ILCA
ANNUAL REPORT
1985/86

Serving African agriculture

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA

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

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Foreword

Africa is now the only major region of the world where food production per caput is declining. It is also the only major region where population growth is accelerating. As a result, imports of basic food staples are growing at 7% a year, and annual food imports, currently about 14 million tonnes, are projected to rise to 40 million tonnes over the next 20 years. The supply and productivity of labour for key seasonal tasks in food cropping is widely regarded as a major factor limiting increased output. Associated with low agricultural productivity is the problem of rapid urbanisation, and there are large urban–rural income disparities.

Population growth, food demand, income growth and urbanisation are the key variables shaping the agricultural and livestock scenario of Africa and challenging the research system serving it. The next 10 years in Africa will see the largest increase in human numbers yet recorded, and food needs will escalate. The composition of food demand will change, as demand for livestock products rises with urbanisation and income growth.

The escalating demand for food will mean further pressure on natural resources, and the threat of environmental degradation will become even more pronounced. Already, overgrazing and deforestation cause widespread erosion, firewood scarcity has reached critical dimensions in some areas, and hillside cultivation threatens the fragile resource base.

This degradation intensifies the need for new technology. Crops and livestock must become higher yielding, more efficient at using fertilizer or other inputs and – above all – sustainable in output. The agricultural growth rate needed in Africa to catch up with population growth is close to 4% a year. Actual growth over the last 15 years has been only one third of this. Increases in land and labour productivity are essential; technological innovations which reduce unit costs will raise productivity; the shortage of cash, credit and infrastructure in Africa's rural areas dictates a low-input development strategy.

In the struggle to increase African food production, livestock have a vital contribution to make. They are the catalyst for low-cost improvements in agricultural output: the more animals subsistence farmers have the greater is their cash income, the larger the land area they cultivate, the better seed they can buy and the more fertilizer and manure they can apply; animals contribute substantially to both the area cultivated and the yield per unit area of food crops. Better livestock technology is essential for overcoming Africa's food crisis.

Livestock are central to the African rural economy, yet livestock research takes only a small share of the continent's modest agricultural research budgets. Moreover, research on animals is seldom integrated with research on crops, such that the positive interactions between the two remain largely unexplored and hence unexploited. At the core of Africa's food crisis lies the need to strengthen the livestock systems research capabilities of national research groups.

The 45 countries of Africa's huge landmass contain markedly different ecologies, resources, population densities and land-use systems. The diversity and complexity of African farming systems means that national institutes need a strong capability in the adaptive research necessary for applying technology locally. The support of the inter-

national community is critically important in identifying possible solutions and improving the ability of national institutes to make the best use of them. Institutions such as ILCA have an important bridging function to perform in bringing First World research to bear on Third World problems.

Institution building is a major concern in all that ILCA undertakes. Working closely with national groups, ILCA's field programmes help to build their expertise in adaptive research, while headquarters research units enrich the foundation of knowledge on which such research should be based. ILCA's networks, now seven in number, link national and international research across the continent, spreading knowledge of new techniques and results. National programmes are further supported by the specialist services and advice ILCA provides in areas such as documentation, computing, laboratory analysis and the provision of germplasm. Interwoven with all these activities is ILCA's training programme, strengthening the skills and broadening the outlook of young African scientists.

Sub-Saharan Africa is in crisis. The physical environment is deteriorating; food production per caput is falling; population growth rates are alarmingly high; national economies are overburdened with debt; and aid for development is declining. In many African countries an increase in human misery is the only growth factor in sight.

Yet, given improved technology matched with sensible economic policies, the crisis in agriculture can be turned around. And that is the essential starting point for dealing with Africa's larger economic crisis.

P. J. Brumby
Director General

"In our view, the catastrophe unfolding before our eyes in Africa provides a poignant reminder of the need for institution-building programs. There is no question whatever that, if the institutions for producing and distributing food had been in place, the current tragedy in Africa would have been greatly mitigated, if not actually averted." E.T. York Jr., Chairman, Board for International Food and Agricultural Development (USA).

1985/86 Highlights

Highlands

● Ethiopia's Ministry of Agriculture has included technology generated by ILCA alongside innovations from the national Institute of Agricultural Research in an expanded trials programme that will include 2000 trial sites of 2.5 ha each by the year 1990. The ILCA technology includes a plough for making broadbeds and furrows to improve soil drainage on Vertisols, a row planter to replace traditional broadcasting of seed, ox-drawn scoops for building ponds, a form of alley cropping adapted for highland areas (see below), and the introduction into crop rotations of forage legumes fertilized with natural African rock phosphates in order to reduce the need to apply processed nitrogen fertilizers to food crops.

● The agroforestry system of alley farming, already gaining popularity in lowland West Africa (see below), has been adapted for highland areas using the shrub legume *Sesbania sesban*. Grown in rows 4 m apart in the traditional Ethiopian subsistence crop, teff (*Eragrostis tef*), the legume produced foliage DM yields of 800 kg/ha per year containing 4% nitrogen in its second and third years of growth, providing a mulch to enrich the soil as well as a protein-rich feed for livestock.

Sesbania sesban also grew well in broadbeds on Vertisols, where it yielded up to 6 t of leaf DM/ha per year as a sole crop. Further advantages are its ability to stabilise the soil on terraces made with an adapted local plough and to provide prunings for firewood. An underused tree with considerable potential for African smallholders, *Sesbania sesban* may become the *Leucaena leucocephala* of the highlands.

Humid zone

● Alley farming, using the tree legumes *Leucaena leucocephala* and *Gliricidia sepium*, has been successfully introduced under a pilot development project in Nigeria's humid zone. Launched in 1984 by the National Livestock Projects Unit (NLPU) on the basis of research by ILCA and International Institute of Tropical Agriculture (IITA), the project originally involved 60 small-scale sheep and goat producers. Spontaneous uptake occurred in neighbouring villages, and more than 100 producers now have established trees on their farms.

On-station trials showed that including a 2-year fallow grazing period in the alley farming system can raise crop yields in the first year after fallow to 5.35 t/ha, 30% more than under continuous cropping in alleys.

By reducing mortality and increasing growth rates, cut-and-carry feeding of browse foliage to pregnant and lactating ewes significantly increased the weight of lambs weaned per ewe per year by 55%, from 8.7 to 13.5 kg.

Alley farming has now been included in Nigeria's Fourth National Livestock Development Plan. Over the next 5 years a further 15 000 farmers will be planting alley farms, receiving seeds and advice from NLPU and Agricultural Development Project staff. Participants at an alley farming workshop organised by ILCA and IITA recommended the establishment of a network to promote research and development work on alley farming throughout the humid and subhumid zones of Africa.

Subhumid zone

● In Nigeria's subhumid zone, the testing of 66 fodder banks by NLPU with the assistance of ILCA has attracted support for the establishment of 2000 more fodder banks over the next 5 years, to be financed by a World Bank loan. Spontaneous uptake of the technology continued, with new fodder banks being established in the neighbouring highland area of the Jos plateau. Four farmers in Abet, a village where ILCA is working, revealed a new application for the technology by demanding fodder banks entirely for their small ruminants.

Agropastoralists using fodder banks sold fewer cattle due to nutritional stress than did their counterparts without fodder banks. Maize grown in fodder banks yielded 1.5 to 2.5 t of grain/ha more than maize after a natural fallow. Fodder bank soil was less prone to erosion and required less labour to cultivate than soil under natural fallow. As well as providing a much needed supplementary dry-season feed for livestock, fodder banks

have an important role to play in maintaining soil stability and crop yields in the agropastoral production system of the subhumid zone.

Arid and semi-arid zones

● In Mali, net profits per animal of US$ 33.50 and weight gains of 47 kg over 3 months have been observed in a beef fattening scheme whose impact is currently being studied by ILCA and the Institut National de Recherches Zootechniques, Forestières et Hydrobiologiques (INRZFH). The scheme's high weight gains and profits should encourage more smallholders to join it.

● Compared with watering every day, 3-day watering has been shown to have little effect on the productivity of cattle in the southern rangelands of Ethiopia. No significant differences were found in calving percentages, and compensatory growth quickly made up the differences in calf weaning weights. Shortage of water reduced appetite, with lactating cows eating 10% less on 3-day watering.

Three-day watering saves valuable feed and water resources, reduces the labour required for watering, increases grazing orbits around watering points and lessens the risk of erosion caused by trekking. A commercial ranch in Kenya has expressed interest in the practice, and ILCA has introduced it there on a trial basis.

● Low calf weaning weights, arising from competition between people and animals for cows' milk, have been identified as the main constraint susceptible to intervention in the pastoral production system of southern Ethiopia. Various ways of increasing calf growth are now being investigated, including supplementation with forage legumes grown in shallow depressions in the rangeland where 'run-in' increases soil moisture.

Database management

● A unique database management package has been developed for evaluating livestock performance in Africa and elsewhere. The package, called IDEAS, can be used on an inexpensive microcomputer and is easy to install and operate, bringing informed decision-making on the management of herds and flocks within reach of African scientists and ranch managers for the first time. IDEAS is shortly to be tested in several African countries, where it will be supplied free of charge.

Information and training

● ILCA's training activities have come of age. Training in the international agricultural research centres is important, but tends to gain momentum only slowly. During ILCA's tenth year of existence, the level of group and individual training activities increased dramatically: more than one third of the 389 scientists who have taken courses at ILCA did so during 1985; the number of post-doctoral associates increased from 2 in 1983 to 12 in 1985; three times as many technicians from national research stations were trained in 1985 as in 1984; and a programme to help African graduates take leave from overseas universities to do their research in Africa got under way.

Training courses were held at headquarters in two fields important to ILCA's host country, Ethiopia. Trainees attending ILCA's dairy technology courses studied the theory and techniques of cream, butter and cheese making, and were taught to use new types of churn and separator recently introduced to rural cooperatives. Subsequent visits to cooperatives revealed that trainees were passing on their skills to others, and that the new equipment was being efficiently used. Trainees attending ILCA's first course on pond building learned the preparatory steps and practical techniques necessary for successfully siting and constructing a village pond using metal scoops drawn by oxen. More than 75 ponds are currently being built by government and NGOs at a range of sites throughout the country.

● Demand for information from ILCA rose sharply in 1985. The number of users of ILCA's selective dissemination of information (SDI) service rose by 50%, from 400 to 600, the additional 200 users coming mostly from African countries and research institutes that have been underrepresented in the past. The current titles service started in 1983 also gained rapidly in popularity during 1985, with the number of requests rising by approximately 80%. The two services now represent an important channel of access to international research results for scientists in national institutes whose libraries cannot afford the mounting costs of journal subscriptions.

In 1985 ILCA offered a training course on Handling and Dissemination of Agricultural Information. The course, which was the first of its kind in Africa, was attended by 25 participants from anglophone countries and is shortly to be repeated in French.

In 1985 ILCA's scientists wrote nearly 100 papers for publication by the institute, while publications through external scholarly journals numbered about 40. The output of publications printed at ILCA rose by 80%. Major new titles during 1985/86 included pre-testing editions of a manual on pond building and a textbook on matching livestock production to feed resources, conference proceedings on small ruminants in African agriculture and livestock systems research in Nigeria, and a research report analysing national data on crossbred dairy production in Malawi.

Forage legumes

● Requests for seed from ILCA's germplasm collection increased from 27 in 1984 to 112 in 1985. These requests came from all over the world, but primarily from Africa (88%), indicating the increasing popularity of this service with the continent's research and development groups. To enhance the service, seed storage facilities at ILCA headquarters were improved with the provision of seed dry-

ing and cold storage facilities. The first complete catalogue of ILCA's germplasm was produced, including details of site of collection for all ILCA accessions.

A new network was formed in 1985 – PANESA, the Pasture Network for Eastern and Southern Africa. The network, which has members from 19 countries, reflects the increasing appeal of forage legume technology to African scientists.

Legume agronomy work has focused increasingly on browse legumes suited to agroforestry and alley farming systems. Studies on nutrient responses, nitrogen fixation and agro-ecological zonation to increase the efficiency of germplasm screening are now in progress.

Resource allocation

● A study on research resource allocation at ILCA has shown that:

- ILCA's present spending matches African livestock distribution patterns well,
- more resources should be shifted to the subhumid and humid zones if other criteria, such as human population, income and consumption of animal protein, are included,
- there is a case for allocating more resources to small ruminants and fewer to cattle,
- national programmes have concentrated on animal health; ILCA should therefore concentrate on other subjects.

Livestock economics

● Dairy imports into sub-Saharan Africa increased by 50% between 1977 and 1982 and now account for almost 30% of total dairy consumption. Research indicates that in 16 out of 29 African countries government policies have contributed to this increase. A major factor has been a change in real exchange rates. The potential for using dairy imports (particularly food aid) to stimulate local dairy development has been largely unused. Imports affect domestic production negatively by allowing governments to avoid the difficult task of setting up smallholder milk collection systems.

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Field programmes

Highlands Programme

Introduction

The African highlands, conventionally defined as land areas more than 1500 m a.s.l., cover some 1 million km^2. Mixed smallholder agriculture is the predominant mode of land use, and livestock are an integral part of farm operations throughout the highlands. More than 10 million farm families live in these areas.

The key characteristics of the highlands as regards the need for agricultural research are: rapidly rising human populations, which in some areas are increasing at more than 4% a year, leading to increased pressure on land for growing food crops; increasing erosion and permanent loss of agricultural land; increasing dependence of livestock on crop residues as pasture availability declines; and low productivity of indigenous stock which, with some exceptions, have not been subject to selection for higher meat and milk yields.

In contrast to many other parts of Africa, farmers in the highlands often can not increase the amount of land under cultivation, and are thus obliged to increase yields from already cultivated areas by making more efficient use of existing farm resources and by increasing the quantity and quality of production inputs. In short, they are obliged to intensify production.

Crop and livestock yields in much of the highlands are stagnant, and the processes outlined above are combining to reduce production stability and to increase the risk of food shortages in poor cropping years. The human tragedy caused by the drought in the Horn of Africa in 1984–85 bears stark witness to the need to increase food production.

Smallholder farmers produce most of the food and livestock products in the highlands, and thus must be the target of research concerned with developing technologies to facilitate profitable and ecologically acceptable increases in production.

Crops and livestock are closely integrated throughout the highlands in a complex of competitive and complementary ways. Increases in the efficiency of livestock production lead to increases in food grain production and to generally more stable agriculture. It is for these reasons that ILCA's Highlands Programme concentrates on seeking ways of increasing the yields and efficiency of the livestock component of mixed smallholder systems in its mandate zone.

The Programme's research takes place in Ethiopia, which accounts for approximately half the African highland areas, half the zone's rural population and a substan-

tially larger fraction of its livestock. The Ethiopian highlands support some 35 million people, 22 million cattle and 34 million sheep and goats, the largest national ruminant population in sub-Saharan Africa. Crop and livestock yields are low, farmers use few modern inputs, have low cash incomes and little access to credit for development. While the relative importance of constraints in other highland areas may differ from those in Ethiopia, their common nature implies that interventions developed in Ethiopia will be applicable in other parts of the zone, provided they are adapted to local technical, social and economic needs.

During 1985 station-based research was conducted mainly at Debre Zeit and Debre Berhan. Debre Zeit is an intensively cropped area at 1850 m a.s.l. At Debre Berhan (2850 m a.s.l.) livestock play a more important part in the overall farming system than at Debre Zeit, although both are primarily subsistence cropping areas.

Station-based research is matched by on-farm studies. Farmers in the study areas participate in the research, providing baseline information on the farming system, testing technology developed on station and providing feedback on the efficacy of new technologies. Some 300 farmers participated in the farm surveys and on-farm technology testing done by the Highlands Programme in 1985. Many more farmers used technologies developed and tested by the Programme but their activities were not monitored.

Overall, the research strategy of the Programme is to develop adoptable technologies originating mainly with livestock to enable farmers to intensify farm production.

Socio-economic studies

Analysis of several years' farm management and household data from traditional farmers at Debre Berhan highlighted the vital importance of livestock in the farming system. Of the average annual cash income of US$ 252 per farm, only 17% came from the sale of crops and crop byproducts, while 31% came from the sale of livestock products and 52% from trade in animals. Livestock contributed 53% of overall farm gross margins, excluding the value of draught power as an input to crop production.

The number of oxen kept on a farm had a significant effect on grain yields. There were strong correlations between the number of oxen owned and area cultivated and crop yields. Despite the common claim that farmers in traditional systems keep too many unproductive livestock, the analysis showed overall rates of return on livestock enterprises to be high.

Several technologies developed by ILCA were tested by a total of 175 farmers in the Ethiopian highlands in 1985. The use of single oxen, rather than the conventional pair, was shown to be beneficial by allowing more timely cultivation. Oxen used as singles are able to cultivate approximately 70% of the land prepared by paired oxen. However, farmers reported that the shortage of high-quality feed during the dry season limited the use of oxen as singles, especially for the first cultivation of the season, when the power required to draw the plough was at the limit of the capacity of a single ox. The Programme is conducting on-station research on forage legumes and legumes sown as relay crops in the regular crop cycle to provide additional feed. This work is discussed further below.

On-farm studies of small-scale cross-bred cow dairy enterprises continued in 1985. On the farms under study, the cows produced some 2000 litres of milk per year, about six times the yield of indigenous cows. As a result, the dairy enterprise increased the cash incomes of the farmers to two to four times that of traditional farmers in the same areas without the dairy enterprise. A study on the effects of these higher incomes on the nutritional status of the farmers' families was started in 1985 and will be completed in 1986.

Increasing numbers of small farms in the highlands will not be able to produce the feed necessary to support the draught oxen and parent and replacement stock needed to meet their draught power needs. ILCA's studies in 1982 and 1983 on the use of cross-bred dairy cows for draught work have shown that, when adequately fed, such cows can meet the draught needs of a typical highland farm. In this way, cows can substitute for oxen and, in principle, reduce the aggregate feed demand of livestock enterprises. In 1985, 30 farmers in the Debre Zeit area adopted this practice, but again farmers reported that the enterprise would be more effective if a reliable home-grown source of high-quality feed were available.

Intermediate technology at ILCA

Intermediate technology (IT) is not the panacea for Third World ills it was thought to be 10 years ago in the wake of the oil crisis, but neither is it true that such technology has "failed to deliver". It is taking time for IT to make an impact in Africa, often because what looked like a low-cost solution to the farmers of Asia or the scientists of Europe still proved too expensive for Africa's rural poor.

More research was, and still is, needed to adapt IT to African conditions. The products that flow from such research are often so rudimentary as to evoke scepticism regarding their effectiveness, yet it is their very simplicity that makes them accessible to the African farmer. Again, the potential impact of much IT appears slight when technologies are considered in isolation; only when combined does their real strength emerge.

Beginning in Ethiopia, ILCA has made an encouraging start in testing IT answers to African food production problems. Deceptively simple, the innovations listed below should make a sizeable impact when combined and adapted to a wider range of production systems.

1. *A single-ox plough and yoke* allows poor farmers to improve their crop yields by planting earlier and to economise by keeping or renting fewer oxen;
2. *A low-cost reversible mouldboard plough* facilitates terrace making, preventing erosion and conserving water on steep slopes;
3. *A wooden wing attached to the traditional plough* means that broadbeds and furrows can be introduced to improve soil drainage and hence crop yields on heavy black soils;
4. *A seeder made from simple metal sections* can replace traditional hand broadcasting with row planting, lowering the proportion of seed grain needed;
5. *Low-cost African fertilizers* such as natural rock phosphates can replace expensive commercial fertilizers imported from the developed world;
6. *Forage legumes,* integrated into subsistence cropping systems, improve subsequent food crop yields, stabilise the soil and provide high-protein animal feeds;
7. *Locally available high-protein feed supplements,* such as poultry litter or oilseed cake, can replace expensive imports of commercial feed concentrates for producing meat or milk;
8. *A wooden agitator* designed for insertion through the neck of the traditional earthenware churn increases the efficiency of butter making;
9. *An ox-drawn metal scoop* enables small ponds and dams to be built, providing people and animals with water and allowing farmers to produce fish and irrigate small areas to grow an extra crop during the dry season;
10. *A polythene biogas digestor* separates the fuel and fertilizer in animal dung, providing smallholders with a valuable slurry for their fields as well as gas for cooking.

ILCA's Highlands Programme has begun to show what happens when these innovations are imaginatively combined. More efficient ploughing (1) allows farmers to sow their crops earlier over larger areas of land. When earlier planting is achieved on terraces (2) or on fertile black soils that were previously prone to waterlogging (3), with correct placement of seed (4), on land enriched by forage legumes that respond well to phosphorus (5 and 6), food crop yields rise by several hundred percent while animal production also benefits from the increased quantities of crop residues available for feed. These basic feed resources can be supplemented with other locally produced high-protein feeds (6 and 7) to increase the production of meat and milk, surplus amounts of which become more marketable when appropriately processed (8). The water harvested through better soil drainage (3) can be stored (9) and used to grow a dry-season crop on plots fertilized with slurry (10). Browse legumes (6) may be grown on broadbeds (3) or beside ponds (9), integrating and enhancing the improved farming system still further.

Attempts are now being made to adapt technology successful in one zone to the conditions of others. In humid West Africa the system known as alley farming uses the browse legumes *Gliricidia sepium* and *Leucaena leucocephala,* grown in hedgerows between traditional food crops such as maize, to stabilise and enrich the soil at the same time as providing animal feed. An adapted version of this system is now being tested in the highlands using *Sesbania sesban.*

Other innovations may need little adaptation in order to move from one zone to another. Examples are single-ox ploughing, which should appeal to the smallest farmers regardless of zone, and ox-drawn scoops, which should benefit water supplies in pastoral as well as arable areas.

The IT promoted by ILCA is already beginning to have an 'upstream' effect on the economy of the Centre's host country, Ethiopia, where village blacksmiths and the national Metal Tool Company are benefitting from the new demand for scoops and ploughing equipment[1]. The 'downstream' effects on food production have yet to be widely experienced, but the Ministry of Agriculture has recently announced a new trials programme that should introduce ILCA-generated IT to 2000 farmers by the year 1990.

The best IT, like the best farming systems research, places people at the centre of the development process. It begins with the unexploited potential inherent in the resources they already have, not with expensive inputs they can never hope to acquire. Despite the falling costs of fossil fuels, IT is far from being on the scrapheap: used with a farming systems approach that matches technologies with human needs, it is an effective starting point in the struggle to increase African food production.

[1] Orders for metal scoops placed with the Metal Tool Company in 1985/86 are estimated to be worth US$ 250 000.

Markets for liquid milk are generally inaccessible to those areas of the highlands in which smallholder dairy production is technically feasible. This has hindered dairy development. While most rural societies have traditional methods of processing milk into a range of products, such methods generally give low yields of final product per unit of milk, the products have short shelf lives, and labour inputs into their production, usually by women, are high. Furthermore, hygiene standards are often low, making the products uncompetitive with similar products from modern, large-scale dairy plants.

ILCA has addressed these problems by developing techniques to produce a range of quality milk products with good storage characteristics that can be transported for sale in rural centres. A simple, low-cost butter churn has been developed that can extract up to 90% of the butterfat from soured milk. The high yield means the process can be used in the making of ghee, a product of actual and potential importance in many sub-Saharan countries.

Technologies for both individual and small-scale cooperative milk processing are under study. Technicians from several countries, including Ethiopia, attended two training courses in 1985 on milk processing techniques and the particular technologies developed at ILCA. Future training will be directed at senior staff of national dairy training institutes, to strengthen the syllabuses at those institutes.

Overall, the main constraints on developing smallholder dairy production, identified through ILCA's surveys and on-farm trials, are the difficulty of maintaining appropriate exotic blood levels, poor dairy marketing facilities and inefficient milk processing methods, limited supplies of high-quality feed and high calf mortality. Further work is in progress on each of these topics.

Ox/seed project

In response to the tragic famine in Ethiopia, the Programme embarked on applied research in 1985 into the role of livestock in the post-drought recovery of smallholders. This 'ox/seed' project had both a relief and a research component.

The project covered 600 farmers in drought-affected areas who had lost all their oxen and most of their other cattle and smallstock due to the drought. They were given emergency food aid and each farmer was supplied with one ox on credit, a total of 20 kg of a variety of seed grains and a plough and harness modified for use with a single ox. These inputs cost US$ 200 per farmer.

This project is giving ILCA unique information on the contribution of animals to post-drought recovery in traditional farming systems. The results show that supplying key inputs such as oxen can speed recovery, and that providing seed and oxen can help the most vulnerable farming communities to return to self-sufficiency.

In 1986 another 1200 farmers will be supplied with the ox/seed package. Also, in response to the problems reported by farmers in 1985, the 1986 extension of the project will include terrace-making using a low-cost ox-drawn plough developed at ILCA in 1985, and shrub planting using the forage legume *Sesbania sesban*. This species is indigenous to much of Ethiopia and has yielded well in trials at ILCA's Debre Zeit research station in 1985. It is hoped that these inputs will both stabilise and increase production in this and other risky farming areas.

Lessons learned in this applied research project will be of great benefit to researchers and planners elsewhere in Africa concerned with selecting appropriate ways of restoring production in drought-ravaged areas.

Utilisation of draught animal power

Oxen in Ethiopia and elsewhere in Africa are used for only 50 to 70 days per year for cultivation. For the remainder of the year they and their parent and replacement stock are kept mainly for the meagre supplies of manure and milk they produce. ILCA is seeking ways to increase both the direct contribution of oxen to farm production and the overall efficiency of the ox subsystem by increasing the proportion of feed that is transformed into products of value.

Work to increase the direct contribution of oxen resulted in the development of an ox-drawn scoop that can be used to shape and excavate soil. Its principal use in Ethiopia will be to excavate small farm ponds and to build dams which can harvest runoff water in the wet season and so store water for dry-season use by people and their livestock. Dry-season water supplies are critically short in much of rural Ethiopia, causing production losses through trekking, requiring the women in households to travel up to 4 hours

per day to fetch water, and limiting the intensification of agricultural production. Oxen can be used at a fraction of the cost of alternative methods to create water supplies.

The first pond in Ethiopia to be excavated using oxen was completed by ILCA in 1983. Since then the technique has been used in trials in several farm communities. Farmers in Ethiopia can excavate ponds of about 7000 m^3 within one season using their own oxen, thereby providing sufficient water for the aggregate needs of more than 50 families. In 1985 more than 1200 scoops were made in Ethiopia, and these are now being used in six provinces by the Ministry of Agriculture and other development agencies. More than 40 Ethiopian technicians were trained in the technology during 1985.

Sheep production

Indigenous sheep, even at traditional production levels, generate an important part of total farm incomes of smallholders in sub-Saharan Africa. The Ethiopian highlands have the largest sheep population of the continent. However, to date sheep production has not been targeted by researchers as a means of increasing smallholder incomes.

ILCA's research at Debre Berhan in 1984 and 1985 has shown that low-cost changes in management and feeding can increase net weaning rates by about 50% compared with rates achieved by neighbouring farmers. These changes include provision of well drained housing, longer daily grazing periods and the use of low-cost disease prevention measures. This increase in production has been achieved when animals graze improved pastures. Such gains could be further enhanced by improving the reproductive performance of the sheep, which appears feasible by selection within the Menz breed. Fascioliasis is a major constraint, and work will be conducted to develop low-cost ways of reducing its impact.

As with other Programme activities, a major conclusion of the sheep research has been that legume supplements to augment dry-season feed supplies will be essential if animal productivity is to increase.

While specialised wool production is rare in sub-Saharan Africa, wool from indigenous sheep is used for home weaving and in small-scale cottage industry. The methods used have changed little over the centuries, and more efficient alternatives that result in higher product yields and new products are available. In recognition of these options, and of the importance of increasing the cash incomes of women in rural areas, ILCA has tested a number of ways of handling and processing fleeces from indigenous Ethiopian sheep. During 1985 ILCA trained some 25 women technicians of the Ministry of Agriculture in these methods. These technicians are extending the methods in many of the remoter parts of the highlands where sheep are kept.

Legume technology

Low soil fertility limits crop and pasture production throughout the African highlands. Crop yields are falling due to increased cropping pressure and shorter fallow periods. Smallholders rarely use mineral fertilizers because these are expensive and largely unavailable. The main alternative is to grow legumes, which fix atmospheric N and enhance both crop and pasture production. The Programme has intensified research on the evaluation and use of legumes as strategic elements of smallholder systems.

In early research on the topic it was assumed that farmers would, where profitable, allocate land ordinarily sown to food crops to special-purpose fodder crops (including legumes) to provide feed for dairy cattle. This strategy was successful, but only applies to the small community of farmers with dairy enterprises. In the more general case, risk-averse smallholder farmers will not prejudice subsistence food crop production in this way, so legumes must be introduced as an element of farming systems in such a way that they do not compete with food crops.

In 1985 *Trifolium steudneri* was selected as a promising legume for inclusion in dryland forage legume–food crop systems. This legume has a relatively short growing season (about 45 days to flowering), is widely distributed throughout the high-potential parts of the Ethiopian highlands (although it is not cultivated), and is well adapted to different soils, especially to heavy clays. These heavy clay soils, the Vertisols, are potentially the most important family of cropped soils in the country.

Routine inclusion of *T. steudneri* in farming systems would only follow if routine use of inorganic fertilizers, especially P, could be introduced. Thus, large-scale adoption is unlikely in the next few years.

