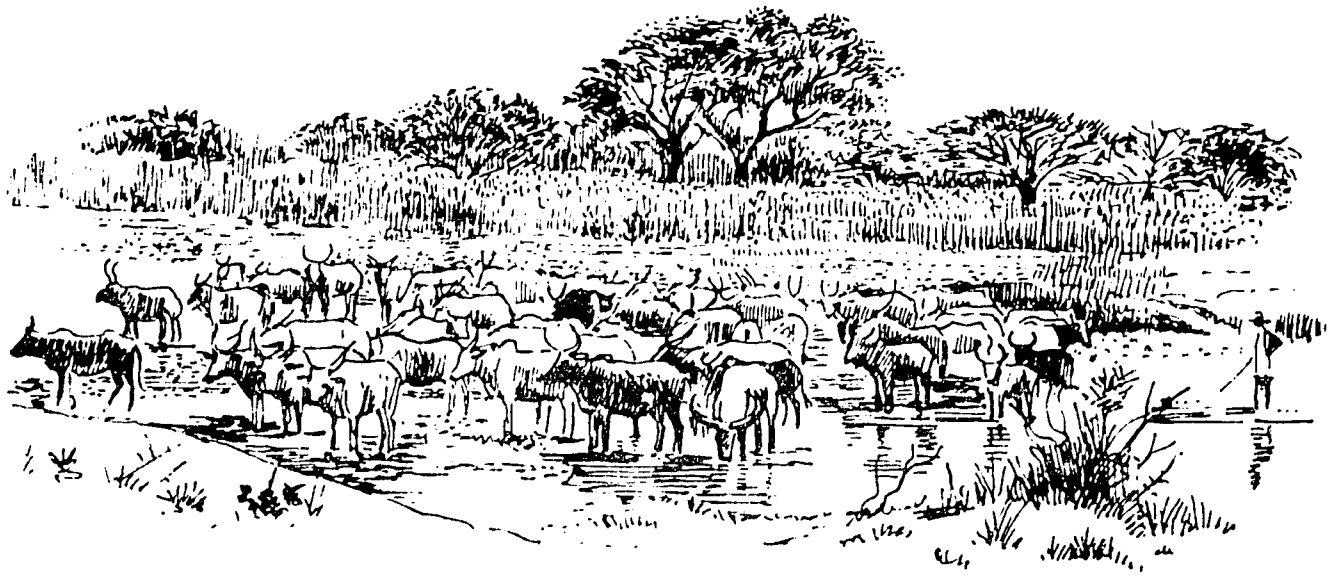
It is important to note that restriction of smallstock movement is a relatively recent development. The extremely high mortality shown in the survey suggests that a generally stable and profitable management strategy has not yet been developed.

## Designing and testing improvements

*Browse as fodder*

The leguminous browse species *Leucaena leucocephala* and *Gliricidia sepium* are believed to hold great promise for improved feed production in the zone. Significant progress has been made on the alley farming approach pioneered by IITA and further developed by ILCA over the last 3 years. Production of over 30 kg of *Gliricidia* seed during the 1982/83 dry season facilitated the establishment of *Gliricidia* from seed in all experiments as well as in 12 new alley farms in villages. *Gliricidia* seed is relatively easy to harvest and germinates quickly and uniformly without any treatment. A trial to determine the optimum plant density for seeded *Gliricidia* under alley farming conditions has recently been established.

The effects of fallow grazing on soil fertility and crop yields are being investigated in two long-term trials. A joint ILCA/IITA/IDRC alley farming trial is now fully established, and cropping and grazing activities began in April 1983. Grazing plots containing natural pasture and *Leucaena* were rotationally grazed at a stocking rate of 32 sheep/ha between April and September, after which the stocking rate was reduced to 14 sheep/ha. A summary of the crop and *Leucaena* mulch yields recorded to date is presented in Table 2. A second grazed fallow



trial was successfully established with seeded *Gliricidia* on highly degraded land. In this trial the effects of browse trees on animal carrying capacity and soil fertility are being investigated.

*Browse evaluation*

In order to evaluate a broader array of *Gliricidia* germplasm for use throughout the humid zone, *Gliricidia* seed was collected in Costa Rica during March 1983. The collecting trip was a collaborative project between ILCA and Costa Rica's Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE), and yielded 47 accessions collected from trees growing under a wide range of conditions. The germplasm collection was planted at Ibadan in April, and the range of plant heights among the accessions during the establishment year is presented in Figure 3. An initial harvest was made 200 days after planting, at which time the best four accessions yielded an average fresh weight 160% higher than the local variety included as a control. The collection appears to contain significant genetic variation in both vigour and growth habit. Foliage yield will be evaluated in 1984, and superior accessions will be multiplied for distribution and wider testing. The team plans to test the use of *Gliricidia* browse in the drier northern areas of Nigeria, using the expanded *Gliricidia* collection as a basis.

*Feeding of Gliricidia and Leucaena*

Following the decision to concentrate on *Gliricidia* and *Leucaena*, emphasis has shifted from broad plant screening to investigating new approaches to feed production and management. A new series of feed management trials has been started to determine the effect of browse supplementation on long-term animal productivity. These trials involve both sheep and goats, which are confined and

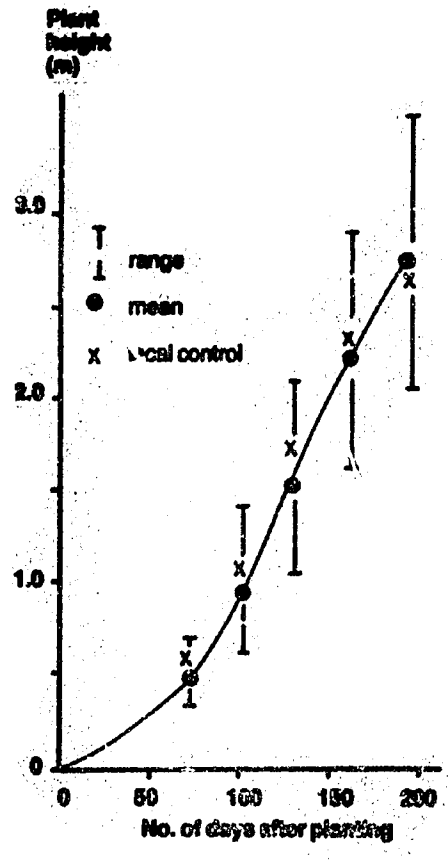
**Table 2. Mulch, nitrogen and maize yields, ILCA/IITA alley farming trial, Ibadan, 1983.**

| Treatment | First season | | | Second season[b] | |
|---|---|---|---|---|---|
| | *Leucaena* mulch yield (t DM/ha) | Estimated N[a] from mulch (kg/ha) | Maize yield (t/ha) | *Leucaena* mulch yield (t DM/ha) | Estimated N from mulch (kg/ha) |
| Maize alone | – | – | 2.19 | – | – |
| Alley-cropped maize | 2.78 | 56 | 2.55 | 3.00 | 60 |

[a] N content of dry mulch estimated at 2% pending analysis.

[b] One additional maize harvest was anticipated in 1983 from the alley farming system

**Figure 3. Plant height of 49 accessions of the ILCA/CATIE *Gliricidia sepium* collection, Ibadan, 1983.**




group-fed. An *ad libitum* basal diet of chopped *Panicum maximum* is supplemented with a mixture of *Leucaena/Gliricidia* browse at a rate of 135 g DM/adult animal/day. This level of supplementation is based on an alley farming model in which approximately 75% of all tree foliage is returned to the soil as mulch, while the remaining 25% supplies a daily browse supplement for up to 15 adult animals/ha.

Initial observations on the effect of browse supplementation on total feed intake are presented in Figure 4. In sheep, 22 g browse/day/kg $LW^{0.75}$ resulted in an 11% increase in daily feed intake, while in goats 39 g browse/day/kg $LW^{0.75}$ increased daily feed intake by 33%.

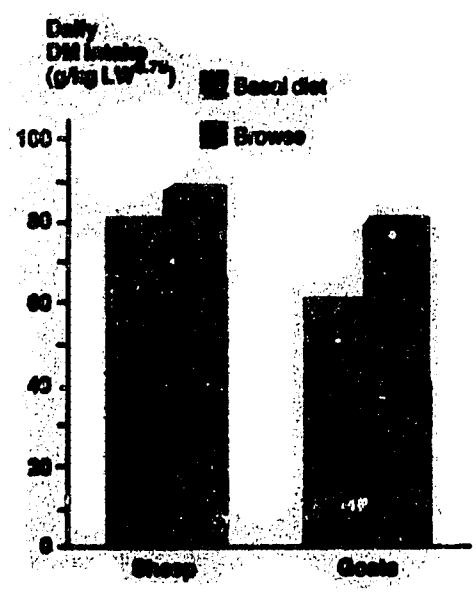
## Application

### *Health package*

Early health monitoring in the Badeku and Eruwa villages near Ibadan indicated the importance of the rinderpest-related viral disease PPR as a cause of mortality, particularly among goats. Preliminary evaluation of the effect of TCRV at these sites showed significant reductions in mortality During 1982, a better-controlled village evaluation of the effects of TCRV and monthly dipping on disease and productivity was started in the Fashola area. At the same time work in the Ikire villages near Badeku was begun. Animals in the Ikire villages received no veterinary treatments and were used as a control group for the treated animals in Badeku.

The effects of the veterinary interventions on mortality at the two sites are shown in Table 3. At both sites annual vaccination with TCRV reduced mortality by an average of 75%. These data confirm the importance of PPR and the effectiveness of TCRV under village conditions. Monthly dipping was effective in controlling sarcoptic mange, but the effects of this disease on productivity remain unclear. A detailed economic analysis of the veterinary package is currently being made, and meanwhile TCRV vaccination will be included as a standard disease control measure for improved production systems in this area.

**Figure 4. The effect of browse supplementation on daily feed intake of sheep and goats over a 10-week period, Ibadan, 1983.**



*Alley farming*

The Programme is now evaluating 16 village alley farms. All 1983 farms included both *Gliricidia* and *Leucaena* and all trees were established from seed. In the Fashola area, where tractor ploughing is common, the alley width was expanded from 4 m to 5 m to reduce the risk of plough damage. Trees were established with a number of different crops including maize, cassava, okro and melon. Farmers experienced some problems with the slower germinating *Leucaena*, which in some cases was weeded out and in others was oversown with another crop.

A preliminary survey indicated that women who own small ruminants near established alley farm sites were particularly interested in alley farming and had the necessary access to land. Further studies of the potential for women's participation in intensified smallstock husbandry through alley farming are in progress.

The Programme will play a central role in a new pilot development scheme launched by the Federal Livestock Department to promote crop – livestock alley farming. In 1984, 60 participating farmers will plant 0.33 ha mixed-browse alley farms and will start a health programme comprising TCRV vaccination, dipping and quarantine of newly purchased animals. Both men and women owning small ruminants are being encouraged to participate. A preliminary economic analysis of the scheme for farmers with four breeding animals predicts an internal rate of return of 65%. ILCA's team has agreed to provide the browse seed and administer the health package as well as train ministry personnel in the principles and practices of alley farming.

Four 'intensive feed gardens' were established in southeast Nigeria, where alley farming may not be an appropriate feed production strategy. These prototype feed gardens contain two browse species as well as *Panicum maximum* and *Pennisetum purpureum*. The gardens are 200 $m^2$ in area and depend on intensive nutrient cycling through the application of manure or fertilizer to maximise feed production from a limited area. The goal is to provide the major feed requirements for 4 to 5 animals. Around 20 new intensive feed gardens will be established in the southeast during 1984.

**Table 3. The effect of veterinary treatment on mortality of free-roaming goats in southwest Nigeria, 1982 – 83.**

| Location | Treatment: | Mortality (%/month) | | | |
|---|---|---|---|---|---|
| | | Control | TCRV | Dipping | TCRV + Dipping |
| Fashola[a] | | 2.3 | 0.4 | 2.5 | 0.8 |
| Badeku/Ikire[b] | | 2.1 | – | – | 0.4 |

[a] May 1982 to May 1983

[b] May 1982 to April 1983

# Two new farming systems from ILCA

## Alley farming in humid Nigeria

*Throughout much of the humid zone of West Africa small ruminants are kept in free-roaming village flocks with low management inputs and relatively low productivity. ILCA's Humid Zone Programme has developed for this region an improved sheep and goat production system that is closely integrated with crop production.*

*The new system employs the fast-growing leguminous trees Leucaena leucocephala and Gliricidia sepium both as feed resources and as a means of maintaining soil fertility. The system uses the alley cropping techniques developed by IITA, in which crops are grown in 4-m wide alleys between rows of Leucaena or Gliricidia. During cropping years 75% of the tree foliage is applied to the soil as mulch, while the rest is fed to small ruminants. The cropping system is periodically interrupted for 2 to 3 years, and during this period the natural fallow vegetation, as well as the tree foliage, is eaten by small ruminants.*

*The Humid Zone Programme is evaluating 16 alley farms in different villages. All the farms include both Leucaena and Gliricidia trees which have been established from seed. More than 40 accessions of Gliricidia were collected from Costa Rica during 1983, some of which are now producing fresh weight yields 160% higher than the local control.*

*Nigeria's Federal Livestock Department is starting a pilot development project in which 60 participating farmers will practise alley farming on their own land. The farmers will also adopt an improved animal health package recommended by ILCA, which includes vaccination and dipping to prevent peste des petits ruminants and sarcoptic mange.*

*Farmers are clearly interested in alley farming, a system which is to the mutual benefit of crops and livestock.*

## Fodder banks in the subhumid zone

*In the West African subhumid zone livestock producers have great difficulty in feeding their animals during the long dry season. Fodder is scarce and of poor quality, and cattle commonly lose 15% of their body weight before the rains return. Milk yields and reproductive performance fall and mortality rises.*

*Supplementary feedstuffs are scarce and expensive; but home-grown legume forages are likely to offer a solution. However, livestock owners have limited access to land, few implements for cultivation and little money to spare for fertilizer.*

*ILCA's Subhumid Zone Programme has countered these problems by introducing 'fodder banks' of forage legumes which are cultivated and partially fertilized by the animals themselves. Large numbers of animals are crowded onto the selected 2- to 4-ha fodder bank areas at the start of the rains. They graze out the remaining vegetation, their hooves break up the soil surface and their dung and urine provide fertilizer to help in the establishment of the forage legumes. The fodder bank is then surface-sown with successfully tested varieties of Stylosanthes and 150 kg/ha of phosphate fertilizer. By the end of the rainy season such fodder banks yield 4 to 6 t DM . with a crude protein content of more than 13%.*

*The fodder banks are made available to animals periodically during the dry season, giving high-quality feed and boosting production at a time of the year when the animals are accustomed to only a limited amount of low-quality grazing.*

*The ILCA package has been enthusiastically received both by local farmers and by Nigeria's Federal Livestock Department. There are now 23 fodder banks in ILCA's case study areas, some of which have been started by the pastoralists themselves after seeing the success of banks grown by ILCA's team.*

# The Subhumid Zone Programme

## Introduction

The subhumid zone, characterised by average annual rainfall of 900 to 1500 mm and a growing period of 180 to 270 days, covers some 1.3 million $km^2$ of West Africa. Despite conditions that favour reasonable forage growth within the zone, the productivity of cattle – the dominant ruminant species – is very low, primarily owing to inadequate nutrition and particularly to deficiencies in protein and some minerals.

The Subhumid Zone Programme has concentrated on defining the present systems of production and testing ways of improving feed resources. This work has necessarily involved studies in the social and organisational aspects of production as well as the animal and agronomic sciences. An interdisciplinary understanding of the existing agropastoral farming systems, which includes feedback from producers, provides the basis for selecting specific components for research. The work of the Programme is at the interesting stage of resolving problems revealed in the farmer-executed phase of the farming systems research. The testing of improvements during 1983 was carried out in three major subject areas: animal productivity, crop – livestock interactions, and forage production through legume fodder banks.

## Diagnostic studies

During 1983 descriptive and diagnostic studies have continued in the two main study areas: Abet and Kurmin Biri. Abet is an area where pastoralists settle among crop farmers, while settlement at Kurmin Biri is on a grazing reserve established by the government.

### *Settlement and resource allocation*

The settled Fulani tend to live year-round at one site, but they do periodically (at intervals ranging from 2 to more than 20 years) move to other sites. In the Abet area they make arrangements with local village chiefs or individual farmers for settlement and cropping rights; in most cases, no time limit is set on the agreement regarding settlement site, but rights to crop fields not contiguous with these sites must usually be renewed annually. These arrangements contrast with the permanent right of occupation within government grazing reserves at Kurmin Biri, which is secured by the 'certificates of occupancy' granted to the Fulani by local government officials.

Aerial surveys of farming areas revealed high correlations between cattle and cultivation densities. The decision to settle in farming areas such as Abet is determined primarily by the availability of sufficient fodder and water. However, high-quality farmland is also important. Low-lying *fadama* land and crop residues on farmers' fields are particularly valued by the Fulani. Markets for the sale of milk products are also mentioned by the Fulani women as a desirable feature of a settlement site. The pastoral homestead is usually within a few minutes' walk of at least one farm compound, and the farm family is invariably a customer for the dairy products of the Fulani. The settled Fulani take advantage of public services such as schools and dispensaries established for the farming community, and have close links with the local cattle traders and butchers. The farmers buy stock directly from the Fulani, either for family or religious celebrations or as an investment of their earnings from crop-

ping. In the latter case, the animals usually continue to be tended by the Fulani from whom they were bought. The agropastoralists are also attracted by the opportunities in established farming areas for employment as hired farm labour. In areas where farming is of low importance, as on government grazing reserves, the Fulani forego the benefits of being close to farmers in order to have permanent rights to land. In such areas they will not be disturbed by farmers seeking crop damage compensation or cropland negotiations.

The settled Fulani women control all milk sales, although they do not usually contribute to expenditure on livestock, even if this might serve to increase milk production (e.g. supplementary feeds or inputs for fodder banks). If production expenditures by men lead to higher milk production, the men can reap the benefits by leaving extra milk for the calves, thus gaining higher rates of calf survival and faster growth of calves.

About three quarters of the annual cash income generated by the cattle herd of an average settled Fulani household in Abet is derived from animal sales and about one quarter from dairy sales. Part of the income from corralling their cattle on farmers' fields to manure the next crop is received as barter, most commonly as grain. After the occasional sale of livestock, Fulani men are able to make bulk purchases of food grains and feed supplements and to meet other large and expensive needs of family and herd. The women's smaller but regular dairy earnings ensure a steady supply of cash for minor daily and weekly household needs.

Farm sizes among 25 Fulani households in Abet and Kurmin Biri average 0.87 ha/adult male, with a range of 0.23 to 2.19 ha/adult male. Where the Fulani have permanent access to land, as on a grazing reserve, the average farm size rises to 1.1 ha/adult male, in contrast to 0.67 ha/adult male in areas where the Fulani have to negotiate with landowners on a yearly basis.

*Animal productivity and health*

The monitoring of traditionally managed herds of cattle has confirmed the low animal productivity reported in the *1982 ILCA Annual Report*. A similar study has been initiated with Fulani sheep owners.

Farmers tend to keep goats in a manner consistent with their cropping activities: during the growing season goats are tethered during the day and kept in special huts overnight, but after harvest they roam freely in the fields, often failing to return to the homesteads even at night. Between June 1982 and June 1983 an increase in goat numbers of 15.9% was observed in the 22 flocks studied. In subsequent months increased sales and transfer out of the flock brought the total number of animals back to the original level. Offtake was 23.4%, and 32% of the sales coincided with the need to raise cash for fertilizer purchases.

The monitoring of the health status of cattle herds has continued. No major problem was detected, but cases of *Dermatophilus* (15) and abortions (7) out of a total of 1400 cattle studied warrant further investigation. The assistance of the Kaduna State Ministry of Animal Health and Forest Resources in vaccinating herds limited losses through rinderpest to only seven calves.

The seasonal pattern of tick infestation of Bunaji cattle was examined over 24 months (1981/83). The tick burden, which was low in both dry seasons, increased after the onset

of the rains. It reached a peak in June each year and declined thereafter. The predominant tick species found was *Amblyomma variegatum* (the vector of heartwater); others found were *Boophilus* spp. (vector of babesiosis), *Hyalomma* spp. and *Rhipicephalus* spp. (vector of theileriasis). Tick bites, particularly those from ticks with large mouth parts such as *Amblyomma* spp., are often associated with *Dermatophilus*.

The results of this survey indicate that it may be feasible to limit the use of acaricides to the period May to July. During the remaining months the current practice of manual deticking should be adequate and less costly.

*Crop – livestock interactions*

The importance of crop residues in the dry-season diet of cattle and the use of animal manure in cropping are the central links between the Fulani and the crop farmers. These interactions have led to an increased focus on crop – livestock research, particularly in Abet where there is a higher ratio of cattle to area cultivated. An assessment of the quantity, quality and availability of crop residues has been made and the prevalence and methods of manuring fields have been determined.

Highly significant correlations were found between sorghum, millet and maize grain yields and their respective leaf and stalk DM yields. Similarly, the following pairs of variables were significantly correlated:

- Sorghum grain yield and its total crude protein (CP) content ($r^2 = 0.64$);
- Sorghum grain yield and leaf CP ($r^2 = 0.59$);
- Groundnut grain yield and total crop DM yield ($r^2 = 0.91$); and
- Soyabean grain yield and the weight of threshing byproducts ($r^2 = 0.97$).

During years of normal rainfall it is possible to use grain yields to predict the quantity and quality of crop residue DM.

During the 1982/83 6-month dry season in Abet, cattle spent approximately 40% of their grazing time (20% of total annual grazing time) on sorghum and millet stovers, on soyabean and rice threshing byproducts and on rice stubble and regrowth. At the beginning of crop residue grazing only sorghum and millet stovers were grazed. Byproducts from threshing soyabeans became important in January and February, and rice byproducts and stubble and regrowth grazed during the last half of the dry season accounted for the highest percentage of time spent on crop residues. Maize, predominant in the cropping pattern as an intercrop with sorghum, is harvested 2 months before grazing of crop residues begins. When its stover becomes available to cattle, it is low in feeding value. In sorghum and millet fields, panicles and upper leaves were the preferred fractions of the stover. As these disappeared from the feed on offer, lower leaves and weeds tended to be selected. During the last 6 weeks of the dry season, selection of upper-stalk material increased considerably.

The feeding value of sorghum and millet stover components and weeds is currently being analysed to obtain a more complete understanding of their relative contributions to the dry-season diet.

Dry- and early wet-season cattle corralling on cropland provides the major manure input to cropping in the subhumid zone. Manure is also added to the land as the crop

residues are grazed. In 20 fields, it was estimated that 111 kg of cattle manure DM/ha was returned to cultivated fields during grazing of residues. Over half of the manure was deposited during the first 3 weeks of grazing.

Although the quantity of manure is small in terms of improving soil fertility, grazing clears fields of unwanted debris, incorporates some of the residue into the top soil and breaks down cultivation ridges.

Half of the farmers surveyed hired Fulani to corral their herds on cropland for payments in cash or kind, including Fulani settlement rights. For the average herd of 50 cattle, the value of weekly payments (excluding settlement rights) was approximately ₦ 6.50 (US$ 8.90), although Fulani having larger herds generally charged less per head. Areas corralled for 13 farmers ranged from 0.04 to 0.16 ha and were principally used for the cultivation of ginger, a cash crop. Yields recorded in eight farmers' fields showed that manure gave increases of 25 to 115% in crop yields over adjacent uncorralled areas.

Trials are being conducted in farmers' and Fulani fields to determine the N contribution of manure to cropping and to assess the importance of weed growth and soil compaction before designing future research.

*Range fodder*

Monthly analysis of herbaceous cover has made it possible to construct generalised productivity and utilisation curves for natural herbage in the case study areas of the subhumid zone. Figure 5 shows examples of such curves for Kurmin Biri, Kaduna State. The variable quality of forage for most months of the year reflects its uneven botanical composition and low nutritional value. High-quality non-gramineous forbs make up only a small fraction of the herbage on offer.

## Designing and testing improvements

*Cattle nutrition*

In terms of economic value and biomass, cattle are the dominant ruminant species in the subhumid zone, followed by goats and sheep. The response of cattle to improved nutrition continued to be good (Table 4), with most of the supplementation in the trials coming from fodder banks of *Stylosanthes* spp. introduced by ILCA's team. Two hundred selected cows grazed on the 24 available fodder banks.

Studies of the effects of stylo on cattle production and of grazing on stylo persistence

**Table 4. The effect of dry-season supplementation on cattle production at Kurmin Biri and Abet, 1980–82.**

| Age of cattle[a] | Calf body weight (kg) | | Milk offtake (litres) | | Total milk production (litres) | | Calf mortality (%) | | Milk production index (MPI)[b] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S[c] | N-S | S | N-S | S | N-S | S | N-S | S | N-S |
| Birth | 19.8 | 18.6 | | | | | | | | |
| 30 days | 28.6d | 25.6e | 32.7d | 19.8e | 135.8d | 100.8e | | | | |
| 60 days | 36.0d | 31.3e | 65.7d | 42.7e | 254.3d | 191.6e | | | | |
| 90 days | 42.4d | 36.9e | 98.5d | 65.6e | 362.1d | 278.4e | 5.1 | 10.9 | | |
| 365 days | 92.2 | 90.0 | | | | | 11.69 | 17.19 | 280.5d | 191.9e |

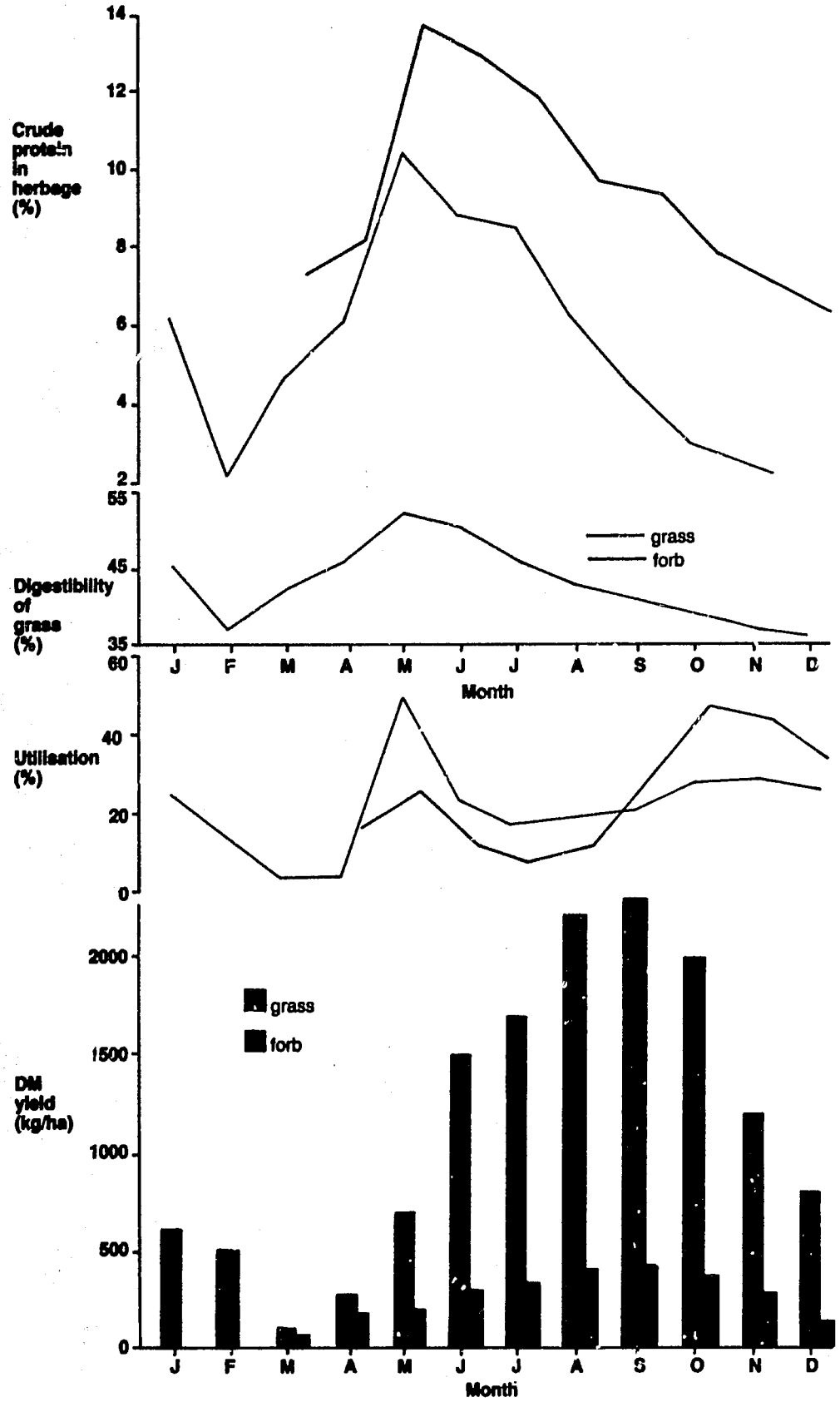
[a] No. of cattle in samples were as follows:
Supplemented:
birth to 90 days : 98
365 days : 52 (for measuring calf body weight and MPI)
365 days : 77 (for measuring calf mortality)
Non-supplemented:
birth to 90 days : 210
365 days : 75 (for measuring calf body weight and MPI)
365 days : 249 (for measuring calf mortality)

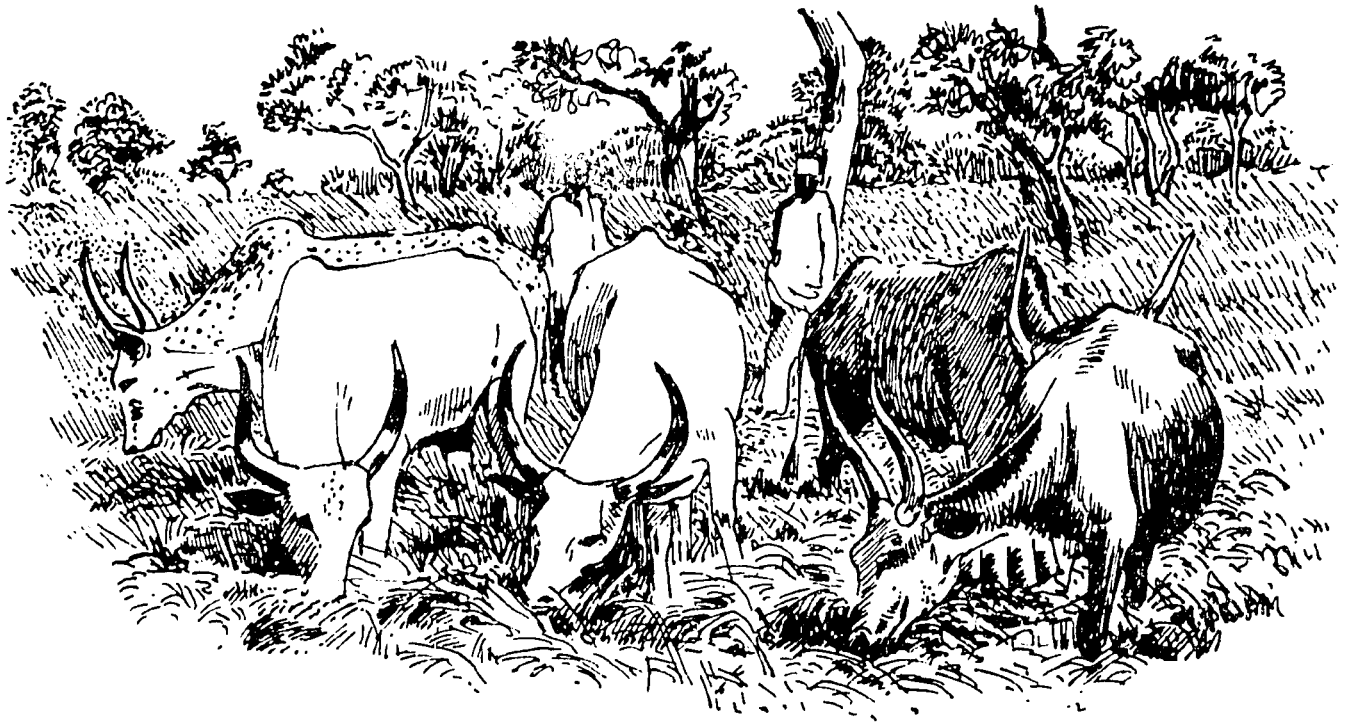
[b] $\text{MPI} = \frac{\text{estimated milk produced (litres) to 180 days}}{\text{calving interval (d)}} \times 365$

[c] S = Supplemented cattle; N-S = non-supplemented cattle.

Means of figures within an S and N-S column pair with different letters are significantly different ($P \leq 0.05$).

Figure 5. A generalised productivity and utilisation pattern of natural herbage at Kachia grazing reserve, Kaduna State, 1982.





will from now on constitute one of the major component research efforts of the Programme.

Calves from dams which had received supplements of cottonseed cake and/or stylo during the dry season grew significantly faster ($P \leq 0.05$) than control animals up to 180 days of age. However, by 1 year of age there was no significant difference in the weight of the two groups. The mortality rate in calves from dams fed supplements was 5.5% lower than that in calves from controls.

Total milk offtake/cow/lactation averaged 315 and 258 litres or 0.72 and 0.65 litres/cow/day over the lactation for the supplemented and control groups respectively. Lactation length was about 39 days longer in the supplemented group. The milk production index for cows fed supplements was 46% higher ($P \leq 0.05$) than for controls.

*Animal health*

A total of 92 calves were studied in an experiment on strategic deworming. There were two treatment groups (A treated five times with fenbendazole, and B three times) and one control group.

Helminthiasis was prevalent in over 50% of calves in the control group from April to December. A similar seasonal pattern was observed in the two treatment groups, but their prevalence rates were lower than the control. The peaks in both prevalence rates and the number of eggs per g of faeces (epg) corresponded to the peak rainfall observed in June and September. There was no significant difference in weight gains between the treated and control groups, even though treatment produced reduction in epg of 97%.

Reductions in epg of 58% to 66% were also observed in three out of four animals in the control group. These reductions were attributed to treatment carried out by pastoralists with proprietary drugs or using traditional herbal remedies. The efficiency of traditional herbs in treating naturally acquired helminthiasis is being studied in conjunction with Ahmadu Bello University. Since the most critical period in the life of calves is the first week, pre-natal infection with *Neoascaris vitulorum* also warrants further study.

*Crop residue improvement*

On-station and on-farm trials were conducted to evaluate the effect of recommended crop management practices on sole crop and intercrop grain and vegetative DM yields. The practices were prescribed by the Institute of Agricultural Research at Ahmadu Bello University, by ICRISAT and

by IITA, and included the use of improved cultivars and recommended planting dates, plant populations and fertilizer rates.

Improved management of the local sorghum variety resulted in a 150% increase in grain and vegetation DM yields. The improved cultivars of maize and soyabeans gave 30 to 100% increases both as sole crops and when intercropped. The on-farm trials provided more data on the management and labour requirements of cereal crops, leading to more effective experimental designs, as well as indicating benefits to farmers. In conjunction with national and international crop research organisations in Nigeria, ILCA's team is now investigating the possibility of introducing dual-purpose cereal and grain legumes into the cropping systems as a means of increasing the quantity and quality of crop residues while ensuring that subsistence needs are met.

### *Intercropping with forage legumes*

The possibility of growing *Stylosanthes guianensis* cv. Cook along with sorghum and soya by simple adjustments of plant spacings and N levels was investigated. Undersown soya and stylo reduced sorghum yields by 22% and 29% respectively. N application to the crop (40 or 80 kg/ha) did not eliminate the negative effect of the undersown legumes. However, growing the cereal and the legume on alternate ridges allowed the sorghum to maintain a grain yield equivalent to that obtained when sole cropped. Cropping the sorghum at a density of two stands/hill uses half the land area of a sole crop with a single stand/hill on all ridges, so that growing an additional grain and/or forage legume crop appears feasible (Table 5). This technique provides an opportunity for improving the fodder quality of crop mixtures without causing grain losses. Such an intervention could be valuable in situations where crop farmers also keep livestock.

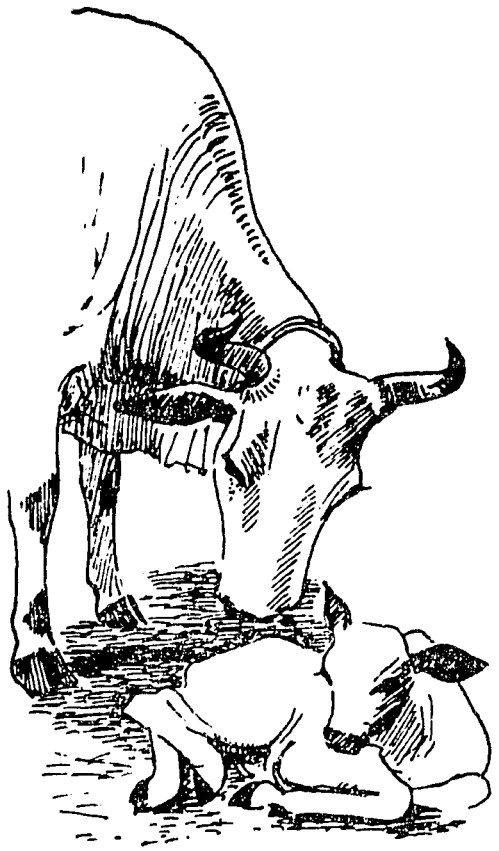
### *Legume fodder banks*

Increasing numbers of pastoralists have opted to grow fodder banks during 1983. The total number of fodder banks in the case study areas increased to 23 during the year. Six of them were partially or completely burnt by accident during the 1983 dry season. Fodder banks with *Stylosanthes guianensis* cv. Cook showed an early flush of germination from the burnt areas, but because of the subsequent low germination and the higher mortality of early seedlings, total stand counts towards the end of the season were low, with no survival from the previous season. On the other hand, observations on the two *S. hamata* fodder banks that burned completely showed no reduction in the emergence of new seedlings compared with the previous season. This suggests that accidental burning, though serious with the perennial *S.*

**Table 5. Sorghum grain and fodder yields under different N applications with sorghum grown in combination with soya and stylo, Kurmin Biri, Kaduna State, 1983.**

| Sorghum spacing[a] (m) | Crop combination | N level: (kg/ha) | Sorghum grain yield (kg/ha) | | | Sorghum fodder yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 40 | 80 | 0 | 40 | 80 |
| 1x0.30 | Sorghum alone | | 952 | 1 481 | 2 040 | 3 921 | 7 092 | 7 571 |
| | Sorghum undersown with soya | | 740 | 1 217 | 1 645 | 2 652 | 6 238 | 6 619 |
| | (Soya grain yield) | | (47) | (90) | (137) | | | |
| | Sorghum undersown with stylo | | 617 | 1 206 | 1 365 | 1 904 | 3 381 | 4 968 |
| | (Stylo fodder yield) | | | | | (1 159) | (1 460) | (1 381) |
| 2x0.30 | Sorghum alone | | 857 | 1 730 | 2 142 | 3 603 | 7 625 | 8095 |
| | Sorghum and soya on alternate ridges | | 834 | 1 666 | 2 174 | 2 998 | 6 619 | 7 031 |
| | (Soya grain yield) | | (162) | (170) | (185) | | | |
| | Sorghum and stylo on alternate ridges | | 778 | 1 429 | 1 963 | 3 540 | 5 238 | 7 008 |
| | (Stylo fodder yield) | | | | | (1 556) | (1 857) | (2 016) |

[a] 1 and 2 m spacings correspond to 1 and 2 sorghum stands/hill.



*guianensis*, is only a temporary setback with the annual *S. hamata*, provided there is a good seed reserve in the soil.

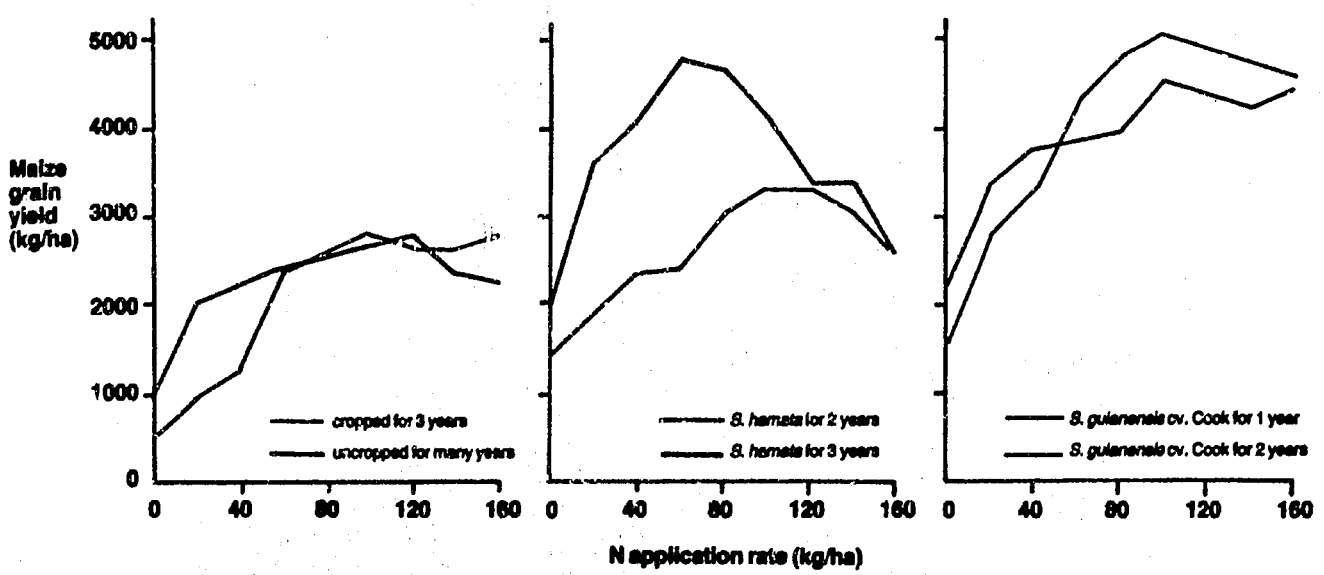
The botanical composition of fodder banks changes with time. After *S. hamata* has grown for 3 years on an area formerly covered predominantly by *Loudetia simplex*, the area became dominated by *Pennisetum pedicellatum* and *Hyparrhenia* spp. This change may have been due to N build-up in the soil.

A bio-assay was initiated in 1983 to estimate the N contribution of legumes in fodder banks to subsequent crops after different lengths of time. Grain yields of maize at various N levels from each site were compared (Figure 6). Soils benefited more from *S. guianensis* cv. Cook than from *S. hamata*. Soils that had been under legumes supported very much higher yields of maize at increased N levels than soils cropped for many years.

Maize yields after 1 and 2 years of *S. guianensis* cv. Cook were approximately the same as those obtained at 45 and 60 kg N/ha respectively from an area cropped for 3 years. Maize derived similar benefits from *S. hamata* cv. Verano after 2 to 3 years of establishment in fodder banks. Replacing part of a food crop's N requirement through the use of forage legumes is an incentive to the arable farmer to allow the pastoralist to establish fodder banks. It also opens up the possibility of sequential food crop – forage rotations within a fodder bank. However, more work is needed to determine the inputs required to maximise N fixation and the relative efficiencies of different legume genotypes in this regard.

The high incidence of anthracnose in *S. guianensis* cv. Cook in 1983 increases the urgency of identifying more tolerant mate-

**Figure 6. The effect of cropping history on grain yield of maize under different N applications, Nigeria, 1982 – 83.**



rials. There appear to be other species within the genus that are more resistant to anthracnose. However, *S. guianensis* from CIAT (cultivars 1523, 1280 and 1283), although tolerant to anthracnose and drought, were either late in flowering or did not flower in the year of introduction. The degree of drought tolerance varies between cultivars of *S. capitata*, but no lines showed any signs of anthracnose. In 1983, 63 accessions were added to the preliminary evaluation plots.

## Application

*Smallholder dairy scheme*

Cottonseed supplementation as a dry-season ration for in-calf and lactating animals was taken over by the Livestock Project Unit of the Federal Livestock Department during 1983. Due to a substantial increase in the cost of cottonseed cake as well as to limited extension resources for implementation, the package developed by ILCA did not have the expected impact. Further work during 1984, funded by the Federal Livestock Department, will include the development of an extension package which takes account of input supply and distribution, and the management and staffing of livestock service centres.

*Fodder banks*

While not yet a proven technology, the spontaneous and extension-aided uptake of fodder banks by livestock owners is encouraging, and is giving ILCA's team a larger research base for diagnosing any adoption problems that may arise. However, the fodder bank idea is still too new and the sample too small with too much variability within it to ascertain the adoption rate or to give firm research conclusions. The Fulani are willing to invest in fodder banks if they have guaranteed tenure of land, if they propose to settle or if they are short of dry-season grazing; but they are still uncertain what benefits they will obtain and how long it will take them to establish their fodder banks. The current Fulani cooperators cover a wide range of wealth, so the costs of fodder bank establishment alone do not appear to be a major deterrent if a flexible credit scheme is in place. Further studies by the team will evaluate uptake, including the degree of adherence to recommendations.

## *ILCA's work: The underlying beliefs*

*Underlying ILCA's achievements to date are key beliefs that have guided the Centre's development. The following represent the views of those who developed ILCA, the other international agricultural research centres and the CGIAR support system.*

1. *In Third World countries generally there is underinvestment in agricultural research, especially in the food crop and animal production sectors.*
2. *Successful agricultural and livestock research yields high rates of return relative to most other investments.*
3. *Research and training are essential inputs for the development of the agricultural and livestock sectors.*
4. *Agricultural development is essential if sustained economic growth and advances in human welfare are to take place.*
5. *International agricultural research centres such as ILCA can speed up the process by which science and technology are successfully brought to bear on food production and distribution problems. Such centres must focus on the identification and solution of practical problems in the agricultural production process; they should be staffed with well qualified scientists and administrators, and provided with continuity in support.*
6. *Strong national research and training systems are essential to the progress of developing country agriculture. The international centres cannot substitute for national systems; but they can complement and help strengthen these essential organisations and, in turn, be strengthened by them.*

# The Arid and Semi-arid Zones Programme in West Africa

## Introduction

In the arid and semi-arid zones of West Africa annual rainfall varies from 100 mm to 1000 mm. In both zones rainfall is unimodal: in the north of the arid zone most of the rain falls during August, while in the south of the semi-arid zone the rainy season lasts from July to early October. The Sahel region of West Africa, with an annual rainfall of 200 to 600 mm, constitutes the southern belt of the arid zone.

Of the five countries covered by the two zones in West Africa, Mali supports the highest livestock population. ILCA began research in these lower rainfall zones in 1976 when the Arid and Semi-arid Zones Programme was initiated in Niono, 350 km northeast of Bamako in central Mali, with later extension to a number of other sites.

The team has made a detailed study of pastoral and agropastoral livestock systems in Mali. The pastoral system studied in depth, that of the Fulani transhumants, is representative of systems in which alluvial floodplains or lakeshores and their surrounding Sahelian pastures are exploited. Such systems are found in Senegal, Mauritania, Niger, Chad and Sudan, as well as in Mali.

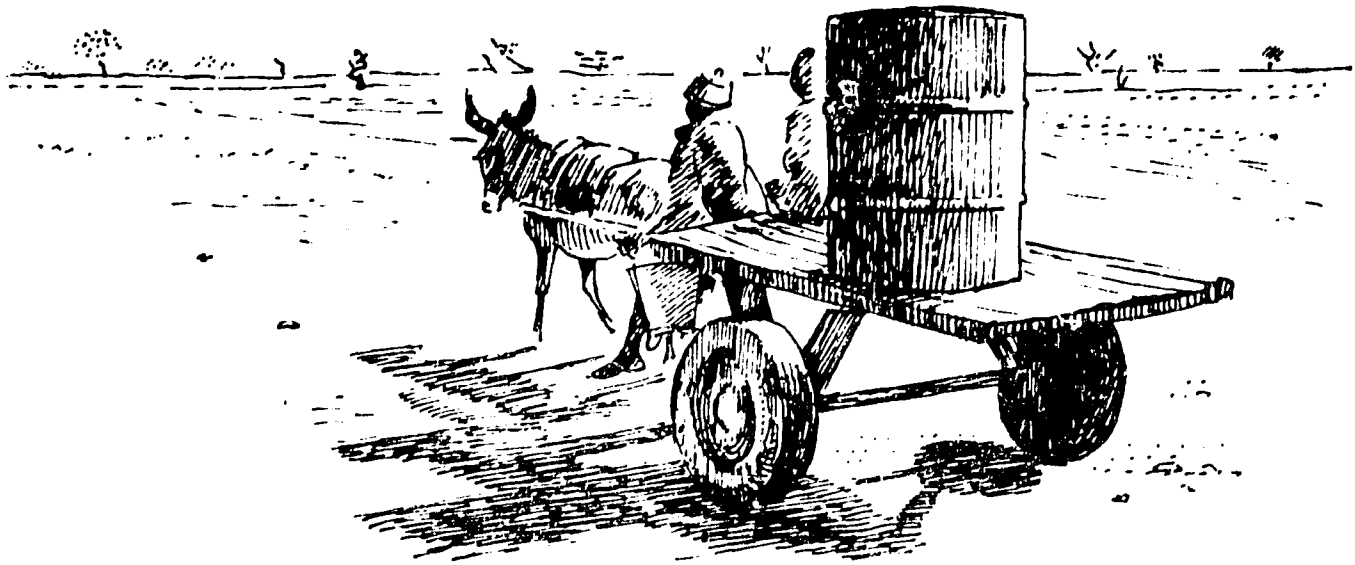
Two agropastoral systems have been studied in depth: one is based on millet residues as fodder in the dry season; the other on rice residues in the dry season. The former system predominates throughout the semi-arid zone of Africa, while rice residues are used for fodder in irrigated areas and where the water table is high.

During 1983 the focus of the Programme's research shifted from diagnostic studies to the design and testing of improvements. Component research now focuses on the following:

- Agronomic trials to increase total DM yields on arable land;
- Improvements in the late dry-season nutrition of work oxen;
- Alleviation of animal health problems, particularly preweaning mortality; and
- Improvements in pasture management in the inner Niger floodplain area.

During 1983 the Programme has also established research activities outside Mali. A substation has now been established at Niamey in Niger, where an ILCA staff member is working with scientists from ICRISAT. Rapid surveys of livestock demography and productivity were also carried out during 1982/83 in areas of Upper Volta and Niger. In Upper Volta the work was carried out for the West German Sahel Programme and was funded by GTZ; in Niger the surveys were carried out at the request of the USAID-supported Niger Range and Livestock Project.

In 1983 a new research project was started in southern Mali. This animal feeding project, termed the *'embouche paysanne'* or *'Mali Sud'* project, is to be carried out by the Institut National des Recherches Zootechniques, Forestières et Hydrobiologiques (INRZFH) in collaboration with ILCA's team based in Mali, to which the project will add two senior staff. The project, which is funded by USAID, will introduce and test forage legumes to improve the nutrition of fattening cattle and sheep in the project area, which receives between 650 and 1000 mm annual rainfall.



## Diagnostic studies

Following the detailed descriptive and diagnostic studies undertaken by the Programme since 1976, the diagnostic studies made during 1983 were limited to some detailed studies in selected specialised fields which had shown themselves to be crucial or in which no previous studies had been carried out, and the geographical extension of earlier studies to broaden ILCA's regional understanding of the two zones.

*Forage production and use*

Further measurements and observations on ecology, forage production and forage use in the pastoral system of the southern Sahelian rangelands were carried out in 1983. These allowed an empirical model for vegetation production on such rangelands to be tested. There was close correlation between the growth curves for a *Schoenfeldia gracilis* rangeland and the rainfall distribution used in the model. Other measurements also confirmed the extreme sensitivity of pastures to rainfall distribution. The mean herbaceous biomass at the end of the 1983 growing season was less than 500 kg DM/ha and was the same as the biomass predicted by the model (assuming no runoff). This biomass had averaged 1500 kg DM/ha for the 7 preceding years of much higher rainfall.

Some of the earlier surveys were extended to other Sahelian regions. Both the Malian Gourma and the pastoral areas of central Niger served as testing grounds for rapid surveys of pastoral resources based on the ecological knowledge and methods developed in central Mali. In both areas the plant production model proved useful in evaluating the effects of annual rainfall on forage resources. These resources were also stratified, using a classification of vegetation types based on ecological environment.

The pastoral resources map covering 20 000 km$^2$ of the 'dead' delta sector at a scale of 1/100 000 was completed during 1983.

*Livestock productivity data*

Livestock productivity and nutrition data have now been collected for 6 years, from 1978 to 1983. Early analyses showed that the principal constraints to increased livestock output in the agropastoral system were high preweaning mortality in all three species of ruminants, and nutritional stress, particularly in cattle, during the late dry season. Within the cattle population as a whole, particular subgroups were found to be more at risk than others. Work oxen, on which the main demand for work falls at the end of the dry season, constitute one such group.

Additional analyses of the data collected from goat and sheep studies showed that management, as expressed by an individual owner's ability in animal husbandry, is a major cause of variation in livestock output. Improved output could almost undoubtedly be achieved with the spread of simple technological and management improvements already practised by some herdsmen.

## Designing and testing improvements

### *Agronomic trials*

Measurements of the production and structure of vegetation on 10 floodplain pastures were continued during 1983. In these trials the effects of grazing, cutting, burning and dry-season irrigation were studied. The results in 1983 were affected by the low flood level of the previous year, but they confirmed the trends recorded earlier. The effects of monthly irrigation on three pastures cut every 2 weeks are given in Table 6, showing the dramatic effect of irrigation on forage production.

**Table 6. The effect of monthly irrigation on the production of three pastures, Inner Niger floodplain, 1983.**

| Species | Forage production, January to July (kg DM/ha/day) | |
|---|---|---|
| | Control plot, cut every 2 weeks | Monthly irrigation, cut every 2 weeks |
| *Andropogon gayanus* | 1.9 | 10.1 |
| *Vetiveria nigritiana* | 0.7 | 4.3 |
| *Oryza longistaminata* | 2.7 | 11.6 |

Regeneration trials were carried out by propagating cuttings of *Echinochloa stagnina*. The regeneration plot produced 1.5 t of forage DM/ha during the season in which it was planted. After the flood waters had receded this plot was indistinguishable from neighbouring plots of the same species.

Further trials were carried out in the agropastoral system to study the effect of drought on the growth of millet (*Pennisetum typhoides*) and cowpea (*Vigna sinensis*), the yields of which were greatly depressed during the very dry 1983 season. The results have been combined with the effects of different fertilizer applications and the growth curves established during 1982, for detailed physiological analysis.

Millet and cowpea intercropping was studied in another experiment during 1983. Following late sowing because of the dry conditions and low yields from the first harvest, a second harvest was not obtained for cowpea. However, the data collected have shown the fragility of millet – cowpea intercropping under low rainfall conditions.

The 20 best forage or dual-purpose cowpea varieties selected since 1979 were also grown in pure stands or were intercropped with millet to further study their performance and forage production. All intercropping practices reduced the yields of both cowpea and millet compared with pure stands of these crops. For example, millet yields were reduced by 21 to 29%. A 15% cowpea to millet ratio of intercropping gave the least reduction in millet grain yields, while a 45% ratio gave the least reduction in cowpea yields.

However, when grown in rotation, millet grain yields following a year of cowpea were 60% higher than those following a year of millet.

Several grain legumes were planted in pure stands and observations on their phenology, morphology and their grain and forage production were made. The legumes studied in this way included cowpea (*Vigna unguiculata*), mung bean (*Vigna radiata* and *Vigna mungo*), pigeon pea (*Cajanus cajan*) and Teparey bean (*Phasiolus acutifolius*). The year 1983 served as a useful one for screening for drought resistance due to the unusually low rainfall.