In 1985 the Programme also started research on *Sesbania sesban*, an indigenous legume shrub. On Alfisols in an 850-mm rainfall environment and at 1850 m a.s.l., *S. sesban* yielded about 1 t DM/ha when sown in dense rows 4 m apart, with the between-row areas sown to cereals and food legumes. In pure stands on broadbeds on Vertisols it yielded about 4 t DM/ha, with an average crude protein content of about 25%. As an indigenous legume it seeds freely, is easy to establish and at present it shows no particular signs of pest damage. Feeding trials with *S. sesban* showed it to be superior to all other legumes so far tested by ILCA (see box, page 50). Successful domestication of this legume will have important implications for livestock production in sub-Saharan Africa.

Management of Vertisols

Vertisols are important agricultural soils throughout sub-Saharan Africa, where they cover an area of about 100 million ha. They are fertile and have an exceptionally high water-holding capacity, but their low percolation rates and high clay contents allow only partial exploitation of their potential using traditional land management practices.

However, studies at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and national research institutions suggest that plant production on these soils can be dramatically increased if they are appropriately managed. Such management interventions include a minimum of land shaping to drain off excessive surface water (ideally combined with water harvesting, storage and re-use), correct timing of ploughing and planting and correct placement of seed and fertilizer. All these interventions are practicable under farmers' conditions.

Increased food crop growth provides higher yields of both grain and crop residues. Crop residues are the most important animal feed of many traditional mixed smallholder farming systems, especially in highly populated areas.

In an on-farm verification trial at Debre Zeit with 16 farmers, 7 growing wheat and 9 growing teff (*Eragrostis tef*), improved surface drainage increased wheat grain and straw yields by 89 and 52% respectively, and increased teff grain and straw yields by 26 and 24% respectively (Figure 1).

An important element of improved utilisation of Vertisols is dry sowing, particularly where the onset of the rains in the main crop season is reasonably dependable. In an experiment at Debre Zeit, faba beans (*Vicia faba* ssp. *equina*) planted before the onset of the long rains yielded 664% more grain than when planted after the rains had begun (Table 1). Gains of over 300% can be anticipated at the farm level over a run of years.

Table 1. The effect of dry planting on the grain and straw yields of faba bean (*Vicia faba* ssp. *equina*) grown on a Vertisol, Debre Zeit, 1985.

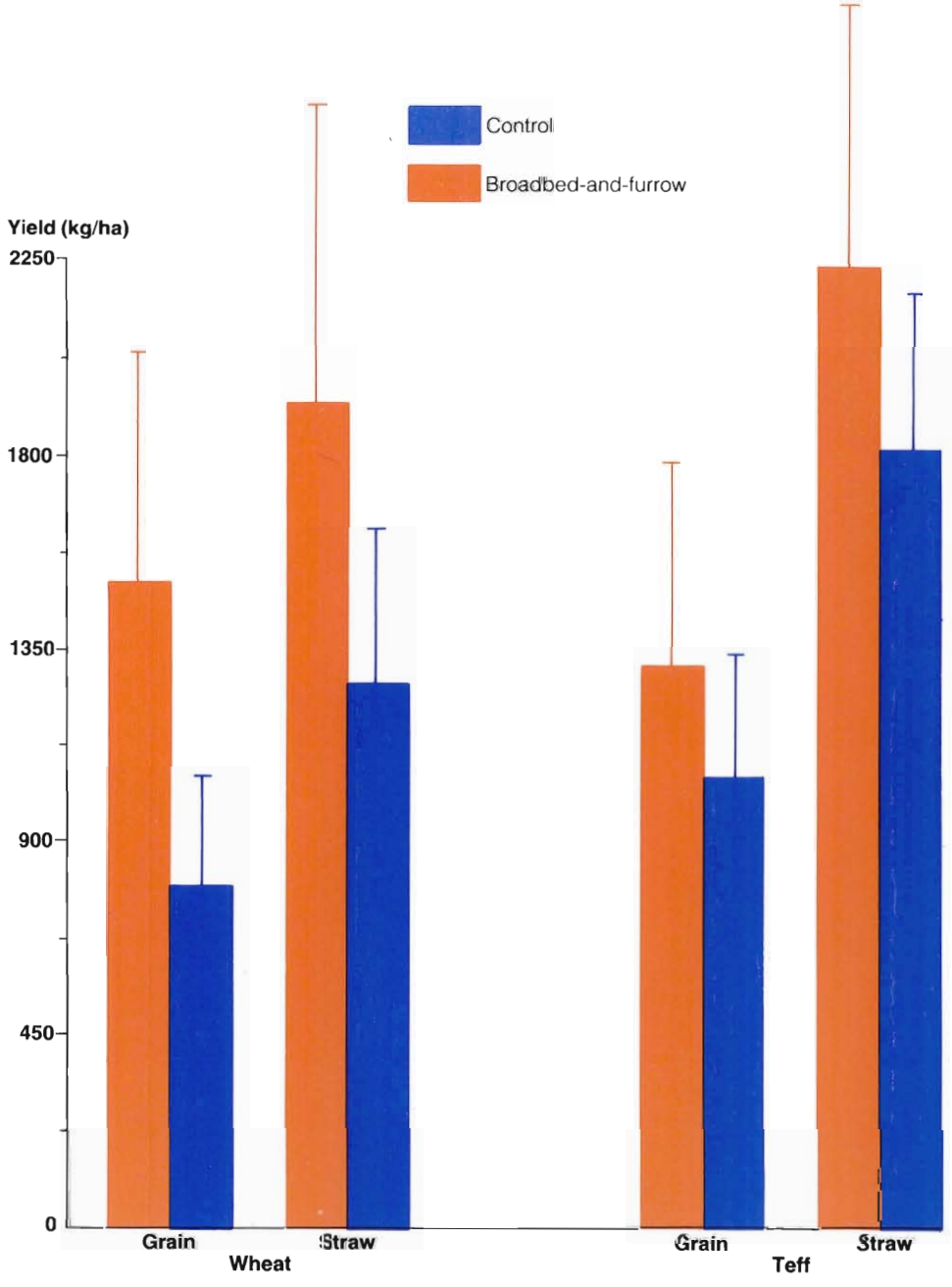
System/planting date	Grain yield (kg/ha)	Straw yield (kg/ha)
Dry planted (10/6/85)	1681 ± 285	3488 ± 198
Wet planted (6/7/85)	220 ± 116	1848 ± 573

Improved surface drainage offers a wider choice of crops. Teff, a traditional but low-yielding Vertisol crop, can be replaced by higher yielding crops such as sorghum or faba beans. Intercrops of sorghum and faba beans yielded 1923 kg of beans, 478 kg of sorghum grain and 1257 kg of sorghum straw/ha when planted such that faba bean occupied the two outside rows of the 1.2-m-wide broadbed with one row of sorghum in the middle. When the intercrop was planted as two rows of sorghum on the outside with one row of faba bean in the middle, the yields were 1153 kg of beans, 1678 kg of sorghum grain and 5424 kg of sorghum straw/ha. These yields contrast with grain yields of less than 1000 kg/ha for most crops traditionally grown on Vertisols.

ILCA has made a number of modifications to traditional animal-drawn implements in order to provide low-cost tools for improved Vertisol management. A simple toolbar based on the local ard *(maresha)* can be used to form broadbeds and furrows for improved drainage at a rate of about 1 ha per 7-hour working day. A planter attachment to this implement allows row-planting and controlled placement of fertilizers.

An inter-institutional project on improved Vertisol management with the participation of ICRISAT, ILCA, the Ethiopian Ministry of Agriculture and the Agricultural University of Alemaya has been set up. In its first phase, this project is working in Ethiopia, where Vertisols cover more than 15 million hectares.

Figure 1. Effect of broadbed-and-furrow cultivation on grain and straw yields of wheat and teff *(Eragrostis tef).*



Humid Zone Programme

Introduction

The humid zone of West Africa covers around 2 million km^2. Annual rainfall (> 1500 mm), mean temperature (27–32°C) and relative humidity (80–90%) are high. Vegetation ranges from tropical rain forest in the coastal belt to derived savanna in the north. Livestock production is restricted by trypanosomiasis, a blood parasitic disease transmitted by the tsetse fly. Cattle production is less important than the production of trypanotolerant breeds of small ruminants. However, in some areas the tsetse fly population has decreased because of increased cultivation associated with the rising human population, and non-trypanotolerant zebu cattle are being brought into the region from the north.

The ILCA Humid Zone Programme is based in Ibadan in southwest Nigeria, near the northern margin of the humid zone. The Programme has concentrated on disease control and improved nutrition as means to increase small ruminant production. Field sites are located in both forest and derived savanna areas of southwest and southeast Nigeria in three states of the federation – Oyo, Imo and Anambra. Studies have been started in other West African countries through networking, to increase the zonal impact of the Programme.

The Programme places major emphasis on the development of alley farming, and the pilot study in southwest Nigeria has expanded to include more than 100 farmers. Some farmers have adopted alley farming without directly approaching the ILCA team, initially obtaining seeds and advice from neighbours. The beneficial effects of mulch from alley trees on soil fertility and crop yields, and of browse for stock feed, have been demonstrated in on-station trials, and their effects on-farm are currently being studied.

An increasingly important aspect of the Programme's work is cooperative studies with national institutions, including evaluation of *Gliricidia* germplasm in eight West African countries and leucaena (mimosine) toxicity trials with the University of Ife. The Programme also trains research and extension staff in techniques for the establishment and management of alley farms.

Extensive use is made of on-farm trials to identify practical problems associated with new interventions. Solutions are then sought and tested on station before being taken back to the farmer. This ensures a close relationship between farmer and researcher, to their mutual benefit. Financial support from donors, including the Interna-

tional Development Research Centre (IDRC), the Ford Foundation and the Federal Government of Nigeria, has been invaluable in facilitating this integrated approach.

Animal health

Between 1983 and 1985 the incidence of trypanosomiasis in small ruminants in villages declined steadily, as did the number of tsetse flies trapped around the Fasola and Ibadan sites. Blood samples from zebu cattle brought from northern Nigeria to Ibadan for slaughter showed trypanosomiasis infection rates of 7.3%, compared with only 3% for N'Dama cattle at Fasola and for village goats. In most cases zebus and goats were infected with *T. vivax*, while the N'Damas were infected with *T. congolensis*. However, goats had a lower packed cell volume (PCV) in their blood than did the cattle. Anaemia, as indicated by a PCV level of less than 20%, was found in 52% of the goats compared with only 10% of the zebu and 3% of the N'Dama cattle.

A survey of cattle in southern Nigeria showed that zebu cattle outnumber trypanotolerant cattle by 240 000 to 67 000. Among the latter group, West African Shorthorns (Muturu) outnumbered N'Dama by 3 to 2. Eighty-seven percent of the trypanotolerant cattle and one third of the owners were found on large-scale farms (more than 30 animals), while 6% of the cattle and 52% of the owners were associated with herds of less than 10 animals.

Animal productivity

Long-term studies of the productivity of small ruminants showed that supplementing sheep with leucaena and gliricidia browse increased their total feed intake but decreased their intake of grass. Lambing intervals decreased, survival increased and daily liveweight gain of lambs to weaning increased. As a result, the productivity index (kg of lamb weaned/ewe/year) increased by 55% (Table 2).

The productivity of goats was generally lower than that of sheep. Free-ranging village goats in southwest Nigeria, after protection against *peste des petits ruminants* (PPR), had a productivity of 10.7 kg of kid weaned/doe/year. However, the productivity of confined and tethered goats in southeast Nigeria was only 5.7 kg of kid weaned/doe/year even after protection against PPR.

Table 2. Effect of browse supplements on the productivity of sheep fed *Panicum maximum ad libitum*.

	Browse (g/day)		
	0	400	800
Lambing interval (days)	262	226	241
Liveweight gain to 90 days (g/day)	64	73	84
Productivity index[1]	8.7	10.2	13.5

[1] kg of lamb weaned/ewe/year.

A potential constraint to the unrestricted use of leucaena is the presence of mimosine, a toxic amino acid. Leucaena is highly palatable and, given the opportunity, livestock will consume more than the safe level. Sheep appear to be more susceptible to mimosine than goats, showing loss of hair around the face. However, a metabolite of mimosine has been found in the urine of both sheep and goats, showing that neither species can detoxify it. Farmers have been advised to offer a mixture of equal quantities of leucaena and gliricidia as supplementary feed to avoid mimosine toxicity. The recent discovery of DHP-degrading bacteria (see box, page 12) promises to remove the problem of mimosine toxicity in ruminants.

Forage agronomy

Research on cultivation and management of the leguminous fodder trees *Leucaena leucocephala* and *Gliricidia sepium* remains the major focus of the forage agronomy work. Both on-station and on-farm work have shown the potential of these trees for maintaining soil fertility and providing protein-rich fodder for small ruminants.

The alley farming system, through which small ruminant production can be integrated into existing cropping systems, continued to receive major research attention. The results of one long-term trial have shown that the incorporation of a 2-year grazed fallow following a period of alley cropping results in increased soil fertility and significantly higher yields of the subsequent maize crop. Total maize yield from two growing seasons in the first year after the grazed fallow period from the alley grazing/cropping rotation plots was 5.35 t/ha, 30% more than under continuous cropping in al-

leys (Table 3). A full comparison will be possible when the planned 2-year cropping cycle is completed in 1986.

The productivity of the trees under alley farming continued to be high. Results from two continuing trials over the last 3 years show a consistent level of production of 6 to 6.5 t DM/ha/year, with a potential nitrogen contribution to the soil of 165 and 60 kg N/ha in the first and second season respectively.

Two new alley farming trials were started in 1985. The first examines the effects of competition between maize and the trees by planting 3 instead of 4 rows of maize within the alleys, using the same population density. The second studies the effect on crop yield of removing different proportions of the tree foliage for animal feed, using the remaining foliage as mulch.

Four high-yielding accessions of gliricidia selected in trials during 1984 are being further evaluated, together with 12 new accessions obtained from the Commonwealth Forestry Institute (UK), in a network of trials extending across eight countries, namely Benin, Cameroon, Ghana, Ivory Coast, Nigeria, Senegal, Sierra Leone and Zaire.

The intensive feed garden, which involves intensive cultivation of fodder trees and grasses on small plots of land, is an alternative fodder production system to alley farming. Research on station in 1985 focused on further intensifying the prototype gardens by modifying the planting geometry. On-farm testing and development of the system continued in southeast Nigeria.

On-farm research

On-farm research is designed to refine innovations, to assess their relevance and acceptability to farmers and to collect technical and productivity data under farm conditions. Alley farming is a composite technology linking tree planting and management, land and soil management, crop production and livestock husbandry. In studying the adoption of such technology, attitudinal, sociological and institutional factors must be considered.

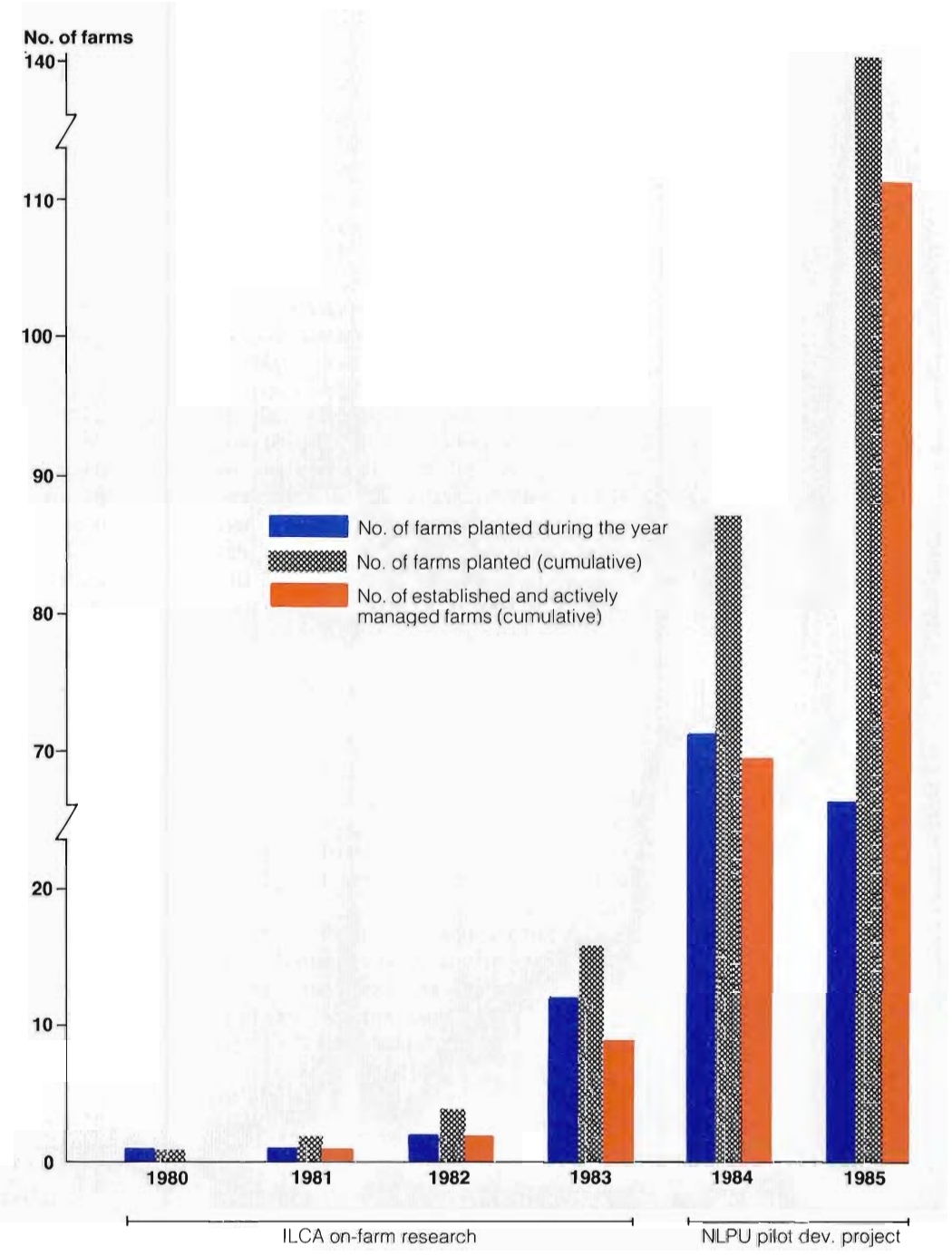
The evolution and definition of the system in the hands of the farmer, as part of the development of the technology, must precede the collection of technical data. An attempt to quantify the benefits in the early stages, when farmers are still adapting to the intervention, would lead to an unrealistic assessment of the benefits. Feedback from on-farm trials is essential to ensure the relevance of on-station research.

Table 3. Effect of a 2-year grazed fallow on maize grain yield in an alley farming system in southern Nigeria.

Treatment	1983	1984	1985	
	First season	First season	First season	Second season
	Grain yield (t/ha)			
Continuous cropping (no trees)	1.86	2.17	2.13	0.93
Continuous alley cropping	2.17	3.06	2.41	1.70
Alley cropping after fallow	–	–	3.30	2.05

In 1983 a pilot project on integrating small ruminant production with alley cropping started in southwest Nigeria, in conjunction with the National Livestock Projects Unit (NLPU). The pilot project involves control of PPR using tissue culture rinderpest vaccine (TCRV) and the establishment and management of leguminous trees to maintain soil fertility and to provide feed for sheep and goats. In the first planting season (1984), 68 farmers established alley farms. Another 46 farmers approached the resident extension worker for seed and advice in 1985 and have successfully established alley farms (Figure 2). In this way, alley farming has spread to three neighbouring communities. Three farmers who in the first year of the project attempted to establish browse trees on highly degraded soils obtained fresh seed in 1985 and have planted on more fertile soil. Nineteen women planted alley farms this year, compared with 11 in 1984.

Figure 2. Number of alley farms established in southwest Nigeria, 1980–85.



The flexibility of the system and the freedom of action allowed to farmers in the establishment and management of the farms are believed to be important factors in the manifest acceptability of alley farming. The alley farms established display wide variation in terms of crops planted, level of management and the way in which the trees are used. In 1985, almost half the farmers used the foliage for both feed and mulch, while half used it for mulch only. Only one farmer used the foliage entirely for animal feed.

Leucaena: An end to toxicity in ruminants?

One way in which ILCA serves Africa is by acting as a bridge over which technology developed elsewhere in the world can reach the continent. Recently, bacteria that degrade DHP, the toxic rumen metabolite that restricts feeding of the tree legume *Leucaena leucocephala*, were discovered in goats from Hawaii and introduced to Australia. ILCA is now testing these bacteria on sheep and goats at its headquarters farm in Addis Ababa.

Initial results indicate that the DHP-degrading bacteria have been successfully introduced into Africa. Two sheep and two goats were inoculated with cultures of isolated bacteria brought to ILCA from Australia. DHP concentration in the animals' urine, determined using high-performance liquid chromatography, declined rapidly over the first 14 days following inoculation, and levelled off to trace amounts after 25 days (Figure i).

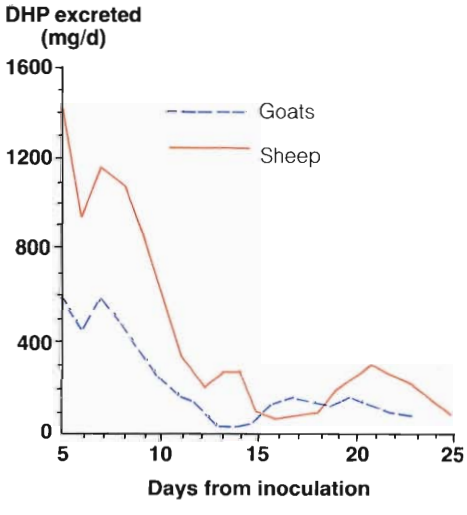
Australian trials have verified observations in Hawaii and southeast Asia that the animals carrying these bacteria can eat a diet comprising only leucaena without adverse effects. At lower feeding levels on a leucaena-based pasture, introducing the bacteria increased the daily weight gain of steers by 70%, from 0.7 to 1.2 kg/day.

A further advantage of the bacteria is that they are easily transmitted from animal to animal, and easily retained in the rumen once transmitted. Extension efforts to promote 'uptake' of the technology need therefore be minimal.

The introduction of the bacteria to Africa is timely. *L. leucocephala* already has considerable potential in agroforestry and reafforestation. Now its full potential as an animal feed can also be realised, giving smallholders an added incentive for growing it. Besides testing the effect of the bacteria on animal weight gains in systems such as alley farming, ILCA will act as a centre for distributing the bacteria to interested national research groups in Africa.

The discovery of rumen bacteria that break down DHP highlights the need for more research on the role of secondary compounds in animal nutrition. Recent ILCA experiments (see box page 50) show that ruminant species can adapt to diets containing high levels of toxic or inhibitory compounds. The challenge now facing ILCA's Nutrition Unit is to explore the mechanisms that make such adaptation possible and find ways of enhancing them, enabling Africa's hungry livestock to make greater use of a wider range of feeds.

Figure i. DHP excreted in the urine of sheep and goats inoculated with DHP-degrading bacteria and fed leucaena (300 g/day).



The use of browse trees and intensive feed gardens is also being studied on farm at two sites in southeast Nigeria: Mgbakwu, in the derived savanna of Anambra State, and Okwe, in the forest zone of Imo State. Population density and cropping intensity are higher at both sites than in the southwest. Animals are confined, cut-and-carry feeding is practised, and manure is collected and returned to compound farmland.

Twenty farmers in the southeast established alley farms or feed gardens in 1984, and a further 22 farmers planted in 1985. Three farmers planted trees as hedges around

their compounds. At this stage ILCA is still partly involved in planting and managing the browse trees, but from 1986 these activities will be entirely the farmers' responsibility, as with the pilot project in the southwest.

Circumstances vary between farmers and between members of the household, and it is important to study the relationships between resource availability, production objectives and involvement in alley farming. Labour availability is a critical issue, especially for women, who, in addition to farming, are also involved in food processing and marketing. Time allocations and returns to these activities are being measured.

Land tenure has emerged as another potential constraint on the adoption of browse trees, especially in the southeast, where communal control over the allocation and use of farmland may undermine both the right to plant trees and the incentive to invest in increasing soil fertility. Land tenure systems vary considerably within the region, and within any one system different categories of land are distinguished to which different tenure rules and patterns of use apply. Further research is being undertaken on the influence of land tenure on the adoption of alley farming.

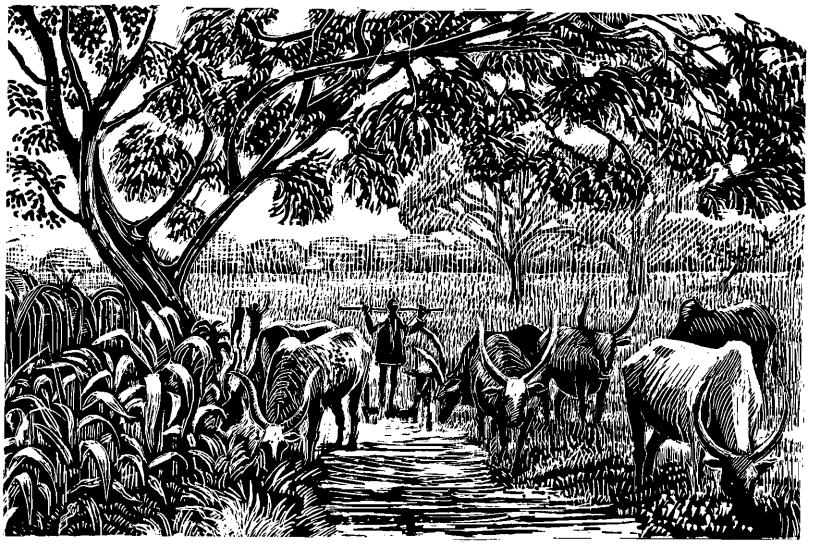
Production economics

Economic modelling shows that, if PPR is controlled, a net increase of 20 to 30% in the productivity of goats due to supplementary feeding with browse makes the incorporation of livestock into alley cropping more profitable than growing maize alone. The cultivation of maize in a traditional bush fallow rotation (without alleys) is the least profitable option.

Training and workshops

Participants from seven countries attended a workshop in February on Gliricidia Germplasm Evaluation. The participants were given seed of various lines of gliricidia to test in their home environments. The results were monitored by a visit from ILCA staff later in the year. Two training courses were held jointly with the International Institute of Tropical Agriculture (IITA) during 1985, dealing with the establishment and management of alley farms.

Subhumid Zone Programme



Introduction

ILCA's Subhumid Zone Programme is based in Kaduna, Nigeria. Research is carried out in three case study areas which represent the major land-use/ownership situations: Kurmin Biri, a grazing reserve for agropastoral settlement; Abet, where agropastoralists have traditionally settled amongst farmers who do not keep cattle; and Ganawuri, where arable farmers keep herds of cattle.

Poor dry-season nutrition has been identified as the major constraint on cattle productivity in the zone. Diagnostic studies of traditional agricultural and pastoral systems were largely completed in 1984, and in 1985 research focused on developing interventions to overcome the constraints identified. This increased the Programme's involvement in the design and testing phase of farming systems research (FSR).

Within each land-use/ownership system there are three states of land use: range grazing, cropping and fallowing. The programme is seeking interventions that will optimise productivity under each state. On range and fallow land the main intervention being tested is fodder banks – fenced legume-based pastures.

Sixty-six fodder banks have been established, some of which are now about 5 years old, and further research is being conducted to address problems that were identified during their adoption. The use of live fence posts to reduce establishment and maintenance costs forms a part of this research.

Following the demonstration of benefits to cropping as a result of soil improvements brought about by the legumes, there has been spontaneous demand from arable farmers for fodder banks to feed small ruminants, and four such fodder banks were set up for experimental purposes in 1985. Research is continuing on a range of intercropping techniques as means of both increasing the feed value of crop residues and establishing forage legumes in subsequent fallows.

The Programme is cooperating with the National Livestock Projects Unit (NLPU) in the multi-location testing of fodder banks. Such testing expands the geographical dispersion of this intervention and enables ILCA to investigate extension and development aspects. Under the auspices of the NLPU the number of farmer-managed fodder banks increased during 1985 from 46 to 62, located in eight states of the Federal Republic. ILCA and NLPU held a workshop in

March to assess the progress of this venture. At the end of 1984 a major symposium was held jointly by ILCA and the National Animal Production Research Institute (NAPRI), repeating the format of the original 1979 'state of knowledge' symposium. The proceedings of this symposium provide an overview of the progress made by the Programme from 1978 to 1984.

Adoption of fodder banks and impact assessment

Socio-economic research in 1985 covered fodder banks within the case study area and, increasingly, those managed by farmers in other parts of the zone. The results demonstrated the importance of the land-use/ownership situation. Half the adopters were on land allocated by the government, i.e. within a grazing reserve, while another 20% had secure title, through either purchase or inheritance. Few fodder banks had been established on land not controlled by livestock owners.

The results also revealed two other constraints to the adoption of fodder banks once the intervention passes from ILCA into the control of the extension and development services:

- More than 90% of fodder banks were started with institutional credit, which indicates that the availability of credit in adequately formulated packages will be crucial to adoption.
- Adopters were largely dependent on the NLPU for the supply of inputs such as fencing materials, seeds and fertilizer. However, the NLPU is not equipped to act as a supply agency, and the source of these inputs needs to be diversified.

Inevitably, management under farmer control differed from the standard recommendations. The most significant deviations were:

- Pastoralists tended to be unselective about the type and number of animals allowed to graze the fodder banks. This indicates that their emphasis is on short-term herd survival rather than on maximising longer term output. Financial analysis suggests that this strategy gives a higher internal rate of return despite lower eventual net income.
- Only about half the fodder banks were surrounded by a firebreak.
- Pastoralists found it difficult to keep to the grazing schedules needed to graze down grasses.