Two further trials were conducted in collaboration with ICRISAT. In one, sorghum (*Sorghum bicolor*) lines were selected for their resistance to drought and for their short growth cycle, and in the other the performance of a short-cycle pigeon pea variety was assessed.

### *Nutrition of work oxen*

Various feeding regimes have been tested on work oxen in the agropastoral system, including feeding of legume hay and cottonseed cake in different quantities and for different periods in trials carried out at Dalonguebougou. Testing has been carried out in collaboration with local farmers using their own oxen in their own fields. Results to date have been encouraging, in that both the intensity and the duration of work of the oxen have been increased through improved feeding, resulting in larger areas being ploughed. No analysis of the economic benefits likely to result from such improvements has yet been possible. Other aspects to be investigated include a study of the residual effects of supplementary feeding on subsequent years' weight changes and performance.

*Improved animal health*

The disease and reproductive status of small ruminants in the agropastoral system is being monitored by a variety of methods including epidemiological surveys, field examinations and slaughterhouse studies. The design and testing of veterinary packages, including the use of autovaccines for the treatment of pulmonary diseases, are also under way. The best results have been obtained by vaccinating small ruminants against *Pasteurella*.

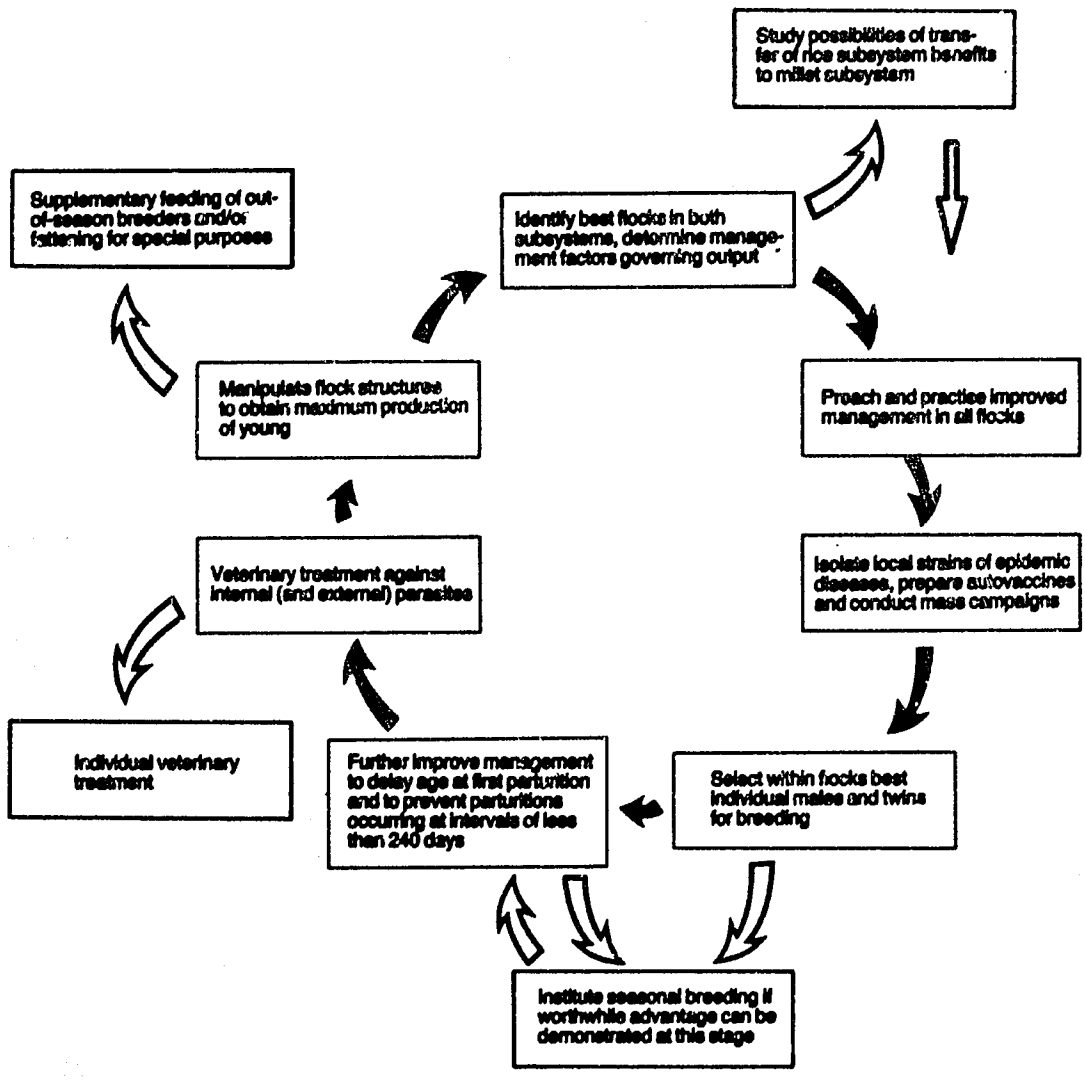
*Pasture and flock management improvement*

Following the analysis of data on sheep and goat productivity in the agropastoral system, and based on the genetic variability exhibited by the animals studied, a simple management improvement plan was drawn up (Figure 7), showing the possible pathways for interventions in small ruminant production.

Further analyses are required before this plan can be fully tested on farmers' herds. In the meantime the team is determining the management techniques which lead to improved output by studying the effect of variations in selected techniques on selected flocks, and by conducting questionnaire surveys.

A rotational grazing trial was established in collaboration with members of the Diafarabé Herdsmen's Cooperative. The trial was conducted on a *harima* – an area of grazing land reserved for village milking herds during the dry season. The area used

**Figure 7. Intervention pathways for small ruminants in the agropastoral system in Mali.**



was a pasture of *Echinochloa stagnina*. The trial studied the introduction of improved rangeland management techniques within the existing pastoral system. The results reflected the advantages to be gained through rotational grazing despite the low rainfall conditions. Under rotational grazing forage production was 27.8 kg DM/ha/day compared with 11.0 kg DM/ha/day with traditional grazing. The herdsmen involved are keen to repeat the trial during 1984.

*On-farm testing*

Two varieties of cowpea suited for both forage and grain production have been grown on the fields of 30 farming families near Dalonguebougou. The dual-purpose varieties used in these tests were TN-63 from Niger and CSIRO 57 317 from Australia. The trial is testing the acceptability of these forage crops by local farmers and is also providing hay for the work oxen trial at Dalonguebougou.

Surplus seed of several forage crop varieties has been distributed to those collaborating farmers who have requested it. Considerable interest has been shown in the grain cowpea variety CSIRO 45 581 and the short-cycle (60 days) millet variety Souna. Results from farmers' fields also confirmed that cowpea gives higher yields in pure stands than when intercropped under low rainfall conditions.

# The Ethiopian Rangelands Programme

## Introduction

The aims of the Ethiopian Rangelands Programme are to propose technical options and production alternatives for the development of range livestock and pastoral systems in Ethiopia. Initially the team studied both the Afar and the Borana pastoral systems in the northeast and the south of the country respectively. However, the Programme concentrated on the Borana system during 1983.

The study programme in the southern rangelands of Ethiopia is carried out jointly by ILCA's team based at Addis Ababa and the Rangelands Development Project (RDP) of the Ethiopian Government. The RDP is supported by funds from the World Bank.

The Borana plateau covers 95 000 km$^2$ in the south of Ethiopia. The area slopes gently from an altitude of 1500 m in the foothills of the Bali – Sidamo massif to the north to 1000 m near the Kenyan border in the south. Mean annual rainfall varies from 700 mm in the northeast to 400 mm in the southeast of the plateau. Rainfall is bimodal, and although 60% of the rain usually falls in the period from March to May and 40% in October to November, the timing, quantity and intensity of rainfall are highly variable within these seasons. A map of the study area in the southern rangelands is given in Figure 8.

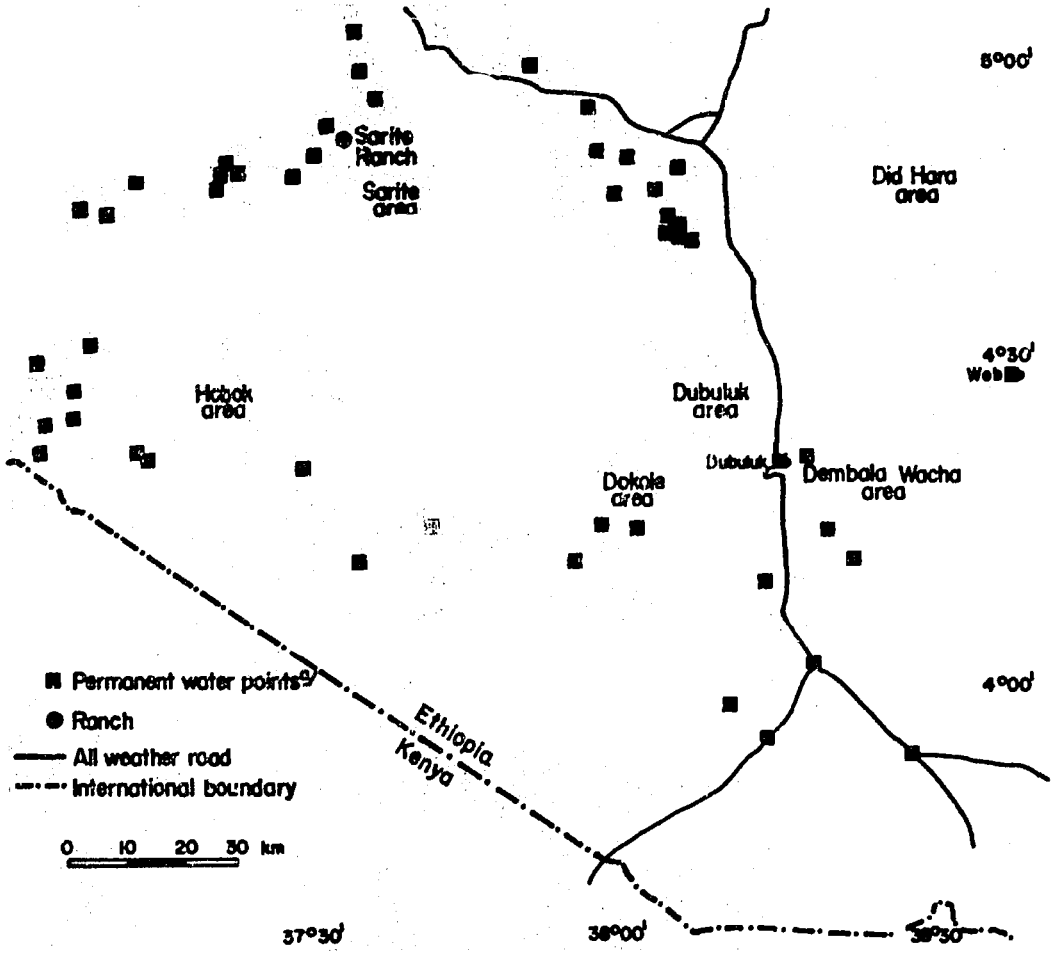
The Borana system is representative of a number of East African pastoral production systems which have in the past been described as inefficient and unproductive. The picture so often presented is one of poor breeds of animals being fed and managed inadequately, with low levels of health and production. However, pastoral systems seek to optimise the number of people supported per unit area of land, and to give these people as much security as possible by maximising food output/ha. This objective is achieved through a multiple goal system in which the production and consumption of milk are far more important than the consumption and sale of meat.

### *Pastoralism versus ranching*

The Laikipia district of Kenya is a ranching area where livestock production is based on Boran cattle under a bimodal rainfall regime, comparable to that of the southern Ethiopian Borana system. The Laikipia district produces on average 18.6 kg/ha/year of animal liveweight offtake, compared with 9.86 kg/ha/year in the Borana system, which also produces 21.33 kg/ha/year of milk offtake. A comparison of livestock production in the two systems is given in Table 7, and shows that the Borana pastoral system produces about the same amount of protein/ha/year as the ranching system, but 57% more energy.

Ranches in the Northern Territory of Australia produce less than 30% of the animal protein/ha and 16% of the edible energy/ha of the Borana pastoral system, even though their economic performance may be considered reasonable. Compared with ranchers pastoralists are poor people, but this is not because the productivity and efficiency of their system is low, but because their numbers per unit area are high. Pastoralists' objectives are to optimise the number of people supported per unit area; ranchers' objectives are to optimise economic returns. The Borana system directly supports 6 to 7 people/km$^2$ of rangeland, Laikipia ranches no more than 0.5 people/km$^2$, and the Northern Territory ranches 0.002 people/km$^2$. The

**Figure 8. The study area of the Ethiopian Rangelands Programme, western Sidamo Province, Ethiopia.**




* Three important wells to the east of Web have also been studied.

ratio of energy produced per man-day for each of these systems is 1:2:27. Quite clearly land is the critical resource for the Borana pastoralist, and labour for the Northern Territory rancher.

Pastoralists, including the Borana, have in the past been criticised as poor husbandmen, for being responsible for rangeland degradation, and for the high numbers of females in their herds compared with ranching enterprises. Table 7 shows that for the Borana this may not be a fair picture. The starting point for the improvement of the productivity of the Borana and other East African pastoral systems, far from being low, is in fact quite high.

The fact that most distinguishes pastoral systems from any other animal production system in arid areas is that pastoralists compete with their calves for milk. In the Borana

**Table 7. A comparison of livestock production in the pastoral Borana system in Ethiopia and in the Laikipia ranches in Kenya.**

| Production | Pastoral Borana, Ethiopia | Laikipia ranches, Kenya |
|---|---|---|
| Animal protein (kg/ha/year) | 1.71 | 1.89 |
| Gross food energy (MJ/ha/year) | 140 | 89 |
| Calving percentage | 75 | 52–83 |
| Calf mortality (%) | 10–23 | 5–24 |
| Cows as % of adult animals | 42 | 38 |
| Cows as % of total animals | 66 | 62 |
| Liveweight density (kg/ha) | 66–74 | 63–125 |

system milk offtake for human consumption averages from 300 to 320 kg/lactation, which is 30 to 38% of total milk production. This restriction of calf milk intake results in weaning weights of around only 48 kg at 210 days, which is less than one third of the known genetic potential of the Boran breed. Low weaning weights lead to slow growth, late maturity and low offtake. This matters more to ranchers than to pastoralists, for whom milk production is far more important than meat production. Failu ' recognize this is the basis of the misunde.. anding of the real productivity of pastoral systems.

The need for self-sufficiency in pastoral systems means continued reliance on mil. consumption. One of the major challenges for pastoral production systems in the future is to achieve gher calf growth rates while continuing to allow milk offtake for human consumption.

## Diagnostic studies

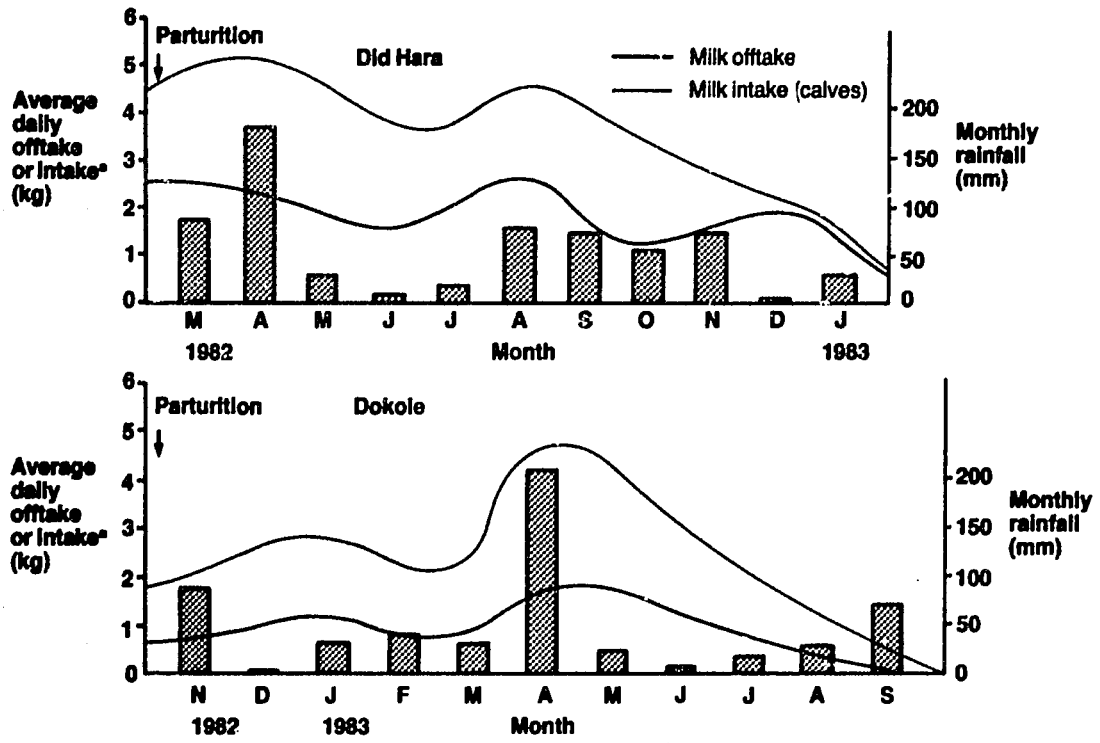
Descriptive studies were completed in 1983 and the analysis of data collected in this phase is providing a detailed understanding of the critical areas for research and development in East African pastoral systems.

### *Animal production*

The Borana pastoral system produces calves with birth weights of 18 kg compared with 28 kg achieved under ranching systems at Abernossa in the southern rangelands and at the Laikipia ranches in Kenya. The final 3 months of pregnancy coincide with peak stress in the dry seasons, and little can be done about this unless supplementation proves feasible. Weaning weights at 210 days average 48 kg, whereas the breed potential is at least 180 kg. Milk offtake for human beings is the main reason for the low weaning weights, and supplementation of calves is likely to achieve high returns.

Calving rates are 75%; the lactation curve for cattle is bimodal (see Figure 9), with mean yields of 922 kg over 320 days and median yields of 680 kg over 210 days; milk offtake for human consumption is 30 to 38% of total yield; 60% of calves are born in the April/May 'main rains' period, and lactations starting at this time provide 31% more

**Figure 9. Lactation curves of Boran cows at two locations in the Ethiopian rangelands, 1982–83.**




* Offtake and intake values are 3-week averages.

milk and result in calves 16 to 23 kg heavier than those born during the October/November secondary rains.

The stress period at 2 to 4 months of age appears to be of more importance than later stress. Lactations starting in March/April also come to an abrupt end after the rains, probably due to increased foetal demand, whereas lactations beginning in October tend to decrease more slowly and are important in carrying pastoralists through the long dry season. These two lactation types are the result of a dual strategy whereby cows giving birth in March/April are managed so as to conceive again early and so provide fresh annual supplies of milk, whereas cows giving birth in October/November are allowed to have longer calving intervals but provide vital dry-season milk supplies. Calf mortality rates range from 10 to 23%.

*Ecology*

The location of encampments has an important effect on the ecology of pastoral areas. Most camps in the southern rangelands are located on high ground, where the environment is most fragile. The areas immediately around camps always contain livestock and thus receive the largest amounts of dung; most of the trees there are cut for firewood. There is an additional heavily grazed area within a radius of 0.5 to 5 km from the camp, where trees are not cut and vegetative growth is still boosted by nutrient transfer. Areas beyond this are grazed in the dry season only. After 3 to 7 years the camp is moved, leaving behind a small core of grassland high in N and a large periphery of land with a steadily increasing cover of trees and shrubs. Over a 60- to 100-year cycle the encampment-based grazing system thus turns grassland into bush and tree areas which provide less feed for cattle. This may account for the steady westward retreat of the Borana and the advance of the goat- and camel-owning Somali over the last 250 years.

This trend could be reversed at least partially if the number of animals based on encampments were reduced. Balancing stocking levels in this way is one of the reasons why the Borana divide their cattle into dry herds *(forra)* and milk herds *(worra)*, with the latter remaining close to the encampment and the former ranging further afield. Herd structure data show that this system is not operating well: 70% of all animals tend to be

in the *worra* herd – including dry animals and castrates, apparently because of labour problems. Reducing labour requirements at the dry-season wells may assist in overcoming this constraint.

A common feature of all pastoral systems is uneven use of grazing resources resulting from uneven distribution of water. The solution to this problem in the southern rangelands has been to construct surface ponds to increase grazing access to underutilised areas. However, by mid-1983 an estimated 57% of the capacity of constructed ponds

had been lost to siltation and other factors. This is a problem common throughout East Africa, and is critical to the success of many future development projects.

*Aerial and satellite surveys*

Systematic reconnaissance flights (SRF) have been flown to provide rapid evaluation of human and livestock densities and distribution, and of many other environmental parameters. SRF surveys were originally evolved by wildlife ecologists to evaluate wild animal populations whose distribution over large inaccessible areas was subject only to natural phenomena. Although the characteristics of domestic livestock populations are different, being organised in large discrete herds whose movements are directed by man, wildlife census techniques have been applied to domestic livestock counts.

Work in 1983 showed that present SRF techniques are unsatisfactory in many respects. Sampling procedures result in a lack of precision, repeatability is too low, observations are often subjective, and there is disagreement about the best methods of data analysis.

ILCA has already gained considerable experience in the field of SRF surveys, and a research programme in 1984 is aimed at improving the efficiency and accuracy of SRF survey methods and data analysis.

The use of satellite-mounted radiometers to measure green leaf density has an important potential for the assessment of vegetative biomass in the rangelands. A cooperative programme between ILCA and the United States National Aeronautics and Space Administration (NASA) using data from the NOAA-7 satellite was started in June 1983. Considerable progress has been made, but the application of the method is complicated by the perennial nature of many rangeland plant species whose growth is not strictly related to rainfall, by the confounding effect of tree and shrub layers, and by the bimodal rainfall regime.

*Management strategies*

Aerial surveys of wet-season livestock distribution show high densities within 5 to 10 km of wells in areas which should be limited to dry-season grazing. Encampments are relatively stable for 3 to 7 years, and since most are established within half a day's walking distance from well areas for dry-season watering, the encampment-based *worra* herds tend to graze areas near the wells, even in the wet season. Yet because of the 3-day watering strategy practised by the Borana, the number of livestock to be found within the critical 0 to 8 km radius of a well system is unlikely to be more than 33% of the total animals using that system.

The Borana draw water from the dry-season wells at rates of 80 to 150 litres/min over a 5- to 7-hour working day. Measurements of human work output at the wells in the southern rangelands have shown outputs of up to 13.6 MJ of energy/day. Pastoralists work very hard at certain times of the year and are certainly far from idle.

Recommendations have been made to government for the immediate physical improvement of 11 major wells which support more than 41% of the area's cattle, 66% of the sheep and goats and most of the equines. These improvements will affect well efficiency and water production, and will reduce some of the present stresses on livestock.

The work of the RDP has included the establishment of three cooperative ranches. The aims of these ranches are to act as sales outlets for immature male cattle from the pastoral system and to introduce improved range management techniques. Comparative data, however, show that animals coming onto the Sarite ranch from the pastoral system outperformed those that had spent the dry season on the ranch. Either the pastoral area has grazing superior to the Sarite ranch, or pastoralists are better managers of their livestock in the dry and the wet seasons than was previously thought. The introduction of ranching in the southern rangelands is of questionable value.

*Household economics and marketing*

Most of the data on household economics and marketing are still being analysed. Even for a relatively self-sufficient system such as the Borana, however, the data show that purchased grain is an important food energy source. In addition to subsistence the Borana system realizes a cash income of about US$ 2/ha/year, 40% of which is spent on food grain. The protein and food energy situation is given in Table 8.

If there were no livestock sales and no purchased grain or grain equivalent, the system would produce sufficient protein but there would be a shortfall in gross food energy of

about 40 MJ/ha/year, unless this could be supplemented with collected bush food. Thus the Borana pastoralists would in most years have insufficient food if they did not exchange meat for grain. This applies to most pastoral systems in East Africa today.

For the Borana capital is in the form of livestock, and considerable capital differences occur. The number of livestock units (LSU) per person in 50 sample households ranged from 2.5 to 113, with 92% of the households averaging 7.7 and 8% averaging 66 LSU/person.

## Designing and testing improvements

Pastoral systems are notoriously difficult to improve, and few parameters lend themselves to manipulation. There are two options which can be pursued: either to optimise the use of existing resources or management practices, such as grazing and watering, or to introduce new activities aimed at the improvement of a specific parameter, such as calf growth.

### *Watering freqency and animal production*

Observations of the 3-day watering strategy of the Borana made during the descriptive phase raise some interesting questions in the field of animal production, physiology, nutrition and range management. The strategy has evolved because raising water by hand up a narrow shaft is extremely labour-intensive, as is the digging and construction of wells. Apart from the wells, no other water sources exist during the dry season.

In terms of animal production, the extent to which 3-day watering affects productivity is not known, although it is believed to reduce feed intake. On ecological grounds the strategy may be beneficial, as grazing pressure is greatest during the dry season. If intake is lowered, overgrazing is less likely, and the erosion risk engendered by cattle walking to and from water points is reduced by two thirds on a 3-day cycle compared with daily watering. The grazing area available to animals on 3-day watering is also six to nine times greater than that accessible to animals watered daily.

Recorded water intakes in 1983 were in excess of all previous measurements; animals of 250 kg LW drank over 70 litres of water in 3 to 5 minutes without showing signs of water intoxication, and bulls of 400 kg LW drank over 100 litres in 5 to 6 minutes. A research programme was started in August 1983 to assess the effect of 1-, 2- and 3-day watering on the productivity of Boran cattle; to examine the physiological adaptations in the 'unimproved' Boran breed which

**Table 8. Protein and food energy produced and purchased in the Borana system of Ethiopia.**

| Energy/protein source | Protein (kg/ha/year) | Gross food energy (MJ/ha/year) |
|---|---|---|
| Animal products directly consumed | 1.10 | 109 |
| Vegetable products purchased (incl. grain) | 0.48 | 82 |
| Total available | 1.58 | 191 |
| Total required | 1.10 | 183 |

# The crisis in Africa

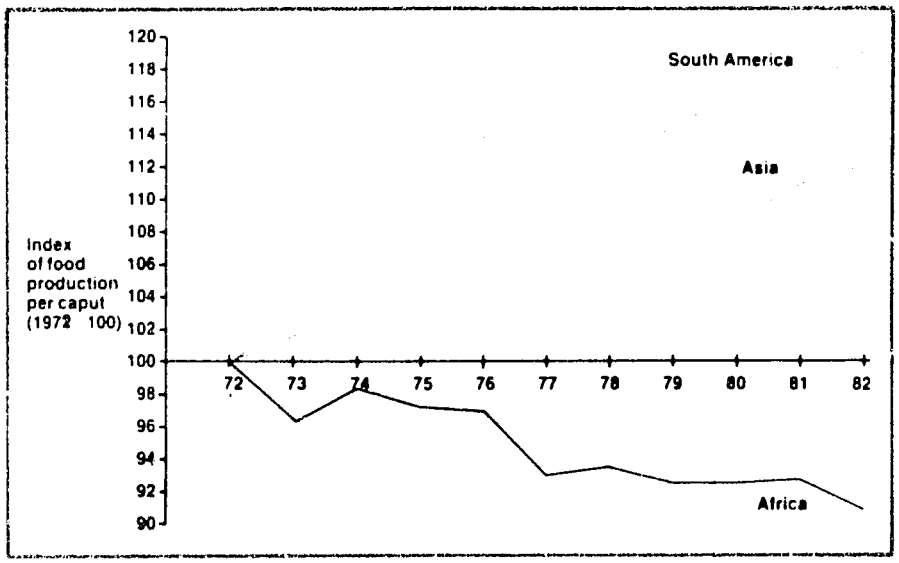
## *Some of the problems*

*Africa is facing a major food crisis. Following the famines in the Sahel countries (1971 – 74) and in Ethiopia (1972 – 74) food shortages in sub-Saharan Africa have proliferated throughout the past decade.*

*The most recent instances include Ghana where, in mid-1983, the Government was forced to request 280 000 t of food aid after the rains had failed at the end of 1982. Bush fire outbreaks, pests and the return of 1.3 million Ghanaians from Nigeria contributed to the severe food shortage (Essien, 1983). The Ethiopian region of Wollo also suffered a famine in 1983, when millions of tonnes of food had to be requested from other countries. A recent report of the Ethiopian Relief and Rehabilitation Commission states that there are now food shortages in four major regions of the country as a result of crop failures, and food shortages are predicted in a further four regions (RRC, 1983).*

*The situations in Ghana and Ethiopia are not unusual. There are widespread reports of further droughts in the Sahel following a decade in which the region has had great difficulty in recovering from the problems of the early 1970s.*

**Figure A. Index of food production per caput in Africa, South America and Asia, 1972–82.**




Source: *FAO Production Yearbooks* 1973, 1976, 1979 and 1982

*In April 1983 a special FAO/World Food Programme study was established to review and monitor the food and crop situation in sub-Saharan Africa. As a result FAO launched an appeal for food aid for several African countries. Since then the prospects for food availability in 1984 have deteriorated still further.*

## *Food production trends*

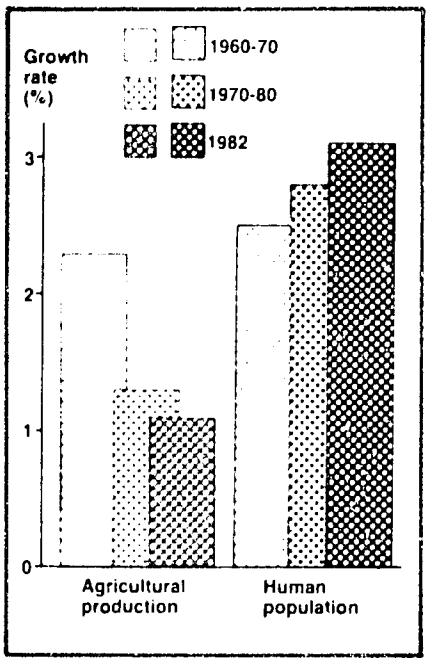
*FAO now estimates that cereal production in the 22 African countries most seriously affected by low food supplies will total only 13.9 million tonnes in the 1983/84 season, compared to 17.0 million tonnes in 1981/82 (FAO, 1983).*

**Table A. Trends and indicators for the 10 most heavily populated countries of sub-Saharan Africa, 1970–81.**

| Country | Population 1981 (million) | GNP per caput 1981 (US$) | Average annual growth rate: Population 1970–81 (%) | Average annual growth rate: Agricultural production 1970–81 (%) | Average annual inflation rate 1970–81 (%) |
|---|---|---|---|---|---|
| Nigeria | 87.6 | 870 | 2.5 | –0.4 | 14.2 |
| Ethiopia | 32.0 | 140 | 2.0 | 0.9 | 4.1 |
| Zaire | 29.8 | 210 | 3.0 | 1.5 | 35.3 |
| Sudan | 19.2 | 380 | 3.1 | 2.3 | 15.9 |
| Tanzania | 19.1 | 280 | 3.4 | 5.5 | 11.9 |
| Kenya | 17.4 | 420 | 4.0 | 4.2 | 10.2 |
| Uganda | 13.0 | 220 | 2.6 | –0.8 | 41.2 |
| Mozambique | 12.5 | n.a. | 4.2 | n.a. | n.a. |
| Ghana | 11.8 | 400 | 3.0 | 0.0 | 36.4 |
| Madagascar | 9.0 | 330 | 2.6 | 0.3 | 10.6 |

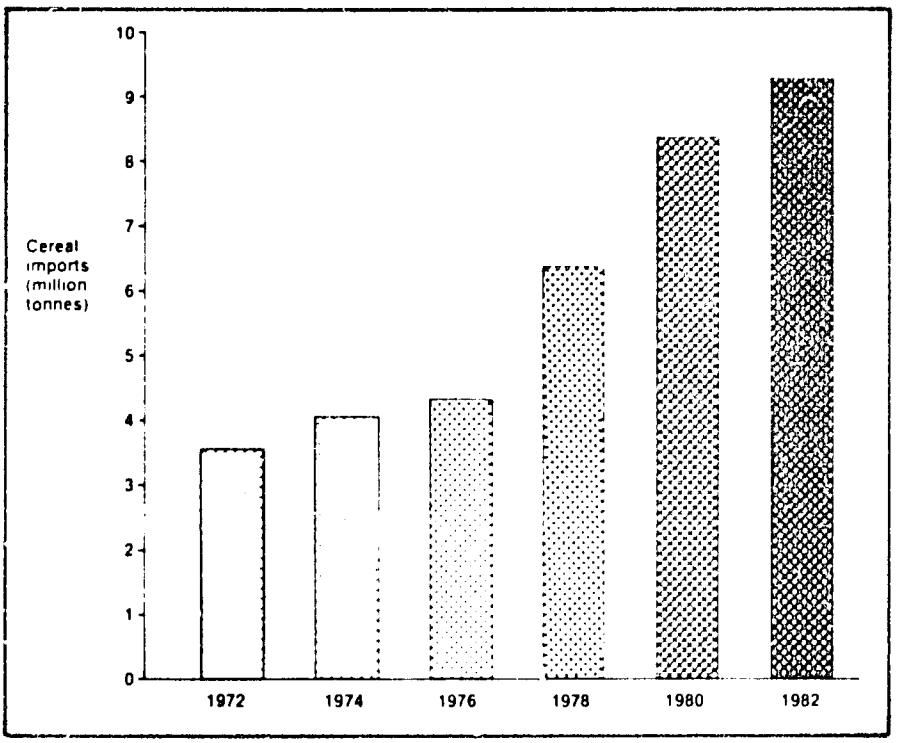
Source: World Bank (1983). n.a. = not available.

**Figure B. Rates of growth in agricultural production and population for 40 countries of sub-Saharan Africa, 1960–82.**



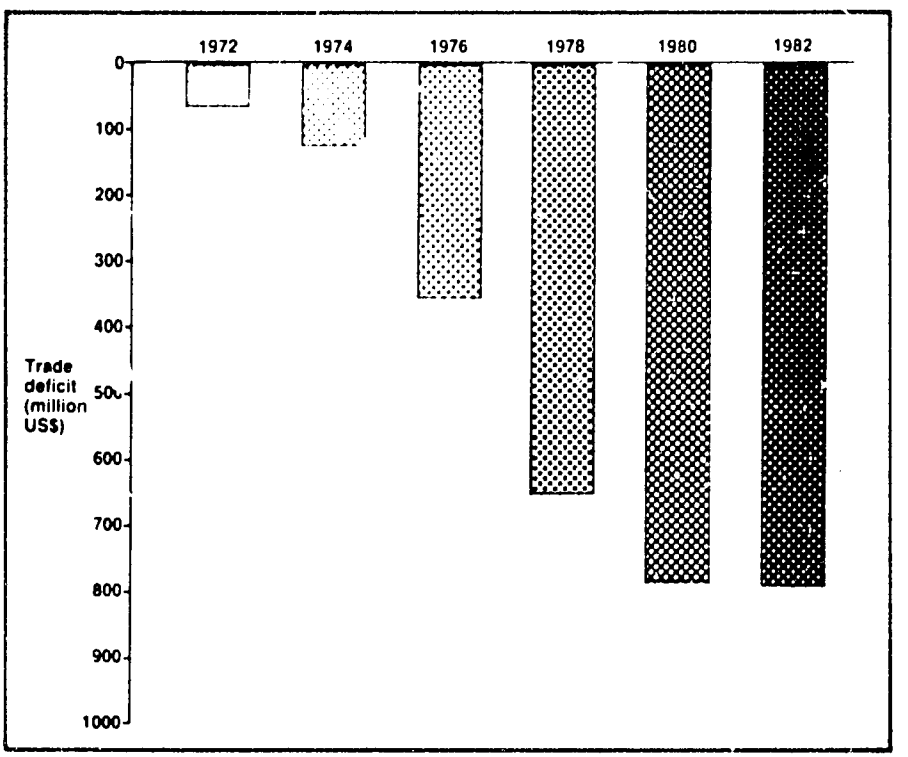

Source: World Bank (1983)

**Figure C. Cereal imports by 44 countries of sub-Saharan Africa, 1972–82.**




Source: *FAO Trade Yearbooks* 1973, 1976, 1979 and 1982.

**Figure D. Trade deficit (exports – imports) in livestock products[a] for 42 countries in sub-Saharan Africa, 1972–82.**




[a] Livestock products = all meat, all milk and dairy products and all eggs.

Source: *FAO Trade Yearbooks* 1973, 1976, 1979 and 1982.

*A simple analysis of the trends in food production per caput in three developing regions of the world is striking. Figure A shows that while this index has increased steadily for Asia and South America, it fell by almost 10% in Africa from 1972 to 1982. It continues to fall.*

*The rates of growth in population in sub-Saharan Africa are rising steadily (Figure B). Rates of growth in agricultural production are falling at a time when they need to be increasing.*

## *Economic trends*

*The most recent trends in these growth rates in the 10 most heavily populated countries of the region are given in Table A. These 10 countries contain 70% of the total human population of sub-Saharan Africa. The problem of inadequate food production is compounded in most of these countries by the rise in the price of food relative to other goods and the low indices of total GNP per caput. In effect, most of the population have insufficient money to purchase decreasing amounts of available food sold at ever increasing prices. The average GNP per caput*

*for eight of these countries (excluding Mozambique and 'oil-rich' Nigeria) was only US$ 273 for 1981.*

### Rising imports

*The result of this situation is that most countries of sub-Saharan Africa have to spend much of the hard-earned proceeds of their national production on food imports. An analysis of food imports into sub-Saharan Africa is alarming.*

*Figure C shows that the imports of cereals alone by 44 countries of sub-Saharan Africa rose from 3.5 million tonnes in 1972 to 9.3 million tonnes in 1982. The situation is similar with livestock products. Figure D shows the enormous increase in the trade deficit for livestock products, which stood at US$ 986 million in 1982.*

*The countries of sub-Saharan Africa have to seek loans from international agencies to pay for many of these imports, and they are running up large debts. While around US$ 1500 million is spent each year on imports of livestock and livestock products by the countries of sub-Saharan Africa, less than US$ 24 million is spent on national livestock research and development in the same region.*

# What ILCA is doing

*ILCA has the task of alleviating some of these problems. ILCA is mandated to generate improvements in livestock production through research, training and communications, and thereby to stimulate overall food production in the continent.*

*In many countries of Africa livestock play an integral role in the economy and in overall food production. The many uses to which livestock can be put are outlined on p. 44; in many African farming systems crop production is dependent on livestock. Livestock provide draught power for crop cultivation and manure for fertilization, and are consumers of otherwise unusable crop byproducts.*

### Research approach

*ILCA has studied livestock production systems in Africa in detail in order to identify specific constraints to production. Subsequent research carried out both in ILCA's field programmes and at headquarters has focused on individual system components in order to remove these constraints. This research has led to the testing of innovations considered appropriate to the systems concerned. Testing is carried out as far as possible in the herds and on the farms of the livestock and crop producers themselves. The testing of innovations is the responsibility of the field programmes, whose staff are on-site to gauge the success and acceptability of the new technology.*

*The systems approach to research at ILCA is reflected in the way the Centre's research efforts are organised.*

*Four areas in which ILCA is attacking Africa's problems are presented here.*

### The fight against trypanosomiasis

*The tsetse-transmitted disease trypanosomiasis is found over one third of Africa. Approximately 7 million km² of the tsetse-infested area are in the humid and subhumid zones, which could support an estimated 125 million additional cattle were it not for the disease.*

*In the absence of satisfactory control for the disease the most promising line of research is to identify the conditions under which breeds which are tolerant to trypanosomiasis can produce most economically, and to introduce appropriate systems of production that harness the potential of such breeds.*

*ILCA has established a network throughout West and central Africa to study in detail the performance of trypanotolerant breeds at 10 major sites under different levels of trypanosomiasis risk. This drive towards economic livestock production in areas at present poor in domestic ruminants is backed up by detailed training of national programme scientists whose institutions are collaborating in the network.*

*Results to date suggest that if the drive is continued, then combinations of trypanotolerant livestock and therapeutic and prophylactic drugs could lead the way to widespread domestic livestock production throughout areas of low to medium tsetse challenge.*

*Increased livestock production per se is one goal. At ILCA this is closely linked with the study of interrelations between crop and livestock production and of the possible benefits to crop production of any improvements in livestock performance.*

### Forage legumes

*Recently ILCA has stepped up its research on forage legumes. Many of these plant species are ideally suited to integration into existing cropping systems in sub-Saharan Africa. They can replace fallow in crop rotations and can benefit the following crop by fixing atmospheric nitrogen and making it available in the soil. Forage legumes also provide high-quality feed for domestic ruminants.*

*In Nigeria's subhumid zone ILCA's team has grown sorghum and the forage legume Stylosanthes guianensis on alternate ridges and still produced a sorghum grain yield equivalent to that obtained by sole cropping. This method is being further tested.*

*In Mali ILCA's team has selected forage and dual-purpose cowpea varieties for their high productivity when intercropped with millet.*

*With ILCA's Highlands Programme in Ethiopia, native African clovers and other forage legumes are undergoing extensive testing for integration into the traditional cropping systems.*

*In the humid zone of West Africa ILCA's team has developed the ingenious alley farming method, based on initial work by IITA, in which food crops are grown in alleys between rows of leguminous browse trees. Small ruminants browse the trees and manure the food crop, while the leguminous trees fix atmospheric nitrogen and, as a mulch, provide the food crop with additional nutrients drawn from the lower soil profiles.*

## *Appropriate technology*

*ILCA's teams have now developed a selection of new techniques, which are appropriate to sub-Saharan Africa and within the reach of the African food producer with his low income.*

*Two notable techniques have been developed by ILCA's Highlands Programme based in Ethiopia. First the single-ox plough, which has generated great enthusiasm among farmers and Ministry of Agriculture officials alike. The new plough is a modification of the traditional maresho plough normally drawn by two oxen. But a majority of smallholder farmers in the Ethiopian highlands do not own two oxen, and so their land preparation and hence their crop production has suffered. Now ILCA's new plough, combined with improved feeding currently being tested by ILCA, should ensure timely cultivation, lower overall feed requirements of oxen and greater self-sufficiency for highland smallholders, who are among the poorest people in the world.*

*Second, the highlands team has adapted a simple metal scoop to construct ponds at both the Debre Berhan and Debre Zeit sites in the highlands. The scoop is pulled by local animals and the pond it excavates provides a reservoir of water throughout the dry season. The team is now assessing the possibilities of using such ponds for small-scale irrigation of food crops during the dry season, and for fish farming to provide an additional protein source.*

*The same scoop has been tested by the Ethiopian Rangelands Programme in the dry southern rangelands. One of the major constraints to livestock production in this area is the laborious work of maintaining water resources, which include the traditional wells and the newer ponds. The ox-drawn scoop is being used with great success to clear silted-up ponds.*

*In West Africa the 'fodder banks' of forage legumes developed by ILCA's Subhumid Zone Programme are being tested on more than 25 farms. These fenced areas of high-quality feed are reserved for grazing during the dry season. Their presence has resulted in striking improvements in animal nutrition and production throughout the dry season, and fodder banks seem likely to make a major impact on livestock production in the subhumid zone. The banks require no mechanical cultivation and only moderate chemical fertilization; the soil is dug by cattle hooves and fertilized with their manure. The seed is surface-sown, making the new technology eminently suitable for pastoral livestock owners unused to crop cultivation.*

*In the humid zone of West Africa, where confinement of small ruminants is often a necessity, ILCA's team has developed a livestock fence which requires a minimum of materials, maintenance and money. The fence is made simply by notching, bending over and intertwining the stems of young Leucaena leucocephala trees. As the trees grow the fence grows denser. The sheep or goats are further restrained using simple neck yokes.*

## *Stimulation of African research*

*The application of new technology cannot be undertaken without close links with national programmes throughout Africa. Responsibility for the implementation and extension of new technology lies with national programmes. ILCA has sought to stimulate national livestock research and development through scientific seminars and conferences, through exchange of detailed information and research results, and by organising regular training courses on different research techniques and methods.*

*Close contact with governments and the research departments of national programmes is maintained by ILCA's field programmes and by the Training and International Liaison Section based at headquarters. These contacts are essential to ILCA's impact on livestock and food production in the continent.*

## *Summary*

*The long-term trends responsible for the present crisis in sub-Saharan Africa cannot be reversed overnight. The problems resulting in such trends require long-term solutions. ILCA's systems approach to research should ensure that once an improvement has been developed and has been adopted by African farmers, the production gains will not be short-lived. ILCA's current research, involving the design and testing of improvements to livestock systems, is based on a sound data base and a detailed analysis of the systems under study. Decisions to introduce innovations to producers have not been taken lightly.*

## *References*

Essien S N. 1983. The spectre of starvation. *New African* (July 1983) 190: 30-31.

FAO (Food and Agriculture Organisation). 1983. *Food outlook* 10:4.

RRC (Relief and Rehabilitation Commission). 1983. *Food supply prospect.* Food Supply System Report, September 1983. RRC, Addis Ababa. 15 pp.

World Bank (1983). *The World Bank Annual Report 1983.* IBRD/The World Bank, Washington. 240 pp.

may be conducive to superior performance under conditions of water restriction compared with other breeds; and to determine if 3-day watering is a practice to be advocated under ranching, pastoralism or similar production systems in the semi-arid areas.

### *Productivity and changes in rangeland vegetation*

Bush encroachment was described in the *1982 Annual Report* as a major problem. It is a response to specific management strategies and is accompanied by a reduction in grass production and availability. Nutrients are immobilised in the trees and shrubs and annual turnover is reduced. Three distinct long-term studies were started during 1983.

The first study concentrates on the determination of the levels of N and P in the soils at different densities of trees and shrubs, before and after bush clearing and burning. The second study involves the testing of various alternatives for bush control. The third study consists of experimentation on food crop and legume production in reclaimed areas, and measurements of the effects of cultivation on soil fertility.

### *Animal traction*

Draught animal power is underused in the rangelands of East Africa. With the exception of transport, most work requirements, ranging from the raising of water to the excavation and maintenance of surface ponds, are accomplished by human physical effort. One of the most common forms of development in pastoral areas is the construction of surface water ponds or dams. These are commonly dug by large earth-moving machines and range in size from 10 000 $m^3$ to 25 000 $m^3$.

In the southern rangelands the life of such ponds currently averages 2 to 5 years, with siltation rates of 1000 to 2500 $m^3$/year. This has meant that in the past expensive periodic machine maintenance had to be undertaken, as an average Borana pond management group could not excavate by hand more than 15 to 20 $m^3$ of silt/pond/season. In August and September 1983, the team tested in Sidamo two of the ox-drawn scoops introduced by ILCA's Highlands Programme. Desilting rates of 9 to 12 $m^3$/scoop/day were achieved, so that the removal of silt loads of up to 1500 $m^3$ by teams of oxen over 3-week periods is now feasible.

One of the major problems in persuading the Borana or any pastoral group to take complete responsibility for organising the use and maintenance of project ponds has been the sheer size of the maintenance task. The ox-drawn scoop has the potential to remove this barrier, and this work will be developed in 1984 with an emphasis on animal management and feeding requirements.

### *Calf growth*

The problem of the effect of milk offtake for human use on calf growth, and the resultant low weaning weights, is common to most pastoral systems. Little attention has been paid to this problem until recently.

Milk offtake for human use varies from 30 to 38% in the Borana system, and since a minimum of 65% of the milk from a low-yielding cow is required for calf maintenance alone, a calf in a pastoral system spends considerable periods on levels barely sufficient for maintenance. Low weaning weights delay maturity and age at first calving.

The problem can be tackled by raising overall lactation yields, which is difficult in pastoral systems; by reducing milk offtake by finding an alternative source of energy for human beings; by eliminating other possible growth-limiting factors such as disease or watering frequency and quality; or by supplementing the calf's diet. (Current milk offtake in the Borana system is equivalent to approximately 1163 MJ GE per lactating cow each year, and this can be supplied by 125 kg DM of good legume hay). A research programme was started at the end of 1983 in which the last three possibilities are being tested.

# The Kenyan Rangelands Programme

## Introduction

ILCA's research on the range livestock systems of Kenya is carried out among the Maasai pastoralists. By studying the Maasai's production systems in the semi-arid rangelands of Kenya ILCA's team aims to determine how varying levels of development interventions are modifying traditional methods of production, to clarify the causal relations within the production systems, to identify the constraints to livestock production and to design and test improvements to the systems.

The research programme in Kenya centres on an area of about 1600 km$^2$ in Kajiado District, southeast of Nairobi. The site includes part of the Kaputiei section of the Maasai grazing lands developed under the first phase of the Kenyan Government's Livestock Development Project, and part of the Kisongo section which has been subject to more recent development under the second phase. The Kenya Government has, in collaboration with the Maasai, adopted the group ranch form of territorial organisation as a model for land adjudication for the Maasai people and for their social and economic development.

Three group ranches in this area were selected for detailed study in 1980, when the team began research in Kenya. Inventory surveys of the human and livestock populations of these ranches – Olkarkar, Merueshi and Mbirikani – were made in the same year and subsequent studies have focused on herd structures, reproductive performance, young stock growth, milk production, livestock diseases, livestock offtake and acquisition, household budgets, marketing and human nutrition.

During 1983 the team completed much of the initial system analysis begun in 1980. Members of the team also assisted the Kenya Government in the planning of national studies on the problems constraining livestock output. The research methods used to date have been critically examined, and simplified, rapid and low-cost methods are being elaborated which are considered applicable to research on pastoral systems in many other areas of Africa.

The research of ILCA's team in Kenya is now moving into the design and testing stages. Research protocols for designing and testing improvements to the livestock production systems studied over the past 3 years have been prepared. Proposed improvements include the establishment of fodder banks, improved management of natural pastures, economic and health care packages and the introduction of simple improvements such as donkey carts, water harvesting techniques and biogas digesters. A development scheme for improving smallstock production and marketing has also been proposed. Several of the research protocols have been developed in conjunction with the National Range Research Station at Kiboko.

A systems research project in a semi-arid mixed cropping area has been prepared in collaboration with the Kenya National Dryland Farming Research Station. The aim of the project is to diagnose constraints and to test appropriate interventions in both crop and livestock production that will substantially increase the productivity of major farming systems in the semi-arid zones of Kenya.

## Diagnostic studies

*Integrated evaluation of semi-arid rangelands*

One of the major aims of the research in the Kenya Rangelands Programme is to develop integrated resource evaluation techniques for pastoral production systems, combining satellite imagery with aerial and ground surveys.

The aerial survey component of this research has now been completed. Two further research components which received major attention during 1983 were multi-stage remote sensing and methods for the evaluation of range condition and trends.

During 1983 the Kenya team started a research project in cooperation with NASA with the aim of evaluating the suitability of remotely sensed data for monitoring the status and productivity of semi-arid rangelands. The project included two components:

- A field study to test the effects of vegetation, soil and sky conditions on reflectance measured by a NASA radiometer at ground level; and
- A comparison of photographic and visual vegetation characteristics with radiometer measurements at low altitude (185 to 400 m).

Range condition was recorded twice along the same circuit in all three ranches (Olkarkar, Merueshi and Mbirikani) in October 1982 and in January and February 1983. This research had the following objectives:

- To test current methods of recording range conditions as used in American range research, and to assess their applicability to the semi-arid rangelands of Kenya;
- To compare dry- and wet-season recordings;
- To link data on range species with herd behaviour studies and information on preferred plant species; and
- To assess the added value of recording range condition within ecological and range productivity research. Such research includes remotely sensed data, systematic reconnaissance surveys and ground truthing of the nutritive value and productivity of range vegetation types over seasons.

Data collection has been completed and initial results indicate that the scoring of plant cover and soil surface characteristics is particularly useful in indicating range condition.

*Herd movement and management*

Data on herd movement and management were collected fortnightly during 1982 and 1983. Among other things this study recorded how livestock in households were divided daily for grazing and watering, the location and type of grazing and watering areas, watering frequencies and labour recruitment. Some of the findings for Merueshi Group Ranch are as follows:

1. Weaned calves and young cattle are herded separately from adult stock, while suckling calves are kept near the homestead. Divisions of smallstock are more complex and vary with season. During the dry season, when birth rates are lowest, adults and their offspring are grazed together. As with calves, suckling kids and lambs are left near the homestead.

2. The majority of herders are children, and most (76%) come from the household of the herd owner; the remainder are recruited from other households in the compound.

3. Two main types of grazing areas, communal and reserved grazing land, can be distinguished. Reserved grazing land is for the exclusive use of one or more households and occupies about 25% of the total group ranch land. The main users are calf herds (60%) and mixed flocks of smallstock (31%).

4. Merueshi Group Ranch is well endowed with water resources. There are three boreholes and four pipeline connections, two of which are owned privately. These facilities account for 52% of water use in the dry season and 37% in rainy months (Table 9). Hand-dug riverbed wells and ephemeral ponds account for the remainder.

5. Daily watering is the dominant practice for cattle and weaned calves, while suckling offspring of all species are watered less frequently. Watering frequency of weaned and adult smallstock is more diverse and seasonal.

6. At the start of the study it was thought that the degree of mobility would increase along the aridity gradient, so that pastoralists in Olkarkar Group Ranch would be more sedentary than those in Mbirikani, with Merueshi intermediate. Initial results indicate that this is true, but that strategies between households within a ranch vary significantly.

7. About half of the households in Merueshi moved very little, whereas the other half changed family and herd/flock locations frequently. Movement patterns in time and space were rather erratic, smallstock changing location more often than cattle. Movements inside and outside the ranch took place throughout the study period, with a rising trend in 1982 when rainfall patterns were erratic.

*Labour allocation to livestock production*

A 14-month labour allocation study was conducted using the time allocation technique. This technique relies on randomly timed visits to a household, during which the activities of all its members are recorded. Analysis for one of the three study sites has revealed important patterns in age/sex division of labour, as well as differences in labour allocation between wealth ranks and seasons. Some of the results for the Olkarkar Group Ranch are presented in Table 10. On this ranch male adults spent on average over 6 hr/day on livestock management. Their main tasks were watering and dipping animals, determining grazing areas, inspecting animals for disease, and treating them. Male adults rarely herded the animals. Female adults (over 15 years) spent on average only 1.4 hr/day, primarily caring for young stock and inspecting animals for disease. Maasai children spent a considerable amount of their time herding livestock: girls spent 5.3 hr/day and boys 4.5 hr/day. The lower figure for boys reflects the higher proportion of boys attending school. While members of poor households spent 1.3 hr/day/LSU on their own livestock-related activities, members of rich households spent only 0.2 to 0.3 hr/day/LSU. The difference reflects two basic factors: economies of scale in pastoral production, and the extent to which richer households are able to marshall extra-household labour through joining herding groups with poorer households.

Seasonal analysis of labour data shows that during the wet season there was a 19% increase in time spent on livestock management/worker. Women spent 39% more time, or an additional 0.5 hr/day, whereas men spent 30% more time or an additional 1.8 hr/day. Children spent 13% more time or an additional 0.8 hr/day. Overall, there was an

**Table 9. Use of watering facilities by season at Merueshi Group Ranch, Kenya, 1982–83.**

| Season | Use of watering facilities (% of total) | | | | |
|---|---|---|---|---|---|
| | Man-made | | | Natural | |
| | boreholes | pipelines | wells | rivers | ponds |
| Wet | 15 | 22 | 17 | 9 | 37 |
| Dry | 16 | 36 | 36 | 3 | 9 |

**Table 10. Labour time devoted to livestock management of Olkarkar Group Ranch, Kenya, 1980–83.**

| Wealth class | Time spent on livestock management | | | | |
|---|---|---|---|---|---|
| | Children[a] | | Adults | | All workers (hr/LSU/day) |
| | male | female | male | female | |
| | (hr/worker/day) | | | | |
| Poor | 5.0[b] | 4.6[b] | 6.3 | 0.8 | 1.29 |
| Medium | 5.7[b] | 7.1 | 6.0 | 1.5 | 0.60 |
| Rich | 6.4[b] | 7.6 | 7.9 | 1.5 | 0.25 |
| Ranch mean | 6.1 | 6.7 | 6.8 | 1.4 | |

[a] Over the age of 6, but under 15.