In contrast, fence maintenance was generally good; only 5% of the fences were in poor condition.

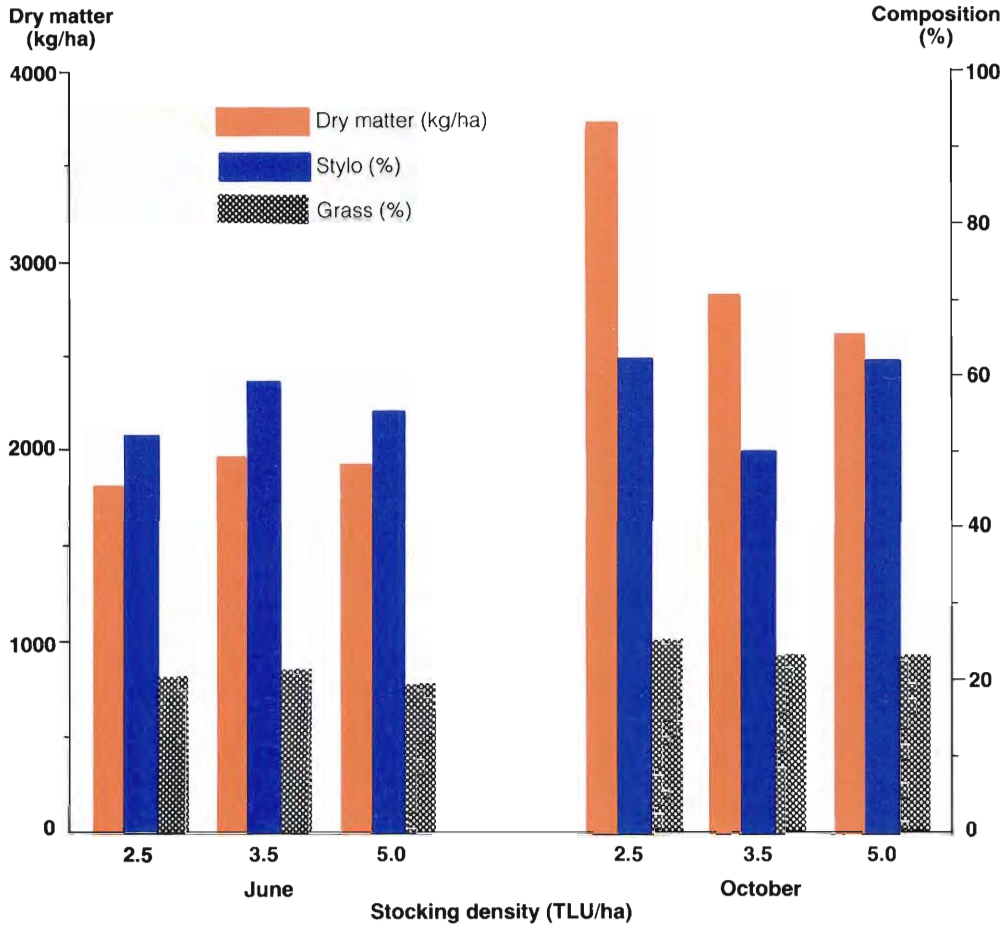
The deviations outlined above indicate that a much stronger extension input is needed. Despite the adoption problems, 25% of the pastoralists rated the fodder production from their banks as abundant, and 60% of them rated it as at least fair.

Agronomic aspects of fodder banks

The fodder banks were designed to overcome dry-season feed (protein) shortages, but in areas of high cultivation intensity there can be shortages of grazing in the wet season, when growing crops restrict access. The potential for fodder banks to alleviate this problem was examined by a 2-year grazing study on a 3- to 4-year-old fodder bank planted with *Stylosanthes hamata* cv Verano. This showed that grazing pressures of 2.5, 3.5 and 5.0 animal units/ha during the wet season had no effect on the proportion of stylo in the fodder bank at the end of the wet season. However, the higher grazing pressures reduced total (DM) yield (Figure 3). This indicates that, provided grazing pressure were kept low, fodder banks could be used to provide some wet-season grazing.

The initial restriction of fodder banks to land over which agropastoralists had rights increased the urgency of demonstrating a mutuality with cropping that would encourage farmers to grow, or permit livestock owners to grow, forage legumes. Trials were set up to test this. In the first year, maize grown on land that had been under *Stylosanthes* for 2 or 3 years yielded 1.5 to 2.5 t more grain/ha than maize grown on continuously cropped land. These yield increases were equivalent to applying 90 to 110 kg N/ha. This beneficial effect was shown to continue into the second year of cropping, as indicated by the significant yield differences between the stylo plots and continuously cropped plots in the second year when no N was applied. However, the yields were smaller than in the first year. These experiments will be followed up with the objective of enhancing the adoptability of legume-based cropping techniques.

Figure 3. Effect of stocking density on DM production and composition of a *S. hamata* cv Verano fodder bank in June and October 1985, Kurmin Biri.



Measurements showed that 'stylo soils' are less prone to ridge slumping during the wet season than fallow or continuously cropped soils, and that this was related to the stylo soil's ability to retain higher water-stable soil aggregates. The stylo soil was also more resistant to erosion, and may have a greater capacity to retain soil nutrients. In a comparison of the properties of fallow soil and soil that had been under a legume for 3 years, it was found that organic matter content had risen from 1.04% to 2.72%, available water-holding capacity from 10.4 to 18.5 g/100 g, and that bulk density had fallen from 1.62 to 1.42 g/cm^3.

Shortage of labour limits the area of land that can be cultivated. However, experiments showed that significantly less labour was required to prepare the land and to crop within a stylo fodder bank than after a natural fallow. The exception was the labour requirement for harvesting, which was higher for crops within the fodder bank due to higher yields (Figure 4).

Forage germplasm testing

The Programme has so far worked with commercially available *Stylosanthes* cultivars, particularly *S. guianensis* cv Cook, *S. guianensis* cv Schofield and *S. hamata* cv Verano. Both *S. guianensis* cultivars are susceptible to anthracnose, and a major priority of the Programme is to identify cultivars that are resistant to this disease. Nigeria needs legumes for a wide range of ecological and agro-pastoral conditions, and the Programme, in cooperation with the headquarters Plant Science Department, has accordingly widened its selection criteria and generic coverage to cope with this need. The following accessions were added to the observation plots in 1985:

Species/cultivar	No. of lines
S. hamata	63
S. humilis	1
S. guianensis cv Pauciflora	68
Centrosema pascuorum	14
Arachis pintoii	1
Arachis sp.	1
Cassia rotundifolia	4
Aeschynomane americanum cv Glenn	1
Leucaena leucocephala	23

Forage crop nutrition

Observations on the residual effects of applied nutrients showed a sharp reduction in legume yields in the second year – so much so that almost all nutrients had to be applied in the third year to restore productivity. This suggests that residual effects cannot be relied on and that even minor elements must be applied relatively frequently on these soils. Micronutrient deficiencies cannot be rectified easily because micronutrient fertilizers are not readily available. However, *kanwa*, a locally mined mineral supplement fed to cattle during the dry season, was found to contain a wide range of nutrients, including Zn, Cu, Mn, Fe, Mg and Ca. A study was therefore conducted to examine the possibility of using *kanwa* as a micronutrient fertilizer.

Applying *kanwa* to stylo both with and without P significantly increased both herbage and seed yields of the stylo (Table 4). Sources of *kanwa*, and the economics of its use as a micronutrient fertilizer, are now being investigated.

A report on the soils of the subhumid zone was delivered to the Programme in March 1985. It focuses on the poor ability of the zone's soils to retain nutrients, mainly due to their low organic matter content and lack of resistance to erosion. These factors are being taken into account in planning future work.

Figure 4. Labour input into maize cropping on soils inside and outside fodder banks.

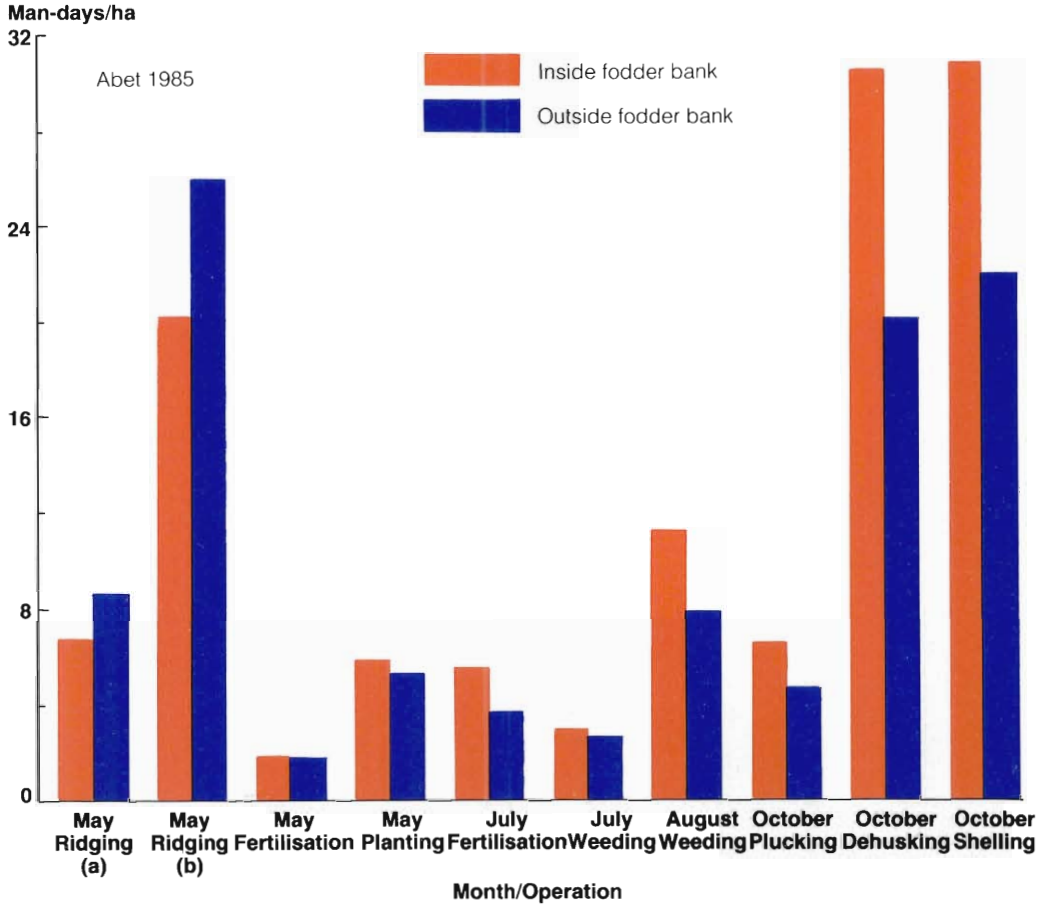


Table 4. Effect of P and *kanwa* applications on DM production of *Stylosanthes hamata* cv Verano.

P (kg/ha)	*Kanwa* (kg/ha)	Stylo yield (kg DM/ha) 0	50	100	Mean
0		2936 ± 252	4412	4828	4059 ± 146
18		4868	5084	5636	5183
36		4544	5884	6484	5637
54		4964	5360	6484	5603
Mean		4327	5176	5858	

Forage intercropping

As noted previously, in intensively cultivated areas such as Ganawuri, wet-season feed shortages are a constraint to livestock production. In another attempt to overcome this constraint, studies were conducted on manipulating the cropping pattern to accommodate a fodder legume and a cereal crop on the same plot in a single growing season. Millet was raised in nurseries and transplanted into Cook stylo plots in August after a total of 4962 kg of stylo DM/ha had been harvested. The stylo then regenerated as an intercrop with the millet and set seed normally, thus ensuring continuity and adding high-quality herbage to the millet residue for feeding during the dry season without reducing millet grain yield.

Animal production

A study was conducted to determine the causes of variation between traditionally managed herds with the highest and the lowest production indices. There was a high, positive correlation between productivity and the age of the herder – cattle herded by children were least productive. This finding highlights the labour problem in agropastoral households, where the labour requirements for herding and for cropping must be balanced against each other.

A rapid survey technique developed for assessing animal production characteristics was used to assess small ruminant production in Abet and Ganawuri, and the results were compared with those of longer-term monitoring of goat and sheep flocks. The results of the two studies were generally in good agreement.

Analysis of 6 years' data on the productivity of traditionally managed Bunaji cattle showed that productivity was related to season of calving, reflecting seasonal fluctuations in the availability and quality of forage. Management system and demand for milk for human consumption were also found to affect cattle productivity.

Dams were supplemented with cottonseed cake in the first 2 years, but thereafter the use of fodder banks was the main intervention studied. The effect of dam supplementation on overall productivity is shown in Table 5.

Supplementation reduced cow and calf mortalities and calving interval, and increased calf growth and milk yield. However, not all the differences were statistically significant.

Table 5. Effect of dry-season dam supplementation on the productivity estimates of Bunaji (White Fulani) cattle under traditional management.

Character	Non-supplemented	Supplemented
Cow survival (%)	94.0	100.0
Calving percentage	48.7	51.5
Calf survival (%)	71.8	86.3
Calf weight at 1 year (kg)	98.1	103.4
Lactation milked-out yield (kg)	300.2	312.5
Productivity index (kg/cow/year)[1]	47.5	63.8

[1] Total weight of 1-year-old calf plus liveweight equivalent of milk produced.

Aerial surveys

The ILCA study areas that were surveyed by air in 1979 were resurveyed in 1984. In addition, as part of the cooperation with the newly established livestock systems team at NAPRI, an aerial survey was conducted to establish the baseline livestock populations and related activities and interactions in NAPRI's case study area at Giwa.

A synthesis of all the survey work in the Nigerian subhumid zone, as well as a report comparing it to other regions of West Africa, will be published soon.

Arid and Semi-arid Zones Programme

Introduction

The main objective of the Arid and Semi-arid Zones Programme is to increase livestock productivity in the drier areas of the Sahel. The Programme aims at achieving this through developing improved forage production and cropping techniques for the agropastoral areas and through improving the management and use of forage resources in the more arid pastoral areas. Further increases in productivity are being sought through improving livestock nutrition and management, and through reducing the impact of diseases.

The Programme is also studying the use of remote sensing to monitor changes in vegetation in the Gourma and the inner delta of the Niger. This work is reported under the Resource Survey Projects section of this report (page 62).

Animal health

The studies started in 1983 on animal health in the agropastoral and pastoral systems in Mali were continued in 1985.

High mortality rates were observed among lambs (30%) and kids (35%) in the agropastoral system. The main causes of mortality were malnutrition and infectious diseases, such as pneumopathy, sheep pox and *peste des petits ruminants* (PPR). However, in 18 to 20% of the cases the cause of death was not known (Table 6).

The mortality rates could be considerably reduced by improving feeding during the dry season for pregnant and lactating females using cereal straw and cowpea hay, and by vaccination against infectious diseases.

Fascioliasis, a parasitic disease, was found to be a major constraint to sheep production in the irrigated rice subsystem, causing 30% of sheep deaths. The disease seldom affected goats and was manifested as a chronic condition in cattle.

Studies of the health status of animals in the pastoral system showed low mortality among cattle for the second year running. However, many instances of low growth rate among calves were observed.

Low fertility was shown to be a much greater constraint to the productivity of the system. Ovarian dysfunction (acyclical or underdeveloped ovaries) was common during the dry season. Intervals between calving and conception were long (17.5 ± 6.5 months), resulting in low calving percentages. These effects are the result of a complex of factors, including nutrition and the effect of lactation on fertility.

Table 6. Causes of pre-weaning mortality in goats and sheep.

Cause	Prevalence (%)	
	Lambs	Kids
Malnutrition	23.3	18.3
Pneumopathy/Pasteurellosis	10	40
Diarrhoea	8.3	11.7
Peste des petits ruminants	–	11.7
Sheep pox	36.6	–
Accident	1.7	–
Unknown	20	18.3

The major health problem in small ruminants was pneumopathy, 50% of the cases being recorded among sheep around Mopti during the cool season of 1984. The etiology of this disease will be studied further in 1986.

Agronomy trials

Agronomy trials were conducted in two areas in the agropastoral system of Mali, distinguished essentially by annual rainfall: the Niono region, receiving 450 mm, and the Banamba area, receiving 720 mm.

Research at Banamba focused on agronomy of cowpeas (*Vigna unguiculata*), both in pure stands and in intercrops with millet, while the work in the Niono region mainly consisted of further testing of the best five lines of cowpea identified in 1984.

At Banamba cowpeas planted on top of ridges had higher dry-matter (DM) but lower grain yields than those planted in furrows or on the sides of ridges (Table 7).

Table 7. Effect of placement on cowpea yields at Banamba, 1985.

Placement	Grain yield (kg/ha)	Hay yield (kg DM/ha)
Top of ridge	183	2052
Side of ridge	306	1711
Furrow	260	1940

The optimum plant population for cowpea at Banamba was found to be 25 000 plants/ha for both fodder and seed production. Planting on ridges 90 cm apart with 45 cm between hills and one plant per hill gave the highest grain and DM yields (Table 8).

In cowpea/millet intercrops, sowing of the legume had to be delayed by at least 6 days in order to avoid competition between the two species and hence reductions in the yield of millet.

Table 8. Effect of planting geometry and number of plants per hill on cowpea yield at Banamba, 1985.

Planting geometry[1]	Plants per hill	Grain yield (kg/ha)	Hay yield (kg DM/ha)
90x45	1	195	4028
	2	93	2288
90x23	1	103	3915
	2	61	1934

[1] Spacing between ridges x between hills within ridges.

The cowpea trials in the Niono region attracted considerable interest from farmers, despite the relatively low yields (Table 9). While these trials demonstrate the potential of some cowpea accessions on farmers' fields, further work is needed to increase yields by introducing improved practices developed in on-station trials.

Poultry

Poultry research in 1985 focused on the productivity, socio-economic importance of and constraints on backyard poultry production. In a survey of households in both urban and rural areas, 60 to 90% of the households were found to keep poultry, particularly chickens, for home consumption. Each flock comprised 10 to 15 chickens, 10 to 20 pigeons and about 23 guinea fowl. The chickens were found to lay 5.4 ± 0.1 times per year, producing 8.1 ± 5.3 eggs weighing 35 ± 5 g. Most of the eggs were kept to produce chicks. Despite a potential production of more than 6 kg of chicken per laying hen per year, the average production was only 3 kg per year, due to high mortality rates of 52 to 60% between birth and 2 months of age.

The main constraints on poultry production are thus the high mortality rate due to diseases, primarily Newcastle disease, and poor management. These problems could be overcome by vaccination, correct feeding and improvement in housing and management. A reliable vaccine against Newcastle disease is available and the local farmers have shown willingness to use it.

Table 9. Grain and hay yields of five varieties of cowpea under traditional management in the Niono region in 1984 (220 mm rainfall) and 1985 (450 mm rainfall).

Variety	Year	Number of fields	Grain yield[1] (kg/ha)	Hay yield[1] (kg DM/ha)
CSIRO 45581	1984	9	47 (577)	204 (947)
	1985	13	113 (32)	1610 (1251)
CSIRO 57317	1984	20	71 (198)	427 (1346)
	1985	10	99 (83)	2027 (1565)
IT82-E-60	1984	1	114 (402)	620 (915)
	1985	6	52 –	1680 –
TN-88-63	1984	15	50 (303)	412 (1517)
	1985	23	106 (167)	1876 (3980)
TVX-3236-O1G	1984	1	164 (507)	662 (1792)
	1985	18	75 (358)	1815 (3157)

[1] Figures in parentheses are mean yields obtained in on-station trials at Niono in 1984 (220 mm rainfall) and Banamba in 1985 (720 mm rainfall).

Supplementing draught oxen

During 1985 the Programme continued to study the effects of supplementary feeding on the work performance of draught oxen. It was found that oxen supplemented during the tilling season were able to till 1737 m^2/hour, compared with only 1498 m^2/hour for unsupplemented animals, an increase of 16%. It was also found that supplementing oxen during the weeding season had little effect on the amount of work done (1079 versus 1031 m^2/hour), since the effort required for such work is low. However, feed supplementation, whether before or during the tilling season, had no significant effect on the work performance of the oxen unless they were below the minimum weight necessary to perform the work in hand.

Embouche paysanne

In 1984 the Programme started a study of crop–livestock systems associated with a smallholder beef fattening project located in two areas, one to the west of the Niger river (the Banamba area) and the other to the east of it. The aim of the study is to increase animal production by increasing both the quantity and the quality of the feed available, primarily through introducing legumes into the cropping system.

In 1985 the study focused on detailed recording of the feeding and weight changes of 120 cattle every 3 weeks, and studies of the economics of the fattening system, including purchase and sale prices of cattle, costs of inputs and seasonal changes in prices on local markets.

Of the animals studied, 50.3% were Fulani Zebus, 45.5% were Maure Zebus and 4.2% were crossbreds, all more than 7 years old.

The cattle gained an average of 47 kg/head over a 3-month fattening period, an average of 0.58 kg/day. The Maure Zebus gained an average of 0.77 kg/day, compared with only 0.44 kg/day for the Fulani Zebus, despite similar feed intakes. The causes of the differences in weight gain will be investigated in 1986.

Bush hay, millet and sorghum straw and cottonseed residues comprised 84 to 97% of the animals' diets. Cottonseed residues were the largest component of the diets, comprising 40 to 60% (3.2 to 3.7 kg/day) of the feed intake, depending on whether the animals were allowed access to grazing. Among zero-grazed animals, the diet included 7% millet straw, 10% sorghum straw and 35% bush hay. The cattle also consumed approximately 31.9 kg of water per day.

The 33 smallholders in the project made an average gross profit of 33 500 CFA francs (US$ 84) per animal from 108 animals, of which 67% was due to seasonal price increases and 27% to weight gain. The average net profit (after deducting costs of production) was 13 400 CFA francs (US$ 33.50) per animal.

While this average net profit appears to be satisfactory, 32% of the smallholders made no profit, and 20% did not generate

enough income to cover their costs of production (17 500 CFA francs or US$ 43.75 per animal). However, 54% of the smallholders made a net profit of more than 10 000 CFA francs (US$ 25) per animal.

Sale price of the animals was found to depend solely on liveweight: the quality of the carcass was apparently not considered in pricing.

Ethiopian Rangelands Programme

Introduction

Studies by the Ethiopian Rangelands Programme over the last 4 years have shown that pastoral systems such as that of the Borana of southern Ethiopia are already highly productive, but that further increases in productivity are possible.

In 1985, the Programme drafted a major report on the productivity and potential of cattle-based pastoral systems in East Africa. The report is a summary of nearly 4 years' work in the southern rangelands of Ethiopia and discusses how pastoral systems operate, their productivity and efficiency, their stability under stress, and the future and potential of pastoralism in East Africa. The report identifies a number of important areas in which research and development are likely to result in increases in productivity in cattle-based pastoral systems.

The most promising of these lies in increasing calf growth while maintaining milk offtake for human consumption. The current poor growth rates of calves result in skeletal stunting, delayed first calving and maturity, and low mature body weights. Analytical models indicate that doubling the currently low calf weaning weights of about 50 kg could increase the self-sufficiency in milk of a pastoral family from 66 to 82%, beef offtake by 69% and cash income net of essential food purchases by 125%.

The key element of an expanded field research programme in southern Ethiopia in 1986 will be a study on increasing the growth rates of calves in pastoral systems by supplementary feeding, and alternate watering and management strategies. Central to this study is the introduction of legume-based fodder and food crops in small, favourable areas with an emphasis in the long term on perennial fodder species and agroforestry. The study will be cofinanced by ILCA and CARE-Ethiopia.

Drought in the southern rangelands

Frequency of droughts

Since the turn of the century, droughts have been reported in northern Kenya and southern Ethiopia in 1918–19, 1928–29, 1933–39, 1943–45, 1958–59, 1970–73, 1975–76 and 1983–85. An initial report on the 1983–85

drought was given in ILCA's 1984 *Annual Report.*

Drought and rangeland degradation

Systematic reconnaissance flight surveys over the southern rangelands during the drought year of 1984 showed large movements of livestock, following the isolated rainfall events. In September 1984 rain fell in the north of the area, providing feed for the livestock for a short period, but once this feed was exhausted more than 75% of the non-milking herd left the area, ranging far north into the highlands and south into Kenya beyond Marsabit.

As a result, the cattle population of the southern Ethiopian rangelands fell to 46% of the March 1983 total. The movements of the cattle followed the availability of grazing, and stocking pressure about equalled the availability of feed. A common theory in East Africa is that a reduction in rangeland feed supply in a drought precedes a fall in cattle numbers, which results in degradation, progressively worse with each drought. There is no evidence to support this theory in the southern rangelands, as the pastoralists match stocking density to the availability of feed. The herds simply leave the area, and long-term damage is minimised.

Decline of the pastoral herd

In March 1985 good long rains set in, and the non-milking herds began to return to the area, all arriving by June 1985. However, the total number of cattle recorded was 30% less than in June 1982, reflecting mortality during the drought ranging from 24% in the northern areas to over 50% in some of the central areas. The decline in livestock numbers occurred in 'waves', rather than as a steady decline: this is shown in Figure 5 for the Borana from 1983 to 1985. The data suggest that cattle can be divided into 'hardiness groups', which range from those that die under moderate stress and are usually high producers, to survivors whose main characteristic is hardiness rather than productivity. Because of selection over centuries, it is probable that cattle productivity is more closely linked to the occasional extremes of climate rather than to better years or long-term rainfall averages.

Variability

Large differences were observed in the effects of the drought on livestock in the Borana between ecological zones within the region, between encampments within zones and between herds within encampments. Losses within encampments for herds of similar sizes ranged from 17 to 60%, and between zones from 24 to 52%. The data indicated that among the 66 herds followed throughout the drought, medium-sized herds suffered smaller losses than did small and large herds. This was probably because the owners of small herds took too much milk for human consumption while the owners of large herds were unable to provide the labour required for the constant search for feed.

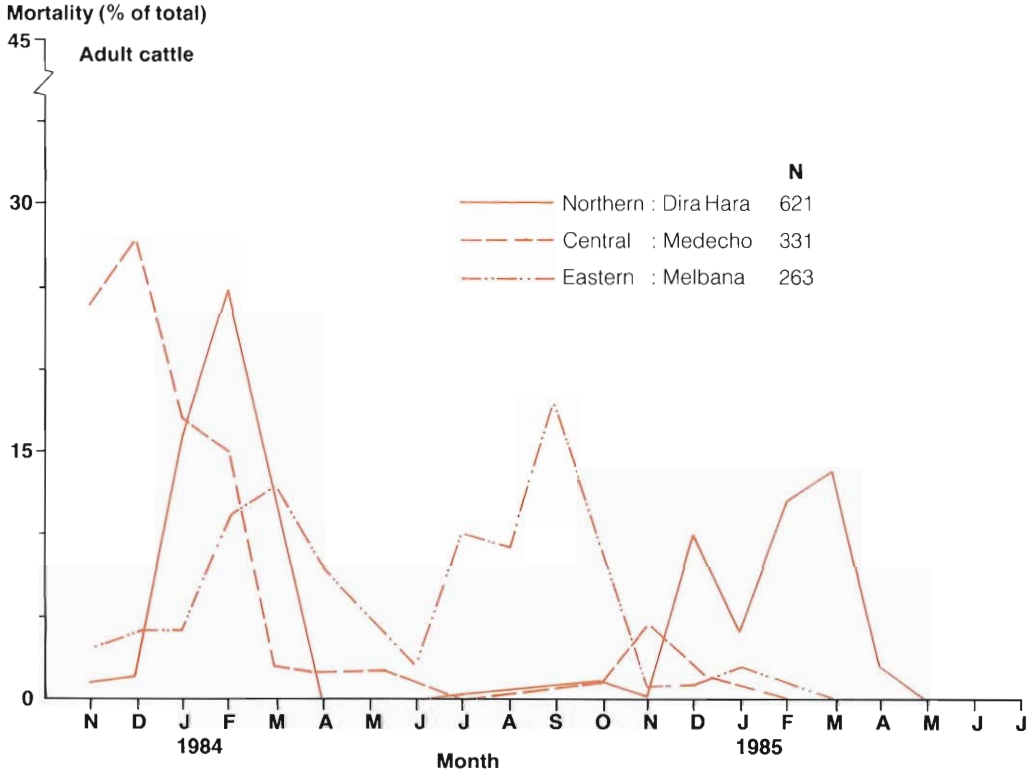
In March 1985, at the height of the drought, the total DM intake of cattle was well below maintenance requirements, but high rumen ammonia levels were recorded in some herds, indicating reasonable feed quality. The ability of the herder to find small areas of forage of better quality may thus have a large effect on the survival and productivity of his herd.