[b] Children in these categories spent an average of 2 hr/day at school.

increase of 0.8 hr/worker/day in the time spent managing livestock during the wet season. The time devoted to watering decreased, but that devoted to livestock work around the *boma* increased.

### *Producer profiles*

Pastoral systems are marked by long periods of drought and post-drought recovery which can affect production and consumption patterns for many years. A critical component of any pastoral research project is to learn where the people went and what they did during drought periods, even if these did not occur during the study period itself. ILCA's Kenya team has tried several ways of recording such 'longitudinal' data for the Kajiado Maasai. Producer profiles from a representative subsample have been constructed, recording changes in herds and flocks, family status, migrations and other drought responses. In order to supplement the data obtained in the 2-year descriptive study, progeny histories detailing the method of disposal (including death) of all offspring of selected animals were recorded. Wealth, family status (especially as it determines herd size and labour availability) and management skills were all found to affect the degree of losses during the last major drought in the 1975/76 season. Non-pastoral employment played an important role in post-drought recovery.

### *Human nutrition*

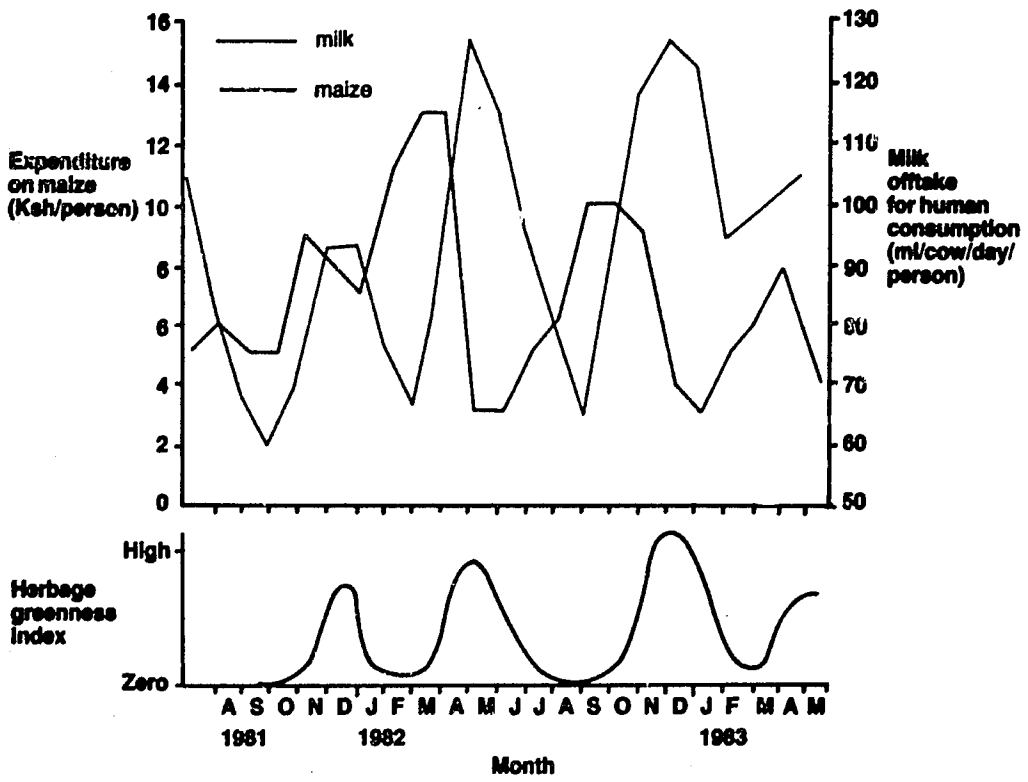
Studies on human nutrition were started in 1982 under a grant from the Ford Foundation. A subsample of 40 households was selected for this study. Initially, anthropometric measurements of women and children were taken, and information on dietary habits and preferences as well as estimates of quantities of food consumed were recorded by interviews based on 24-hour recall. A subset of 12 households was selected for intensive study of diets, and food prepared by each household was weighed. These measurements were taken seasonally to determine the effects of the dry and wet seasons on dietary intake.

The staple diet of the Maasai consists of milk, maizemeal and meat, the proportions of which vary greatly by season depending on the availability of milk. Figure 10 shows that on the Olkarkar Group Ranch increased milk production was positively correlated with the availability of green fodder and inversely related to maizemeal purchases. Milk was drunk fresh or in tea with sugar. Butterfat was an important infant food. Sour milk was consumed by men during the rainy seasons when milk was plentiful. Maizemeal was prepared with water and/or milk, and its availability was closely associated with the decline in animal blood consumption.

Meat consumption was irregular, being determined largely by the death of animals and the timing of ceremonies. Other cereals, pulses and vegetables were rarely included in the diet, and wild roots were eaten only by children when herding.

The food intake studies suggest that the diet in the northern part of the study area was more balanced than in the south. In both areas there were seasonal deficiencies

**Figure 10. Comparison between expenditure on maize per person, milk offtake for human consumption and herbage greenness index for Olkarkar Group Ranch, Kenya, 1981 – 83.**




in calorie intake. These deficiencies were borne out by measurements of the heights and weights of women and children over a 1-year period. Women and children in the southern area were for all periods nutritionally worse off than those in the northern area; fewer children in the southern area attained normal heights and weights, particularly in the dry season. Once the rains started, children gained weight rapidly while women did so more slowly.

Birth weights were normal but nutritional status varied with age. Children over the age of 5 were nutritionally worse off than those below 5, essentially due to the high energy demands of herding. Generally, children actively involved in herding and collecting water and firewood were nutritionally worse off than children who had no such responsibilities. Among women, younger wives were nutritionally better off than older wives, particularly in the northern area.

Morbidity varied with season, with a higher incidence of illnesses at the end of the dry seasons, suggesting that susceptibility to infectious diseases is linked to nutritional stress.

*Studies of research methods*

ILCA's Kenya team has emphasised the importance of developing appropriate methods for pastoral systems research (PSR). The ILCA/IDRC workshop on *Pastoral systems research* was an important step in the development of PSR methods, and the Kenya team made major contributions to discussions on household studies (including the collection of data on household budgets, livestock transactions and labour), on marketing and ecology and on animal productivity (particularly milk production). Work has also been carried out on a rapid, informant-based technique for stratifying populations according to wealth either before or after sampling in order to assess representativeness.

Surveys are an essential part of systems research, but standard techniques may be poorly adapted to mobile populations with a low level of literacy. ILCA's Kenya team, in conjunction with the Computer Unit at headquarters, is exploring different techniques for handling missing data – omissions which are characteristic of long-term studies among mobile pastoral populations.

# The Botswana Rangelands Programme

## Introduction

The economy of Botswana has grown rapidly in the last decade, but the lives of poor people in the rural areas have not improved correspondingly. Most of the poor live in the eastern communal areas, where material poverty is associated with range degradation, vulnerability to drought, low income and limited economic opportunities.

In Botswana livestock, and cattle in particular, are a major source of wealth, subsistence and security, and their number and productivity are major factors in the development of rural areas. Yet poor management of range and livestock is reducing potential primary and secondary productivity. Possible technical solutions are known, but factors such as lack of labour and capital and the fact that the land is communally grazed prevent their adoption. However, it may be possible to devise a socially acceptable strategy for communal range management using traditional institutions and practices, combining these with the currently popular acceptance of 'drift-fencing' of arable land, and taking advantage of the facility with which people in the communal areas form associations for the management of animals, water and land.

At present, the government's approach to the problems of range and livestock management relies on the identification of groups with an interest in common – a grazing area or management practice – with the aim of winning their support by dealing first with problems of disease, nutrition, water and management facilities. It is hoped that such groups will later come to accept the need for communal management, including controls on the distribution and numbers of livestock.

ILCA's work in Botswana has been concerned with the government's policies for the communal areas. Between September 1982 and December 1983, ILCA and various government departments and projects have studied range conditions and livestock production in two study areas. The research objectives have been to:

- Monitor the seasonal distribution of livestock in the two study areas;
- Measure home ranges and small-scale movements of selected herds;
- Explain animal distributions at various spatial scales in terms of the distribution, quality and quantity of range resources; and
- Demonstrate and adapt cost-effective and rapid survey methods so that approaches found useful in the two study areas can be used elsewhere in the communal areas.

The northern study area is within the project area of the recently established Agricultural Technology Improvement Project (ATIP) of the Botswana Government, supported by USAID. The southern area is under the Integrated Farming Pilot Project (IFPP) of the Botswana Government. ILCA works cooperatively with both these projects.

In the ATIP area, ILCA's work is intended to contribute information to the descriptive phase of the project. It also aims to help the Ministry of Agriculture identify groups of people, herds and areas of land where extension efforts should be focused during the implementation of a new policy towards cattle development and range management in the communal areas.

In the IFPP area, ILCA's work provides a technical and biological basis for proposals for communal range management related to the project.

ILCA's work in Botswana during 1983 was funded jointly by the Government of Botswana and ILCA.

## Diagnostic studies

Diagnostic studies in 1983 included examinations of the vegetation, the distribution and abundance of livestock, and the nutrition, condition and feeding habits of animals.

### *Vegetation*

The species composition, structure and seasonal changes of vegetation were assessed to provide a background for the studies of livestock distribution, nutrition and feeding habits.

Species composition in the IFPP area proved to be correlated broadly with soil type, and four out of the ten dominant grass species were good fodder grasses. The ecological and economic significance of the distribution and abundance of palatable tree species is now emerging from studies of plant selection by browsing animals.

For structural analysis the vegetation was classified into 13 types according to tree canopy cover. A map for the IFPP area has now been completed. Methods used were a mix of conventional aerial photography, low-level 35 mm vertical colour transparencies, satellite imagery and ground truthing. Structure maps are used in applying correction factors for aerial surveys of animals, and for describing habitats.

Seasonal changes in the vegetation were monitored using a grid of 35 mm vertical colour transparencies taken from 400 feet during the aerial survey of livestock. The 16 factors measured included grass cover, height class and greenness, the areas of cropland or fallow, and the canopy cover of bush and trees.

### *The distribution and abundance of livestock*

Seasonal changes in the numbers and location of livestock were monitored at several scales. Aerial surveys were used at large and intermediate scales, while small-scale patterns were measured by following herds; a radio-tracking programme was also started for more detailed studies.

Aerial surveys were flown in alternate months over a full season in each study area. Distribution patterns were analysed at four scales using sample unit sizes of 200 m x 500 m, 1 km x 3.2 km, 2 km x 6.4 km and 3 km x 9.6 km. This approach was used because relationships between animals and range resources operate at different scales, each reflected by a particular pattern of animal distribution. Interpretation of animal – resource relationships therefore requires analysis at a range of scales.

To describe and interpret livestock distribution patterns at the smallest scales, 12 herds were followed in the IFPP area over a full season. A complementary study involving radio-tracking was delayed by technical problems. Both radio-tracking and herd-following trace the movements of individual herds. This knowledge may be crucial to the success of proposals which restrict herd movements.

It is apparent that even non-herded animals do not have a free choice in their use of the range. IFPP and the Rural Sociology Unit of the Ministry of Agriculture have, with ILCA's support, begun to study the ways in which people control livestock distribution. The intention is to build on existing methods in making proposals for communal range management.

### *Animal nutrition, condition and feeding*

Studies of feed intake and animal condition are needed for the interpretation of relationships between range resources and the abundance and movements of livestock. Three approaches were used: herd-following, condition studies and chemical analyses of forage.

Two cattle herds and two goat flocks were followed over 6 weeks of the dry season in the IFPP area. Factors recorded included time spent feeding and browsing, the occurrence and use of browse plants, and any management practices used. Browse plants eaten by the animals are being analysed for nutrients and fibre by ILCA's Nutrition Unit.

Seasonal and spatial differences in the condition of animals in the IFPP area were assessed by IFPP and ILCA by classifying cattle encountered along road transects into condition classes based on slaughter grades. The range resources along the road transects

were subsequently photographed from the air to assess vegetation condition. In the middle of the dry season the selection of plants by cattle feeding along the road transects was studied, and hand-plucked samples of grass and browse were taken. Fresh dung was also collected. Dung and feed are being analysed for nutrients and fibre by ILCA's Nutrition Unit.

Preliminary analyses of the condition study data are showing clear relationships between cattle condition and distance from water, grass cover, habitat type and cattle density. The approach used enables a distinction to be made between the effects of animal husbandry practices and the effects of access to range resources. The approach assumes that adjacent herds, being on similar range, will be in similar condition unless receiving different management. The distinction is important, for while husbandry practices can be dealt with by extension contacts with individual herd owners, access to range resources is a matter of range management requiring communal solutions. In ILCA's study resource effects became important towards the end of the dry season; for the rest of the year management effects appeared to account for most of the variation in cattle condition.

## Designing and testing improvements

ILCA's work in Botswana is not concerned with the design and testing of improvements directly with pastoralists, but rather with helping the government to perform these functions. Government plans for the two study areas are still in the formative stage, but future proposals for improvements are expected to include the introduction of fodder crops and grazing reserves, splitting of herds and strategic feeding, the location, relocation and seasonal closure of water points, and large-scale grazing rotations based on vegetation types, soil catenas and soil moisture regimes.

The proposals for range management will be tested to a limited extent by simple ecological modelling. This method has been chosen because of the complexity of the problems and the large areas of land involved. However, the only way to test the proposals satisfactorily will be to implement them.

# *Multi-purpose livestock*

## *Food*

*World production of meat and milk was 140 million and 469 million tonnes respectively in 1980. Together with fish and eggs, livestock products provided 33% of the global average intake of protein and 17% of the total intake of calories. In Africa from 1978 to 1980 livestock provided 20% of the human protein intake (FAO, 1983).*

## *Draught power*

*As a source of power, animals are three times more important than tractors in Africa and almost eight times more important in the Far East (FAO, 1981). Draught animals are used for crop cultivation, processing, irrigation and transport. In Africa, around 10 million draught animals are used to till 15% of the area cultivated each year. The high cost of machinery, lack of foreign exchange, poor maintenance and high fuel costs limit agricultural mechanisation in the continent. The improved use of animal resources represents an attractive alternative.*

## *Manure*

*Livestock manure contributes to crop – livestock interdependence by improving soil fertility. Dried manure is also used extensively as fuel. In Ethiopia, for example, dried manure provides heating and cooking fuel throughout the highlands and is also used as a building material.*

## *Other products*

*Fat is removed from livestock carcasses, yielding 10.3 million tonnes worldwide in 1980. Such fats can be used for margarine, cooking and soap. More than 2.5 million tonnes of wool are produced in the world each year, and hair from Camelidae and goats is used to make garments, tents, blankets and handicrafts in many developing countries. Hides and skins are also used extensively.*

## *Capital*

*Livestock represent an important capital asset in many farming systems. Not only can livestock be used as a source of cash when other sources of income (e.g. crop harvests) do not realize their full potential, but they also represent wealth and prestige in many societies. Livestock are vital for subsistence among pastoral communities.*

## *Employment*

*Much of the necessary work in keeping livestock on the family farm is performed by unsalaried women and children. Nevertheless, tasks tend to be more regular than those associated with seasonal crop production, and livestock provide a continuous source of employment in many rural areas where alternative occupation is scarce.*

*As a country develops there is generally a greater demand for livestock products. During the early stages of industrialisation and intensification of the livestock industry, livestock production becomes more labour-intensive and jobs are created (FAO, 1981).*

## *Users of crop byproducts*

*Crop byproducts and residues which are consumed by livestock, and which are otherwise of limited use, include vegetable waste, ground and fermented rice hulls, and maize, millet and sorghum stalks and leaves. There is little conflict between livestock and man in the use of such byproducts.*

## *Users of marginal lands*

*Plant production is severely limited in the arid and semi-arid rangelands. Livestock can survive in these areas on low-quality forages under variable rainfall conditions. The pastoralists who live in these areas are heavily dependent on their livestock, whose milk and sometimes blood provide the most important components of the human diet. Such communities can use some of the harshest areas of the world, areas that would otherwise not be inhabited by man.*

*In less arid areas also, most of the feed intake of ruminants is derived from fibrous forages. Much of this feed is produced on land unsuited to crop production or else lying fallow; much is also produced as an integral and beneficial part of a crop rotation.*

## *References:*


FAO (Food and Agriculture Organisation). 1981. *Agriculture toward 2000.* FAO, Rome. 134 pp.

FAO. 1983. *The state of food and agriculture.* FAO, Rome. 203 pp.

# Central research and support units

## The Livestock Policy Unit

### Introduction

The work of ILCA's newly formed Livestock Policy Unit began in earnest during 1983 with the appointment of several additional staff. The role of the Unit is to assess the importance of policy issues in livestock development, to carry out research on selected policy issues, and to bring the results of these and other studies to the attention of those who make policies for the livestock sectors of African countries.

During 1983 much attention was paid to defining the work programme for the next 2 years. Work started on three major studies:

- The financing of livestock services in Africa;
- The identification of some of the factors which determine why the livestock sectors of some countries perform better than those of others; and
- The effects of the growing quantity of dairy commodities imported into Africa on domestic consumption, production and welfare.

Research proposals were prepared on two other subjects: pricing policies and domestic dairy marketing systems. Staff were identified to join the Unit in early 1984 to work on these two areas. Most of the funds required to hold a major conference during 1984 on livestock policy issues were secured, and authors were commissioned to write the necessary background papers.

### Financing of livestock services

The study on the financing of livestock services will continue throughout 1984. The rationale for this study is the continuing series of financial crises that affect African livestock development services. The financial resources available to them are inadequate, not just to meet their more ambitious intentions but even to fulfil their duty to provide routine protection against the major livestock diseases. Among other things, the study is investigating the following:

- The relationship between governments' budgets for livestock services in different countries and the importance of the livestock sectors in those countries;
- The structure of expenditure, and in particular the ratio between staff and non-staff expenditure;
- The extent to which livestock sectors and services can be self-financing through taxes and user charges; and
- The effect of different financing methods on resource allocation, the overall quality of the services rendered, and the distribution of services between different classes of livestock keepers.

Some preliminary results, in respect of 14 countries mainly in West and central Africa for which easily accessible data exist, were presented at workshops in Addis Ababa and the UK. These results indicate that:

- Governments spend on livestock sectors only a small proportion of the revenue they raise from them in terms of taxes and fees;
- An excessive and increasing proportion of total expenditure on livestock services in most countries is going to staff costs, with consequent shortages of money for vaccines, drugs and transport; and
- The numbers of middle level staff in particular are being increased too fast in relation to the numbers of more junior staff operational at field level.

In the second half of 1983, visits were made to a number of East and southern Afri-

**Table 11. A comparison of annual growth rates in the output of major food crops and livestock, and in human population, 1963–80.**

| Region | Annual growth rate (%) | | | | |
|---|---|---|---|---|---|
| | Total livestock output 1963–80[a] | | | Major food crop output 1963–80 | Human population |
| | Beef | Sheep and goat meat | Cow's milk | | |
| Sub-Saharan Africa | 2.2 | 3.4 | 1.4 | 1.6 | 2.8 |
| West Africa | 2.3 | 3.4 | 2.1 | 0.9 | 2.9 |
| Central Africa | 4.3 | 3.0 | 0.5 | 3.0 | 2.3 |
| East Africa | 2.5 | 3.6 | 1.5 | 1.9 | 2.8 |
| Southern Africa | 1.3 | 2.0 | 0.2 | | |

[a] For livestock output 1963 = average of 1961–65, and
1980 = average of 1979–81.
Source: FAO Production Yearbooks.

can countries in order to expand the geographical coverage of the study.

## Livestock output in sub-Saharan Africa

During the 1960s the output of meat from sub-Saharan Africa's ruminant livestock population (which provides 80% of all livestock output in the region) did slightly better than keep pace with the growth of the human population, but output of milk fell behind. However, in the 1970s the rate of growth of all kinds of ruminant livestock output was only about half that of the human population. Taking both decades together meat output, but not milk, from ruminant livestock grew faster than crop output (see Table 11). Meat and milk yields per head of livestock have tended to rise in most subregions, although often more slowly in the 1970s than in the 1960s. However, in the case of some regions and some commodities yields have declined (see Table 12).

Although output from ruminant livestock in the sub-Saharan region as a whole and in most subregions within it has been poor, there are wide variations in the performance of individual countries. A study was undertaken to identify the factors associated with better or worse than average performance in the period from 1963 to 1980, and to determine which of them might be causally related to performance. In this study only easily available data (mainly those published internationally) were analysed, and as a consequence many of the variables tested were, at best, only proxies for the most likely poten-

**Table 12. Changes in yield[a] per animal in sub-Saharan Africa, 1963–80[b].**

| Region | Yield per animal relative to 1963 (1963 = 100) | | | | | |
|---|---|---|---|---|---|---|
| | Beef | | Sheep and goat meat | | Cow's milk | |
| | 1970 | 1980 | 1970 | 1980 | 1970 | 1980 |
| Sub-Saharan Africa | 102 | 102 | 103 | 106 | 99 | 102 |
| West Africa | 101 | 102 | 114 | 117 | 106 | 109 |
| Central Africa | 109 | 110 | 107 | 107 | 130 | 131 |
| East Africa | 104 | 103 | 94 | 97 | 96 | 101 |
| Southern Africa | 101 | 99 | 94 | 95 | 103 | 96 |

[a] Yield based on number of animals slaughtered or number of cows in milking herd.
[b] 1963 = average of 1961–65
1970 = average of 1969–71
1980 = average of 1979–81
Source: FAO Production Yearbooks.

tial causes. The reliability of much of the data is poor. However, fairly strong positive correlations were found between:

- Growth in livestock population and growth in output of the associated commodities (excluding cow's milk);
- Growth in cereal output and growth in livestock output; and
- Growth in GNP and growth in milk output.

No statistically significant correlations were found between livestock output and agricultural research, government expenditure in the agricultural sector or on veterinary services, or a number of other potential causal factors. This study is now complete and a summary version has appeared in *ILCA Bulletin* 17.

Late in 1983 work started on a study of the consequences of the imports of dairy commodities into Africa. Staff of the Unit also contributed several papers on other subjects at various conferences during 1983.

# The Livestock Productivity and Trypanotolerance Group

## Introduction

During 1983 the work of the Livestock Productivity and Trypanotolerance Group continued to focus on the biological and economic aspects of livestock productivity, with a strong emphasis on trypanotolerant livestock. Research was carried out in close collaboration with organisations in 12 countries of Africa.

## Trypanotolerance research

### *Network objectives*

In order to realize the maximum potential of trypanotolerant breeds of cattle and other livestock it is necessary to identify and measure the environmental factors which influence the trypanotolerance trait so that the appropriate management measures can be instituted. It is also important to understand the mechanisms of trypanotolerance with a view to enhancing this trait. Current work at ILCA and at the International Laboratory for Research on Animal Diseases (ILRAD) in Nairobi is being carried out on both topics. With inputs from a number of donor agencies, ILCA is coordinating a network of national research and epidemiological and productivity studies. At present the network includes nine countries in West and central Africa: Zaire, Gabon, Nigeria, Ivory Coast, Congo, Benin, Togo, Senegal, and Gambia. The objective of these investigations is to evaluate the productivity of trypanotolerant breeds of domestic ruminants, and of other breeds where relevant, living under different measured levels of tsetse-trypanosomiasis risk.

Once essential baseline data, which are completely lacking at present, are established and productivity indices are computed, it should be possible:

- To predict the productive capacity of different breeds living under different levels of tsetse-trypanosomiasis risk e.g. to determine precisely at what level of risk N'Dama cattle cease to be productive and when they need health or improved management care. This knowledge will lead to more efficient use of different breeds and, consequently, to increased livestock production; and
- To evaluate the cost-effectiveness and impact of the introduction of any control method such as trypanocidal drugs, tsetse control, improved management and nutrition.

### *Network operations*

The four sites from which the first results were analysed in 1983 were in Gabon, Ivory Coast, Nigeria and Zaire.

In Gabon work centred on the ranch of the Office Gabonais d'Amélioration de la Production de Viande at Okouma, where N'Dama and Nguni cattle and their crosses are raised under different levels of trypanosomiasis risk and prophylactic regimes.

Preliminary indications of relationships between packed red blood cell volume (PCV) as a measure of anaemia, and daily liveweight gain over the previous month in

# *Trypanotolerance: Background to ILCA's optimism*

*The problems of increasing livestock production in the face of a widespread epidemic disease are exemplified by tsetse-transmitted trypanosomiasis. At present, tsetse flies infest approximately 10 million km² of Africa, affecting 38 countries. Seven million km² of this area would otherwise be suitable for livestock or mixed agricultural development. Currently, about 50 million cattle in countries affected by tsetse are exposed to the disease.*

*The information available indicates that the overall situation is deteriorating and that, since the 1950s, the areas of savanna infested by tsetse have continued to expand. Thus, with the steadily increasing human population, there are now too many cattle on the tsetse-free pastures and there is an increasing need to utilise the areas currently infested.*

*Control of the disease is difficult, however. Because of the antigenic variation exhibited by each of the three trypanosome species which cause the disease – namely Trypanosoma congolense, T. vivax and T. brucei – no vaccine is available for field use. Present control methods involve treating animals with trypanocidal drugs or limiting tsetse flies by residual or non-residual insecticides and by habitat clearance. While such methods can be highly effective in certain situations if properly applied, their net impact at the continental level is small. This is due partly to the lack of manpower trained to introduce these measures, partly to the cost of implementation, and partly to the massive area involved.*

*Because of these constraints increasing consideration is now being given to the use of trypanotolerant breeds of domestic livestock in tsetse-infested areas. It has long been recognized that certain breeds of domestic livestock, as well as some species of wildlife, possess the ability to survive and be productive in tsetse-infested areas, without the aid of trypanocidal drugs, where other breeds rapidly succumb to the disease. This trait has been termed trypanotolerance and is generally attributed to the Bos taurus breeds of cattle of West and central Africa, namely the N'Dama and the West African Shorthorn, as well as to some sheep and goat breeds from the same regions.*

*While trypanotolerant breeds of cattle are widely used in livestock production in certain areas of West and central Africa, they represent only about 5% (8 million out of 147 million) of the total cattle population in the 38 countries where tsetse occur.*

*ILCA's research has shown that the productivity of trypanotolerant cattle relative to other indigenous breeds is much higher than previously believed. Furthermore, trypanotolerance is an inherited characteristic and may therefore be exploited in breeding programmes.*

*Thus it would appear that rigorous natural selection, over several thousand years, of characteristics that permit survival in the face of tsetse challenge has provided Africa with a group of animals capable of making a significant contribution towards resolving the continent's food problems.*

breeding cows diagnosed negative or positive for trypanosomiasis, are shown in Table 13. In all three breed groups there occurred a significant drop in PCV and a decrease in daily liveweight gain or an increase in daily liveweight loss of approximately 157 g in trypanosomiasis-positive animals.

In northern Ivory Coast, sheep research carried out by the Société de Développement des Productions Animales (SODEPRA-Nord) was extended to cover all the recording requirements in a village in the sub-humid savanna around Korhogo. The work is being performed in collaboration with SODEPRA-Nord, the Veterinary Laboratory of Korhogo and an FAO project on tsetse control.

During 1983, matching data on the productivity and health status of 350 Djallonke sheep and their offspring were analysed for the period January 1982 to March 1983. The flocks under study are kept in eight villages around the town of Tengrela in Ivory Coast under two herd management systems. Monthly performance data recorded included growth, reproduction and deaths. Health

**Table 13. Packed cell volume (PCV) and daily liveweight gain (DLG) over the month before cows were diagnosed negative or positive for trypanosomiasis.**

| Breed | PCV (%) | | | | DLG (g) | | | |
|---|---|---|---|---|---|---|---|---|
| | Trypa-negative | | Trypa-positive | | Trypa-negative | | Trypa-positive | |
| | n[a] | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ | n | $\bar{x}$ |
| N'Dama | 684 | 39 | 144 | 31 | 591 | −3 | 143 | −149 |
| Nguni x N'Dama | 600 | 38 | 124 | 28 | 553 | 159 | 124 | −14 |
| Nguni | 451 | 37 | 100 | 28 | 396 | 134 | 110 | −19 |

[a] n = number of cattle in sample; $\bar{x}$ = mean value.

data recorded included blood analyses and faeces examination. Tsetse data were obtained from regular surveys in three areas.