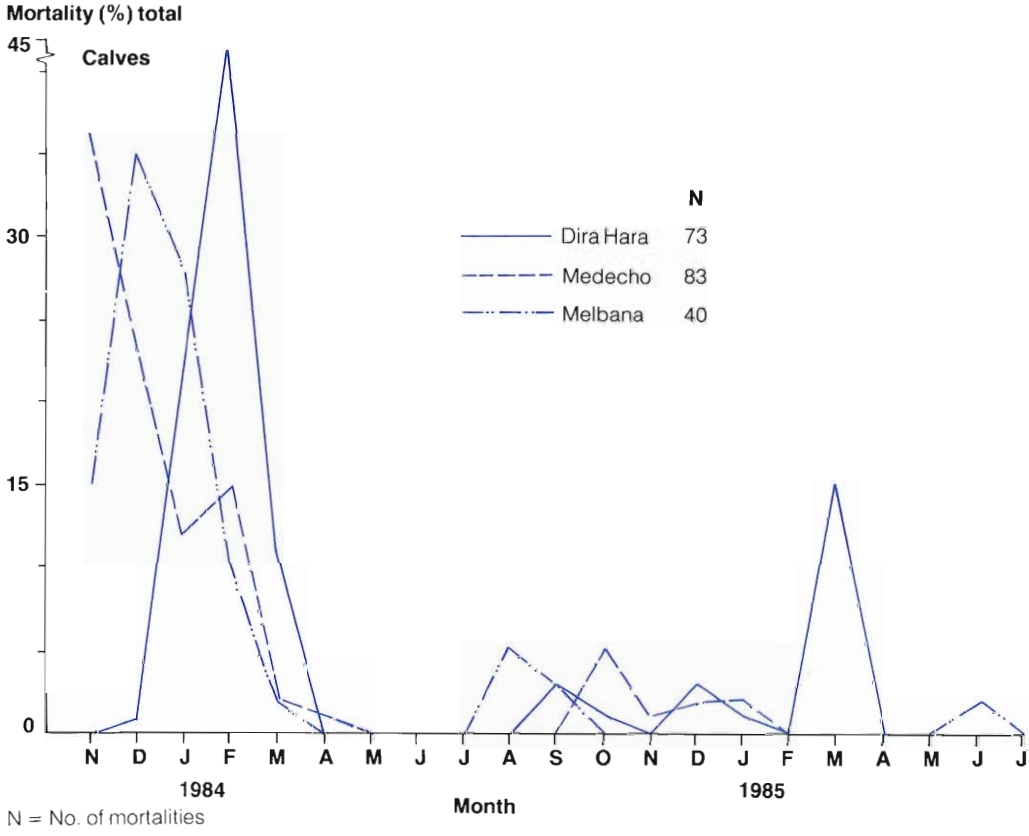
Human stress

In the sequence of effects of drought, people are affected last, and in Borana severe hunger among people was not observed until November 1984, a year after the onset of the drought. The pattern of recovery is the reverse, with feed supplies recovering first, leading to a rapid recovery in livestock condition and calving rates, while people remain hungry throughout the first post-drought year (Table 10).

Studies of the daily food intake of a sample of families in Borana provided a picture of severe food shortage being managed by a humane and disciplined people. The men and old people stood back and let the more vulnerable young and nursing mothers eat first. Given a base daily maintenance requirement of 10.6 MJ per active adult male equivalent (AAME), all but the children were on a sub-maintenance diet. Inevitably, this reduced the amount of work people could do and therefore affected their herd management strategies. The data suggest that the shortfall in food production in 1986 will be equivalent to between 200 and 400 kg of cereal per family, or from 27 to 54% of total food energy needs.

Figure 5. Distribution of cattle mortality at sites in the southern Ethiopian rangelands, 1983–85.





N = No. of mortalities

Table 10. Daily food energy intake (MJ GE/AAME) measured at two camps in Borana, 1984/85.

	Age group				
	0–5	6–10	11–15	Adult male	Adult female
	Energy intake (MJ GE/AAME)				
Medecho (central zone)					
Nov 1984	11.1	7.4	4.2	4.0	4.8
Dec	11.7	6.7	6.4	4.3	5.2
Jan 1985	10.8	7.0	9.0	6.5	6.2
Feb	10.2	5.7	8.3	7.2	7.9
Mar	10.9	8.1	9.2	8.8	8.7
Apr	14.8	8.7	10.5	9.8	8.8
May	14.2	9.3	12.7	6.3	5.6
June	13.3	9.9	9.6	7.5	7.8
July	14.4	12.0	8.8	6.7	5.6
Aug	11.9	9.0	5.9	5.9	5.2
Sept	12.5	10.7	9.6	8.5	6.6
Melbana (eastern zone)					
Nov 1984	10.0	6.9	n/a	5.2	6.3
Dec	13.4	5.9	4.1	n/a	5.2
Jan 1985	12.0	6.6	5.0	6.2	6.3
Feb	n/a	6.4	4.7	6.4	5.4
Mar	13.7	7.1	5.5	7.4	7.1
Apr	15.4	10.7	5.9	5.6	5.7
May	13.5	7.3	6.8	5.7	5.4
June	11.0	6.3	6.6	5.2	4.9
July	15.5	5.5	6.3	6.1	5.6
Aug	14.2	9.0	6.0	7.3	6.7
Sept	13.2	9.0	10.0	5.9	3.6

Drought mitigation and recovery

Recovery and terms of trade

A computer model of the Borana pastoral system has shown that, although it may take 7 to 12 years for herds to recover to pre-drought levels, pastoralists will usually be able to support themselves in the second year after a drought of the severity of that in 1983–85 through food production and by selling livestock to buy cereals. The model can be used to determine the minimum terms of trade that will allow survival. Favourable terms of trade are important in most years, but are crucial in a drought year, as is the availability of willing trading partners.

Calf survival and milk output

In a follow-up to the calf feeding study reported in the *ILCA Annual Report* of 1984, it was found that dams of calves that survived had lactations of 154 ± 80 with a milk offtake of 56 ± 34 litres of milk, compared with 53 ± 57 days and 17 ± 23 litres of milk for cows whose calves died. Although the differences in the amounts of milk produced are relatively small they are very important in a drought year. In a model of drought recovery, the reasonable calf survival rates achieved in calf feeding trials (30% mortality compared with 90 to 95% for traditional herds) resulted in self-sufficiency of the pastoralists in the first post-drought year, and reduced by 25% the time taken for herds to recover to pre-drought numbers and for offtake to reach pre-drought levels. Thus, feed supplementation of calves has implications for drought mitigation and recovery as well as for productivity in normal years.

Supplementation of the breeding herd

In last year's *Annual Report* we reported on the start of a drought feeding trial using

molasses and urea. This intervention was readily accepted by the Borana, who stated that it doubled milk yield and increased survival. Earlier feeding of molasses and urea to ILCA's research herd had dramatically decreased mortality rates, and the condition of animals that received the molasses/urea mixture was uniformly better than that of animals that did not receive the mixture.

Measurements in Borana herds confirmed that molasses/urea supplementation increased milk yield, but there were no appreciable differences in mortality between the supplemented and unsupplemented groups of animals. The trial lasted for only 3 months before the drought broke, and the differences in mortality might have been greater if the drought had persisted. Conception rates are now being monitored and a comprehensive report on drought feeding is planned for 1986.

Pastoralism and forage crop production

The major constraint to increased calf growth is the lack of high-quality feed. The Programme is therefore studying the potential of a number of herbaceous and tree legumes in semi-arid rangeland areas. The research centres on growing the legumes in areas in which soil type and depth and water run-in combine to produce a more favourable environment.

Large plot trials in Borana in 1984 showed that forage and failed cereal crops can produce up to 1 t DM/ha even in drought years. This can be used as feed to enhance calf survival. In 1985, with the better long rains, cowpea, pigeon pea and lablab yielded between 3 and 7 t DM/ha, and *Stylosanthes scabbra, S. hamata* and *S. guianensis* yielded 2 to 3 t DM/ha, indicating the potential of these legumes to provide extra feed of high quality even in these arid areas.

Maize yields were also between 1 and 5 t/ha in 1985, justifying the inclusion of maize or other cereals in a long-term fodder crop rotation. Yields of this order would have made the Borana self-sufficient in the immediate post-drought period. There are some reservations concerning the production of cereals in the rangelands, but pastoralists should be encouraged to cultivate small plots of cereals in post-drought years.

In 1986 the Programme will concentrate on screening perennial and semi-perennial legumes for their productivity in arid areas, and on methods of integrating these into the cropping cycle. Other research topics will include studies on increasing the feed value of enclosed areas, which are increasingly common in East African pastoral areas, through selective introduction of *Stylosanthes* species; studies on the effects of manuring and other practices on the production of annual legumes; and continuing investigation of the value and potential of native fodder species.

Bush encroachment and rangeland degradation

Tree and shrub encroachment on open grazing areas is an active phenomenon in much of East Africa, and is of increasing importance in Borana. In some zones more than 30% of the area has 40 to 60% tree cover, and only in the north does more than 25% of the land have tree cover of less than 20%. The Programme started detailed studies of the dynamics of bush encroachment at three sites in the Sidamo area in 1984.

The Borana are aware of bush encroachment and many believe that the initial stages are accompanied by an increase in the carrying capacity of the land, while others regard the increased availability of wood and shade as beneficial. However, they also believe that thick bush reduces grazing and provides shelter for predators.

The results of the studies suggest that depletion of soil minerals is not a trigger for tree invasion, as was previously thought, but that it accompanies the invasion of bush. In areas invaded by bush, soil degradation was not noticeably altered, and between 26 and 48% of the edible biomass was in the form of bush, leaves and branches. In some cases the availability of grass was reduced by as much as 70%, even where the total grass/browse biomass was greater than the previous grass biomass alone.

There are indications that browse production in the semi-arid rangelands of East Africa may be far more stable than that of grass. Throughout the drought in Sidamo, camel productivity remained quite high, with milk offtakes of 90 to 120 litres per month, and the mortality of goats was only

slightly higher than the norm. The Borana recognise this and are, where possible, keeping camels as a security measure. A major study on browse utilisation will be completed in 1986, and additional complementary studies are planned.

In much of East Africa's rangelands trees can be exploited with little effect on the nitrogen and phosphorus balance of the soils. In Borana it has been estimated that each family could produce a sustainable output of 1.4 t of charcoal each year. This would increase their gross income by 37% and, if exported, relieve the pressure on wood and dung in the adjacent highlands as well as help control bush encroachment. However, at present this practice is prohibited by the government and, if introduced, would need careful control.

Watering frequency and animal production

In 1983 the Programme started a 4-year trial to study the effects of some of the management practices of pastoralists, including infrequent watering, long walking distances and night penning of animals.

After 27 months, the effect of infrequent watering on cattle was small but statistically significant. While there were no significant differences in calving percentages or birth weights among cattle watered at 1-, 2- and 3-day intervals, 2- and 3-day watering depressed weaning weights by 9 and 14 kg respectively, compared with the weaning weights of animals watered every day. However, there were no significant differences in the weights of animals at 2 years old, due to compensatory growth in the lighter animals. In a trial with 700 steers in Kenya in a hotter environment, animals watered every 3 days were 19 kg lighter at 2 years old than animals watered every day.

In lactating cows, watering at 3-day intervals decreased milk yield by 10% and increased loss of body weight and condition during the dry season. Most importantly, DM intake fell by 9.0% in cows and by 10 to 15% in steers, but no increases in digestibility were observed.

The main advantages of watering animals every 3 days are that water and feed are conserved, and that the pastoralist can exploit feed resources further from the watering point. Watering the animals at 2- and 3-day intervals reduced water consumption by 10 and 25% respectively, compared with watering every day. In Borana, this represents a saving of 1.2 million t of hand-lifted water per year, thus significantly reducing the amount of labour required to water the animals. The lower dry-season feed consumption can either prolong the availability of dry-season feed or, as in Borana, allow a higher stocking rate, while the exploitation of distant grazing resources allows a further increase in stocking rate or reduces overgrazing near to water.

There is a trade-off between the advantages of 3-day watering and the slightly lower productivity that results. In commercial production a viable alternative may be to raise stock on 3-day watering but to finish them for a short period on daily watering to obtain optimum sale weight. The study in Ethiopia is being continued, with animals watered every 3 days, with the addition of long-distance walking and night kraaling to the trial.

Pond construction and calf growth

One of the key requirements for increased calf growth is regular supplies of water. At present in Borana, calves are not given free access to water until they are weaned and can walk to the larger ponds and wells. A model simulating water requirements indicates that calves in the traditional system receive sufficient water from milk and occasional watering to digest available dry matter and solids, but that an additional 1 to 2 litres of water would be required to produce reasonable weaning weights. The provision and management of readily available water is thus important and is the principal objective of the animal-drawn scoop project.

Previous attempts to persuade pastoralists to use oxen to pull scoops for pond construction failed, because the pastoralists wanted to fatten the oxen for sale. In 1985, camels were used successfully to pull the scoops. Partly because of its greater body weight, a single camel can do more work than a pair of oxen, the main disadvantage being that it must be led. In addition, the harnesses and scoops need to be modified for use with camels. The problems of transferring the technology to pastoral groups will be studied further in 1986.

ILCA and CARE-Ethiopia

Between 1982 and 1985, ILCA's Ethiopian Rangelands Programme studied the Borana pastoral system in southern Ethiopia in order to clarify structural and functional aspects of the system and to identify ways of increasing its productivity. Work focused on seasonal patterns of livestock management and production, human diets, household economics, range ecology and screening of forage legumes.

A major conclusion of these studies was that calf supplementation offers the best opportunity for increasing livestock production and improving human welfare among the Borana. As in other African pastoral systems, competition for milk between people and calves substantially reduces calf growth rates and weaning weights and delays maturity, all of which are critical production parameters. The study also showed that if calf growth is to be increased without reducing milk offtake for human consumption, feed quality and water availability will also have to be increased.

The Ethiopian Rangelands Programme then ran into a common problem: funding began to wane just when benefits from the work began to seem possible and interventions were ready for testing. Enter CARE-Ethiopia, a development-oriented NGO interested in cooperating with other organisations and able to provide funds for a further 3 years.

Under a new joint research and development project, ILCA will supply scientific staff and guidance, while CARE-Ethiopia provides funds for logistics and equipment. The project allows the Ethiopian Rangelands Programme to expand the testing of interventions identified during the diagnostic study. The work will include: (1) calf growth trials to quantify the effects of legume supplements and water availability on calf weaning weights and age at maturity, (2) studies of the management constraints faced by Borana herd owners in calf production, (3) forage establishment trials at encampments, (4) analyses of post-drought increases in cropping activity and (5) testing and transfer of animal-drawn scoops for building and desilting ponds.

Besides facilitating further research, CARE is providing grain for food-for-work projects, including construction of a calf experiment facility and fencing of forage cropping test plots. Food for work will also be used to induce pastoralists to participate in the pond-building programme. CARE has also facilitated cooperation with the Ministry of Agriculture, and will assist in extending promising interventions to the pastoralists once the research phase of the project is completed.

There is little doubt that joint work of this kind creates occasional strain between the participants: CARE donors want immediate impact on a target population, while the ILCA mandate for research does not permit direct involvement with extension. However, despite this superficial conflict of interests, both sides see the cooperation as exciting and as providing a model for future research and development: each group stands to get more for its dollars, with the prospects for impact in the longer term being much greater.

Such strategic funding by NGOs could help overcome research bottlenecks and smooth over the crevices that occur between research, extension and development. This is particularly true for pastoral East Africa, where precisely such a lack of coordination has contributed to the general void in applicable technologies. Research institutions need to join more effectively with NGOs and national groups to tackle problems together: they are too large for individual agencies to surmount alone.

Minor practical innovations

In any research programme, minor but interesting innovations continually occur. Two of the more interesting of those developed in 1985 are a condition scoring manual and a new sighting device for use in systematic reconnaisance flights.

The condition scoring manual is based on the experience of the Programme and has been produced with the aim of developing a standard system of condition scoring for African conditions, and in order to promote the use of condition scoring where other measurements are difficult.

The sighting device allows the aerial survey sample strip and photographs of livestock groups to be more precisely delineated.

The future of pastoralism

Research and development projects in pastoral areas will be faced increasingly with three major self-fueling changes: enclosure, cultivation and commercialisation.

Pastoralists are increasingly enclosing strategic areas of land for specific purposes. Grazing enclosure has just started in the southern rangelands but is advancing fast in the Kenyan Maasai system. In the central rangelands of Somalia more than 48% of the land has already been enclosed. This trend will reduce the free access of pastoralists to land but will increase the ability of specific groups or individuals to control land use, and so pave the way for the introduction of innovations hitherto impossible.

Cultivation is also increasing. A recent survey in Borana showed that 80% of the encampments covered were growing a food or forage crop, most for the first time. Similar trends are apparent in Kenya, and in Somalia over 14% of the arid central rangelands area is now under cultivation. Unchecked, cultivation can lead to rapid increases in degradation, but it also opens the door to the introduction of strategic areas of improved fodder and food crops.

Commercialisation is also increasing, particularly in Somalia and Kenya. Where it occurs, commercialisation displaces increasing numbers of people and this, combined with a population increase likely to outstrip feasible productivity gains within 20 years, means that the future of many pastoral families must lie in the diversification of enterprises within the area or in employment elsewhere. The future of pastoral people is thus linked with alternative means of making a living, and the development of higher potential areas.

Kenya Rangelands Programme

Introduction

ILCA's research on range livestock systems in Kenya is conducted among the Maasai pastoralists. The Kenya Rangelands Programme aims to provide a detailed description of the Maasai's production system, in order to determine the causal relationships among its components, to identify constraints to increasing livestock productivity and to design and test possible interventions.

Between 1981 and 1984 the Programme conducted an interdisciplinary study of the Maasai livestock production system on an area of about 1600 km^2. The study area comprised three group ranches, with a population of about 3500 people in 326 households. The area supported a livestock population of 53 000 cattle and 29 000 small ruminants. The grazing availability varied from 1.7 ha/TLU[1] in the more favourable areas to 4.3 ha/TLU in the drier areas in the south of the study area.

The Programme spent 1985 analysing the data collected during the 4-year study. The findings of the analyses are reported below.

Determinants of producer strategies

The location and wealth of the producer are the two most important factors determining producers' strategies and decisions with respect to grazing, watering, milk offtake and sales and exchanges of animals. The northern part of the study area receives more rainfall (500 to 700 mm per annum) than the southern part (300 to 400 mm per annum), which experiences longer dry seasons and more frequent droughts. Consequently, Maasai in the north are more sedentary and have much smaller grazing orbits than those in the south, who split their herds, sending dry animals to distant pastures over extended periods. Producers in the north have greater access to markets, facilitating the sale of animals, especially small ruminants, and the purchase of consumables and veterinary drugs. In addition, those in the north, who belong to the Kaputiei sub-tribe, have been more exposed to outside influences than the Kisongo in the south, who are more traditional, living in large encampments and cooperating more in herding and exchanging animals.

The wealth of producers, measured by the size of livestock holding per caput, varies considerably. Rich households have 8 to 10 times as many cattle as poor households and 5 times as many small ruminants. Poor households own more small ruminants

[1] One TLU (tropical livestock unit) = 250 kg liveweight.

than cattle, whereas the opposite is the case for rich households. The mean numbers of cattle and small ruminants per household were 132 ± 151 and 63 ± 67 respectively.

Range productivity

Due to the extreme variability of rainfall during the study period, the availability of forage varied greatly among seasons and years as well as between the northern and southern parts of the study area. In good years standing biomass exceeds 2 t DM/ha per month for 6 months, and the grazing diet is likely to contain more than 7% CP and over 50% digestible energy for 7 months. In poor years grazeable biomass exceeds 1 t DM/ha per month during only 2 months. Due to excessive grazing pressure, peaks of good quality fodder are shortlived. Most seasons between 1981 and 1984 fell between these two extremes, the northern ranches experiencing more favourable conditions than the southern ranch. In September 1983, the driest month studied, cattle managed to consume forage that contained 4.7% CP and was 44% digestible. Deficiencies of magnesium and copper were observed, but all other minerals measured (P, Ca, Na, K, Fe and Zn) were above critical levels.

Grazing pressure was uneven across the study area, ranging from a high of 1 ha/TLU to a low of 35 ha/TLU, and decreased sharply along the rainfall gradient from north to south. Factors that contributed to this large variation were: (a) unequal distribution of vegetation due to edaphic site conditions, (b) clustering of homesteads near permanent water sources and (c) differential rights of individual households to reserved grazing areas. The study period coincided with a peak livestock population following a steady build-up of animal numbers since the big crash after the 1974–76 drought.

Cattle productivity

Maasai herds were characterised by: (a) low mortality in adults (5%) and in calves (11%), (b) low calving rates (58%), (c) low growth of calves (95 kg at 1 year of age) and (d) low milked-out yields (260 kg per lactation). These figures give a low productivity index of 64 kg of calf liveweight/cow/year or 25 kg/100 kg liveweight of cow. The productivity of the Maasai pastoral system is thus higher than the output of 17 kg/100 kg liveweight obtained in traditional transhumant Fulani herds in the Niger Delta, but lower than that of commercial ranches in Tanzania (32 kg) and Kenya (35 kg) in similar climates. However, low productivity per animal is offset by high stocking rates, giving high productivity per unit of land.

Small ruminant productivity

The productivity of sheep and goat flocks was very low, ranging from 107 g of weaned lamb/kg of flock biomass in sheep in the northern area to only 29 g/kg of biomass in goat flocks in the southern area. This poor performance is attributed to very low birth rates (25 to 70%) and very high pre- and post-weaning mortalities of 20 and 35% respectively. The very low productivity in the southern area was due to a combination of drought and a severe outbreak of viral Nairobi sheep disease.

Utilisation of livestock production

Maasai pastoralists rear livestock to fulfil various needs. Livestock provide the main means of subsistence by supplying milk and meat for consumption and sales throughout the year. The proceeds of sales are used to purchase both food and non-food items. Animals are exchanged in order to acquire stocks for breeding, fattening or sale. Animals and their products are given or loaned to needy friends and relatives to maintain and develop social ties. Finally, livestock are the means of accumulating wealth and hence prestige and influence in the pastoral community.

The average gross output of the Maasai livestock production system from 1981 to 1983 was estimated to be 3800 kg of milk and 7100 kg of meat per household per annum. Net output was worth about US$ 2715 per household and US$ 270 per caput. This corresponds to US$ 7.4/ha or US$ 19.9/TLU. The net output of large-scale (rich) producers was worth US$ 5370 per household or US$ 370 per person, while that of small-scale (poor) producers was valued at US$ 1290 per household or US$ 160 per person. However, these levels of output are attainable only during good years (such as those of the study period) and when livestock population

is high. Net output of the system becomes negative during drought periods, when large numbers of livestock are lost.

Overall, 27% of gross output was consumed in the home, 28% was sold and 45% was used for stock accumulation. However, there were significant differences in partitioning among producers of different wealth classes. For small-scale producers, home consumption represented the largest proportion (42%) of gross annual output, and stock accumulation the smallest (20%). Conversely, for large-scale producers, stock accumulation constituted the largest proportion (56%) and home consumption the smallest (20%). For medium-scale producers, gross output was more evenly divided between sales (31%), home consumption (30%) and stock accumulation (39%).

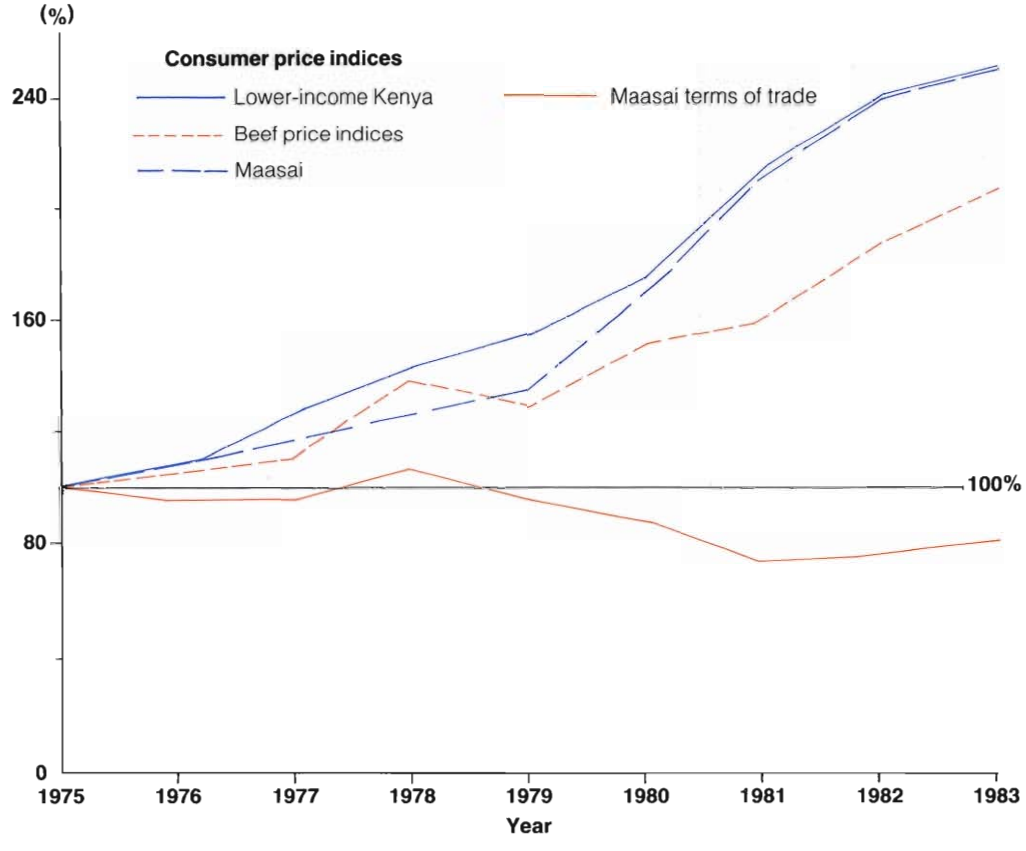
Institutional constraints

In addition to the environmental constraints on livestock productivity outlined above, there are a number of institutional constraints that contribute to the poor welfare of Maasai pastoralists. The most important of these are low producer prices, an underdeveloped market for small ruminants and the ineffectiveness of group ranch management.

The terms of trade (purchasing power) of Maasai pastoralists have been declining since 1975, reaching a low of 71% in 1982 but improving to 75% in 1983 (Figure 6). Meat prices are regulated by the government and have not kept abreast of increases in the prices of other commodities. Pastoralists are under increasing pressure due to their declining resource base in the face of rapid population growth, exacerbated by the government's policy of keeping meat prices low for urban consumers. No technological improvement could match the dramatic effect that a proper price alignment would have in increasing the income of the Maasai.

The lack of a market for smallstock limits commercial offtake. This is reflected in the high proportion of old castrates and infertile females in flocks far from markets.

Figure 6. Maasai terms of trade 1975–83.



The establishment and promotion of small-stock markets could increase commercial off-take.

The group ranch is a new form of social organisation for the Maasai, involving an alien concept of decision-making and enforcement by a committee of elected representatives. The system has not functioned satisfactorily and has been a source of aggravation to many Maasai, who are attempting to break up the group ranches in favour of individual holdings.

Central research and support units

Livestock Productivity and Trypanotolerance Group

Introduction

The work of the Livestock Productivity and Trypanotolerance Group focuses on the biological and economic aspects of livestock productivity, with a strong emphasis on trypanotolerant livestock. Trypanotolerance research is carried out at a network of sites in West and central Africa and associated sites in East Africa. Livestock productivity research comprises comparative breed studies in cooperation with national organisations, private producers and other international organisations. Training and documentation are vital components of both work areas. In 1985, the Group carried out research in close cooperation with organisations in 13 African countries.

The objective of the trypanotolerance research is to increase livestock production in tsetse-infested areas of Africa through a better understanding of genetic resistance, acquired resistance, environmental factors that affect susceptibility and the efficacy of present control measures, and by ensuring optimal application of both existing knowledge and recent research findings. The objective of the livestock productivity research is to build up comparative production information on important livestock groups in Africa so that decisions can be more easily made when genotype 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.

Trypanotolerance research

The nature of genetic resistance to trypanosomiasis has now been extensively reviewed by the Group. It is clear that trypanotolerance is an innate genetic characteristic and that trypanotolerant breeds such as the N'Dama and the West African Shorthorn are much more productive than previously supposed. The expression of trypanotolerance is, however, modified by the environment. High levels of disease challenge and other environmental stresses lower the tolerance of most animals, while previous exposure to the disease enhances it.

The Group has established an extensive network of research sites in different trypanosomiasis areas throughout tropical Africa in order to study the complex interactions that affect trypanotolerance. A very large body of data is now being built up on various breeds and their crosses under different levels of trypanosomiasis risk and different management and institutional situations.

The network for trypanotolerance research was developed because it was impossible to study the many aspects involved in a single research situation. Network sites were selected according to their complementarity in terms of disease level, tsetse challenge and livestock breed, the desire of the institutions concerned to cooperate, the availability of basic infrastructure and the willingness of donor agencies to provide supplementary funds. From the start, scientists at the different sites have tried to work to a uniform protocol, have taken part in standardised training and have followed a single working manual. The comparisons for which data were recorded at each site in the Trypanotolerance Network during 1985 are summarised in Table 11.

Network sites

Gabon. Work in Gabon has centred on the ranch of the Office Gabonais d'Amélioration et de Production de Viande (OGAPROV), where N'Dama, Nguni and crossbred cattle are reared under various levels of challenge from three species of tsetse fly (*Glossina palpalis, G. tabaniformis* and *G. nashia*) using trypanocidal drugs and different treatment regimes.

Ivory Coast. At Boundiali and Tengrela in northern Ivory Coast, cattle and sheep are being maintained in village situations under challenge from *G. morsitans submorsitans, G. palpalis gambiensis* and *G. tachinoides*. The cattle are trypanotolerant N'Dama and Baoule, susceptible zebu and their crosses. The sheep are all trypanotolerant Djallonke.

Nigeria. In southern Nigeria the work has centred on trypanotolerant sheep and goats in two contrasting village situations. One village, Fasola, is in a low to medium tsetse challenge zone (*G. tachinoides* and *G. palpalis*), while the other, Badeku, is virtually free of tsetse.

The Gambia/Senegal. At the International Trypanotolerance Centre (ITC) in the Gambia, N'Dama cattle are being evaluated at different levels of tsetse challenge (*G. m. submorsitans* and *G. p. gambiensis*) under village production conditions. Major emphasis is being placed on milk production capabilities under different tsetse challenge and nutritional levels. In Senegal work will start in 1986 in conjunction with ITC.

Togo. In Togo, N'Dama and West African Shorthorn cattle are being studied under research station (Centre de Recherche et d'Elevage at Avetonou) and village production management in an area infested with *G. tachinoides* and *G. palpalis*. To the north, in the Sokode area, Djallonke sheep and Dwarf West African goats are being studied under much higher challenge from the same tsetse species.

Zaire. In Zaire, the studies have concentrated on two large commercial ranches and on the development of a village production scheme, all producing N'Dama cattle. At Kolo ranch, cattle are exposed to a very low challenge from *G. palpalis,* while at Mushie ranch, cattle are exposed to a high challenge from *G. palpalis* and *G. tabaniformis*. Work in a village situation at Idiofa has now started.

East Africa. In southwestern Ethiopia, zebu cattle in village herds are being evaluated under varying levels of trypanosomiasis risk. In Kenya, chemoprophylactic drug programmes are being tested on East African Zebu cattle in village herds. In Tanzania, work has focused on sheep and goats maintained under different levels of trypanosomiasis risk in villages in the Mtwara and Newala districts.

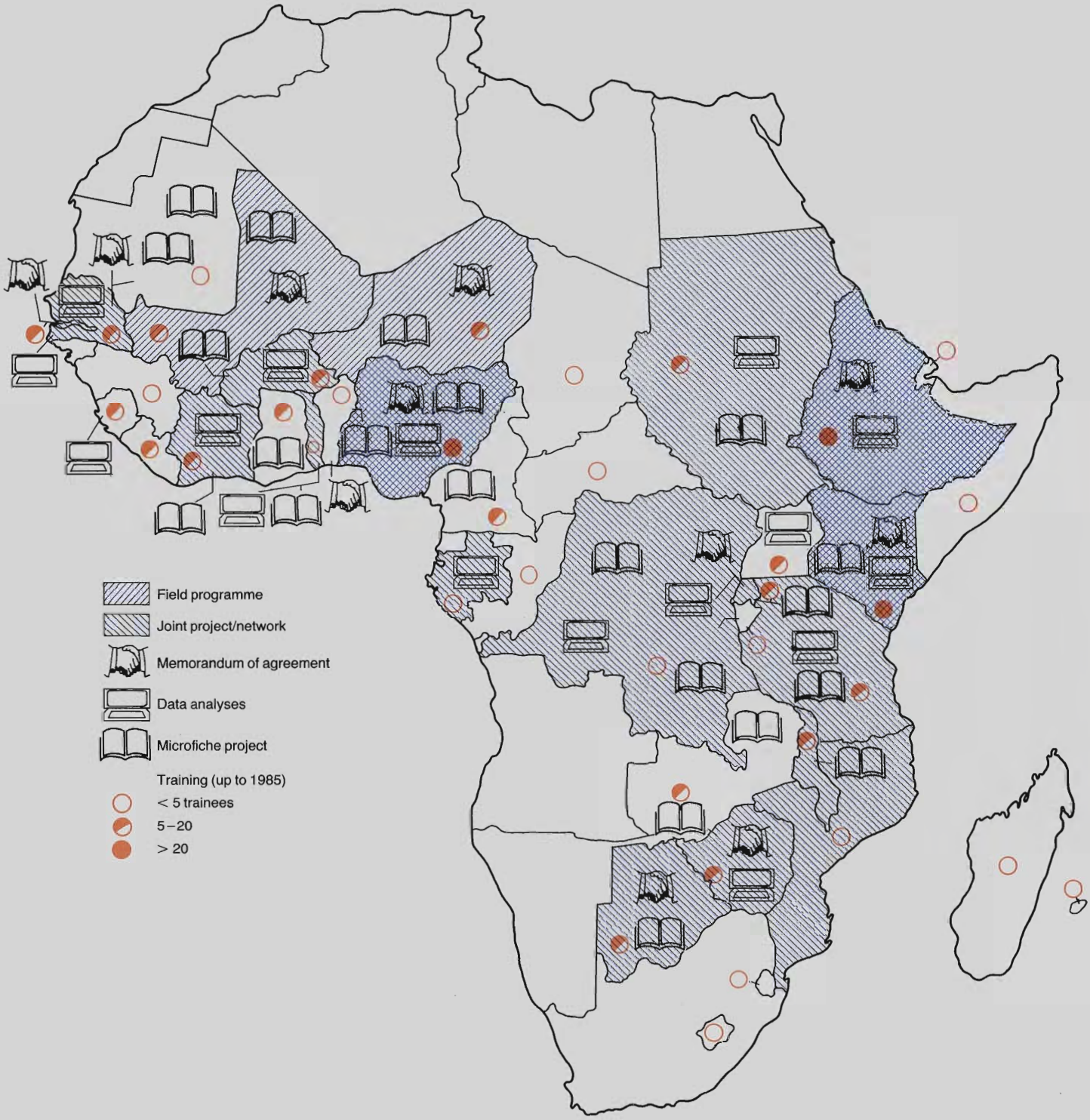
Network technical meeting

A major meeting of key researchers from all network sites was held in Nairobi in November/December 1985. Presentations by representatives from each site described their particular operation, commented on initial results, indicated the strengths and problems of their programmes and made suggestions on aspects into which detailed analyses should be carried out.

The first aim of the group working sessions at the meeting was to use the preliminary individual monthly analysis results for each site, and the knowledge of the researchers familiar with each situation, to plan suitable analyses covering a minimum

(Cont. on page 41)

ILCA in Africa



IDEAS – a microcomputer-based animal recording system

What is IDEAS?

IDEAS is a microcomputer-based animal recording system developed by ILCA to facilitate the recording and analysis of performance data for different livestock species.

Why did ILCA develop it?

A lot of research is conducted on livestock production in Africa, but much of the information obtained lies unused because of the lack of a suitable data collection and analysis system in the national research programmes, many of which do not have access to large computers. Added to this, there is little consistency in the way in which the data are recorded, making combined analysis of data from more than one source a long and complicated process.

Over the last 3 years ILCA has sponsored African scientists in the analysis and publication of information on livestock productivity from their countries, using ILCA's computer facilities at headquarters. But, as the scientists themselves have pointed out, these studies provide only a short-term solution unless their own national programmes can set up a system for data recording and analysis that will prevent backlogs of data building up again.

In response, ILCA reviewed the computer-based animal performance recording systems available on the world market, but found that none met all the requirements of African livestock research. The systems available either required large, powerful computers that would be too expensive for African research programmes, or dealt with only one aspect of livestock production, such as dairying. As a result, the Centre decided to develop its own livestock performance recording and analysis program.

What does it do?

ILCA set out to develop a system that would offer an integrated approach to recording and analysing all biological facets of animal production operations, would be easy to use and would be adaptable to a wide range of animal species. Additionally, the system was intended to run on a small, inexpensive microcomputer.

Work started on the project in late 1984, and IDEAS (the ILCA Data Entry and Analysis System) was completed in July 1985.

IDEAS is a comprehensive data recording and analysis package that meets all the above requirements. It can be used to:

- Record data on cattle, sheep, goats, camels, horses and donkeys;
- Record all important performance traits, i.e. reproduction, viability, growth, milk, wool and traction, plus their combinations;
- Perform all the analyses of these traits needed to make logical decisions about herd management without having to link up with a larger computer;
- Provide standardised database files to allow regional and national comparisons;
- Record climatic, nutritional and management information to facilitate biological interpretation of the statistical output; and
- Provide immediate access to information on individual animals.

How does it work?

The package centres around 10 databases that store details of each herd, climate, individual animals in the herd, reproduction, weight, milk production, wool production, traction, health and nutrition.

These details are manipulated using the modern database programming language dBASE III.[1]

Simplicity

Operating the program is simple: a series of 'prompts' on the computer screen leads the user through the system. The first step is the 'herd details' database, which provides the primary operation of the system. Entering information into the 'herd details' database (site characteristics and species) generates the framework for data entry in the other nine databases automatically, linking them according to site and species.

Some data inputs are mandatory, others are optional. For example, in the 'basic animal details' database the animal identification must be entered, but other data (for instance, ease of birth of the animal), which may not be known, need not be recorded. While the databases are set up to handle a fixed set of data, 'comment' fields are included to allow users to enter additional information that may be relevant. These 'comment' fields can be accessed at will by the user.

The interlinkage of all the databases allows the system to update more than one database at a time, reducing the risk of the user forgetting to enter information. For example, entering a birth on the 'reproduction' database creates the foundation record for the offspring on the 'basic

[1] dBASE III is a registered trademark of Ashton-Tate.

animal details' database. A prompt on the screen also asks for additional information, such as the birth weight of the mother. If these are provided, the 'weight' database will be updated for both animals. The system also performs many internal checks to ensure that the information entered is correct or within the range of values expected.

IDEAS has built-in analysis functions, which provide accurate information on which to base herd management decisions, breed comparisons, feeding strategies, etc. The data are analysed using a standard least squares program that handles up to nine main effects. The program can also make calculations at strategic times. For instance, when given a dry-off date for a lactation the program automatically calculates the total lactation yield, the average butterfat and solids-not-fat contents of the milk over the entire lactation, and other factors. At present, analyses can be carried out on:

- age at first parturition
- first parity reproduction (age at first parturition and percentage conception)
- parturition interval or reproduction result (litter size)
- weaning weight
- survival to weaning
- weight at any specified post-weaning age
- survival to any specified post-weaning age
- growth over any specified period
- milk production, including lactation yield, lactation length, butterfat percentage, protein percentage and solids-not-fat content; and
- maternal productivity, including weight of offspring weaned per annum, weight of milk produced per annum or a combination of the two.

Flexibility

The animals whose performance is to be analysed can be selected in a number of ways: by identification number, by birth date range, by sire, etc. Thus, if the user wants to know the effect of season on the performance of calves, he/she can specify a range of dates of birth and analyse the performance of the calves on that basis. However, if he/she is interested in comparing the performance of the offspring of particular sires, the data can be accessed according to sire identification.

Once the group of animals and the trait(s) to be analysed have been specified, the program retrieves the required data from the various databases, manipulates them to ensure that there are sufficient data points in each subclass, and passes the data to the least squares program, which calculates least squares constants, means and significance. Least squares adjustments can be carried out, databases updated, indices and ranking calculated and the results reported for use in decision-making.

How does it help?

IDEAS is a potentially invaluable tool for the African livestock sector. For the scientist it provides a quick and easy way of recording all the data on animal performance needed to compare the performance of different breeds and the effects of different feeding or breeding strategies. For those involved in development, it will help in making the many decisions essential to productive herd management. The ability of IDEAS to provide standardised data files allows national comparisons of livestock performance to be made, greatly aiding those involved in national livestock development planning. All the information stored on the databases is instantly accessible, analyses can be performed as and when desired, the printout giving statistical analysis of the data in a variety of forms to suit the needs of the user.

The flexibility of IDEAS means that a research station or a government ranch keeping, say, cattle, sheep and goats needs only one piece of software for all its data recording, since IDEAS can handle data for all three species. And the internal cross-referencing performed by the program ensures that there is no confusion as to which database or species the information belongs to. This flexibility is one of the package's greatest strengths.

A major advantage of IDEAS is that it puts computerised data recording and analysis within the reach of most animal research and production units, since the total cost of equipment needed should be less than US$ 10 000.

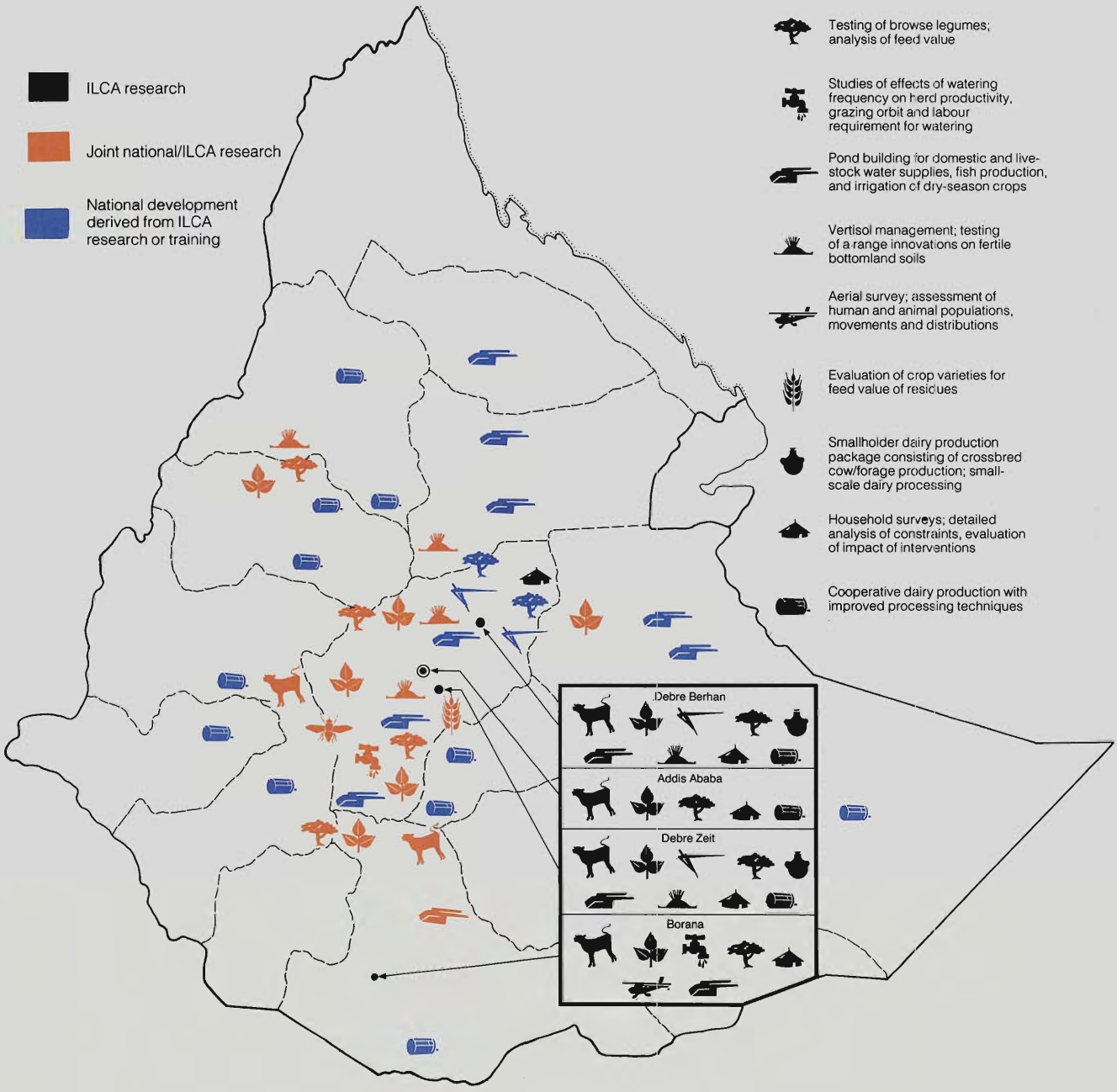
ILCA's assistance

For national livestock projects in Africa, ILCA will assist in the installation of IDEAS and train staff in the use of the package. The training will cover both the use of the computer and interpretation of the statistical output, since incorrect interpretation of the output of IDEAS would negate the benefits of the system.

Over the next year it is expected that IDEAS will be installed in many African countries. In the meantime, continuing development work on the package promises users further benefits from advances in microcomputer software.

ILCA in Ethiopia

Host countries are likely to be among the first to benefit from the work of international agricultural research centres. The concentration of resources represented by the headquarters of an institute such as ILCA means that links with national agencies should be both strong and plentiful. Although ILCA cannot yet claim an impact on the lives of many thousands of rural Ethiopians, the number of research and development activities derived from its work now taking place in the country is impressive, holding out great hope for the future. The map below shows these activities and their sites at the end of 1985. In addition to these, the Ethiopian Ministry of Agriculture plans to expand activities to include on-farm trials of ILCA packages with a further 2000 farmers by 1990.



Legend:

- Supplementation of calves to promote herd growth; studies on reproductive physiology and disease, to improve herd productivity
- Screening of forage legumes for different environments in sub-Saharan Africa; testing of "best-bet" lines; feeding trials
- Single-ox ploughing, replacing the traditional ox-pair; ploughing with crossbred cows
- Assessment of tsetse challenge, as part of the ILCA/ILRAD Trypanotolerance Network covering tsetse-infested Africa
- Testing of browse legumes; analysis of feed value
- Studies of effects of watering frequency on herd productivity, grazing orbit and labour requirement for watering
- Pond building for domestic and livestock water supplies, fish production, and irrigation of dry-season crops
- Vertisol management; testing of a range innovations on fertile bottomland soils
- Aerial survey; assessment of human and animal populations, movements and distributions
- Evaluation of crop varieties for feed value of residues
- Smallholder dairy production package consisting of crossbred cow/forage production; small-scale dairy processing
- Household surveys; detailed analysis of constraints, evaluation of impact of interventions
- Cooperative dairy production with improved processing techniques

Table 11. Comparisons for which data are recorded at each site or group of sites in the Trypanotolerance Network.

Country	Comparisons	Notes on comparisons
Zaire (3 sites)	Management system	Village and ranch
	Challenge level	Under ranch system
	N'Dama type/management	Selected and multiplication herds under ranch system
	Individual genotype	
	Physiological status	
	Age	
Gabon (2 sites)	Challenge level	
	Breed	N'Dama, Nguni and Nguni x N'Dama cattle under ranch system
	Prophylaxis	
	Individual genotype	
	Physiological status	
	Age	
Togo (2 sites)	Management system	Village and station
	Breed	N'Dama, local breed and crossbred cattle
	Animal species	Sheep, cattle and goats
	Individual genotype	Under station system
Ivory Coast (2 sites)	Challenge level	
	Species	Cattle and sheep under village conditions
	Breed	N'Dama, Baoule and zebu crossbreds
	Physiological status	
	Age	
Nigeria (2 sites concluded)	Challenge level	Village conditions with sheep and goats
	Species	
The Gambia (3 sites)	Challenge level	Village conditions, N'Dama cattle, opportunity for milk evaluation
	Nutrition level	
	Individual genotype	
Senegal (1 site)		Work to start in 1986
Kenya (1 site)	Prophylaxis	Village conditions with zebu cattle
	Physiological status	
	Age	
Tanzania (2 sites, 1 concluded)	Species	Sheep and goats under village conditions
	Prophylaxis	Cattle productivity under ranch conditions
	Other health interventions	
	Physiological status	
	Age	
Ethiopia (1 site)	Challenge level	Village conditions, zebu cattle, opportunity for work evaluation

(Cont. from page 36)

of 2 years' data available at 31 December 1985. The results derived from the monthly analyses indicate considerable possibilities for matching and contrasting health and performance data collected in several ecological zones and management systems and at different levels of tsetse challenge. The analyses indicated the existence of a number of relationships, including those between:

- Rainfall and relative density of tsetse;
- Tsetse challenge (relative density x trypanosome infection rate) and trypanosomiasis incidence in livestock;
- Trypanosomiasis incidence and packed red cell volume (PCV) levels;
- Trypanosomiasis incidence and management system;
- Trypanosomiasis incidence and animal species;
- Trypanosomiasis incidence and cattle breed;
- Trypanosomiasis incidence and trypanocidal drug use;
- Trypanocidal drug use and liveweight gain.

An example of the marked relationship between tsetse challenge (calculated as rela-

tive density x infection rate) and trypanosomiasis incidence is illustrated in Figure 7 for Mushie ranch, Zaire. Linear regression showed a significant 2.3% increase in trypanosomiasis incidence for each 100 unit increase in tsetse challenge.

An example of the relationship between PCV levels and trypanosomiasis incidence is illustrated in Figure 8, also for Mushie ranch, Zaire. Linear regression showed a highly significant 1.08% increase in trypanosomiasis incidence for each 1% drop in PCV.

An example of the relationships between cattle breed and various health parameters is shown in Table 12 for Lekedi Sud, Gabon. These preliminary results for cattle raised without chemoprophylaxis indicated significant differences between breeds. The mean PCV values were 34.0% for N'Dama cows, 29.3% for Nguni and 32.2% for crosses between the two. Differences in trypanosomiasis infection rate followed the same trend, with 8.7% of N'Dama cows, 28.3% of Nguni and 19.1% of crossbreds being infected. The number of curative Berenil treatments required per cow per year can be used as an indicator of the degree of trypanotolerance. N'Dama cows required an average of 0.5 treatments per cow per year, crosses required 2.3 and Nguni 4.2. Mean annual mortality rates for N'Dama, crosses and Nguni over the complete 31-month period were 2.9, 3.2 and 16.7% respectively.

Figure 7. Tsetse challenge and trypanosomiasis incidence in cattle, Mushie Ranch, Zaire.

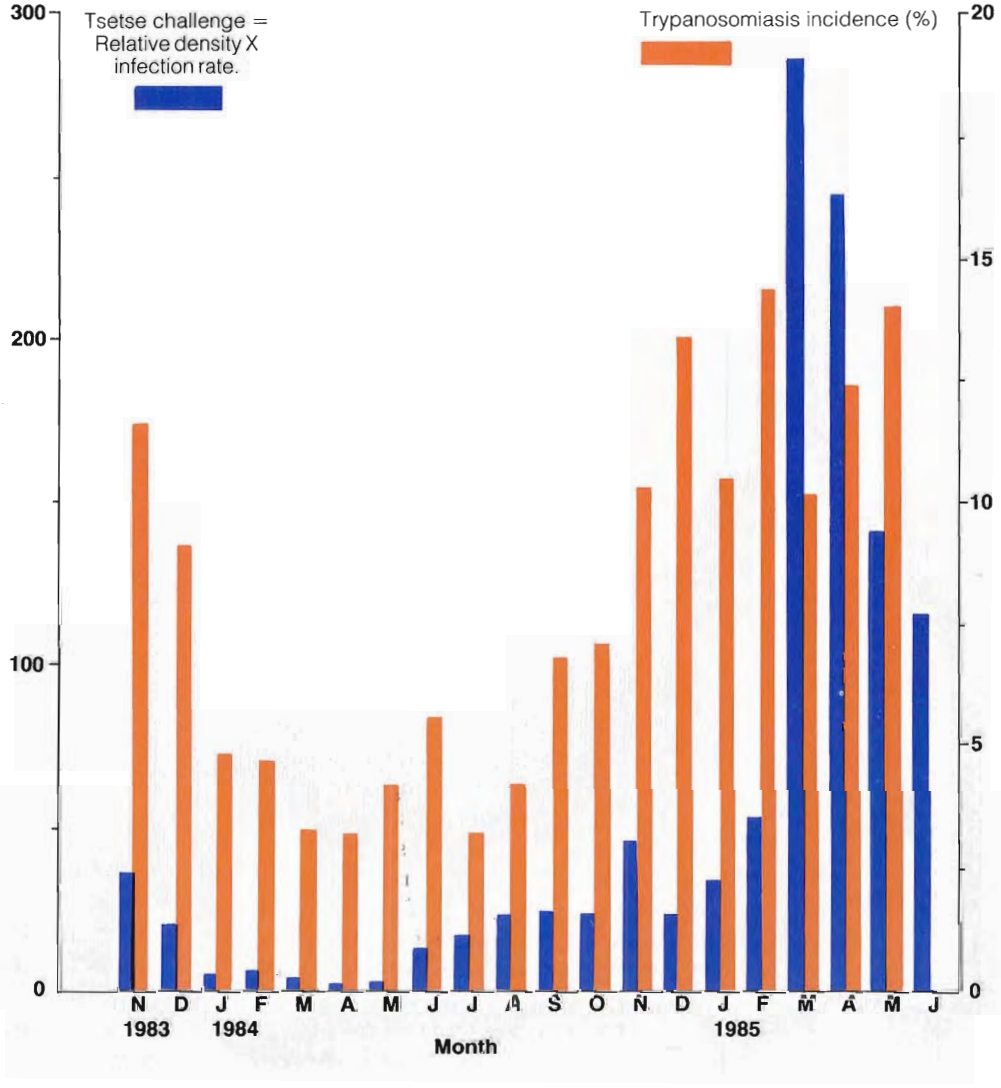
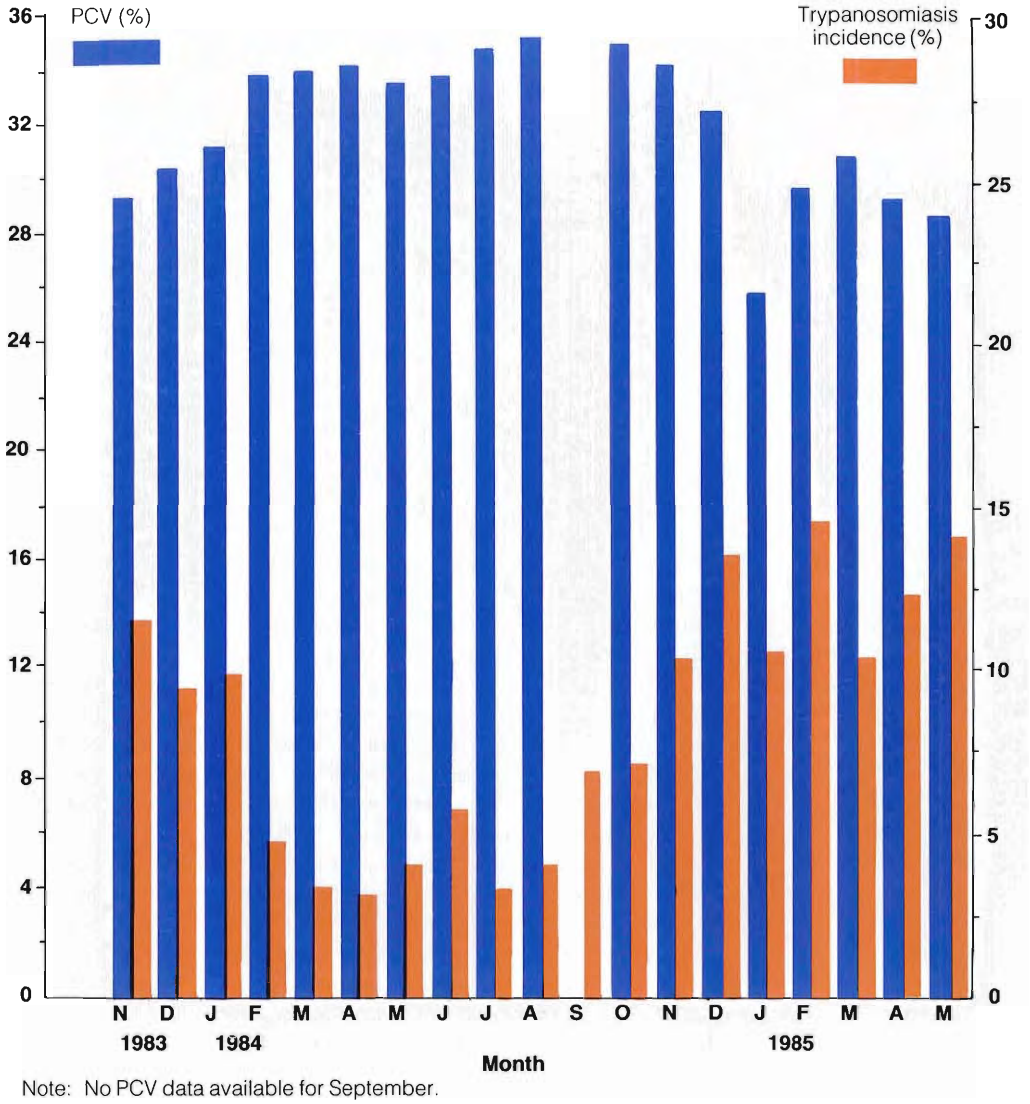


Figure 8. Average PCV and trypanosomiasis incidence of N'Dama cows and calves, Mushie Ranch, Zaire.



Note: No PCV data available for September.

Ongoing network research

In studies of the genetics of trypanotolerance, dam–progeny linkages and, whenever possible, sire–progeny linkages are being built up at each network site. Once sufficient data have been built up, selection programmes based on normal quantitative genetics approaches will be used. Practical approaches, fitting in with current network protocols, that give estimates of heritabilities and genetic correlations between some of the more important traits within a reasonable time-frame have been established.

A 2-year pilot nutrition study at Muhaka, Kenya, is being used to estimate the availability and quality of forage throughout the year in a few contrasting herds. Analyses of these data may allow improved biological interpretation of statistical results from this and other network sites and thus suggest possible nutritional interventions worth evaluating.

Economic analysis of the results of using trypanocidal drugs on ranches at Mkwaja in Tanzania, at OGAPROV in Gabon, and under village conditions at Muhaka in Kenya and at Mtwara in Tanzania, will indicate the profitability of their use.

Tsetse control measures will be tested in Ivory Coast and Gabon in 1986. The Or-

Table 12. Means for health parameters in cows of different breeds without chemoprophylaxis at Lekedi Sud, Gabon, December 1982 to June 1985.