Figure 11 indicates the type of approach taken in the analysis of a matching animal production/health data set, in which monthly body weights are related to relevant disease parameters and rainfall.

Also in Ivory Coast, GTZ agreed to fund the extension of research to cover cattle in addition to sheep in an area of higher trypanosomiasis risk. This operation started in July 1983, following the training of a German scientist in Nairobi.

In Nigeria the ILCA Humid Zone Programme has collected information on matching production, health and tsetse aspects in two contrasting situations for village small ruminants. One is in a low-to-medium challenge zone, and the other in a virtually tsetse-free zone. Initial analyses were carried out in September 1983.

In Zaire research focused on N'Dama cattle raised in ranches and in *métayage*[1] operations under various levels of trypanosomiasis risk. Field operations started in November 1982. The recording programme became fully operational in the ranches at the end of April 1983. The *métayage* operations are dependent on the recruitment of a second associate expert at the end of 1983.

The Government of Togo and GTZ proposed the extension of the activities of the Centre de Recherche et d'Elevage at Avetonou (CREAT), with *métayage* operations being expanded to 300 N'Dama females in village herds around the station. The *métayage* project includes cattle breeding and fattening, and the use of work oxen. ILCA's team is providing technical advice and training for local scientists, and carrying out data analysis. The same recording scheme will also be applied to a village cattle project funded by the Togo Government and GTZ. The project is in the Centre Region and concerns Somba and Borgou cattle. Following the training of two Togolese scientists in Nairobi, this operation began in December 1983.

In 1984, further work will be conducted at new sites in Benin, Gambia and Senegal. In Benin, in conjunction with FAO/UNDP, ILCA will conduct research on herds on three farms – Samiondji, M'Betecoucou and Okpaha – as well as in surrounding villages. The Lagune, Somba and Zebu breeds will be studied. It has been agreed that ILCA will organise training, provide technical supervision and conduct data analysis.

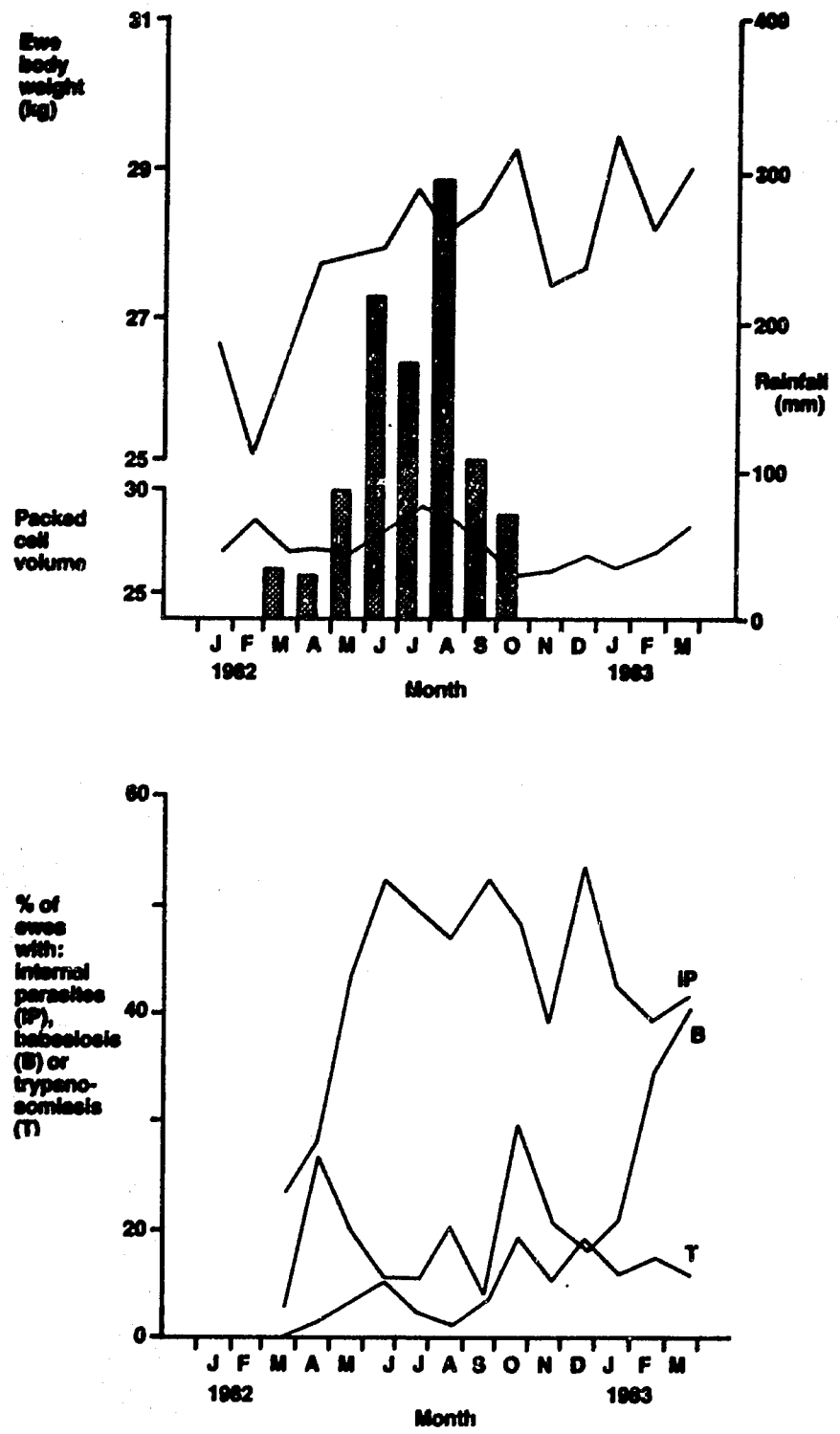
In Gambia the African Development Bank has agreed to finance an N'Dama production project. The project will have a strong research component aimed at evaluating N'Dama production in villages under various levels of trypanosomiasis risk, and at improving productivity. The productivity and health surveys will be carried out by ILCA and ILRAD, with funds provided by the European Development Fund (EDF). In 1981, ILCA was requested by the Government of Senegal to organise and support similar research work on Djallonke sheep and N'Dama cattle in Casamance and Senegal Oriental, which encompass different ecological zones and degrees of tsetse challenge. This proposal has been linked with a request to EDF to fund the Gambian operation. The two projects will therefore constitute a single, integrated operation.

[1] The *métayage* system is a contract system used in several African countries to introduce cattle husbandry at the village level in areas where it has not been a traditional activity.

## Livestock productivity research

During 1983, ILCA was involved in a considerable number of comparative breed studies, in cooperation with national organisations or private producers, and sometimes

Figure 11. Djallonke ewe body weight, packed cell volume and incidence of trypanosomiasis, babesiosis and internal parasites in relation to rainfall distribution, northern Ivory Coast, 1982 – 83.



with other international organisations. The aim is to build up comparative production information on important livestock groups in Africa so that decisions can more easily be made when a breed has been shown to be a constraint in a particular production system. In this way the many questions directed to ILCA on the value of alternative genotypes for specific production systems in various ecological zones can be answered more clearly.

In Ethiopia, results of dairy crossbreeding work at the Arsi Rural Development Unit (ARDU) have been analysed by a visiting scientist in cooperation with ILCA's Highlands Programme. These results were published during 1983 as *ILCA Research Report* 11 (see p. 7).

In Tanzania, in conjunction with ILRAD, Amboni Estates (at Tanga), and May and Baker Ltd, the evaluation of the productivity of Boran beef cattle maintained under prophylaxis against trypanosomiasis continued. A scientist from May and Baker was seconded to ILCA for the whole of 1983. Details of approximately 24 000 calvings, occurring between January 1973 and December 1982, were extracted from the ranch records. Complete performance, health, prophylaxis and therapeutic records of these cows and their calves were constructed. Major analyses covering biological and economic aspects of productivity will be carried out early in 1984.

In Kenya, analyses continued of data on the Boran and its crosses with several different breeds under a range of management systems and ecological zones. These data were recorded on 11 commercial herds and showed the performance levels achieved over a 12-year period by pure Boran cattle under extensive range conditions with 720 mm annual rainfall. A mean calving interval of 13.8 months, preweaning survival of 94.6% and an 8-month calf weaning weight of 174 kg resulted in an average of 141 kg of 8-month-old weaner calf being produced per cow per year, or 35 kg of weaner calf per 100 kg of cow metabolic weight per year.

A research scientist from Sierra Leone completed a 5-month research fellowship on N'Dama cattle productivity at Teko Livestock Station and obtained initial results on crossbreeding with Sahiwal. The overall herd productivity was 35 kg of 6-month-old calf per cow per year, 20 kg of 6-month-old calf per 100 kg of cow per year and 80 kg of 6-month-old calf per 100 kg of cow metabolic weight per year. Herd productivities of N'Dama cows with Sahiwal-sired calves were 10% higher than those with N'Dama-sired calves, mainly due to a 30% faster growth of Sahiwal-sired calves. In spite of preferential management and health treatment the herd productivity of pure Sahiwals was 3% lower per 100 kg of cow per year and only 12% higher per 100 kg metabolic weight of cow per year than N'Damas with Sahiwal cross calves.

A research scientist from Zimbabwe began a 4-month fellowship on analysis of data from Africander, Mashona, Nkone and Tuli cattle and their crosses with several different breeds at Matopos Research Station, Zimbabwe.

# The Forage Legume Agronomy Group

## Introduction

A Forage Legume Agronomy Group was established at ILCA's headquarters in 1982, incorporating the plant collection work which had been carried on since 1980 in the Highlands Programme. The long-term objectives of the Group are to investigate, evaluate and promote the introduction of more productive plants, particularly legumes, into African livestock production systems of all types.

The initial research staff, responsible for plant collection and germplasm introduction, are identifying, acquiring and screening suitable legume lines at a range of sites. This work aims to provide seeds and technical advice for ILCA's field research teams and for national research and development organisations throughout sub-Saharan Africa. When fully staffed, the Group will be concerned also with legume establishment and ecology, productivity in pastures and cropping systems, N fixation, soil fertility and improvements in crop yields.

It is hoped that the Group will play a key role in training and communication among forage research workers in Africa, through the publication of germplasm and forage information newsletters and the development of a forage systems network.

## Germplasm acquisition

Seven collecting trips were made in Ethiopia during the 1982/83 growing season. Four of these were in the highlands and three in the lowlands, and the trips resulted in a total of 1124 accessions. Most of the accessions collected were of the order Leguminosae and included 25 genera and 66 identified species. About three quarters of the accessions were collected in the highlands, and of these about two thirds belong to the genus *Trifolium*. *Trifolium semipilosum* and *T. tembense* were the most common highland accessions. In the lowlands, *Neonotonia wightii*, *Stylosanthes fruticosa* and *Zornia glochidiata* were the major species collected. Six further collecting trips were made in Ethiopia towards the end of 1983, with an increased emphasis on lowland legumes. ILCA's germplasm collection activities are supported by the International Board for Plant Genetic Resources (IBPGR) in Rome.

Sufficient stocks of commercial forage cultivars were acquired to enable the Group to provide small (50 g) quantities to all who requested them. Several hundred lines of *Vigna sinensis* were received from the ILCA programme in Mali for storage at headquarters.

In 1983 the total germplasm collection increased by 82% to 3556 accessions. Details of these accessions including sources and/or sites of collection and other data, classified by 120 descriptors, are stored on ILCA's computer at headquarters.

## Germplasm evaluation and multiplication

During 1983 the Group screened a large number of lines of forage germplasm at a range of altitudes, rainfalls and soil types at five sites in Ethiopia (Table 14). Two 2-ha irrigated sites were established during 1983, one in the Rift Valley (1650 m a.s.l.) for the screening of tropical and subtropical lines and one near Addis Ababa (2400 m a.s.l.) for the screening of temperate lines.

In the Rift Valley, the forage species with the best growth and persistence after two seasons were lines of *Stylosanthes guianensis*, *S. fruticosa*, *S. hamata*, *Centrosema brazilianum*, *C. pascuorum*, *Desmodium distortum* and *Dolichos lablab*. A study which related the environments of the Rift Valley to other areas of Africa was completed during 1983, and published in *ILCA Bulletin* 17.

Research on native highland *Trifolium* species has shown marked differences both between species and between accessions within *T. tembense*. There was a strong response to P fertilizer on P-deficient soils and the addition of as little as 10 kg P/ha was found to significantly improve growth rates and to enhance interspecific differences at the Shola site (Figure 12). The native *Trifolium* species have been found to be excellent seed producers (200 to 800 kg/ha), but to require at least 65 days of effective rainfall to reach maturity. DM yields of these species were as high as 6 t/ha, linear growth being recorded at 86 kg DM/ha/day during the latter (drier) part of the rainy season for *T. quartinianum*.

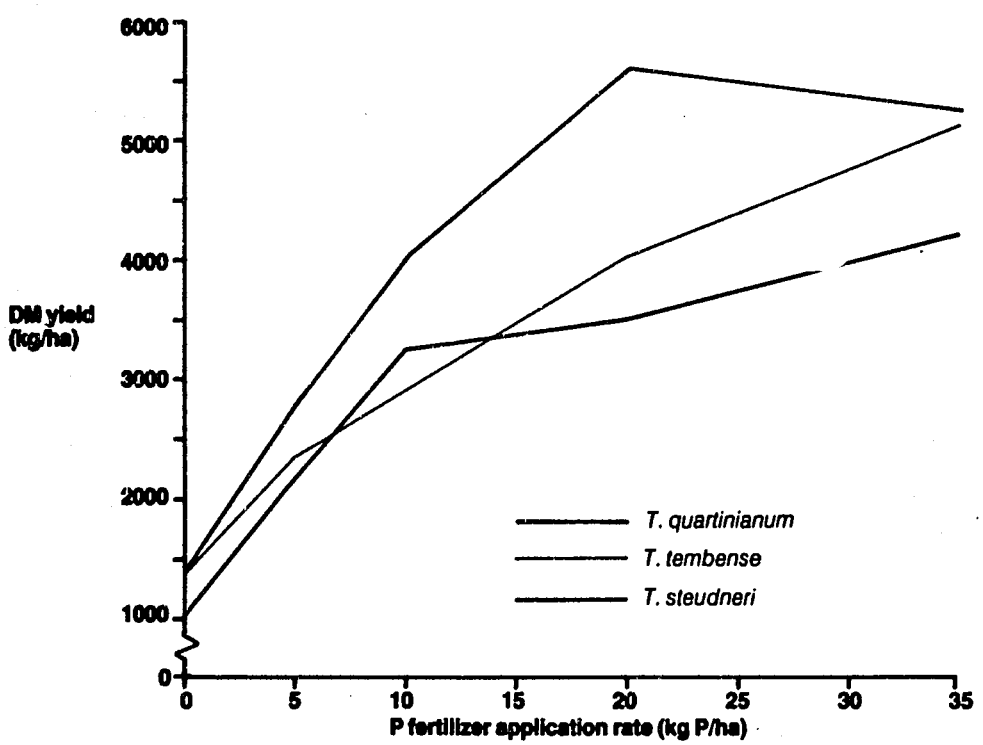
**Table 14. Number of forage lines and trials planted at five sites in Ethiopia during 1983.**

| Site (altitude, rainfall) | Activity | No. of lines (trials) planted | | |
|---|---|---|---|---|
| | | Legumes | | Grasses |
| | | annual | perennial | perennial |
| 1. Debre Berhan (2900 m, 1100 mm) | screening | 12 (1) | | |
| 2. Shola/Mulo (2400 m, 1100 mm) | screening | 209 (5) | 119 (3) | 162 (3) |
| | replicated trials | (8) | (1) | (3) |
| | multiplication | 53 | 8 | 11 |
| 3. Debre Zeit (1800 m, 800 mm) | screening | | 22 (11) | |
| | replicated trials | 20 (3) | | |
| | multiplication | | 39 (1) | |
| 4. Abernossa (1650 m, 800 mm) | screening | | 170 (2) | |
| | replicated trials | | 8 (1) | |
| 5. Rift Valley (800–2000 m, 450–1300 mm) | screening | | 23 (12) | |
| | multiplication | 10 | 160 | 24 |

## Cooperative activities

Seed was supplied to a number of individuals, ministries and other research organisations throughout sub-Saharan Africa during 1983. Close contacts were maintained with forage researchers throughout Ethiopia by means of the Forage Network in Ethiopia established by ILCA at the Ministry of Agriculture. The activities of this network include regular meetings, field trips and multi-location trials. ILCA now publishes a quarterly newsletter to support the network. The Group is also responsible for publishing a Germplasm Newsletter three times a year in cooperation with the Plant Genetic Resources Centre in Ethiopia. This newsletter is now distributed to 1700 people in Africa and elsewhere in the world.

**Figure 12. The effect of P fertilizer on forage dry matter yields of four native clovers, Shola, 1983.**



# *Livestock and human nutrition*

*Meat and milk have long been recognized as important contributions to the human diet. However, the contribution of livestock goes far beyond the direct effects of meat and milk. Livestock in many countries are a critical resource in the production of food crops, and improvements in livestock productivity often act as catalysts for improvements in crop enterprises.*

*In pastoral systems livestock are traditionally used for milk production; the major production problems of such systems are insufficient feed and water during the dry season. Considerable potential for improving human nutrition in these systems lies in stabilising production and increasing the cash income of pastoralists, enabling them to buy a wider variety of food items. Many pastoralists, such as the Maasai in Kenya, are now increasing the proportion of cereals in their diet. For the Maasai, cash for buying more cereals comes from the sale of milk.*

*One of ILCA's main objectives is to exploit the complementarity of the livestock and crop components of mixed farming systems. Stimulating crop yields through livestock improvement increases the number of calories available for producers and other consumers. For example in Mali, millet is the major food crop, but its production depends on the amount of land ploughed by oxen: by providing extra dry-season feed for work oxen, ILCA's team hopes to increase the area of land planted to millet.*

*In Nigeria, ILCA's studies on alley farming are improving goat and sheep production while maintaining high output of food crops. Small ruminants in the humid zone of West Africa are a significant source of income, particularly for poor families, and an improvement in their status should result in higher selling prices and increased cash income for purchasing a wider variety of food items.*

*While it is possible to have an adequate human diet which excludes animal products, the importance of the quality of animal protein is well documented. Using a reference standard of the hen's egg or mother's milk as the 'perfect' protein (100), meat proteins from ruminant livestock have a value of about 80 and those from cow's milk 96. Most plant proteins have values no higher than 75, and many are between 50 and 65. A balanced diet is more easily attained if it includes animal protein.*

*The demand for meat and milk has increased rapidly in Africa, as witnessed by the dramatic increase in imports of these products (see Centre Spread). Imports are a drain on the foreign exchange revenues of African countries and often place the price of livestock products out of reach of the poor. Increases in livestock production will in the long term reduce the price of livestock products for the poor and allow alternative uses of the money invested in imports.*

*Livestock have a critical role to play in human nutrition, by contributing directly to the diet through meat and milk and indirectly through increasing the yields of food crops and boosting household income.*

# The Nutrition Unit

## Introduction

ILCA's Nutrition Unit is based at headquarters and includes laboratory and animal barn facilities. The Unit provides a laboratory analysis service for ILCA's field programmes and for other African institutions. The Unit also carries out original research on the development of improved nutrition and feed for African livestock.

### *Shola Farm*

Facilities for nutrition research have been further improved by the construction of a second animal barn with facilities for individually feeding up to 48 growing stock. Livestock at ILCA headquarters at the end of 1983 included 19 cows, 32 heifers and calves, 4 oxen with oesophageal fistulae, 2 with rumen fistulae and 14 traction animals used for the construction of a pond by the Highlands Programme. A sheep flock of approximately 150 head supplied animals for digestibility trials as well as for reproduction studies. During the 1983 wet season, 2.5 ha was used for initial screening of plant introductions and a further 5 ha was sown to improved pasture. Farmland was also used to demonstrate the broad-bed system of cultivation being evaluated by the Highlands Programme. A further area was used for the production of the local *Trifolium tembense* for use in feeding trials.

### *Nutrition and soils laboratory*

Laboratory facilities were expanded during 1983 with the installation of an atomic absorption spectrophotometer and a flame photometer, which together enable a large range of both macro- and micro-elements to be determined. Progress was made on setting up a laboratory for soil analysis, and soil samples are now being processed. A modified apparatus for the determination of *in vitro* digestibility has been constructed, and determinations have been made on a wide range of samples.

During the year, a total of 47 446 determinations were made on 6103 samples. Approximately half the samples were received from ILCA's field programmes and research units based in Ethiopia, and half from

ILCA's field programmes outside Ethiopia and from collaborating institutions.

## Forage studies

### *Browse intake and digestibility*

Routine methods of forage analysis developed in temperate areas do not reflect the actual values for digestibility and intake of browse for camels and goats. This may be caused by the presence of relatively high levels of inhibitory compounds such as alkaloids, tannins, terpenoids or cyanogenic glycosides. The nutrition laboratory is therefore developing new methods suitable for the prediction of the nutritive value of browse.

The laboratory's work has so far concentrated on those tannins which have lower protein digestibility, inhibit microbial enzymes and reduce palatability. A new gravimetric method for the determination and isolation of tannins by precipitation with ytterbium has been developed. The inhibitory properties of isolated tannins can then be studied. These properties depend both on the quantity of tannins present in the plant and on their chemical structure. Inhibition of cellulase activity is measured by incubating the enzyme with isolated neutral detergent fibre (NDF).

**Table 15. Percentage of standard neutral detergent fibre (NDF) digested by cellulase alone or with tannin added, and levels of tannin in five browse species.**

| Species | % NDF removed by cellulase | Tannin content (% of DM) |
|---|---|---|
| Control (no tannin added) | 50.5 ± 0.8 | – |
| *Cadaba farinosa* | 50.7 ± 0.5 | 14.1 ± 1.5 |
| *Acacia nilotica* | 46.5 ± 0.1 | 49.1 ± 1.5 |
| *Acacia seyal* | 28.6 ± 1.1 | 28.1 ± 0.6 |
| *Rhus natalensis* | 14.6 ± 0.3 | 33.1 ± 0.2 |
| *Euclea schimperi* | 14.2 ± 1.0 | 43.9 ± 0.6 |

Table 15 shows the percentage of NDF digested by cellulase alone or when tannin from an equivalent quantity of browse is added. It can be seen that tannins from *Euclea schimperi* and *Rhus natalensis* had the greatest effect in inhibiting cellulase, while *Cadaba farinosa* had the least. Two of these species – *C. farinosa* and *R. natalensis* – are important browse components of the southern Ethiopian rangelands; the former is consumed by all classes of stock, whilst the latter is intensively browsed by camels. *E. schimperi* is not widely used by cattle, goats or camels.

### *Use of legumes to improve the nutritive value of crop residues*

Although it has been shown that the nutritive value of fibrous crop residues may be improved by treatment with alkalis etc, these

**Table 16. Intake and digestibility by sheep of different levels of *Trifolium tembense* hay fed with cereal straws.**

| Straw type | *Trifolium* hay as % of total intake | DM intake (g/kg $LW^{0.75}$) | | | % digestibility of whole diet |
|---|---|---|---|---|---|
| | | *Trifolium* | Straw | Total | |
| | 0 | 0 | 51.5 | 51.5 | 45.0 |
| Teff straw | 19.3 | 12.0 | 50.2 | 62.2 | 46.9 |
| | 35.6 | 23.9 | 43.2 | 67.1 | 52.5 |
| | 50.1 | 36.7 | 36.5 | 73.2 | 56.1 |
| | 0 | 0 | 59.5 | 59.5 | 53.8 |
| Oat straw | 14.0 | 8.6 | 52.9 | 61.5 | 55.0 |
| | 23.9 | 16.1 | 51.3 | 67.4 | 60.4 |
| | 35.7 | 24.5 | 44.1 | 68.6 | 60.8 |
| | 0 | 0 | 45.5 | 45.5 | 40.4 |
| Wheat straw | 19.4 | 10.1 | 42.0 | 52.1 | 44.7 |
| | 34.2 | 18.6 | 35.8 | 54.4 | 49.3 |
| | 44.1 | 27.3 | 34.6 | 61.9 | 48.3 |
| | 0 | 0 | 42.8 | 42.8 | 54.2 |
| Maize stover | 24.3 | 10.0 | 31.2 | 41.2 | 59.2 |
| | 34.7 | 19.3 | 36.3 | 55.6 | 61.0 |
| | 50.7 | 28.1 | 27.3 | 55.4 | 65.0 |
| 100% *Trifolium* | 100 | 90.2 | 0 | 90.2 | 66.7 |

methods are generally out of reach of the smallholder farmer. For this reason, research during 1983 focused on the use of legumes to improve intake and digestibility. Feeding trials were carried out in which common Ethiopian crop residues, including oat straw, wheat straw, maize stover and teff[1] straw, were fed to sheep with different levels of *Trifolium tembense* hay. It was shown that total intake and digestibility of cereal straw could be improved by the addition of some 45% of the legume hay. A low-quality maintenance feed with approximate intake of 50 g/kg $LW^{0.75}$ and digestibility of 50% was improved to an acceptable production ration with corresponding values of 58 g/kg $LW^{0.75}$ and 65%. However, wide differences occurred among the straws tested, and some of these are shown in Table 16. In all cases, it was noted that the increased intake was associated with lower levels of NDF in the total ration and with a decreased consumption of the straw. Analyses were carried out for individual dietary components including N, NDF, acid detergent fibre (ADF), Si, lignin and minerals.

[1] Teff *(Eragrostis tef)*, a cereal crop used for making the Ethiopian bread *injera*, is widely grown in the highlands of that country.

*Trifolium* hay was used with wheat or teff straw and urea or *nueg (Guizotia abyssinica)* meal in a factorial trial in which weight gains were measured in growing heifers. Wheat straw was inferior to teff straw, adjusted mean weight gains being 176 and 184 g/day respectively. Growth rates of control animals (72 g/day) were improved by the addition of either urea (to 179 g/day) or *nueg* meal (to 289 g/day). The growth rates of heifers fed *Trifolium* hay (227 g/day) were significantly higher than those fed straw alone (133 g/day). The addition of *Trifolium* significantly increased total DM intake in diets based on wheat straw but not those based on teff. There was no economic advantage in feeding *Trifolium* and *nueg* meal together to growing animals. The occurrence of oestrus in the experimental heifers was observed during the experiment. Although differences were not consistent, mature heifers on supplemented rations had the most regular cycles.

In a similar study, the effect of the addition of faba bean *(Vicia faba)* haulms to teff and wheat straw was investigated. Teff straw was significantly superior to wheat straw in terms of intake, but not in terms of liveweight gains. Both urea and bean haulms significantly depressed intake. However, while urea depressed liveweight gain, bean haulms had no effect on liveweight. Addition of *nueg* meal had no effect on DM intake but significantly improved animal performance. A combination of *nueg* meal and urea also improved animal performance.

## Nutrition studies

### *Grazing animals*

The nutritional status of grazing lactating cows was studied in two widely differing sites in the Borana area of Sidamo in southern Ethiopia. Samples of cow faeces and of forage preferred by the cattle were taken at 6-weekly intervals. Cattle were condition scored and forage availability was determined simultaneously. Laboratory determinations were made of N, P, NDF, ADF, lignin, Si (as ADF ash), ash and DM solubility using pepsin and cellulase. Important major and trace minerals were also determined. There were significant differences between sites, among forage species and among sampling dates for the various determinations carried out. These were related both to forage availability and to condition score.

The Nutrition Unit is also collaborating with ILRAD and the Livestock Productivity and Trypanotolerance Group in the assessment of the nutritional status of livestock which are trypanotolerant or exposed to the stress of trypanosomiasis. A major objective is to identify nutritional components which may constrain productivity or make the effects of the disease more acute. The first location where work has already started is at Muhaka in the Coast Province of Kenya, where the ILCA team is collaborating with the Kenya Veterinary Department. Future work will include sites in Gabon, Zaire and Ivory Coast. Nutritional assessment involves condition scoring, collection and analysis of forage and faecal samples, and analysis of blood and bone samples.

### *Work oxen*

The nutritional plane of an ox during the cultivation season is likely to be important in determining work output. In order to assess the magnitude of this effect, oxen were subjected to two levels of nutrition: approximately 100% and 50% of calculated maintenance and work requirements. Measurements were made on both Ethiopian Zebu and crossbred (Friesian x Zebu) animals while they were

working singly with traditional implements in the fields of participating farmers. These studies were made over a period of approximately 3 months. Although weight losses of the low-plane animals were appreciable, no differences in work output could be detected under the conditions of the study. It therefore appears that the nutrition of an ox during the working period is not as critical as its condition at the beginning of the season. On-station trials are continuing under more rigorously controlled experimental conditions at the Debre Zeit research station.

*Dairy cattle*

An early weaning system for dairy cows adapted to Ethiopian conditions would enable healthy heifers to be reared whilst permitting farmers to sell more whole milk. Calves reared by means of a conventional system using approximately 300 litres of milk in total were compared to calves which were fed only 95 litres up to 4 weeks of age. All calves had access to good-quality roughage. Preweaning gain was 370 and 324 g/day in the two groups respectively. Daily gain for the 3 months after weaning was 241 and 342 g/day for the two groups respectively. Field trials of this system are now being planned in collaboration with the Highlands Programme.

An observation trial was carried out to determine the value of urea as a supplement to lactating dairy cows. The urea (75 g) was dissolved in 0.5 litres of water and spread on 1 kg of chopped oat straw, which was fed twice daily as a separate ration. When this had been consumed, a limited amount of maize and hay were given *ad libitum*. Milk production was compared with that of cows given a commercial dairy ration at the rate of 1 kg concentrate for each 2 kg of milk produced. Cows fed urea maintained an average production of 6.3 litres/day throughout the 84 days of the trial, whereas the cows fed the commercial concentrate ration produced 7 litres/day. It appears therefore that urea could be used for dairy cows in areas where concentrates are not available.

# The Small Ruminant and Camel Group

## Introduction

In terms of liveweight biomass and total output cattle constitute the most important group of domestic animals in most African countries. On the basis of output/kg LW, however, the output of goat and sheep meat and of goat, sheep and camel milk is superior to that of cattle. The rising proportion of small ruminants as a percentage of the total number of ruminants slaughtered in four African countries is shown in Table 17.

Goats and sheep, because of their short breeding interval and fast maturing rate, now account for 28% of African meat production, while their total liveweight is equivalent to only 17% of the domestic herbivore biomass. The productive output of both small ruminants and camels complements that of cattle, output of the latter tending to be concentrated in the most favourable seasons while that of small ruminants and camels is more likely to be sustained throughout the year. Small ruminants are particularly important to the millions of agropastoralists who live on the fringes of productive cultivation zones. Camels are the main, if not the only, source of subsistence for many people living on the margins of deserts and at the very edge of survival.

In spite of the increasingly recognized importance of goats, sheep and camels, relatively little research has been carried out on their current production and future potential. However, in the years since its creation ILCA has concentrated on the social and economic importance of small ruminants in several of its field programmes. ILCA has also recognized the important role of the camel and has published a bibliographical review on the subject (*ILCA Monograph* 5).

## Staffing and initial work

The Small Ruminant and Camel Group hopes to build on this base by making full use of ILCA's data and by assisting national and regional research organisations in the analysis and interpretation of their own data.

A start to the development of this Group was made in 1983 with the transfer of the team leader of the Arid and Semi-arid Zones

Table 17. Pre- and post-drought slaughter of domestic ruminants in four African countries, 1970 and 1976.

| Country | 1970 | | 1976 | |
|---|---|---|---|---|
| | Total no.of ruminants slaughtered ('000) | Goats and sheep as % of total | Total no. of ruminants slaughtered ('000) | Goats and sheep as % of total |
| Mauritania | 25 | 16 | 13 | 23 |
| Mali | 103 | 22 | 128 | 30 |
| Niger | 141 | 56 | 122 | 73 |
| Chad | 66 | 15 | 68 | 19 |
| Total | 335 | 35 | 331 | 43 |

Programme in West Africa to headquarters, where he is now acting as coordinator of the Group. During 1984 the human resources of the Group will be augmented by the addition to the staff of post-doctoral fellows or visiting scientists, and a further full-time staff member.

The Group's work will focus on the following areas:

- Analysis of the existing data collected by ILCA's field programmes, and in-depth analysis of certain aspects where this is required. Particular attention will be paid to mortality and the factors causing it;
- Identifying existing national, regional or international researchers working on small ruminants and camels, and attempting to link research groups more effectively to each other and to research and development needs;
- Identifying gaps in existing research and promoting new research to fill them; and
- Disseminating results through a newsletter and other publications.

# The Aerial Survey and Cartography Unit

## Introduction

The Aerial Survey and Cartography Unit assists ILCA's field programmes in the survey of livestock numbers and movements, human populations and feed resources. The Unit complements the ground survey work of the field programmes. The Unit is also responsible for mapping areas of particular interest to ILCA.

## Aerial surveys

In Mali, two surveys were carried out during the 1983 dry season. The Gourma region (83 300 km$^2$) was surveyed twice in close collaboration with ODEM (Opération de Développement de l'Elevage dans la Région de Mopti). This work constituted continued training for ODEM staff. A further survey covered 6500 km$^2$ of the Niger River basin in collaboration with the Office du Niger.

Three surveys were completed in Nigeria. The survey of southern Gongola State (44 000 km$^2$) was carried out as part of a multi-disciplinary livestock survey for regional development planning. Two surveys of Bauchi State yielded information on the areas of cropped land and rural population levels (66 000 km$^2$) and on cropping enterprises (4250 km$^2$).

In Ethiopia a survey was carried out during March 1983 to describe wet-season livestock distributions in the Sidamo area of the southern rangelands. The data collected have given insights into the relationships between livestock distribution and tree cover, and have highlighted grazing patterns which do not appear to be related to water distribution. The survey covered an area of 15 500 km$^2$ and was flown on a 5-km grid north to south.

The aerial survey component of the Maasai system study in Kenya is determining, among other things, how such surveys can contribute to a better understanding of the resource


use strategies of pastoral people. The emphasis has been on the integration of aerial surveys in multi-disciplinary systems research. In-flight data collection for estimates of total populations and their distribution has been compared with ecological data sets collected simultaneously. Comparisons between aerial and ground data have enabled the precision and complementarity of the two techniques to be tested. Further remote sensing, using satellites, will add another dimension to this approach.

During 1983 the Unit developed a technique for use in surveys of cropping activities. Because of cloud cover, wet-season surveys of cropping activities are not normally possible using traditional aerial photography or satellite imagery. However, by employing low-altitude aerial survey and a combination of wide-angle and telephoto photography the team has overcome this problem. This technique provides both a large area coverage and the resolution necessary to identify individual crop species.

In July 1983 ILCA increased its aerial surveying capacity with the delivery of a new plane, a Cessna 206. This single-engined, high-winged monoplane is suitable for high-altitude operations. The plane was purchased with a grant from the Canadian Government through the Canadian Embassy in Addis Ababa. It is being fitted with a radar altimeter, a Hasselblad camera, a radiometer with digital recorder and a global navigation system. It will be used principally to serve the East African rangeland programmes.

It is expected that improvements in satellite imagery coupled with more efficient data processing, digital analysis, mapping and modelling techniques will soon result in wider application of remotely sensed data in sub-Saharan Africa. Increased use of time series data from satellites with different levels of resolution will result in clearer definition of complex vegetation and land-use patterns. The integration of such remotely sensed data with other monitoring systems will greatly assist in forecasting environmental changes and droughts, and could lead to early warning of the need for preventive planning and action.

## Cartography

The Unit has completed the detailed mapping of 20 000 km$^2$ of the 'dead' Niger inland delta. The final product takes the form of a 33-sheet map assembly.

The maps were drawn on a new topographical base map at a scale of 1/100 000. The base map was established by the Unit from existing smaller documents and aerial photographic assemblies. The new maps are a result of ground truth observations and photo-interpretation of colour and infrared aerial photography as a function of a pre-established legend defined by computer.

The complete set of maps was delivered to ODEM in April 1983. The Unit is currently measuring the areas of the ecological units in the Niger delta area and comparing these with the traditional administrative land areas *(leydi)* as well as the livestock distribution results obtained from aerial surveys. Final map models of the 33 sheets at a scale of 1/50 000 are also being prepared. The 'live' and 'dead' delta maps are now available as ozalid prints in a single 51-sheet map assembly with separate legends for each delta.

The Unit, in conjunction with the ecologist of the Ethiopian Rangelands Programme, also carried out an integrated survey for the Swiss Overseas Technical Cooperation (Helvetas) over 3500 km$^2$ of the Ambasel Wereda in the northwest of the Wollo province of Ethiopia. The survey included comprehensive studies of the vegetation and soils of the area (scale 1/250 000) and a comparison of land use over a 23-year span (scale 1/50 000).

The Unit also established a watershed map of approximately 400 km$^2$ (scale 1/25 000) around ILCA's site at Debre Berhan for the Highlands Programme.

# The Computer Unit

## Facilities

During 1983, 404 million characters of on-line disc storage and 10 terminals were added to the Hewlett Packard (HP) 3000 computer at headquarters. Three HP 125 micro-computers were also connected to the system, which now has its full complement of interactive devices. The HP 125 micro-computers located at Ibadan and Nairobi have proved useful in transferring data to and from headquarters.

The main software purchase for the HP 3000 during 1983 was the General Ledger system of McCormack and Dodge, a replacement for the system which had been developed in-house during 1981–82. The new software is well documented and will enable the Finance Department to carry out budgeting and financial projections. The software forms part of a larger system covering personnel and other administrative requirements; these extra products should be available during 1984.

Most of the software purchases made during 1983 were for the HP 125s. D Base II and Stat-Pak are already in use by the staff of ILCA's field programmes, who have expressed their satisfaction with the new software.

The basic HP 3000 operating system has been updated from MPEIV C.00.03 to MPEIV C.A1.01. The new operating system was needed in order to install the 404 Mb disk drive.

**Table 18. Use of ILCA's central computer facilities, 1983.**

| Department | Hours of use | Percentage of total |
|---|---|---|
| Research | 443 | 60.0 |
| Information/SDI | 172 | 23.3 |
| Computer Unit[a] | 69 | 9.3 |
| Administration | 40 | 5.4 |
| Training | 14 | 2.0 |
| Total | 738 | 100.0 |

[a] Computer Unit use includes system work and use by outside organisations, including: the Ethiopian Transport and Construction Authority; the Plant Genetic Resources Centre, Ethiopia; Maternal Mortality Research; the International Labour Organisation; and the Institute of Agricultural Research, Addis Ababa.

## Computer use

The use of ILCA's computer facilities during 1983 is summarised in Table 18. The major difference from 1982 was a fall in use by research programmes relative to other ILCA departments. The documentation and SDI services provided by the Library and Documentation Section accounted for 23% of total use.

Less computing time was required by the two field programmes based in Nigeria than by the other field programmes. This lower level of use was due in part to major analyses having been completed during 1982, and to the greater specificity of field data collected by the Kaduna- and Ibadan-based teams during 1983.

The Livestock Productivity and Trypanotolerance Group continued the analysis of large data sets on animal production and started analyses for the trypanotolerance network. The Kenyan Rangelands Programme neared completion of the data analyses for the Kenya system study during the year. A number of surveys were completed by the Arid and Semi-arid Zones Programme in West Africa during 1983, and analyses for these data sets were carried out.

The Nutrition Unit and the Forage Legume Agronomy Group developed their use of computer facilities during 1983, and it is expected that both groups will increase their use still further in 1984.

A number of outside organisations made use of ILCA's computer during the year, including the Ethiopian Transport and Construction Authority, the Plant Genetic Resources Centre in Addis Ababa and the International Labour Organisation.

A Senior Research Programmer and an Administration Programmer joined the Computer Unit during 1983, bringing the Unit's complement of international staff to four.

# The Library and Documentation Section

## Introduction

ILCA's Library and Documentation Section plays a major role in providing information services to the Centre's own staff and to other research workers in sub-Saharan Africa. There are three areas in which the Section is actively involved: a computerised information system now provides retrospective literature searches and selective dissemination of information services; the Section stores, retrieves and disseminates non-conventional literature obtained by visiting different countries of sub-Saharan Africa; and the Library service provides a comprehensive collection of books and journals.

## Computerised information services

The regular provision of abstracts through the selective dissemination of information (SDI) service attracted many research workers in Africa during 1983 (Table 19). This service is based on the monthly supply of information from the Commonwealth Agricultural Bureaux (CAB) in UK and from FAO's Agricultural Information Service (AGRIS) in Rome, Italy.

This service, begun in January 1983, has so far proved to be a very effective way for national programme researchers to gain access to up-to-date agricultural information from throughout the world.

A number of retrospective literature searches were also made for ILCA staff and for outside users. The searches were made on ILCA's internal data base, which now contains over 25 000 records, as well as on external agricultural data bases.

Documentation staff helped the Forage Legume Agronomy Group to develop a computerised data bank for plant genetic resources. The data bank was prepared using the MINISIS software package, and was designed in collaboration with the Plant Genetic Resources Centre of Ethiopia.

## Collection of non-conventional literature

Additional funding was provided by IDRC for a continuation of the microfiche project. The project will thus run for a further 2 years from 1983. This aspect of the documentation team's work is designed to identify and record unpublished literature related to livestock research, development and production in African countries. The second phase of the project also includes the collection of agroforestry information on behalf of the International Council for Research on Agroforestry (ICRAF).

During 1983 six countries (Malawi, Botswana, Zimbabwe, Upper Volta, Ivory Coast and Rwanda) were visited and relevant literature was identified and microfiched. Seven-

**Table 19. Distribution by country of the users of ILCA's SDI service during 1983.**

| Country | No. of SDI profiles |
|---|---|
| Botswana | 6 |
| Burundi | 6 |
| Cameroon | 1 |
| Ethiopia | 33 |
| Gambia | 2 |
| Ghana | 3 |
| Guinea | 1 |
| Ivory Coast | 1 |
| Kenya | 48 |
| Madagascar | 3 |
| Malawi | 2 |
| Mali | 10 |
| Mauritius | 2 |
| Niger | 3 |
| Nigeria | 58 |
| Rwanda | 5 |
| Senegal | 4 |
| Sierra Leone | 2 |
| Somalia | 6 |
| Sudan | 7 |
| Tanzania | 3 |
| Upper Volta | 2 |
| Zaire | 25 |
| Zambia | 3 |
| Zimbabwe | 8 |
| ILCA | 40 |
| Total | 284 |

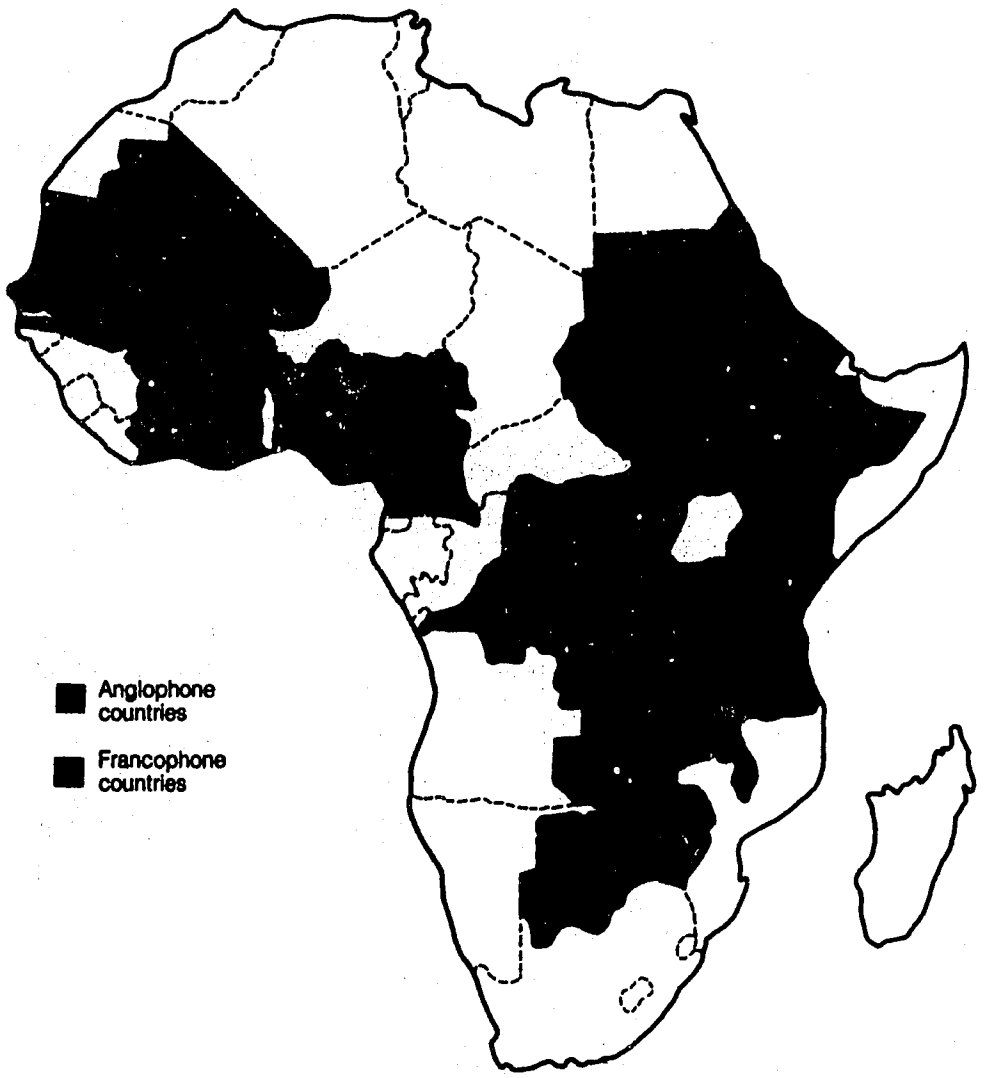
teen African countries have now been visited by the project; these are shown in Figure 13. Six hundred copies each of country catalogues for Ghana, Senegal, Zambia and Zimbabwe were also printed and distributed to various research centres, government departments and libraries in Africa. Duplicate sets of microfiches and 11 microfiche readers were distributed to 23 institutions in countries where microfilming has been conducted.

## Library

The Library's book collection grew to 15 000 volumes, more emphasis in 1983 being given to disciplines not well covered in the past, such as forage agronomy and soil science. The microfiche collection increased to 24 300 fiches of unpublished research reports. The map and slide collection was also increased to around 10 000 items. The periodical collection now includes some 940 titles, 380 of which are obtained through subscriptions while others are exchanged or obtained free of charge.

During 1983 the Library provided over 90 000 photocopy sheets of scientific information to both internal and external users; this is almost three times the amount sent out during 1982. The Library also distributed over 18 000 microfiches to various research institutes in Africa, and lent 8200 titles to users both inside and outside ILCA.

**Figure 13. Countries visited by the ILCA/IDRC microfiche project.**



# The Publications Section

The Publication. Section at ILCA headquarters now employs 24 people and accounts for about 4% of the Centre's core budget. In addition to editing, designing, printing and distributing ILCA's official publications, it meets all the Centre's administrative printing requirements.

In terms of the number of pages printed, output of ILCA's publications increased by 79% in 1983 compared to 1982. Several factors made this large increase possible, including the addition to the team of an English-language science writer, the dedication of ILCA's production and print-shop staff, greater efficiency in the use of resources, longer print runs, and a slight reduction in the proportion of administrative printing. The bulk of the increase in production occurred in the publication of research reports (5 titles in 1983, as against 2 in 1982), network newsletters (8 issues in 1983, none in 1982) and conference proceedings (3 published in 1983, 2 in 1982); the number of titles appearing in French also rose substantially. The titles printed in 1983 are listed at the end of this report.

During the year two prizes were won by publications from ILCA. The first was the distinguished Malbrant Feunteun prize, awarded by the Académie Vétérinaire de France for the multidisciplinary research of ILCA's Mali team reported in ILCA Research Report 5, *Recherches sur les systèmes des zones arides du Mali: Résultats préliminaires*. The second was an award for excellence for the *ILCA Newsletter* under the Critique and Awards Program of the Agricultural Communicators in Education (ACE), a professional association of the USA. In addition, ILCA's 1982 Annual Report received widespread acclaim for both its content and its design.

Efforts to improve ILCA publications, however, are wasted if the information produced fails to reach its intended audiences. The year 1983 saw a major drive to build ILCA's mailing list, which more than doubled during the year reaching 3250 addresses, 68% of which are in Africa. The production of two new network newsletters began in 1983, strengthening ILCA's links with African research workers, while contacts with several external commercial publishers were taken up in order to broaden dissemination in both the developed and the developing world. In addition, the *ILCA Newsletter* served as a useful basis for the development of short articles appearing in newspapers, the popular international scientific press, and the magazines of donor agencies.

The professional contacts of publications staff were also broadened in 1983. Meetings and events attended included the Annual Conference of ACE in Madison (Wisconsin, USA), the Frankfurt Book Fair and the subsequent International Communications Workshop hosted by GTZ, and the International Workshop on Copublication: Strategies for Multi-language Publishing in Agriculture, sponsored by IDRC and IRRI and held in Manila (Philippines). In addition, contacts were developed with the London College of Printing with a view to fulfilling the Section's training needs in graphic arts, while the feasibility of using machine translation to aid ILCA's French-language publishing was also studied.

# Training and International Liaison

## Group training

A total of eight group training courses and workshops were held during 1983. They were attended by 207 people and are listed in Table 20. Most of these activities were held at headquarters in Addis Ababa.

A study of the training activities at ILCA was initiated during 1983. This study was aimed at determining the priorities for future regular group training for national programme scientists in Africa. Repeated training courses are now vital in order to produce well-trained staff in the numbers needed by African countries.

## Individual training

During 1983, 49 awards were made for individual training at ILCA. Around 20% of these awards were supported by non-ILCA funds. One third of the awards were made to junior African scientists fulfilling the requirements for higher degrees at African universities or elsewhere. Six of the awards were given to recently graduated scientists who were enrolled in ILCA's postgraduate programme. Seven people benefited from the technicians' training programme given by the Nutrition and Computer Units at ILCA headquarters, and by the Livestock Productivity and Trypanotolerance Group in close collaboration with IITA, ILRAD and ICIPE at the IITA laboratories in Nigeria and at ILRAD's headquarters in Kenya.

Under the Visiting Scientist scheme, the Deputy Director of NAPRI in Nigeria spent 1983 on sabbatical leave at ILCA headquarters, where he studied the nutrition of Zebu x Friesian crossbred cattle. A scientist from Senegal spent 4 months with the Nutrition and Computer Units at headquarters and contributed to the Animal Nutrition and Forage Evaluation Techniques course. A further six scientists were sponsored to attend international research conferences under the same scheme.

## International liaison

ILCA's links with many countries in sub-Saharan Africa were strengthened during 1983. Agreements with the countries hosting ILCA's field programmes (Ethiopia, Kenya, Nigeria, Mali and Botswana) were consoli-

**Table 20. Group training courses and workshops organised by ILCA during 1983.**

| Title of course/workshop | Sponsor(s) | No. of participants | Dates and location |
|---|---|---|---|
| Economics of animal health and disease control (course) | ILCA/University of Reading | 29 | 28 Feb.–18 March Addis Ababa |
| Pastoral systems research in sub-Saharan Africa (workshop) | ILCA/IDRC | 38 | 21–24 March Addis Ababa |
| Design and analysis of livestock development projects (course) | ILCA/EDI | 22 | 18 April–20 May Addis Ababa |
| Rangelands research in Kenya (seminar) | ILCA | 20 | 13–14 June Kiboko, Kenya |
| Animal nutrition and forage evaluation techniques (course) | ILCA | 14 | 19 Sept.–7 Oct. Addis Ababa |
| Tropical rangeland management methodology (course) | ILCA/FAO/UNESCO/ Commonwealth Secretariat | 18 | 9–23 Oct. Addis Ababa |
| Small ruminant production research (course) | ILCA/IFS/AAASA | 32 | 24–29 Oct. Addis Ababa |
| Land evaluation for extensive grazing (course) | ILCA/ITC | 42 | 31 Oct.–5 Nov. Addis Ababa |

dated. The field programmes are now becoming focal points for the intensification of training activities and for the transfer of ILCA-generated technology.

Further cooperative agreements were made with other African countries which do not at present host ILCA staff or programmes. Agreement was reached between ILCA, ILRAD and the Government of Gambia for the establishment of an international trypanotolerance research centre based in Gambia. Another agreement with the Government of Niger now allows ILCA staff to work in close collaboration with ICRISAT at the latter's new Sahelian Centre. The research activities of the Highlands Programme are being extended to Rwanda with the agreement of the Rwanda Government. Additional agreements have been reached with the governments of Benin and Malawi, and negotiations are progressing with Cameroon, Senegal and Zimbabwe.