Breed	PCV[1] (%)	Trypanosomiasis infection rate (%)	Berenil treatments/ animal/year (No.)	Annual mortality (%)
N'Dama	34.0	8.7	0.5	2.9
Nguni	29.3	28.3	4.2	16.7
N'Dama x Nguni	32.2	19.1	2.3	3.2

[1] Packed cell volume.

ganisation of African Unity's International Scientific Council for Trypanosomiasis Research and Control currently sees the large-scale use of traps, screens and other targets as adding a new dimension to tsetse control operations. An intervention of this type will be introduced in 1986 in a village area of Ivory Coast where matching livestock productivity and health data have been collected for a number of years. New dip formulations that may be useful in tsetse control will be tested in Gabon in 1986.

Overall analyses are now needed to evaluate the various traits considered in the monthly analyses and, in addition, livestock reproductive performance, viability and milk production. Major factors influencing animal health and performance will be examined for each site using models giving least biased estimates. Productivity indices will then be produced, where possible, combining reproduction, viability and growth (plus milk production where appropriate) and these will be related to health status as measured by trypanosomiasis incidence and PCV.

Consideration of the results by ecological zone, tsetse challenge and management system will indicate further research and development priorities for the network. Research resources for the implementation of required field experiments will be allocated when the results of these overall analyses are available in the second half of 1986.

Livestock productivity

In trypanosomiasis-free situations throughout Africa, inadequate nutrition and numerous disease problems generally favour the use of traditional *Bos indicus* breeds of cattle. Increasingly, however, increases in the meat and milk production of Africa's livestock are being sought through breeding. Relatively modest increases in output can lead to large gains in the efficiency of energy use, and this underlies the persistent attempts to upgrade the *B. indicus* breeds by using imported *B. taurus* breeds with their higher additive genetic merit for meat and milk.

The theoretical aspects of using heterosis, crossbreeding and composite breeds in the African tropics have been presented[1] and a series of reports on crossbred performance published. This work allows more accurate characterisation of the performance of African livestock breeds, and of their crosses with imported stock, together with an assessment of their adaptability to different environmental and management conditions. Overall, results to date indicate that indigenous breeds are well adapted to local environments, and that any improvement in the genetic potential of these breeds for greater productivity can only be realised if nutritional, disease and climatic stresses are reduced.

Major studies have also been completed of dairy cattle crossbreeding at the Arsi Rural Development Unit in Ethiopia; on crossbreeding N'Dama with Sahiwal at Teko Livestock Station in Sierra Leone; on grade Boran cattle maintained by chemoprophylaxis in Tanzania; on Zebu Gobra cattle at the Centre de Recherches Zootechniques de Dahra, Senegal; on crossbreeding of range beef cattle at the Matopos Research Station, Zimbabwe; and on the productivity of Djallonke sheep and N'Dama cattle at the Kolda Research Station, Senegal.

During the 7 years 1979–85, 84 papers were published or presented at a wide variety of scientific meetings by the Group. The extent of the Group's cooperative work is illustrated by the fact that, of the 58 different

[1] Gregory K E, Trail J C M, Koch R M and Cardiff L V. 1982. Heterosis, crossbreeding and composite breed utilisation in the tropics. In: *Proceedings of the 2nd World Congress on Genetics Applied to Animal Production* Madrid pp. 279–292.

authors involved in these publications, 6 were from the Livestock Productivity and Trypanotolerance Group, 6 from other ILCA units, 21 from other international organisations in Africa and overseas and 25 from national research groups in Africa.

Nutrition Unit

Introduction

The Nutrition Unit is based at ILCA's headquarters and conducts research at both headquarters and the Debre Zeit station. The laboratory run by the Unit in support of these activities also performs analytical services for ILCA's field programmes and, to a lesser extent, for other research groups. The major nutritional problems of ruminants in sub-Saharan Africa include deficiencies of protein and energy due to the poor quality of the basic feed resources available, which are largely rangeland grasses and crop residues.

In 1985, the Unit concentrated on improving dietary quality by utilising higher quality agro-industrial byproducts, and on the influence of deleterious compounds present in a number of feed resources.

Supplementation of low-quality roughages

The Unit continued to study the use of feed supplements for improving the utilisation of crop residues or grass hays for milk production or growth. Oilseed cakes are agro-industrial byproducts frequently used as high-protein supplements: *noug (Guizotia abyssinica)* cake, representative of these materials, is widely available in Ethiopia and has been used in several supplementation studies.

Supplementing a basal ration of urea-treated teff (*Eragrostis tef*) straw and a grass/legume hay with 800 and 1200 g of *noug* cake significantly increased the milk yield of crossbred cows by 14%. In a second experiment, in which the basal ration was grass hay, also of low quality, daily supplements of either 1 kg of molasses/urea (10% urea) or 500 g of *noug* cake increased milk yield by the same extent. When fed together, these supplements increased milk yield by 23%.

Supplementing a diet of *ad libitum* teff straw and molasses/urea (2.5% urea) for Ethiopian highland sheep (average liveweight 17 kg) with 100 g of *noug* cake per day reduced straw consumption but increased total intake as well as that of the molasses/urea mixture, and increased liveweight gain. In this experiment a comparison was also made of three watering frequencies – *ad libitum,* once daily or once every 3 days. In-

termittent watering resulted in slightly lower overall intakes of water. However, animals watered once every 3 days performed satisfactorily, particularly when supplemented with *noug* cake, suggesting that such a practice can be an appropriate labour-saving strategy when necessary. Supplementation with small amounts of *noug* cake appears to be useful as part of a drought feeding strategy. Responses to other oilseed cakes might be expected to be greater, since *noug* has a higher fibre content than many other oilseed cakes.

Highland sheep with an average weight of 15 kg were fed a forage legume hay (LH) and teff straw (TS) in the proportions of 0:100, 22:78, 42:58 and 100:0 (LH:TS). Straw intake was similar in all three treatments involving straw. Inclusion of LH increased animal performance, and the effects of LH and TS on total feed intake, digestibility, nitrogen retention and sheep growth rates were associative. The molar proportions of acetate, propionate and butyrate in the rumen were similar in the three diets containing straw, while acetate was lower and butyrate higher in the all-legume diet. Inclusion of LH in the diet increased the proportions of higher straight- and branched-chain volatile fatty acids (BRAC) in the ruminal fluid; BRAC are essential for some cellulolytic bacteria, the presence of which would provide partial explanation of the benefit of including LH in the diet.

Utilisation of supplemented straws

The effects of feeding *noug* meal at various levels were studied in castrated male sheep fed *ad libitum* maize stover or oat straw. Intake, digestibility, nitrogen balance and rumen ammonia levels were determined.

Noug increased total DM intake but reduced straw intake. It also increased the digestibility of dry matter, organic matter and most cell-wall constituents, the incremental effect of *noug* diminishing as its rate of inclusion increased.

There was strong evidence that *noug* had a positive associative effect (i.e. more than that which could be explained by substitution alone) on the digestibility of the cereal straws. *Noug* also increased apparent N digestibility, rumen ammonia level and N balance in the sheep. The N requirements of the sheep for maintenance, calculated by regression analysis, were lower than recent recommendations.

These findings indicate that a diet of *ad libitum* cereal straw supplemented with 15 to 30% *noug* meal should be able to support reasonable levels of production in sheep.

Feed utilisation by donkeys

Donkeys are an important mode of transport in many regions of Africa, and they are normally fed only poor-quality roughages. The Unit has been examining the degree of utilisation by donkeys of representative feeds, with a view to formulating recommendations for their improved husbandry.

Nine 3-year-old male donkeys were fed three roughages (teff straw, meadow hay and a stemmy legume [*Stylosanthes guianensis*]) in a latin-square design. Although the DM digestibilities of the three feeds were only about 50%, the donkeys gained weight at an average of some 140 g/day, with no significant differences between any of the diets. This degree of utilisation is higher than would be expected from ruminants consuming diets of similar digestibility.

Evaluation of fibre growth by sheep as an index of dietary protein supply

It has been known for many years that the rate of wool growth in sheep can be increased by post-ruminal infusion of sulphur-containing amino acids, a situation mimicked when relatively soluble dietary proteins are protected from ruminal degradation by formaldehyde treatment. Linear responses in wool growth were found in Australia when increasing quantities of formaldehyde-treated casein were fed.

Two experiments were conducted at ILCA's headquarters barn to establish whether similar responses might occur in the rate of fibre growth in Ethiopian highland sheep. In the first, a fixed quantity of oaten hay was given, supplemented with varying amounts of formaldehyde-treated *noug*. Higher levels of *noug* significantly increased the liveweight gain of the sheep, but the *noug* did not have a significant effect on fibre growth, although there was a trend for wool growth to increase with increasing levels of supplementation. No differences were detected between untreated and formaldehyde-treated *noug* in either weight gain or

fibre growth. In the second experiment, the roughage was given *ad libitum*, and the results were virtually identical to those of the first experiment.

It was concluded that the rate of fibre production cannot be used as an index of the adequacy of dietary protein supply in Ethiopian highland sheep. This may be equally true for all hair-type sheep.

Phenolics and digestibility in sorghum grain

As noted in the *ILCA Annual Report* of 1984, birds are an important pest in Africa and sorghum breeders are selecting for bird resistance, which is primarily a function of the phenolic content of the pericarp, the outer layers of the grain. The pericarp of bird-resistant varieties needs to be removed in order to make them more acceptable for human consumption, and the bran will thus become available for animal feeding.

The effects of phenolic compounds on the nutritive value of sorghum crop residues were reported in the *ILCA Annual Report* of 1984. In 1985, the Unit applied recently developed methods to studying phenolics in the grain of bird-resistant and non-bird-resistant varieties, to determine the possible effects of these phenolic compounds on the feeding value of the bran. The sorghum varieties were grown at ILCA's Debre Zeit research station in collaboration with the Sorghum Improvement Team of the Ethiopian Institute of Agricultural Research.

The ytterbium method for gravimetric determination of soluble tannins and other phenolics (*ILCA Annual Report 1983*) was highly correlated ($r = 0.93$, $P < 0.001$, $n = 24$) with the standard vanillin-hydrochloric acid method. However, not all tannins were soluble, as indicated by the presence of insoluble proanthocyanidins in the neutral-detergent fibre from bird-resistant varieties. The highest level of insoluble proanthocyanidins was in a Group-II-type sorghum variety. Group I varieties contain low levels of soluble tannins and are not bird resistant. Group II varieties also contain low levels of soluble tannins but contain high levels of insoluble proanthocyanidins and are intermediate in bird resistance. Group III varieties contain high levels of soluble tannins and are bird resistant. Insoluble proanthocyanidin content was significantly correlated ($r = 0.646$, $P<0.01$, $n = 24$) with lignin content.

All phenolic measurements had significant negative correlations with *in vitro* organic matter digestibility (Table 13). Tannins from sorghum grain were isolated and added to an *in vitro* system that measures inhibition of fungal cellulase. The amount of tannin in the grain was negatively correlated with fibre degradability by cellulase.

Table 13. Correlation of phenolics with *in vitro* organic matter digestibility (IVOMD) and degradability of neutral-detergent fibre (NDF) by cellulase in bird-resistant and non-bird-resistant sorghum grain.

Phenolic measurement	IVOMD (%)	NDF degradability
Ytterbium precipitate	−0.620*	−0.893**
Vanillin-HCl	−0.559*	−0.932**
Insoluble proanthocyanidins	−0.815**	–
Lignin	−0.881**	–

* = significant at $P<0.05$

** = significant at $P<0.01$

These results thus indicate that tannins lower the nutritive value of sorghum bran from bird-resistant varieties. This hypothesis will be further investigated in feeding trials with sheep and goats in 1986.

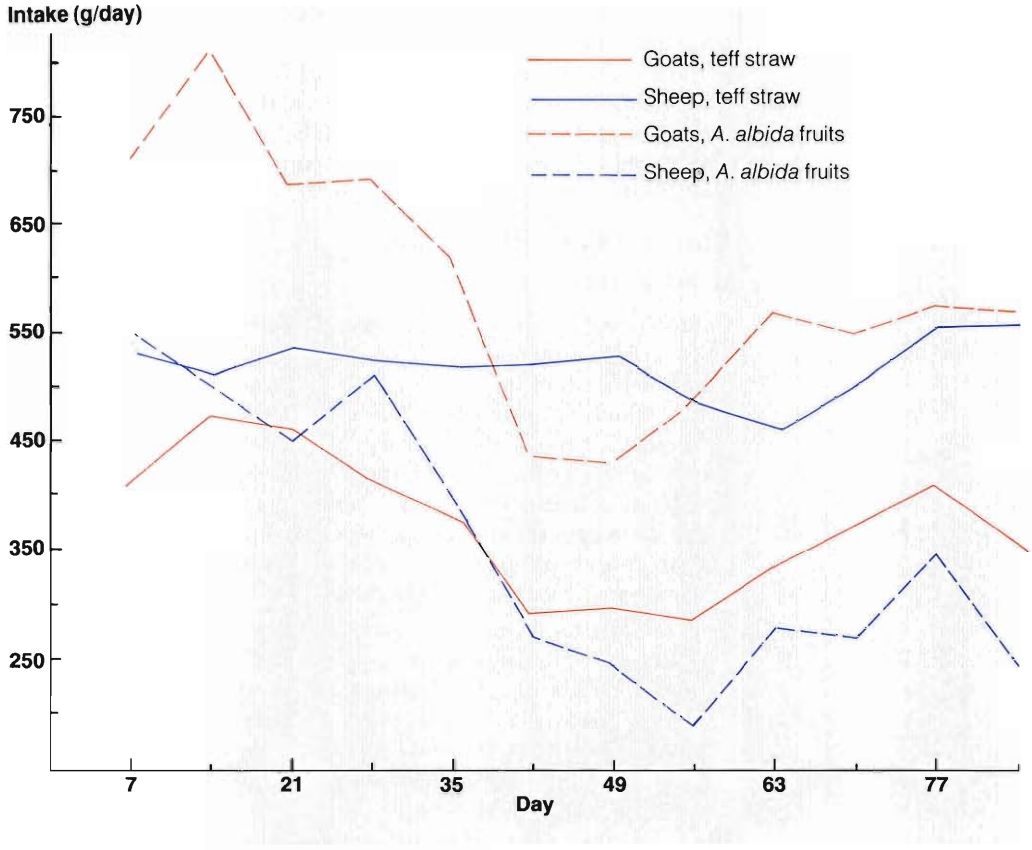
Animal experiments at Debre Zeit

Research on the nutritive value of fodder trees (see box, page 50), forage legumes, cereal crop residues and agro-industrial byproducts is being conducted in collaboration with the Highlands Programme at the Debre Zeit research station. This research includes both feeding trials and detailed metabolic studies with work oxen, crossbred dairy cattle, sheep and goats.

A trial was conducted to compare sheep and goats in their ability to use cereal straw and fruits from acacia trees as feed. Five sheep and five goats were fed entirely on teff straw and four sheep and four goats were fed entirely on the fruits of *Acacia albida*, an important leguminous tree in sub-Saharan Africa. All animals were locally purchased, intact yearling males.

Goats fed on fruits from *A. albida* had the highest feed intake (Figure 9) and lost the least weight, but sheep fed these fruits had the lowest intake and lost most weight. Sheep fed teff straw had higher intakes and smaller weight losses than goats fed teff straw.

Figure 9. Intake of sheep and goats fed *Acacia albida* fruits or teff straw.



Animals were slaughtered after 90 days. All animals eating *A. albida* fruits had abnormalities in the ventral sac of the rumen, consisting of a number of areas of nodular hyperplasia involving the rumen papillae. However, the gross appearance and density of papillae in goats was normal, whereas in sheep the papillae in the ventral sac had sloughed off in patches. Thus, *A. albida* fruits appear to contain a digestive tract toxin to which goats seem less susceptible than sheep.

Sheep had greater rumen fill and higher intake of teff straw than goats. This difference suggests that sheep utilise cereal crop residues better than goats.

Effect of work on intake and utilisation of straw by oxen

Sixteen mature oxen (eight Holstein x Borana crosses weighing approximately 550 kg and eight local zebus of approximately 320 kg) were fed on teff straw *ad libitum* and a limited amount of grass hay. Intake and liveweight changes were observed over a period of 293 days. From day 45 onwards, the animals pulled sleds loaded with stones for 5 hours per day for a total of 207 days. Two force levels of 1.0 and 1.4 Newton/kg liveweight, equivalent to low and high forces measured under practical ploughing conditions, were used and controlled with dynamometers. There were six periods (rest before work, four work periods and a rest period after work) during which total faeces and urine collections were carried out for determinations of digestibility and N balance.

Feed DM intake declined over the experiment from 2.2 to 1.7% of body weight. The effect of work level was not significant, but intake during work was lower than during the initial rest period. Absolute DM intakes were higher for crossbred oxen, but intake expressed as a percentage of liveweight or relative to metabolic weight was not significantly different between the breeds.

Mean DM digestibility was 55% for all animals during the experiment. However, the local zebus exhibited slightly, but sig-

nificantly, higher digestibility coefficients than the crossbred animals (56.3 versus 54.0%). Digestibility was negatively correlated with intake but was not influenced by level of work.

Animals gained weight throughout the experiment in spite of declining intakes. In the crossbred group, weight gains were significantly higher during the rest periods (550 versus 140 g/day) than during the work periods.

Average intake of metabolisable energy (ME) for a 300-kg ox during the experiment was 55 MJ/day, of which 36 MJ were theoretically required for maintenance. The energy expended in work was about 1.7 MJ/day. Thus, if net energy for work is 10% of ME (a low estimate), then the ME required for work was 17 MJ/day, and the animals in this experiment would have been in slight positive energy balance. Lower intake during work was not reflected by weight loss, a discrepancy which suggests that work either increased the efficiency with which ME was used or else reduced maintenance requirements.

However, these results indicate that oxen are unable to meet the nutritional requirements for higher work levels by increasing their feed intake. This may lead to negative energy balance and weight loss in oxen fed roughages of lower digestibility than those used in this experiment. In such a situation, energy reserves in the body tissues may be important in determining work performance.

Leguminous browse in straw diets for sheep

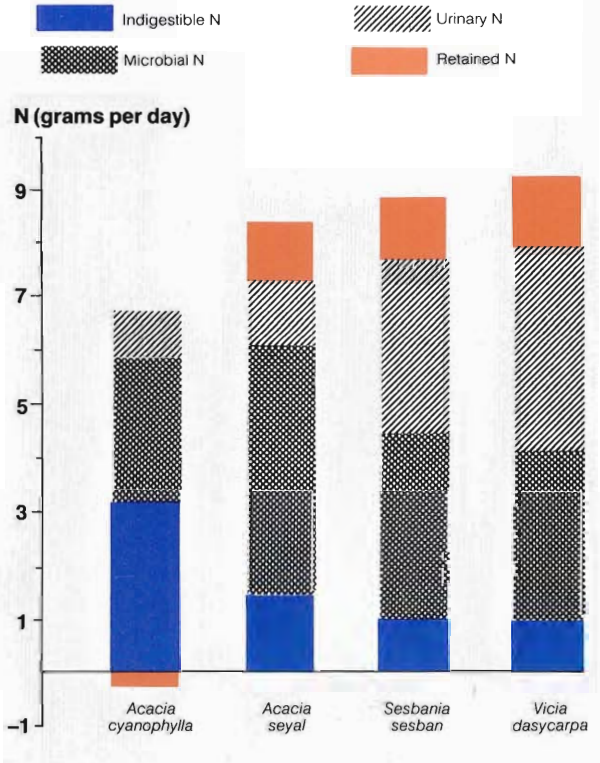
Leguminous browse trees are an important feed resource for ruminants in Africa. In addition to providing high-protein forage and increasing soil fertility, a number of introduced species also have a potential to reduce soil erosion and to supply wood for fuel and construction.

ILCA's Animal Nutrition Unit has been studying the potential of three browse species (*Acacia cyanophylla*, *A. seyal* and *Sesbania sesban*) as feed supplements to a basal diet of teff (*Eragrostis tef*) straw for growing sheep, in comparison to vetch hay (*Vicia dasycarpa*).

A. cyanophylla, an introduced Australian species, grows well in semi-arid areas and has been used extensively in reafforestation projects in Africa. *A. seyal* is an indigenous African species that is widely distributed in arid and semi-arid rangelands in East Africa and the Sahel, while *S. sesban*, also an African species, has good agronomic potential for use in alley cropping systems in highland areas.

S. sesban has shown good promise as a feed supplement to straw-based diets, resulting in higher growth rates than vetch hay (Figure ii). Over the 91-day trial period, sheep supplemented with *S. sesban* gained an average of 48 g/day compared with 39 g/day with vetch hay and –11 and 21 g/day with *A. cyanophylla* and *A. seyal* respectively. Sheep fed *A. cyanophylla* lost weight throughout the trial. Sheep apparently adapted slowly to eating *A. seyal*, losing weight during the first 5 weeks of the trial. However, by the eighth week they were consuming nearly all the *A. seyal* on offer and their daily weight gain increased to 45 g/day, similar to that observed with *S. sesban* and vetch hay during this period.

Figure ii. Growth of sheep fed foliage from three different fodder trees or vetch hay as supplements to straw.

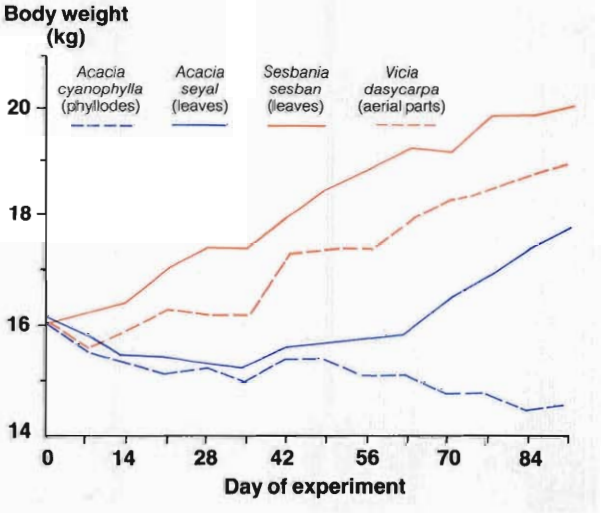


Nitrogen balance studies showed that the sheep supplemented with *A. cyanophylla* had a negative N balance (i.e. they were excreting more N than they were consuming), while those supplemented with the other three forages had similar, positive N balances (Figure iii). Faecal losses of N were greatest with *A. cyanophylla* and *A. seyal*, while urinary losses were greatest in *S. sesban* and vetch hay, reflecting their relative phenolic contents. Separating the faecal N losses into indigestible dietary N and microbial N showed that *A. cyanophylla* had the largest proportion of indigestible N and *S. sesban* and vetch hay had the smallest. Microbial N was highest for *A. seyal* and lowest for *A. cyanophylla*.

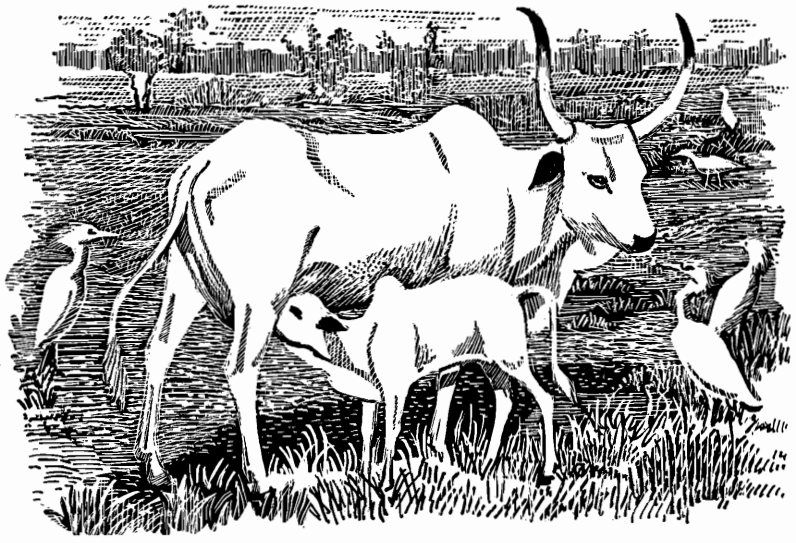
The differences in the effects of these browse species on average daily weight gain and N balance are related to differences in the quantity and type of tannins and phenolics present in the forages. *A. cyanophylla* contains high concentrations of both soluble and insoluble proantho-cyanidins (condensed tannins), phenolic compounds that form strong complexes with proteins and inhibit protein digestion. It also contains a potentially toxic flavonol glycoside, myricitrin. *A. seyal* also contains a high concentration of tannins, but of a different type to those in *A. cyanophylla*. *S. sesban* and vetch both contain low levels of phenolic compounds with low molecular weights.

This study has highlighted important differences in nutritive value among browse species. The different effects of the phenolic compounds in *A. cyanophylla* and *A. seyal* are of particular interest and demand further investigation.

Figure iii. N balance in sheep fed foliage from three fodder trees and vetch hay.



Animal Reproduction and Health Group



Introduction

There is now reason to believe that permanent increases in livestock productivity in Africa are more likely to be achieved through improving the continent's native animals than through importing exotic breeds. However, there are problems in indigenous livestock that must still be overcome, such as 'silent' oestrous periods and poor milk letdown in the absence of the calf. These are essentially problems of reproductive physiology and endocrinology, yet there has been little research in Africa in these disciplines. It is this deficiency that the Animal Reproduction and Health Group was set up to overcome.

Work programme

The Group started field studies of indigenous zebu cattle populations in 1985. The many breeds of zebu cattle in Africa are well adapted to the African environment: they are less susceptible to diseases and are able to withstand the long dry seasons and shortages of feed and water. But they do not produce much milk or many offspring. The Group will study the physiological processes involved in reproduction in order to find means of increasing the productivity of these indigenous cattle.

The Group was established in late 1983 and concentrated on planning and training during 1984, becoming fully operational during 1985. It is funded by donations from the Government of Italy, and also benefits from Italian professional advice and institutional support.

Six teams of consultants from Italian universities spent 40 man-weeks in Ethiopia between February 1984 and December 1985, assisting in setting up the laboratory and in developing a research strategy. The laboratory became operational in June 1985. A consultant veterinary pathologist spent 3 months working with the newly recruited staff and setting up laboratory procedures in the second half of 1985.

During late 1984 and early 1985 five young scientists were trained in Italy. Two Africans working with the Group each received 3 months' training, one in laboratory techniques for histology, reproductive physiology and embryology, and one in veterinary clinical methods used in animal reproduction research. Three young Italian scientists were given a total of 9 months of training to prepare them for their overseas assignments. All three started assignments with the Group at ILCA headquarters in Addis Ababa in 1985.

An ILCA director has been assigned overall responsibility for the Group. He has worked for brief periods with staff and graduate students at the University of Milan, the University of Perugia and the Centro per lo Sviluppo Agricolo e Rurale (CESAR) at Assisi during the past 14 months. The staff of the Group now includes three African veterinarians, three laboratory technicians, three laboratory assistants, a clerk-typist and the three Italian scientists.

Famine in Ethiopia: The response of ILCA's staff

In late October 1984 staff at ILCA's Debre Berhan research station learnt that a previously disused compound on the edge of town was now serving as a refugee camp. Immediately, they organised deliveries of fresh milk from the research station to help feed the camp's rising numbers of hungry and destitute families.

Thus began ILCA's voluntary famine relief efforts. Soon members of staff at headquarters asked the Staff Council to set up a Famine Relief Committee, and a financial appeal to all staff and their friends was launched. The target was to raise US$ 50 000 by Christmas.

In the event this target was easily surpassed as individuals and institutes across the world responded rapidly and generously to the appeal. Donors included companies, schools, churches and theatres, as well as charities, friends and colleagues working for aid agencies and other international research centres, and many hundreds of individuals from all walks of life. Within 6 months the appeal raised more than a quarter of a million US dollars.

At first, activities concentrated on emergency relief at the Debre Berhan refugee camp. With the help of other agencies and individuals, teams of ILCA staff working mostly at weekends provided milk powder, baby food, grain, biscuits, firewood, charcoal, blankets, clothing and cooking utensils. An emergency feeding unit was set up, a medical team installed and latrines and tents organised and delivered.

While these activities were necessary to save lives, they were no more than a palliative. Other measures were needed to persuade farmers to stay on the land instead of joining the refugee trail, and to help them recover after the drought. In March 1985 the purchase and trucking of food grain to drought-stricken areas north of Debre Berhan began. Then, with large donations from several charities and an aid agency[1], a project to supply oxen and seed was launched.

With the help of local government officials and ILCA employees, oxen were bought, taken to a holding area and maintained during the crucial months before the main ploughing and cropping season. Six hundred near-destitute farmers were provided with the oxen, a single-ox yoke and harness and enough food and seed grain to enable them to work and plant a crop. Local blacksmiths made the yokes and harnesses, while ILCA staff trained the farmers to use them.

Project farmers were thus able to cultivate without paying high rents for hiring scarce draught animals. Earlier planting over larger areas, combined with the use of Serena, an improved sorghum variety from Zimbabwe, meant that the crop yields of project farmers were double those of their non-project neighbours. Because of hard ground, weak farmers and underweight oxen the single-ox plough was difficult to use for the first cultivation, but the technique proved beneficial for later cultivations, sowing and seed covering. The results of the project are reported in more detail in *ILCA Newsletter* vol. 5(1).