# Abbreviations

| | |
|---|---|
| AAASA | Association for the Advancement of Agricultural Sciences in Africa (Ethiopia) |
| ACE | Agricultural Communicators in Education (USA) |
| ADF | Acid detergent fibre |
| AGRIS | FAO Agricultural Information Service (Italy) |
| ARDU | Arsi Rural Development Unit (Ethiopia) |
| a.s.l. | Above sea level |
| ATIP | Agricultural Technology Improvement Project (Botswana) |
| CAB | Commonwealth Agricultural Bureaux (UK) |
| CATIE | Centro Agronomico Tropical de Investigacion y Ensenanza (Centre for Research and Training in Tropical Agriculture) (Costa Rica) |
| CIAT | Centro International de Agricultura Tropical (International Centre for Tropical Agriculture) (Colombia) |
| CP | Crude protein |
| CREAT | Centre de Recherche et d'Elevage at Avetenou (Togo) |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation (Australia) |
| DAP | Diammonium phosphate |
| DLG | Daily liveweight gain |
| DM | Dry matter |
| EDF | European Development Fund (Belgium) |
| EDI | Economic Development Institute of the World Bank (USA) |
| epg | Eggs per gram |
| FAO | Food and Agriculture Organisation of the United Nations (Italy) |
| GE | Gross energy |
| GNP | Gross national product |
| GTZ | Gesellschaft für Technische Zusammenarbeit (Agency for Technical Cooperation) (Federal Republic of Germany) |
| hr | Hour |
| IBPGR | International Board for Plant Genetic Resources (Italy) |
| IBRD | International Bank for Reconstruction and Development (USA) |
| ICIPE | International Centre for Insect Physiology and Ecology (Kenya) |
| ICRAF | International Council for Research in Agroforestry (Kenya) |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics (India) |
| IDRC | International Development Research Centre (Canada) |
| IFPP | Integrated Farming Pilot Project (Botswana) |
| IFS | International Foundation for Science (Sweden) |
| IITA | International Institute of Tropical Agriculture (Nigeria) |
| ILCA | International Livestock Centre for Africa (Ethiopia) |
| ILRAD | International Laboratory for Research on Animal Diseases (Kenya) |
| INRZFH | Institut National des Recherches Zootechniques, Forestières et Hydrobiologiques (Mali) |
| IRRI | International Rice Research Institute (Philippines) |
| ITC | International Institute for Aerial Survey and Earth Sciences (The Netherlands) |
| LSU | Livestock unit (250 kg) |
| LW | Liveweight |
| MINISIS | A software package developed by IDRC for handling bibliographic data |
| MJ | Megajoule |
| MPI | Milk production index |
| N | Nitrogen |
| NAPRI | National Animal Production Research Institute (Nigeria) |
| NASA | National Aeronautics and Space Agency (USA) |
| NDF | Neutral detergent fibre |
| NIAE | National Institute of Agricultural Engineering (UK) |

| | |
|---|---|
| NOAA | National Oceanic and Atmospheric Administration (USA) |
| ODEM | Operation de Développement de l'Elevage dans la Région de Mopti (Mali) |
| P | Phosphorus |
| PCV | Packed cell volume |
| PPR | *Peste des petits ruminants* |
| PSR | Pastoral systems research |
| RRC | Relief and Rehabilitation Commission (Ethiopia) |
| S | Sulphur |
| SDI | Selective Dissemination of Information |
| Si | Silicon |
| SODEPRA | Société de Développement des Productions Animales (Ivory Coast) |
| SRF | Systematic reconnaissance flights |
| t | Metric tonne |
| TCRV | Tissue culture rinderpest vaccine |
| TSP | Triple superphosphate |
| UNDP | United Nations Development Programme (Italy) |
| UNESCO | United Nations Educational, Scientific and Cultural Organisation (France) |

# Annexes

## Staff List

*(Supervisory and professional staff, as at 31 December 1983)*

CENTRAL UNITS

### Director General's Office

P J Brumby, *Director General*
G Gryseels, *Assistant to the Director General*
Zewdnesh Abegaz, *Executive Secretary*

### Other Directors

L J Lambourne, *Director of Research and Operations*
M Sall, *Director of International Liaison and Training*
S G Sandford, *Director of Information*
M H Butterworth, *Deputy Director of Research*

### Livestock Policy Unit

S G Sandford, *Economist and Head of Unit*
Addis Anteneh, *Economist*
Valentin von Massow, *Economist*

### Livestock Productivity and Trypanotolerance Group

J C M Trail, *Animal Geneticist and Head of Group*
G D'Ieteren, *Animal Scientist*
H Machl, *Animal Scientist*
Y J Wissocq, *Trypanotolerance Network Coordinator*

### Forage Legume Agronomy Group

J R Lazier, *Forage Agronomist*
J M Kahurananga, *Plant Ecologist*
A Russell-Smith, *Forage Agronomist*

### Nutrition Unit

M H Butterworth, *Head of Unit*
Aklilu Askabe, *Research Farm Supervisor*
J Greiling, *Post-doctoral Fellow*
A K Mosi, *Senior Animal Nutritionist*
J D Reed, *Post-doctoral Fellow*
H Soller, *Post-doctoral Fellow*

### Small Ruminant and Camel Group

R T Wilson, *Animal Scientist and Head of Group*

### Aerial Survey and Cartography Unit

J Meunier, *Pilot*
Admassu Wondafrash, *Draftsman*

### Computer Unit

J Durkin, *Computer Manager*
D Light, *Senior Programmer*
G Roscoe, *Administration Programmer*
A R Sayers, *Biometrician*

### Library and Documentation

Michael Hailu, *Head of Section*
Azeb Abraham, *Librarian*

### Publications

S D Chater, *Head of Section*
A Gillard, *Designer*
D Niang, *Revisor/Editor (French)*
R A Stewart, *Science Writer*
C de Stoop, *Administrative Assistant*

### Training

E Mukassa-Mugerwa, *Training Officer*

### Liaison Office

Amde Wondafrash, *Liaison Officer*
Alemayehou W. Giorgis, *Travel Officer*
Bekele Teferi, *Liaison Assistant*
Membere Shitaye, *Liaison Assistant*
Tafesse Akale, *Protocol Officer*
Werqu Mekasha, *Extension Officer*

### Administration

K F M Geerts, *Head of Administration*
E Albers, *General Services Officer*
A M Conti, *Personnel Officer*
F Leone, *Maintenance Engineer*
Sahle Kebede, *Catering Officer*
Shiferaw Kebede, *Registry Supervisor*
Tekeste B Habtu, *Procurement Officer*
J A T Thersby, *Warden*
J W Whalley, *Site Development Manager*

### Finance

A H Thabit, *Financial Controller*
Ahmed Osman, *Accounts Supervisor*
Belayhun Wondimu, *Chief Accountant*
Emmanuel Tesfamariam, *Budget Officer/Internal Auditor*

## FIELD PROGRAMMES

### Highlands Programme

F M Anderson, *Agricultural Economist and Team Leader*
Abate Tedla, *Forage Agronomist*
Ephraim Bekele, *Dairy Technical Advisor/ Animal Scientist*
Getachew Assamenew, *Agricultural Economist*
I Haque, *Soil Scientist*
S Jutzi, *Forage Agronomist*
Tadesse Tessema, *Debre Zeit Station Coordinator*
I Whalen, *Post-doctoral Fellow (Rockefeller Foundation)*
Woldeab Wolde Mariam, *Debre Berhan Station Coordinator*

### Humid Zone Programme

C Okali, *Socio-economist and Team Leader*
S D Mack, *Animal Scientist*
E Onyeka, *Farm Manager*
B Opasina, *Veterinarian*
J·E Sumberg, *Forage Agronomist*

### Subhumid Zone Programme

R von Kaufmann, *Agricultural Economist and Team Leader*
J A Maina, *Veterinarian*
E O Otchere, *Animal Nutritionist*
J M Powell, *Crop Agronomist*
M A M Saleem, *Forage Agronomist*
H Suleiman, *Ecologist/Administration Officer*

### Arid and Semi-arid Zones Programme (West Africa)

M Haywood, *Photo-interpreter/Cartographer and Research Coordinator*
M I Cissé, *Sociologist*
S Cissé, *Sociologist*
A Diallo, *Animal Scientist*
M Dicko, *Animal Nutritionist*
L Diarra, *Ecologist*
P Hiernaux, *Ecologist*
S Maiga, *Veterinarian*
S Soumare, *Sociologist*
A Tall, *Administrative Officer*
A Traore, *Veterinarian*
K T Wagenaar, *Animal Scientist*

### Ethiopian Rangelands Programme

N J Cossins, *Socio-economist and Team Leader*
Assefa Eshete, *Ecologist/Photo-interpreter*
Belete Dessalegne, *Animal Scientist*
J C Bille, *Ecologist*
Michel Corra, *Ecologist*
M J Nicholson, *Animal Scientist*

### Kenyan Rangelands Programme

Solomon Bekure, *Agricultural Economist and Team Leader*
F Chabari, *Agricultural Economist*
B E Grandin, *Anthropologist*
P N de Leeuw, *Ecologist*
A Okuome, *Administrative and Finance Officer*
I ole Pasha, *Sociologist*
P Semenye, *Animal Scientist*
M de Souza, *Sociologist*

### Botswana Rangelands Programme

N Abel, *Range Scientist*

# ILCA publications in 1983

### *Research Reports*

Wilson R T, de Leeuw P N and de Haan C (eds). 1983. *Recherches sur les systèmes des zones arides du Mali: résultats préliminaires.* ILCA Research Report 5, Addis Ababa.

Edwards K A, Classen G A and Schroten E H J. 1983. *The water resource in tropical Africa and its exploitation.* ILCA Research Report 6, Addis Ababa.

King J M. 1983. *Livestock water needs in pastoral Africa in relation to climate and forage.* ILCA Research Report 7, Addis Ababa.

Sandford S G. 1983. *Organisation and management of water supplies in tropical Africa.* ILCA Research Report 8, Addis Ababa.

Konandreas P A, Anderson F M and Trail J C M. 1983. *Economic trade-offs between milk and meat production under various supplementation levels in Botswana.* ILCA Research Report 10, Addis Ababa.

Kiwuwa G H, Trail J C M, Kurtu M Y, Getachew Worku, Anderson F M and Durkin J. 1983. *Crossbred dairy cattle productivity in Arsi Region, Ethiopia.* ILCA Research Report 11, Addis Ababa.

### *Systems studies*

de Haan C, Westley S B and Chater S (eds). 1983. *L'élevage des petits ruminants dans les régions tropicales humides.* ILCA Systems Study 3, Addis Ababa.

### *Bulletin*

*Pastoral systems research.* ILCA Bulletin 16. October 1983.

### *Newsletters*

*ILCA Newsletter* Vol. 2 (Nos. 1–4)

### *Training Manual*

Murray M, Trail J C M, Turner D A and Wissocq Y J (eds). 1983. *Livestock productivity and trypanotolerance: Network training manual.* ILRAD/ILCA/ICIPE, Addis Ababa.

### *Conference Reports*

Le Houérou H N (ed.). 1983. *Les fourrages ligneux en Afrique: état actuel des connaissances.* Papers presented at the International Symposium on Browse in Africa sponsored by the International Livestock Centre for Africa; held in Addis Ababa, 8–12 April 1980. Addis Ababa.

Stewart R A (ed.). 1983. *Pastoral systems research in sub-Saharan Africa.* Proceedings of the workshop held at ILCA, Addis Ababa, Ethiopia, 21–24 March 1983. Addis Ababa.

Hill D H (ed.). 1983. *Peste des petits ruminants (PPR) in sheep and goats.* Proceedings of the international workshop held at IITA, Ibadan, Nigeria, 24–26 September 1980. Addis Ababa.

### *Bibliography*

Goe M R and Michael Hailu (compilers). 1983. *Animal traction: A selected bibliography.* Addis Ababa.

### *Cartographic Report*

Bille J C and Haywood M. 1983. *Land use and ecological study of Ambasel Werda, Ethiopia.* Study undertaken for the Swiss Association for Technical Assistance, Helvetas, 31 pp. and 12 maps. Addis Ababa.

### *Indexes*

Documentation Services. 1983. *Index to livestock literature microfiched in Zimbabwe (Part I).* Addis Ababa.

Service de la documentation. 1983. *Index des documents microfichés au Sénégal.* Addis Ababa.

Library and Documentation Services. 1983. *Accessions Bulletin* (March 1983). Addis Ababa.

Library and Documentation Services. *Serial holdings of ILCA headquarters library* (October 1983). Addis Ababa.

### *Annual Report*

*ILCA Annual report 1982. A year in the service of African livestock improvement.* 1983. Addis Ababa.

*Leaflets/Brochures*

*ILCA: Past, present and future.* A presentation for Centres' Week 1983, Washington D.C.

*Guide to ILCA's Library and Documentation Services/ Bibliothèque et Service de la documentation du CIPEA.* 1983. Addis Ababa. Describes the services offered by ILCA's Documentation Section.

*ILCA training and international liaison activities in 1983.* Addis Ababa. An overview of ILCA's individual and group training activities as well as meetings scheduled for 1983.

*Livestock production in West Africa's subhumid zone.* 1983. Addis Ababa. Information brochure describing ILCA's Subhumid Zone Programme based at Kaduna, Nigeria.

*ILCA 1983.* Addis Ababa. Highlights ILCA's research and other activities, and the Centre's achievements up to 1983.

# Other 1983 publications by ILCA staff


Bayer W. 1983. Futterbau in den subhumiden Tropen (Forage production in the subhumid tropics). *Entwicklung und ländlicher Raum* 5: 7–11.

Brumby P J. 1983. The International Livestock Centre (ILCA) and food production in Africa. In: *Proceedings of the International Conference on the Impact of Diseases on Livestock Production in the Tropics.* The 4th International Conference of the Institutes of Tropical Veterinary Medicine held at the Orlando Hyatt Hotel, Kissimmee, Florida, USA, 9–13 May.

Butterworth M H. 1983. Seasonality of calving amongst unimproved cattle in Swaziland. *Trop. Agric. (Trinidad)* 60: 218–220.

Butterworth M H. 1983. Animals in relation to land. In: *World Animal Science, Volume A2: Development of animal production systems* (B. Nestel, ed.). Elsevier Scientific Publishing Co., Amsterdam.

Butterworth M H and McNitt J I. 1983. Slaughter and carcass characteristics of Malawi Zebu steers and some observations on hindquarter conformation. *Trop. Agric. (Trinidad)* 60: 221–223.

Butterworth M H and McNitt J I. 1983. Projection of cattle herd composition using a programmable calculator. *Agric. Syst.* 11: 211–223.

Chater S. 1983. Ethiopia's one ox job. *International Agricultural Development.* July/August 1983.

Fall A, Diop M, Sandford J, Guèye E, Wissocq Y J, Durkin J and Trail J C M. 1983. Etude sur la productivité de moutons Djallonke au Centre de recherches zootechniques de Kolda au Sénégal. 1. Paramètres de reproduction et viabilité. *Rev. Elev. Méd. Vét. Pays Trop.* 36 (2): 183–190.

Farmers find one animal is better than two. *New Scientist.* 9 June 1983.

Goe M R and Gryseels G. 1983. Animal traction: A technology for smallholder farmers. *The Courier* 82: 56–58.

Gryseels G and Anderson F M. 1983. Farming systems research in ILCA's Highlands Programme. *Farming Systems Support Project Newsletter* 1 (3): 7–10.

von Massow V H. 1983. On the impacts of EEC beef preferences for Kenya and Botswana. *Q. J. Int. Agric.* 22(3): 216–234.

von Massow V H. 1983. EG – Agrarpolitik und Ernährungssicherung in der Dritten Welt – der Dialog findet (noch) nicht statt. (EEC – Agricultural policy and food security for Third World countries – the dialogue is not (yet) under way). *Entwicklung und ländlicher Raum* 6.

Opasina B A. 1983. *Ctenocephalides canis* infestation of goats. *Trop. Anim. Health Prod.* 15: 106.

Opasina B A and Dipeolu O O. 1983. Fatal infection of a West African Dwarf sheep with *Mammomonogamus nasicola (S. syngamus nasicola) Zb. Vet. Med. (B)* 30: 313–315.

Otchere E O. 1983. Digestibility of cocoa husk based diets fed to sheep. *Trop. Anim. Prod.* 8: 33–38.

Sandford S G. 1983. *Management of pastoral development in the Third World.* John Wiley, in association with the Overseas Development Institute, London.

Sumberg J E. 1983. Leuca-fence: Living fence for sheep using *Leucaena leucocephala. World Anim. Rev.* 47: 49.

Toulmin C. 1983. *Herders and farmers or farmer-herders and herder-farmers?* Overseas Development Institute, London, 22 pp.

Trail J C M. 1983. Cattle breed evaluation studies by the International Livestock Centre for Africa (ILCA). *Anim. Genet. Resour. Inf.* 1: 17–20.

Trail J C M and Gregory K E. 1983. Animal breeding in sub-Saharan Africa: Towards an integrated program for improving productivity. In: *Livestock development in sub-Saharan Africa: Constraints, prospects, policy.* Westview Press, Colorado.

Wilson R T. 1983. Husbandry and productivity of sheep and goats in the Sahel states of West Africa and in semi-arid northeast Africa. In: Yousef M K (ed.) *Animal production in the tropics*. Praeger, New York. pp. 175–191.

Wilson R T. 1983. Research on the camel: A look at the past and some possibilities for the Fulani. In: Yousef M K (ed.) *Animal production in the tropics*. Praeger, New York. pp. 309–323.

Wilson R T. 1983. Livestock production in central Mali: The Macina wool sheep of the Niger zone. *Trop. Anim. Health Prod.* 15(1): 17–31.

Wilson R T. 1983. Studies on the livestock of southern Darfur VIII. A comparison of productivity indices for goats and sheep. *Trop. Anim. Health Prod.* 15: 63–68.

Wilson R T and Durkin J W. 1983. Livestock production in central Mali: Weight at first conception and ages at first and second parturitions in traditionally managed goats and sheep. *J. Agric. Sci.* (Cambridge) 100: 625–628.

Wilson R T, Peacock C P and Sayers R. 1983. Livestock production in Maasai group ranches. 2. Growth and liveweight in goats and sheep at Elangata and the factors influencing them. *Beitr. Trop. Landwirtsch. Veterinaermed.* 21: 191–198.

# Papers presented at meetings during 1983

Addis Anteneh. 1983. Financing animal health services in some African countries. Paper presented at the Overseas Development Institute Workshop on Financing the Recurrent Costs of Agricultural Services in Developing Countries, held at Cumberland Lodge, Windsor, UK, 3–8 July.

Anderson F M. 1983. An overview of ILCA's animal traction research in Ethiopia. Paper presented at the Third Annual Farming Systems Research Symposium, Kansas State University, Kansas, 31 October–2 November.

Bille J C. 1983. L'évolution du milieu. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Bille J C. 1983. Ecologie et écosystèmes des zones tropicales d'altitude; Ecologie des zones subhumides; Gestion des pâturages sub-humides. Papers presented at the Joint ILCA/EDI Seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

Bille J C. 1983. The role of fodder banks and grazing reserves in livestock production systems. RDP conference, Addis Ababa, June 1983.

Brumby P J. 1983. Alternative strategies for dairy development. Paper presented at the Séminaire sur la recherche agricole au Rwanda, Kigali, 5 – 12 February.

Brumby P J. 1983. ILCA in 1983. Paper presented at the Centres' Week, World Bank, Washington, D.C. 25 October – 4 November.

Cossins N. 1983. Production strategies and pastoral man. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Cossins N. 1983. The relevance of research in the rangelands. Paper given at a seminar at USAID, Washington and University of Colorado, Fort Collins, June 1983.

Cossins N. 1983. The productivity and potential of the camel. Paper given at the Livestock Subsector Review Seminar held at Addis Ababa, October 1983.

Grandin B E. 1983. The importance of wealth effects on pastoral production: A rapid method for wealth ranking. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Grandin B E. 1983. Livestock transactions data collection. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Grandin B E and Solomon Bekure. 1983. Household income and expenditure studies. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Gryseels G. 1983a. Place de l'élevage dans la recherche sur les systèmes de production agricole chez les petits exploitants: expériences tirées du Programme du CIPEA sur les hauts plateaux. Paper presented at the Séminaire sur la recherche agricole au Rwanda, Kigali, 5–12 February.

Gryseels G. 1983b. Issues and options in dairy development in African highlands. Paper presented at the Joint ILCA/EDI Seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

Gryseels G. 1983c. On-farm animal traction research: Experiences in Ethiopia with the introduction of the use of single oxen for crop cultivation. Paper presented at the Third Annual Farming Systems R search Symposium, Kansas State University, Kansas, 31 October–2 November.

de Haan C. 1983. Towards a framework for pastoral systems research. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Haque I. 1983. Micronutrient research in Swaziland. Paper presented at the National Seminar on Managing Soil Resources of Swaziland. University of Swaziland, Kwaluseni.

Hiernaux P. 1983. Les végétations et les ressources fourragères dans les systèmes pastoraux. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Jutzi S C. 1983. Forage agronomy research for the small-scale farming systems of the Ethiopian highlands. Paper presented at the symposium on the Network of Draft Power and Animal Feeding, organised by CIMMYT (Eastern and Southern Africa Economic Programme); held at Mbabane, Swaziland, 3–6 October.

von Kaufmann R R. 1983a. Research on increased food production from African livestock by ILCA. Paper presented at the Second All African Nutrition Congress, Ibadan, 27 February–3 March.

von Kaufmann R R. 1983b. Design and testing procedures in livestock systems research: An agro-pastoral example. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

von Kaufmann R R. 1983c. Development of integrated crop/livestock systems. Paper presented at the meeting of the FAO Ecological/Technical Advisory Panel of the Programme for the Control of African Animal Trypanosomiasis and Related Development, ILCA, Addis Ababa, 20–24 June.

Lambourne L J, Dicko M S, Semenye P and Butterworth M H. 1983. Animal nutrition. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Lambourne L J and Butterworth M H. 1983. Biotechnical options. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

de Leeuw P N. 1983a. L'élevage dans les zones arides: écologie et utilisation des terres. Stratégies d'exploitation des parcours dans les zones arides. Paper presented at the Joint ILCA/EDI Seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

de Leeuw P N. 1983b. Stratégie de développement de la zone pastorale au Sahel. Paper presented at the Joint ILCA/EDI Seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

de Leeuw P N. 1983c. L'élevage en zone subhumide. Paper presented at the Joint ILCA/EDI Seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

de Leeuw P N and de Haan C. 1983. A proposal for pastoral development in the Republic of Niger. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

de Leeuw P N and Milligan K. 1983a. Integration of remote sensing techniques for resource evaluation in pastoral systems research. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

de Leeuw P N and Milligan K. 1983b. The use of low-level aerial survey for assessing numbers and distribution patterns of livestock and people and their relationship to environmental conditions. Paper presented at the ILCA/IDRC workshop on Pastoral Systems Research in Sub-Saharan Africa, held at ILCA, Addis Ababa, 21–24 March.

Michael Hailu. 1983. *ILCA's Documentation Centre: An information service for African livestock research.* Paper presented at the Second OAU Expert Committee Meeting on Animal Genetic Resources, Bulawayo, 20–24 November.

Milligan K and de Leeuw P N. 1983. Low-altitude aerial surveys in pastoral systems research. In: *Pastoral systems research in sub-Saharan Africa.* Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Mosi A K and Butterworth M H. 1983. ILCA's approach to livestock nutrition in the farming systems context. Paper presented at the symposium on the Network on Draft Power and Animal Feeding, organised by CIMMYT (Eastern and Southern Africa Economic Programme); held at Mbabane, Swaziland, 3–6 October.

Murray M and Trail J C M. 1983. Trypanotolerance: Potential and possible enhancement. Paper presented at the meeting of the FAO Ecological/Technical Advisory Panel of the Programme for the Control of African Animal Trypanosomiasis and related Development, ILCA, Addis Ababa, 20–24 June.

Negussie Tilahun. 1983. Household economics research in the northeast and southern rangelands. Paper presented at the ILCA/IDRC workshop on Pastoral Systems Research in Sub-Saharan Africa, held at ILCA, Addis Ababa, 21–24 March.

Powell J M. 1983. ILCA's research on crop – livestock interactions in the subhumid zone in Nigeria. Paper presented at the Conference on Collaborative Research with ACIAR. NAPRI, Shika, Nigeria, 14–15 November.

Sandford S G. 1983. The development experience. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Sandford S G, Anderson F M and Addis Antench. 1983. The scope for improvement. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Semenye P. 1983. A study of Waduruma goats on Samburu South Group Ranch in Kwale District, Kenya. Paper presented at the ILCA/IDRC workshop on Pastoral Systems Research in Sub-Saharan Africa, held at ILCA, Addis Ababa, 21–24 March.

Solomon Bekure. 1983. Household income and expenditure studies. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Solomon Bekure and Negussie Tilahun. 1983. Livestock marketing studies. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Stewart R A. 1983. Livestock systems research at ILCA. Paper presented at the ECA Expert Consultation on Livestock Research and Development in Africa, Addis Ababa, September 1983.

Trail J C M. 1983. Animal genetic resources data banks. Paper presented at the first meeting of the FAO/UNEP Expert Panel on Animal Genetic Resources, Rome, 24–27 October.

Trail J C M, Murray M and Wissocq Y J. 1983. Trypanotolerant livestock network in West and central Africa. Paper presented at the first meeting of the FAO/UNEP Expert Panel on Animal Genetic Resources, Rome, 24–27 October.

Whalen I T. 1983. Women and agriculture in the Ethiopian highlands. Discussion paper prepared for the FAO Expert Consultation on Women in Food Production, Rome, 7–14 December.

Wilson R T and Semenye P. 1983. Livestock productivity and management. In: *Pastoral systems research in sub-Saharan Africa*. Proceedings of the ILCA/IDRC workshop held at ILCA, Addis Ababa, 21–24 March. Addis Ababa.

Wissocq Y J. 1983. Tsé-tsé, trypanosomiase et trypanotolérance. Paper presented at the Joint ILCA/EDI seminar on the Design and Analysis of Livestock Development Projects, ILCA, Addis Ababa, 18 April–20 May.

# Financial Statement

## AUDITORS' REPORT TO THE BOARD OF TRUSTEES OF INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA

Our examination was made in accordance with generally approved auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary.

Depreciation has not been provided on fixed assets. This is in accordance with procedures and requirements established by the Secretariat of the Consultative Group on International Agricultural Research.

We have not visited sites of country programmes operated by ILCA in Botswana and Mali. Returns made from these country programmes of revenue, expenditure and unexpended funds for the year ended December 31, 1983 and of assets and liabilities at that date have been incorporated in the annexed accounts. The net assets so incorporated were as follows:

| | | |
|---|---|---|
| Botswana | $ | 33 640 |
| Mali | | 911 918 |
| | $ | 945 558 |

Since original documents and vouchers in support of expenditure are retained within these countries, the scope of our audit was restricted accordingly.

Subject to the above, in our opinion the attached Balance Sheet, Statement of Revenue, Expenditure and Fund Balances and Statement of Source and Application of Funds, together with the notes thereon forming part of the accounts and exhibits A, B and C which have been prepared under the historical cost convention, present fairly under that convention the financial position of the International Livestock Centre for Africa at December 31, 1983 and the results of its financial operations for the year then ended in conformity with generally accepted accounting principles except as indicated above.

A.A. Bromhead & Co.
Chartered Accountants
March 19, 1984

P.O. Box 709
Addis Ababa
Ethiopia

# INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
# BALANCE SHEET at December 31, 1983

(US$ '000)

## ASSETS

| **Current assets** | **1983** | **1982** |
|---|---|---|
| Cash | $ 2 689 | $ 1 508 |
| Receivable from - donors | 427 | 613 |
| - employees | 70 | 34 |
| - others | 683 | 624 |
| Inventories | 376 | 173 |
| Deposits and prepayments | 181 | 193 |
| **Total current assets** | 4 426 | 3 145 |
| **Fixed assets** | | |
| Buildings | 7 150 | 6 600 |
| Research and laboratory equipment | 1 216 | 894 |
| Computer | 556 | 518 |
| Furnishings and office equipment | 1 887 | 1 596 |
| Vehicles and aircraft | 1 583 | 1 524 |
| Other | 113 | 310 |
| **Total fixed assets** | 12 505 | 11 442 |
| **Total assets** | $ 16 931 | $ 14 587 |

## LIABILITIES AND FUND BALANCES

| **Current liabilities** | | |
|---|---|---|
| Bank overdraft | $ – | $ 2 |
| Accounts payable employees | 257 | 171 |
| Other payables and accruals | 2 070 | 1 660 |
| Contributions received in advance | 515 | 633 |
| **Total current liabilities** | 2 842 | 2 466 |
| **Fund balances** | | |
| Invested in fixed assets | 12 505 | 11 442 |
| Working capital | 1 013 | 578 |
| Restricted capital grant | 319 | – |
| Special projects | 252 | 101 |
| **Total fund balances** | 14 089 | 12 121 |
| **Total liabilities and fund balances** | $ 16 931 | $ 14 587 |

# INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
# STATEMENT OF REVENUE, EXPENDITURE AND FUND BALANCES
## for the year ended December 31, 1983

(US$ '000)

| **Revenue** | **1983** | **1982** |
|---|---|---|
| CGIAR contributions (Exhibit A) | $ 11 783 | $ 9 852 |
| Special project grants (Exhibit A) | 824 | 1 262 |
| Earned income | 137 | 159 |
| **Total revenue** | 12 744 | 11 273 |
| **Operating expenditure** | | |
| Research | | |
| Direction | 143 | 98 |
| Central scientific units | 1 950 | 558 |
| Central support services | 1 120 | 889 |
| Field programmes | 3 126 | 3 772 |
| Networks | 253 | 39 |
| Total research | 6 592 | 5 356 |
| Information services | 956 | 693 |
| Training and conferences | 663 | 316 |
| General administration | 584 | 590 |
| HQ operations and maintenance | 911 | 642 |
| Board and management | 392 | 626 |
| **Total operating expenditure (Exhibit B)** | 10 098 | 8 223 |
| **Capital expenditure** | 1 063 | 1 095 |
| **Special projects (Exhibit C)** | 678 | 1 195 |
| **Total expenditure** | 11 839 | 10 513 |
| **Excess of revenue over expenditure** | $ 905 | $ 760 |
| **FUND BALANCES** | | |
| **Opening balances** | | |
| Core | $ 578 | $ (115) |
| Special projects | 101 | 34 |
| **Total opening balances** | 679 | (81) |
| **Add excess of revenue over expenditure** | 905 | 760 |
| **Closing balances** | | |
| Working capital | 1 013 | 578 |
| Restricted capital grant | 319 | – |
| Special projects | 252 | 101 |
| **Total closing balances** | $ 1 584 | $ 679 |

# Source and application of funds, 1982 and 1983