Thanks to further donations, including the proceeds of a benefit theatrical performance staged by the Royal Shakespeare Company (UK), the project is now entering its second year. It is expanding to include 1200 more farmers, and has developed from a relief project into an applied research and development project that studies and promotes the role of animals in post-drought recovery. The project is now testing additional technology such as terrace making to reduce erosion and alley farming with tree legumes.

ILCA's famine relief appeal brought other benefits besides those to the famine victims themselves. The Centre forged contacts with new donors for its work, and evolved a new type of research project. ILCA's scientists gained a better understanding of how their research can help the poorest, most vulnerable farmers. Above all, the staff of ILCA faced an invigorating challenge to work hard together on behalf of some of the many millions of Africans less privileged than themselves.

[1] Major donors to the project during its first year were Oxfam America, Oxfam UK, Medios (Belgium), Comité Français contre la Faim and the Gesellschaft für Technische Zusammenarbeit (Federal Republic of Germany). Additional donors for the second year include Caritas Catholica (Belgium) and the Royal Shakespeare Company (UK).

Small Ruminant and Camel Group

Introduction

Although small ruminants and camels are important elements of African livestock production systems, research into their productivity has been neglected in favour of cattle. The Group aims to increase knowledge of these species and to improve their productivity through cooperation with ILCA zonal programmes and collaborative research with national and regional organisations.

The Group intends to achieve these objectives by:

- Carrying out fundamental and applied research;
- Assisting with the analysis and publication of research results from ILCA's zonal programmes;
- Collaborating with national organisations in the planning, execution and analysis of research;
- Relating data on reproduction, growth and disease to ecological, nutritional and management conditions;
- Assessing, diagnosing and devising ways of overcoming specific causes of mortality;
- Developing a training manual for use in productivity studies in Africa;
- Encouraging research on the potential for improving productivity by selective breeding within and among indigenous breeds;
- Helping in the organisation of regional and national training; and by
- Publishing a newsletter to disseminate results of research or development experiences and to establish and maintain contacts among researchers and development workers.

During its second full year of operation the Group worked towards fulfilling a number of its stated objectives.

Network activities

Four issues of a newsletter (in both English and French) were produced as the cornerstone of the Group's network activities. The response to the newsletter has been favourable: from a modest start with some 250 addresses in 29 African countries and a few non-African countries, the number of network members has risen to over 700 in more than 40 African and 30 non-African countries. The number of requests for inclusion on the mailing list is increasing rapidly and it is apparent that the network is meeting a need.

To complement the newsletter, and partly with the aim of assisting network participants in the analysis and publication of their results, a series of Group Documents (i.e. papers of a working-document type) has been started. Four were published in 1985 in collaboration with researchers from Mali, Zimbabwe and Ghana, relating to various aspects of productivity. In addition, one document was produced that reviews all the research carried out on the trypanotolerant West African Dwarf goat and suggests future lines of research.

In early October 1985 the Group hosted a conference on Small Ruminants in African Agriculture, at which 33 participants from 17 countries presented and discussed 24 pa-

pers. The major subjects covered were reproduction and growth, nutrition, health and mortality problems, productivity, and socio-economics. The 275-page proceedings of the conference were edited by the Group's staff and were published and distributed to the participants and network members 2 months after the conference.

Collaborative research

In 1985 the Group assisted national organisations in Zimbabwe, Djibouti, Mozambique, Cameroon and Congo with setting up research programmes, with assessing current research or with the design and execution of systems studies in their traditional sectors. Major analyses were undertaken in collaboration with the Animal Production Research Administration of Sudan and the Institut des sciences agronomiques du Rwanda (ISAR). The results of the Sudan analyses are still being studied.

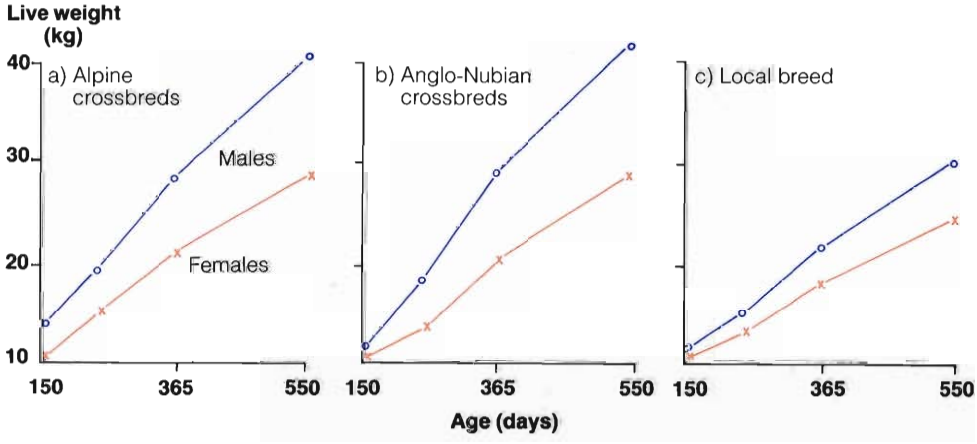
The Rwanda collaboration comprised the analysis of data on indigenous African long-, fat-tailed sheep on two stations in the highlands in the south of the country and analyses relating to the productivity of the indigenous Small East African goat and its crosses with Anglo-Nubian and Alpine goats in the semi-arid eastern lowlands of the country. Results of the sheep analyses show that there is considerable scope for increasing productivity by selection within the indigenous population (Table 14). The analyses also showed that there were no differences in productivity resulting from lambings taking place throughout the year, and that the ISAR policy of mating at only one time of the year should be changed to permit three lambings in 2 years. Comparisons of the exotic half-bred goats with the native purebreds showed that the former were not significantly more productive than the latter. However, sexual dimorphism of the crossbreds was very marked (Figure 10), indicating that there are considerable possibilities for increasing meat production from male crossbreds, if good management standards can be achieved in the traditional sector.

Table 14. Effect of selection on the principal production parameters of Rwandan sheep between 1975 and 1982.

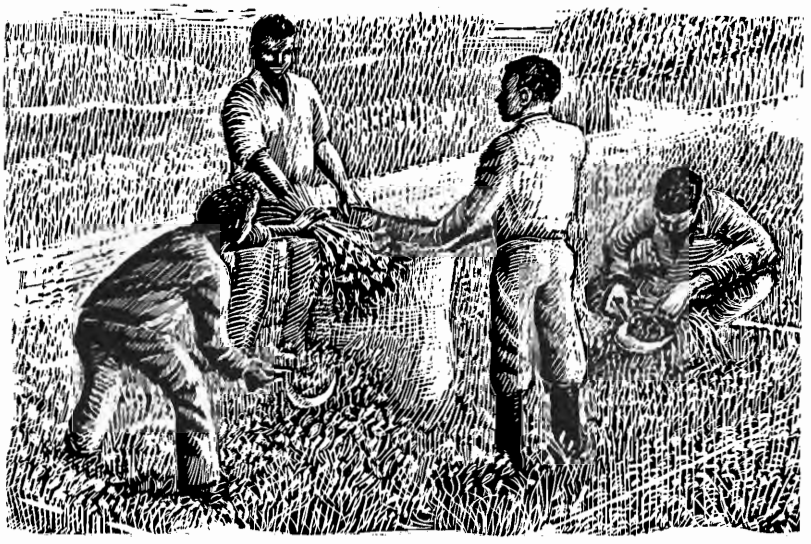
Parameter	Change per year
Litter size (number)	+0.04
Birth weight (kg)	−0.14
Weaning weight (kg)	−0.34[1]
Mortality (%)	−0.70[1]
Productivity index	+1.61

[1] These decreases were due to higher incidence of twinning. Total birth weight and total litter weaning weight increased over the period.

Figure 10. Liveweight gain of goats according to breed and sex, Karama, Rwanda.



Forage Legume Agronomy Group



Introduction

The main objective of the Forage Legume Agronomy Group (FLAG) is to study and promote the use of improved forages, particularly legumes, in African farming systems, in order to increase both crop and livestock production. Two areas of particular interest to the Group are soil fertility as it affects plant growth, and forage nutrition as it affects livestock production.

The Group also provides technical advice and seeds to ILCA's field programmes and to national research and development organisations in sub-Saharan Africa.

Germplasm activities

FLAG acquires, maintains and multiplies forage germplasm, with the aim of making it available to research and development workers in sub-Saharan Africa. The International Board for Plant Genetic Resources (IBPGR) has designated ILCA as the centre to hold base collections of a number of forage species, including members of the genera *Neonotonia,* African *Trifolium, Cenchrus* and *Digitaria.* A germplasm newsletter is published in association with the Ethiopian Plant Genetic Resources Centre (PGRCE).

ILCA's genebank now houses some 8000 accessions of forage and browse species and some food crops. A catalogue of the genebank was published in 1985, and will be updated periodically. Germplasm is distributed on request, together with trial designs for testing and screening.

During 1985 ILCA received funding from IBPGR and World Vision for equipping a controlled environment store for the germplasm collection. The planned store will comprise facilities for medium-term storage of seeds at 4° C under controlled humidity and for long-term storage at –20°C.

Seed from the germplasm collection is multiplied either year-round on neutral pH soils under irrigation in the Rift Valley or under rainfed conditions on acid soils at Soddo. This activity was expanded in 1985 to meet the rising demand for seed from national research bodies in sub-Saharan Africa. The seed production unit also multiplies the initial seed of genebank accessions and regenerates seed from the collection, particularly that of the short-lived grasses. The scope of these activities is shown in Table 15.

A collection mission to Tanzania in 1985, supported by IBPGR, focused on African *Trifolium* spp, *Stylosanthes fruticosa, Neonotonia wightii, Zornia* spp, *Cenchrus, Chloris, Panicum, Setaria* and *Cynodon* spp. Centro International de Agricultura Tropical (CIAT) also participated in the collection mission, their interest being mainly in *Brachiaria* and *Andropogon* species.

Table 15. Number of genera, species and accessions currently under multiplication at the FLAG seed production unit.

	Genera	Species	Lines	Annuals	Perennials
Legumes	40	118	760	123	637
Grasses	20	47	276	2	274
Total	60	165	1 036	125	911

Mycorrhizae and plant nutrition

Commercial fertilizers are becoming increasingly scarce and expensive in developing countries. This has led scientists to investigate cheaper and less soluble sources of fertilizer, such as phosphate rocks (PRs), and to study the use of soil organisms that increase the availability of nutrients to plants.

One group of organisms that has shown promise in this respect is the vesicular arbuscular mycorrhizal (VAM) fungi. When grown in association with plant roots, these fungi increase their effective surface area, and hence the plant's ability to absorb minerals, particularly phosphorus, from the soil. This results in large increases in plant growth, and may also enhance the drought tolerance of the plant. The presence of the fungi apparently promotes soil stability as well, by binding particles into semi-stable aggregates.

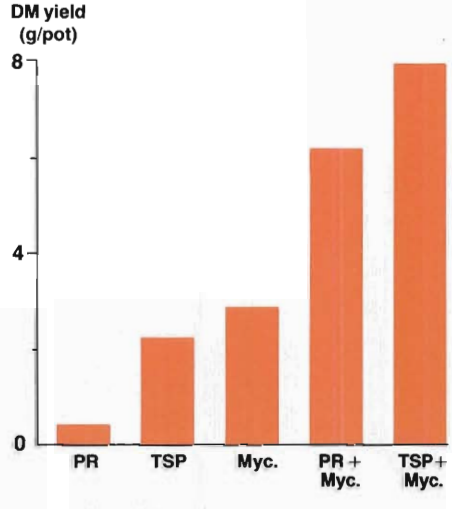
The VAM fungi are particularly useful when associated with legumes, which often have a high P requirement for optimum nodulation and growth. Numerous studies have shown that legumes use insoluble PRs more efficiently when inoculated with VAM fungi than when grown without them.

In a greenhouse experiment conducted at ILCA headquarters on a low-P Vertisol, inoculation with VAM fungus alone increased the DM yield of lucerne (*Medicago sativa*) nearly 150-fold compared with uninoculated plants. In addition, the DM yield of unfertilized inoculated plants was 670% and 130% more than that of uninoculated plants fertilized with 40 kg of PR and 40 kg of triple superphosphate (TSP)/ha, respectively. Inoculating fertilized plants with the mycorrhizae increased yields 3.5-fold in the case of PR-fertilized plants and 14-fold for TSP-fertilized plants, compared with plants receiving fertilizer alone (Figure iv).

The effect of the VAM fungi varies among legume species, and certain strains of fungus are more effective than others. Scientists in ILCA's Soil and Plant Nutrition Section are studying the effects on PR utilisation of several fungal strains, using a range of forage legumes on low-P acid soils.

Although VAM fungi show great potential for increasing plant growth on low-P soils, there are still problems in producing inocula of the fungi commercially, since they grow only on living plant root tissue. This problem is being addressed by researchers in the developed world, and ILCA eagerly awaits developments. An alternative to using inocula is to manipulate the length of fallow and cropping periods so as to promote natural mycorrhizal fungus populations. At present, this approach appears to be more practicable.

Figure iv. Effect of mycorrhiza and phosphorus on the DM yield of 12-week-old *Medicago sativa*[1] plants grown on sterile soil.



PR = phosphate rock
TSP = triple super phosphate
Myc. = mycorrhiza

[1] Control plants yielded only $0.02 \pm 5 \times 10^{-4}$ g/pot.

Field activities

The Group's field activities consist mainly of screening and evaluating germplasm under highland (temperate) and subtropical conditions, but the Group also assisted in screening activities conducted by ILCA's Subhumid Zone Programme in the West African lowlands during 1985.

The Group screens forage germplasm at two highland sites: ILCA headquarters at 2300 m a.s.l and Debre Berhan at 2800 m a.s.l. The testing focuses mainly on African *Trifolium* species. In 1985, 30 elite lines from the 6 annual clover species, *T. tembense, T. quartinianum, T. decorum, T. ruepellianum* and *T. steudneri,* were tested in replicated yield trials, and a further 296 lines of 11 species were tested in unreplicated strip trials and for seed increase. *T. quartinianum* lines gave the highest yields, as in previous years. In 1985 the best yielding lines produced about 4 t DM and 1 t of seed/ha. The performance of 98 lines of three perennial clover species, *T. burchellianum, T. cryptopodium* and *T. semipilosum,* is also being investigated at the two sites. Among the exotic temperate grasses screened in a 3-year trial, *Phalaris aquatica, Festuca arundinacea* and *Lolium perenne* continued to be the most promising.

A wider range of legume species are tested at mid-altitude, subtropical sites. At the drier site of Abernossa in the Rift Valley (< 800 mm mean annual rainfall), *Stylosanthes scabra* and *S. hamata* have proved to be the best adapted species though their persistence has been lower than expected. At the wetter site of Soddo (>1000 mm mean annual rainfall) the highest yields were produced by *S. guianensis* cvs Cook (5.2 t/ha) and Endeavour (4.7 t/ha), *S. scabra* cvs Seca (4.7 t/ha) and Fitzroy (3.4 t/ha), *Macrotyloma axillare* and *Desmodium intortum* (2.3 t/ha each). Interestingly, the best lines tested so far have all originated from Australian commercial cultivars, which suggests that the agroclimatic adaptation of species from Australia to African conditions may be closer than that of species from South America. Alternatively, it may indicate the inadequacy of the range of germplasm tested so far.

The Group screens browse species across three environments ranging from temperate highland to mid-altitude subtropical. The most promising species belong to the genera *Acacia, Erythrina, Leucaena, Desmodium, Sesbania, Gliricidia* and *Cajanus.* A set of *Leucaena* spp accessions from the Mexican highlands (600–2000 m a.s.l.), obtained from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), is being grown at six sites covering a range of soil types, altitudes and rainfall regimes. These are looking promising at all sites except the high-altitude Debre Berhan site.

Outreach activities included underplanting coffee and ensete with Greenleaf desmodium *(D. intortum)* to provide cut-and-carry fodder, and underplanting maize with Cook stylo *(S. guianensis)* and *M. axillare* to enhance the feeding value of the stover and to maintain soil fertility.

Soils and plant nutrition

Studies were started in 1985 on soil fertility problems, as part of the background work on plant nutrition and adaptation of germplasm to soil fertility constraints. These studies included:

- Typifying soil fertility constraints in the major soil types at ILCA research sites and in important African soils.
- Focusing on soil P as the major factor limiting legume growth, including the selection of species that tolerate relatively low levels of soil P, determination of optimum levels of fertilizer P for legumes, use of cheaper and less soluble forms of P, such as rock phosphate, and the application of soil amendments, such as lime, to increase pH and the availability of native soil and applied P.
- Identifying suitable methods for the determination of available P for a range of soils, as the basis for advising on fertilizer use.
- Studying the role of mycorrhizae in enhancing the nutrition of forages growing on infertile soils, particularly in relation to the availability of P.

Initial results from field and glasshouse experiments indicated significant differences in the yield and nodulation response of *Medicago sativa* to P application on a Vertisol, a Nitosol and a Fluvisol. Micronutrient effects were also indicated, and these will be studied further. These studies have already helped to explain the widespread failure of *M. sativa* on Nitosol or red acid soils.

A series of 'state-of-knowledge' reports on soil fertility, as it affects the agronomic

performance of crops and forages in the major West African agro-ecological zones and in the Ethiopian highlands, has been completed.

Agroclimatology

An initial evaluation of the agroclimatic zones of the Rift Valley in relation to environments in other parts of Africa was completed in 1985. A water balance model installed on ILCA's computer is being used to interpret climatic data in terms of length of growing season and the possibility of predicting plant performance.

Microbiology and tissue culture

A start was made in 1985 in developing a backup facility for studying problems of field inoculation with *Rhizobium* spp and monitoring inoculant quality and suitability. The initial results of a collaborative project with the Welsh Plant Breeding Station (UK), indicated that nodulation and N-fixation problems may hamper the use of African *Trifolium* species on a wide scale in the African highlands. This work indicated that rhizobium strains, soil conditions and plant genotype must be taken into account in selecting for adaptation in these African *Trifolium* genotypes.

A tissue culture facility was developed in 1985, initially to assist in the propagation of the *Brachiaria* spp collection made by the joint CIAT/ILCA collecting missions. However, the facility will also be used for the provision of disease-free germplasm, for the possible storage of shoot buds and for the multiplication of other genera that are poor producers of seed, such as *Cynodon* and *Digitaria.*

Networks

The Forage Network in Ethiopia (FNE) published four issues of its newsletter in 1985. The Group was involved in planning a range of multi-location screening trials executed by FNE participants from a wide range of organisations. The annual meeting and field trip were also held.

During the year a second network, the Pasture Network for Eastern and Southern Africa (PANESA), was established with funds from the International Development Research Centre (IDRC), Canada. A second international workshop was held in Nairobi in late 1985 under IDRC sponsorship.

Livestock Economics Unit

Introduction

The Livestock Economics Unit has two sub-programmes:

- Policy work – to assess the importance of policy issues, to carry out research on selected topics and to bring the results of these and other studies to the attention of those who analyse and make policies for the livestock sector of African countries.
- Micro-economics – to identify, in conjunction with other ILCA scientists, constraints to livestock production, and to evaluate techniques for overcoming them.

Outreach

The Unit undertook two new outreach activities and expanded a third in 1985.

In January, the Unit launched ALPAN – the African Livestock Policy Analysis Network – which provides a forum through which those involved in the livestock sectors of African countries can exchange views and learn from others' experience. The Unit distributed two sets of ALPAN documents in 1985, each set comprising a newsletter (bilingual, English and French) and a number of longer papers (usually monolingual). Although the papers in the first set were written largely by ILCA staff, most of those in the second set were by non-ILCA authors: it is expected that most contributions will continue to come from outside ILCA. By the end of 1985 ALPAN had about 700 members, 85% of whom were from sub-Saharan Africa. More than one third of the members in sub-Saharan Africa were from francophone Africa.

In collaboration with the United States Agency for International Development (USAID) and the University of Florida, the Unit held a workshop on research methodologies and priorities in systems research on livestock in mixed farming systems. The workshop was attended by more than 20 scientists from different countries and, for the first time in Africa, tackled the methodological problems of conducting on-farm livestock research in a systems context.

Since its inception the Unit has produced a series of working papers that report provisional results of its research. In 1985 it was decided to make these working papers available on a regular basis to a wider audience, and by the end of the year they were being distributed to 230 social scientists in 40 countries, 75% of the addressees being in sub-Saharan Africa.

Research

Dairy marketing systems

The Unit continued to study five major policy areas, two of which – financing livestock services and imports of dairy commodities – were reported in some detail in the 1984 *ILCA Annual Report*. The other three areas were dairy marketing systems, research resource allocation and pricing policy.

As a result of rapid urbanisation, market demand for milk in sub-Saharan Africa is rising fast, but so far there have been few serious studies of dairy marketing systems in Africa. Early in 1985, as part of a case study of the merits of different dairy marketing systems, the Unit surveyed milk acquisition in a sample of households in Addis Ababa. The city was first stratified into three zones, inner, middle and peripheral, where different supply and demand conditions apply. Enumerators visited 3900 households once, of which a subsample of 500 was subsequently revisited daily for 7 days.

Over 70% of the households either seldom or never acquired milk. Of the households that did acquire milk, 90% purchased it and 10% kept their own cows. Table 16 presents some of the data on purchases of liquid milk according to household income and location. Purchases of non-liquid milk (powder, evaporated or condensed) were negligible. Lower-income households were defined as those with monthly incomes of EB 250[1] or less, and accounted for more than 80% of all households in Addis Ababa.

[1] Eth. birr 2.07 = US $1.

In this study, the different marketing systems are defined in terms of the chains linking the producer to the consumer. It is clear from the results that the most important chain, in terms of both the amount of milk and the number of consumers served, is also the shortest: 70% of the milk purchased by households in Addis Ababa is bought direct from producers, almost all of whom keep their animals within the city limits. Both higher- and lower-income households cited convenience when collecting milk, regularity and reliability of supply, and hygiene and cleanliness as the main reasons for selecting particular sources.

The Ethiopian Government's aim to provide milk at low prices to lower-income families through *kebele*[2] shops is being only partly fulfilled. Although *kebele* shops are usually the cheapest source of milk for lower-income families in the three zones surveyed, in each zone some other source of milk was used more extensively by the small proportion (about 22%) of lower-income households that did purchase milk.

[2] A *kebele* is an urban dwellers' association, i.e. the lowest tier of municipal administration.

Table 16. Liquid milk purchases in Addis Ababa, 1985.

	Zone in city[1]			
	Inner		Peripheral	
	Income class (EB/month)			
	<250	>250	<250	>250
Households seldom or never acquiring milk (%)	77	50	76	30
Percentage of purchasers using:				
1. *Kebele* or DDE[2] shop	36	28	6	7
2. Small private shops	43	37	16	26
3. Intra-urban milk producer[3]	11	25	68	64
Main reason for choice of source (%):				
1. Convenience of collection	32	29	33	21
2. Regularity or reliability of supply	32	27	17	19
3. Hygiene and cleanliness	14	12	37	28
4. Price	14	12	0	10
Average price paid (EB/litre)	0.85	0.89	0.85	0.87
Average weekly purchase among purchasing households (litres)	2.2	3.2	3.0	4.3

[1] The results of the third ('middle') zone are excluded for the sake of clarity.
[2] DDE = Dairy Development Enterprise – a parastatal collection, processing and marketing organisation.
[3] That is, a person keeping cows within the city boundaries.

Allocation of research resources

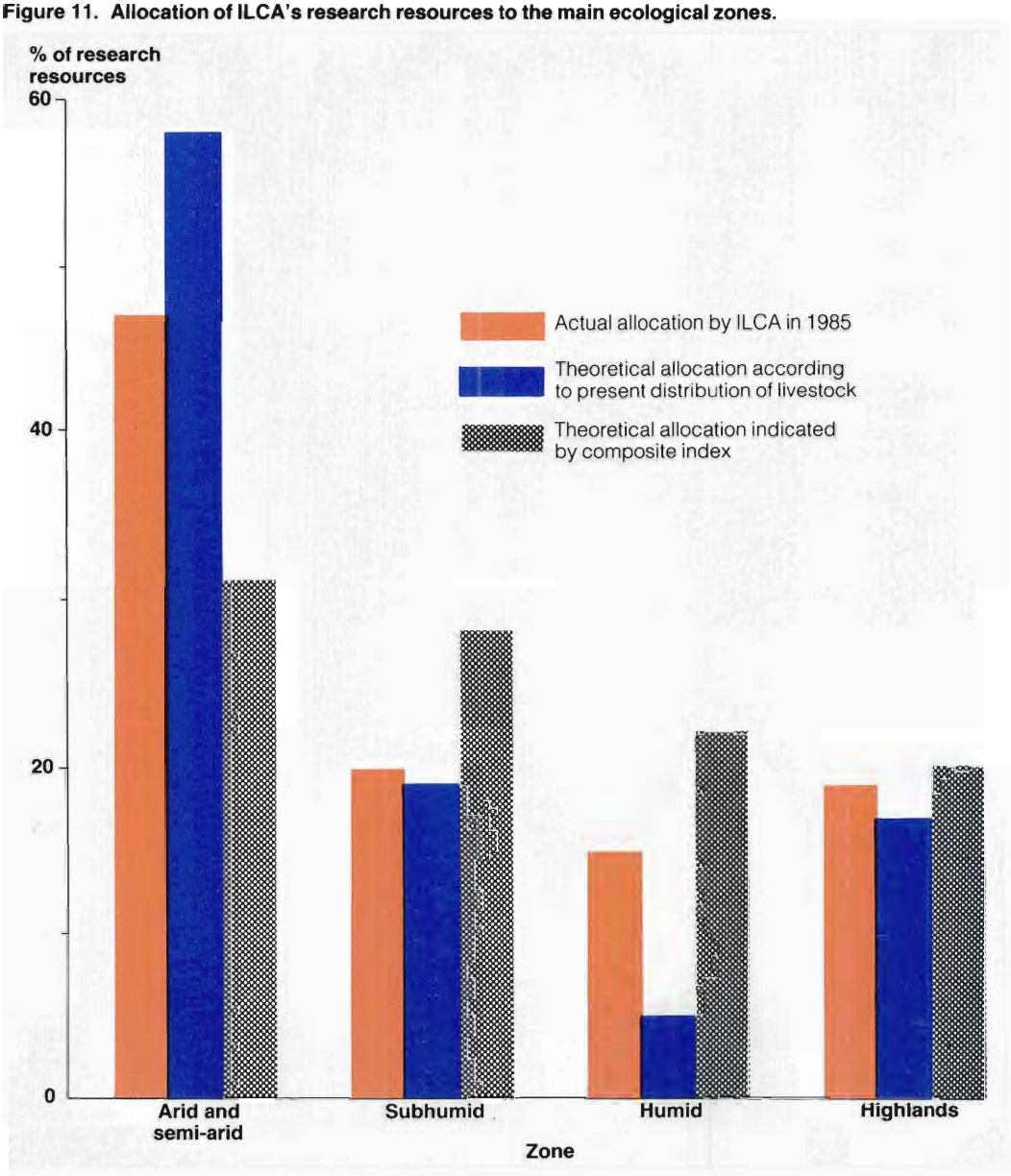
Since 1984 the Unit has been studying the extent to which ILCA's allocation of research resources matches that indicated by various criteria, and in 1985 the Unit further refined this study.

Figure 11 shows the actual allocation of ILCA's resources by zone, compared with the theoretical allocation indicated by:

1. The region's livestock population (in TLUs[3]); and
2. A composite index comprising four variables:
   - The importance of livestock in the region, as measured by their con-

[3] One TLU (tropical livestock unit) = 250 kg liveweight.

Figure 11. Allocation of ILCA's research resources to the main ecological zones.



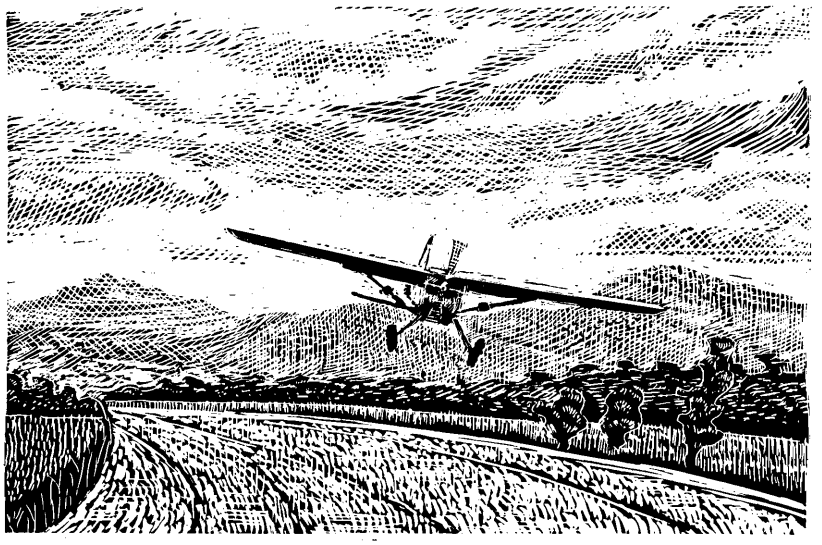
tribution to the protein intake of the human population;

- Per caput income (this is given a negative weighting so as to favour poorer regions);
- Total human population, as an indicator of the number of potential beneficiaries; and
- Human population density, as an indicator of pressure on natural resources.

The figure indicates that ILCA's allocation of research resources matches fairly well with the existing distribution of livestock. However, to match the composite criterion there would need to be some reallocation of resources from the drier to the wetter zones.

Calculations of this sort do not substitute for human decisions, since they themselves are based on both value judgements and assumptions. However, they do permit the values and knowledge of decision makers to be handled methodically so that different options can be considered in a consistent way.

Resource Survey Projects



Introduction

Over the last 3 years, ILCA has increased its research into the use of data from the advanced very high resolution radiometers (AVHRRs) on board the NOAA-7 and NOAA-9 satellites to establish a drought early warning system and to determine the length of plant-growing seasons and the production of plant biomass over large and often inaccessible areas of Africa.

The programme began as a modest joint venture between ILCA and the Global Inventory Monitoring and Modelling Section (GIMMS) of the NASA Goddard Space Flight Center (USA), but now includes cooperation with the Global Environmental Monitoring System (GEMS) of the United Nations Environment Programme (UNEP), and links with the Commonwealth Scientific and Industrial Research Organisation (CSIRO, Australia) and with the Food and Agriculture Organization of the United Nations (FAO).

ILCA currently has two teams studying the use of remote sensing: one in West Africa working with annual grasslands under a monomodal rainfall regime, the other in East Africa studying the more diverse perennial grasslands under bimodal rainfall. The West African team is working in Niger and Mali, covering the Sahelian zone, and in East Africa there are projects in Ethiopia and Kenya.

West Africa

Mali

Work began in Mali in 1983 and has focused on the calibration of reflectance data for estimates of the primary productivity of annual plants in the Sahel. Thirty ground sites are being used to determine the correlation between end-of-rainy-season plant biomass and reflectance values throughout the season following multi-temporal compositing of the records. The ground sites cover a range of ecosystems from very arid environments in the northern Gourma to highly productive areas in the inner delta of the Niger.

Variations in the transmissivity of the atmosphere are one of the major problems in the use of data derived from satellite instruments, as indicated by comparison of satellite data with those derived from instruments on low-flying aircraft. Transmissivity is time specific and varies in space according to the presence of haze, dust and other aerosols. Poor records resulting from such interference must be either corrected or eliminated from the data set. This selection is in addition to that already carried out for 'cloud mask', which discards those parts of the image under cloud, as measured by the thermal channel of the AVHRR.

A network of 'transmissometers' has been established so that data can be selected for 'clear' days and to find out whether correction factors can be developed.

Niger

In Niger, work has focused on the development of an early warning system for drought. The programme was developed in collaboration with the Government of Niger, the United States Agency for International Development (USAID) and Tufts University (USA), and was started in 1985. The field work has combined measurements of reflectance and plant biomass on the ground with low-level aerial photography and reflectance characteristics.

The results indicate that, while predictions can be made at a fairly coarse level, the precision of estimates of grass production is limited, both within and between years. Precision may be influenced by sampling methods, which will be the next area for research. The results have also shown that the composition of plant communities and the stage of growth of the plants influence reflectance measurements, and that calibration of satellite information is a complex exercise still in the research, rather than the application, stage.

East Africa

Ethiopia

In Ethiopia, work started in 1983 and concentrated on changes in reflectance through the year. Satellite data were compared with the FAO growing period model and correspondence was found between peak reflectance values and plant growth, allowing for time lags. The beginning and end of growing periods, as determined by the FAO model using meteorological data, were found to be strongly correlated with rates of change of canopy reflectance measured by the satellite. Estimation of the length of growing periods thus appears possible from satellite data using the techniques developed at ILCA. Since length of growing period can be related to crop and biomass production, this result could have useful applications in environmental monitoring.

The field work in southern Ethiopia was integrated with a systems study started in 1982 and used a multi-stage sampling system comprising twelve 400-km^2 plots, six 100-km-long flight transects and an ecological map derived from Landsat imagery. Satellite and low-level aerial survey data showed a similar trend but seasonal differences were considerable, particularly during the short dry season when plants are mainly green but cloud cover is high. Tree and shrub cover also often interfere with changes in reflectance.

Kenya

Work in Kenya started in 1985, jointly funded by ILCA and UNEP. The calibration programme was based on the use of a series of regularly flown aerial transects over a wide variety of plant communities, and on specific studies of four large ground areas. The initial results have shown a close relationship between reflectance and the product of plant cover and greenness developed from visual estimates across a very diverse environment.

A major workshop on the use AVHRRs to measure grassland productivity was held in Nairobi in 1985 and a complete issue of the *Journal of Remote Sensing* was dedicated to papers presented at this workshop.

The results of the Programme to date suggest that the qualitative information derived from NOAA satellites can be used immediately for the prediction of climatic disasters, but that further research on the quantitative aspects is required. If, however, the problems of calibration and correction for atmospheric interference can be overcome, AVHRR data have considerable potential as a cost-effective and reliable means of predicting and monitoring rangeland production.

Computer Unit

Introduction

The use of the HP 3000 minicomputer increased by only 4% in 1985, compared with 60 and 100% in the previous 2 years. However, the use of microcomputers more than doubled during the year, their number increasing from 25 to 54.

The minicomputer hardware was upgraded by adding a 400 megabyte disk, 2 megabytes of memory, 12 ports and a high-speed magtape unit, which will provide adequate computer capacity through to the end of 1986. With the upgrade of the hardware, the operating system was changed to MPE V[1], which brought ILCA into line with Hewlett-Packard's latest software and will give faster response to users.

[1] MPE V = Multi-Programming Executive Operating System.

Activities

Figures 12 and 13 show the changes in overall computer use and research use respectively from 1984 to 1985. The dramatic reduction in computer use by the research units (down from 53% to 32%) was due to the completion of computer analysis for three major studies in 1984. However, the amount of computer use by research is expected to increase in 1986 as other studies near completion. The extra capacity available from the second processor purchased in 1984 was absorbed by Administration (+7%), Information (+7%), Training (+4%) and external users (+4%).

The greater use of the computer by Administration indicates the better and fuller use of ILCA's financial package, as well as the automation of more administrative functions, notably those of the Registry. This automation uses both the minicomputer and microcomputers. The latter are used for payroll, stock control, and by the field programmes for general ledger. There is full compatibility between the two systems. During 1985 the payroll and general ledger for the Kenya field programme were installed on their microcomputer, and it is hoped that by the middle of 1986 all the field programmes will have these software packages installed.

External users

The increased use by Training and external users indicates the close contacts that ILCA is maintaining with both international agencies and national research institutes within Ethiopia and throughout Africa. In 1985 the Computer Unit worked closely with scientists from the Institute of Agricultural Research and the Ministry of Agriculture in Ethiopia, and also with scientists from Rwanda and Sudan.

International agencies such as the United Nations High Commission for Refugees (UNHCR) and the Food and Agriculture Organization of the United Nations (FAO) also used ILCA's computer facilities. FAO was involved through the Land Use Planning Division of the Ethiopian Ministry of Agriculture. During the first few months of 1985 the UNHCR completed a project started in late 1984.

The doubling in the use of microcomputers has led to the purchase of more software for these machines as departments require more specialised applications. The Unit has also transferred software from the minicomputer to microcomputers, thus giving scientists in the field access to more sophisticated analysis techniques.

Figure 12. Use of ILCA's mini-computers, 1984 and 1985 (dollar index).

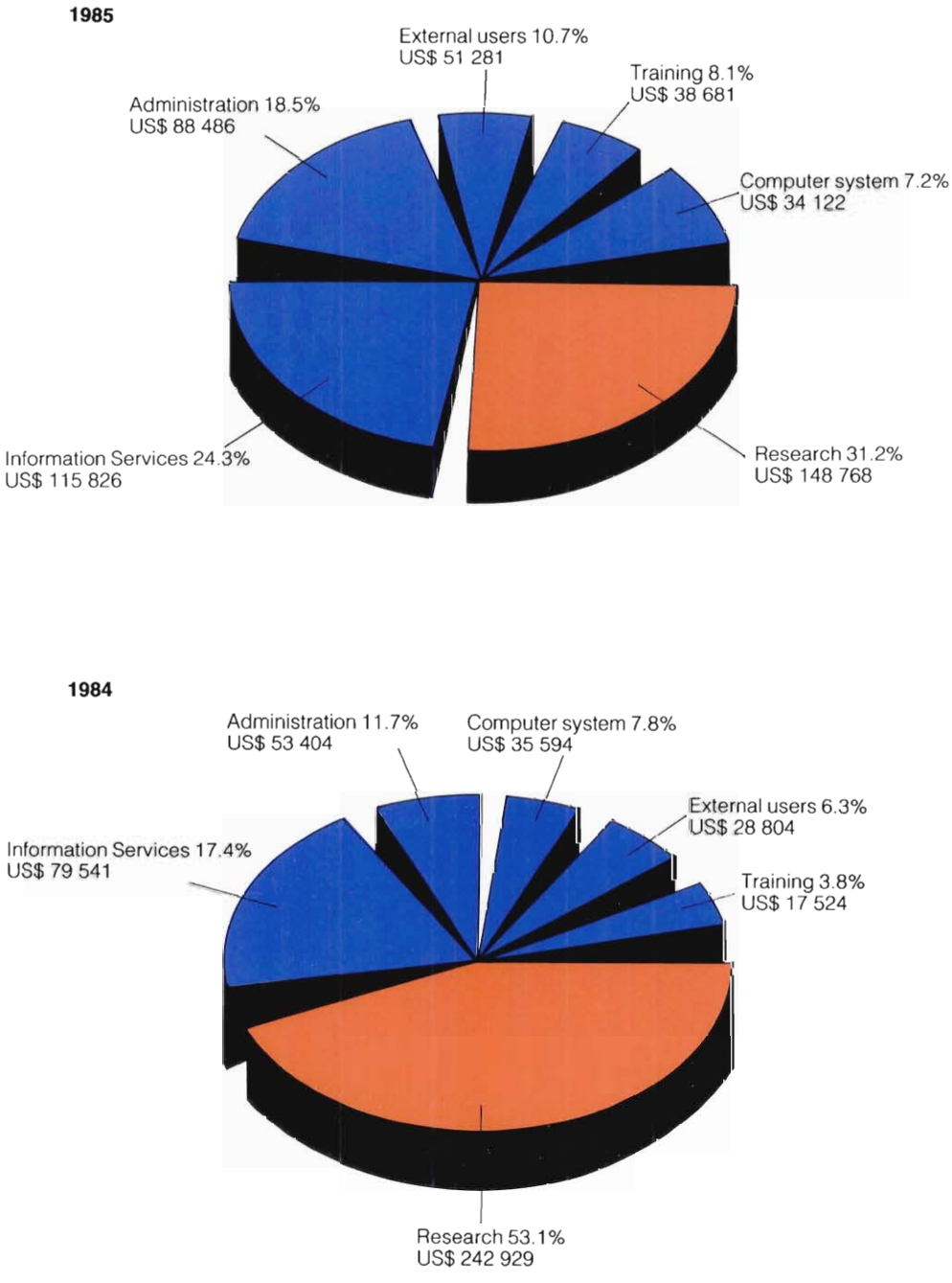
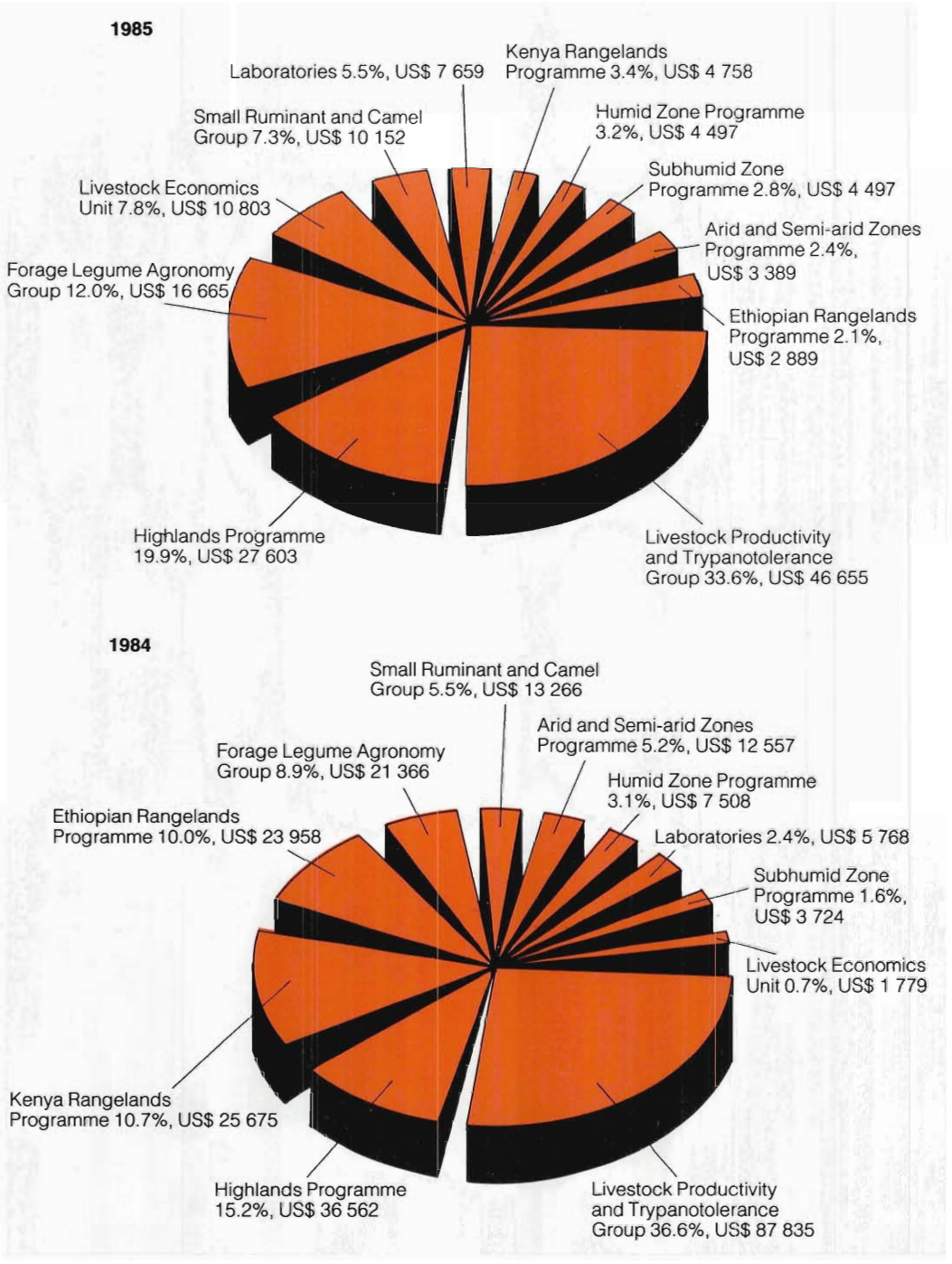


Figure 13. Use of ILCA's mini-computers by research department, 1984 and 1985 (dollar index).

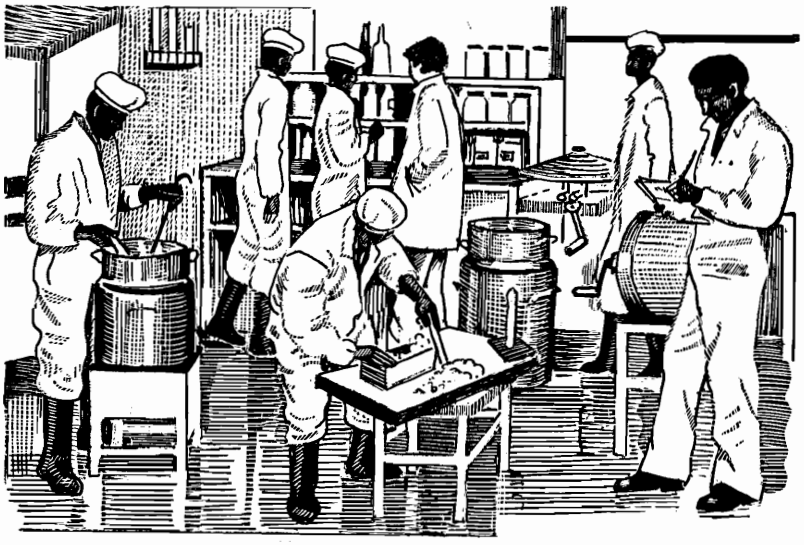


Staffing

The two Ethiopian trainee programmers who joined the Unit in 1984 have now become permanent staff. One is assigned to understudy the administrative programmer, and the second is working as a scientific programmer. A trainee programmer was recruited locally in late 1985.

The Unit is now staffed by four expatriate and two Ethiopian programmers, an Ethiopian trainee programmer, a biometrician, four operator/data entry personnel and a secretary.

Training Department



Introduction

One of ILCA's most important activities is training African scientists. ILCA believes that major advances in agricultural productivity can only be achieved through strong national research bodies, and that the Centre can make a major contribution by helping to provide national programmes with the trained staff they need. ILCA's strategy is to use all possible resources for intramural training to take advantage of the Centre's unique position as a well endowed institution in an underdeveloped continent.

Group training

ILCA held eight training courses in 1985, compared with 12 between 1977 and the end of 1984. New subjects covered included rural dairy husbandry, the standardisation of cattle production data, the handling of agricultural information and the use of microcomputers in livestock management and research. Details of the courses held in 1985 are shown in Table 17.

Individual training

Five principal forms of individual training are given at ILCA, three of which are given high priority as they strengthen ILCA's research efforts and provide training opportunities rarely found elsewhere.

Technician associates (13 during 1985) are junior staff from national research institutes who spend 2 to 10 weeks working in ILCA laboratories, research projects or service facilities, learning techniques that will enhance their capabilities.

Undergraduate associates (1 during 1985) are young agriculturalists, many from

Table 17. ILCA training courses held in 1985.

Title	Date	No. of participants
Milk products for rural areas	14 Jan. – 15 Feb.	21
Standardisation of cattle production and selection data	20 – 24 May	19
Economics of animal health and disease control	15 July – 2 Aug.	23
Handling and dissemination of agricultural information	12 – 23 Aug.	23
Animal nutrition and forage analysis[1]	16 Sept. – 4 Oct.	16
Animal nutrition and forage analysis	21 Oct. – 8 Nov.	15
Rural dairy husbandry and technology	18 Nov. – 6 Dec.	17
Microcomputers, data management and analysis	9 – 20 Dec.	18

[1] Course conducted in French: all others conducted in English.

developed countries, working on their first degree, who want to gain experience of working in developing countries. They spend from 1 to 6 months working as junior staff in ILCA's field projects.

Graduate associates (10 during 1985) spend from 6 months to 3 years at ILCA conducting their thesis research as part of an advanced degree programme at either an African or an overseas university. Visits by the university supervisors of these associates also provide an important scientific input into ILCA's research programmes.

ILCA's programme for postdoctoral associates (12 during 1985) was established to help African graduates of overseas universities to return to their home continent. It is also an important means of increasing the scientific expertise of ILCA's staff. Because of the need for new generations of experienced development workers in donor countries the programme is not limited to Africans, but not more than 25% of the postdoctoral postings can be allocated to non-Africans. Each postdoctoral associate is given a challenging research project and is expected to publish several original scientific papers on the basis of his/her work at ILCA.

The most senior category of individual trainee is the visiting scientist (1 during 1985). Through this category, ILCA aims to gain from the experience of African scientists and from their knowledge and understanding of the African context, rather than to give 'training' to the scientist. Only now is ILCA's research programme maturing sufficiently to make full use of senior African scientists on secondment from their institutions.

During 1985, 38 scientists from 15 African and 6 other countries received individual training at ILCA, 12 for the entire year, 10 for more than 6 months and the others for periods ranging from 3 to 24 weeks.

Library and Documentation Section

Introduction

Information services receive low priority in the planning and management of agricultural research in Africa. ILCA has thus placed emphasis on developing a well equipped library and documentation centre in order to provide both ILCA staff and national institutes with the information that is so vital to agricultural development.

The Section's main activities comprise:

- Computerised information services;
- Collecting, processing and disseminating non-conventional literature on microfiche;
- Library services; and
- Management of ILCA's mailing list and distribution of ILCA publications.

Training

In previous years, the Section has offered individual training to staff from agricultural libraries in Africa. However, the demand for training has increased so rapidly that a for-

mal course on Handling and Dissemination of Agricultural Information was conducted in August for 25 participants from anglophone African countries. The course will be repeated in 1986 for francophone African countries.

Computerised information services

The number of users of the selective dissemination of information (SDI) service increased by 30% to 407 in 37 African countries. The service provides each user with individualised current information from the Commonwealth Agricultural Bureaux (CAB) and FAO's AGRIS databases. Four hundred retrospective searches were conducted for both ILCA and external users on ILCA's in-house database and on the AGRIS, CAB and AGRICOLA databases. ILCA's database now contains over 37 000 entries and is increasing at a rate of about 5000 entries each year.

Microfiche project

The microfiche project, funded by the International Development Research Centre (IDRC), was launched in 1978 to identify and retrieve unpublished 'grey literature' in Africa for use by livestock researchers. The project has so far covered 22 countries in sub-Saharan Africa. In 1985 the Section published catalogues of documents collected in Benin, Botswana, Malawi and Zimbabwe. Each institute participating in the microfiche project was provided with a microfiche reader, microfiches of all the documents collected in their country and copies of the national bibliographies.

Library

In 1985 the Library distributed 150 000 photocopied sheets and 44 000 microfiches free of charge to ILCA and non-ILCA users, an increase of 36% and 69% respectively over the 1984 totals. These increases were largely due to ILCA's 'current contents' service and to the country catalogues produced by the microfiche project. The 'current contents' service introduced in 1984 has thus proved an effective way of supporting African libraries, many of which, due to limited budgets, are unable to subscribe to international journals. In addition, 4000 ILCA publications requested in response to advertisements in the *ILCA Newsletter* were distributed.

Mailing and distribution

In late 1985 responsibility for distribution of ILCA publications was passed to the Library and Documentation Section from the Publications Section. ILCA's computerised mailing list now contains 5000 addresses of institutions and individuals, 66% of which are in Africa. The Section is currently analysing past mailing list composition, and attempting to define a structure for future growth.

A study was carried out comparing the distribution of the *ILCA Newsletter* with two indexes: one combining the number of TLUs with human population in the countries of sub-Saharan Africa, and the other reflecting the level of donations from donor countries (Figures 14 and 15). This study revealed that several countries receive a low proportion of newsletters in relation to their livestock and human populations or their contribution to ILCA's budget. Efforts are now being made to increase ILCA's penetration into these countries.

Figure 14. Percentage of people receiving the *ILCA Newsletter* compared with percentage of combined human/livestock (TLU) population by country in sub-Saharan Africa.

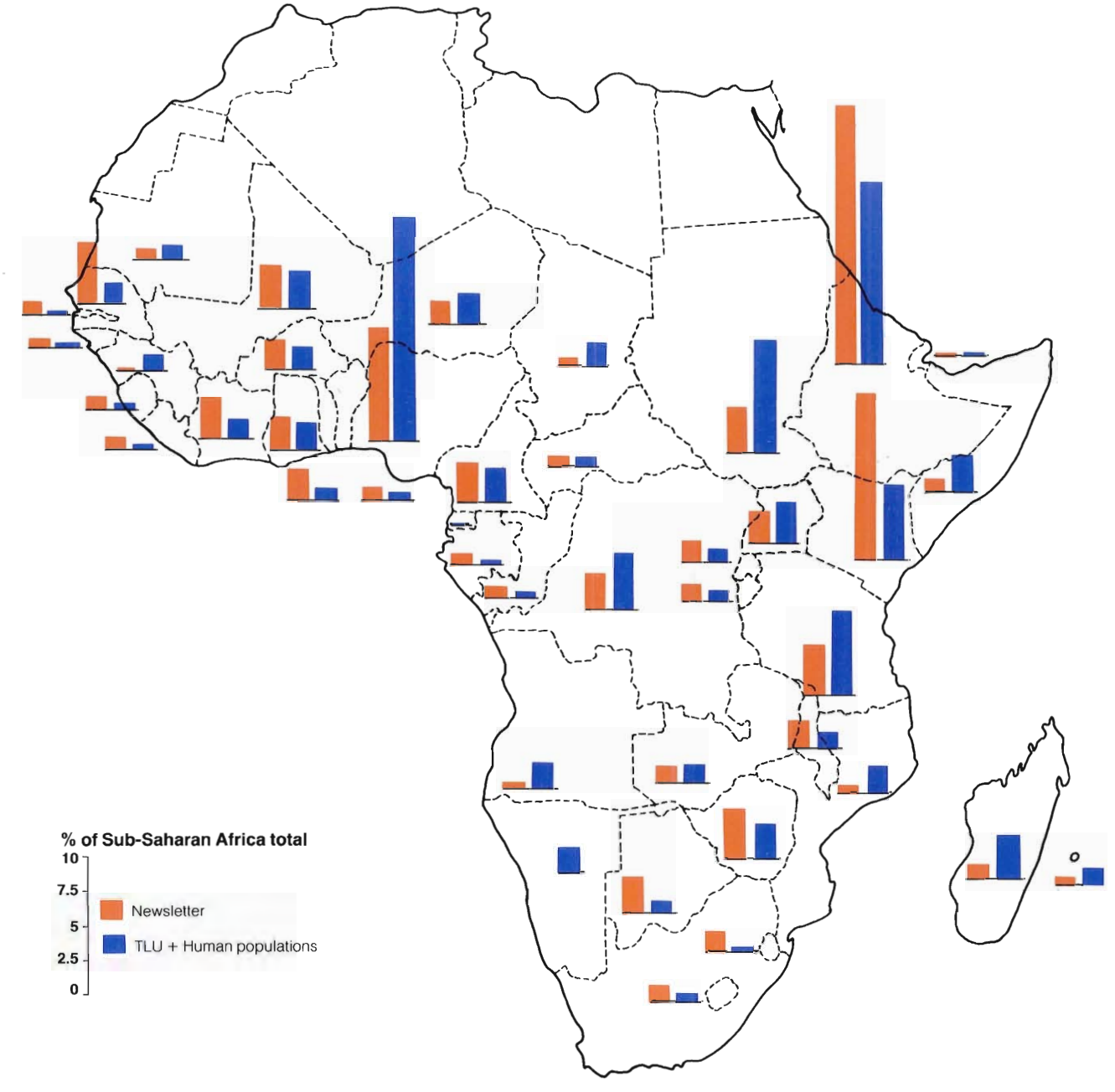
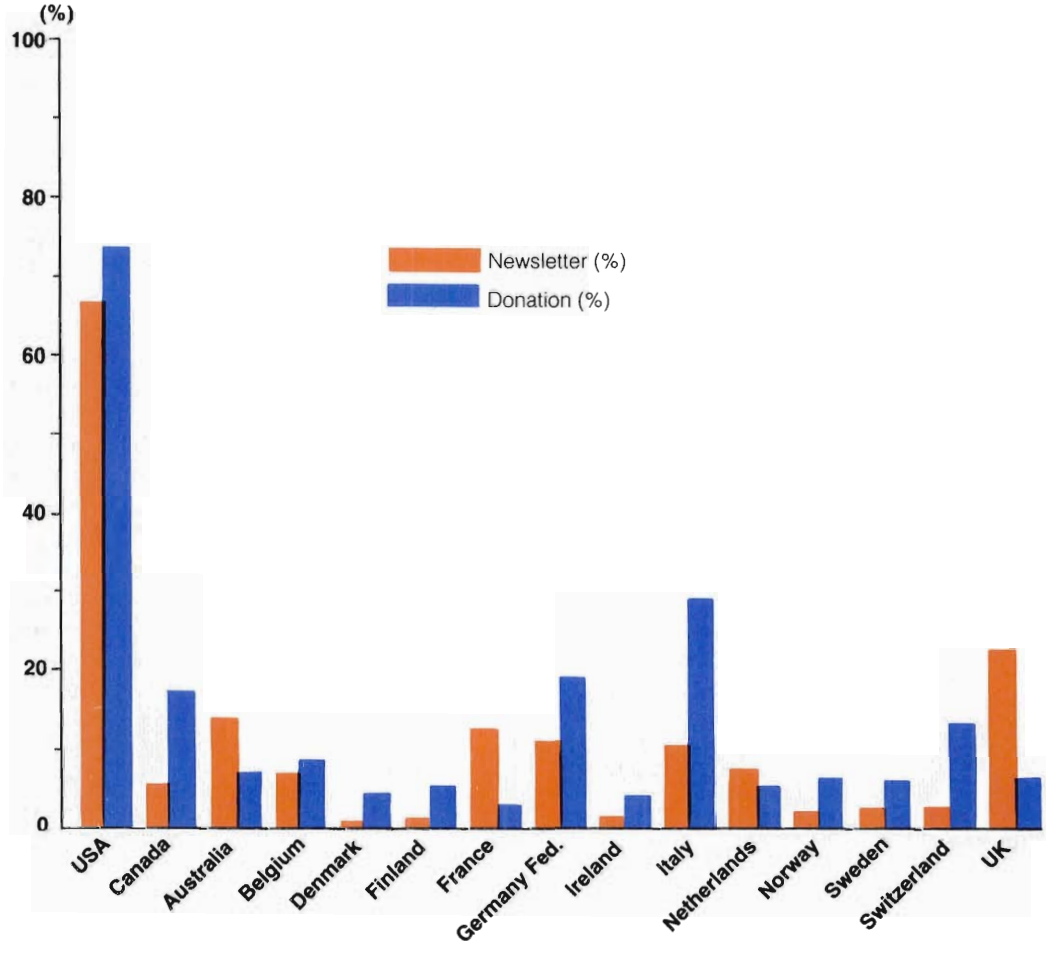
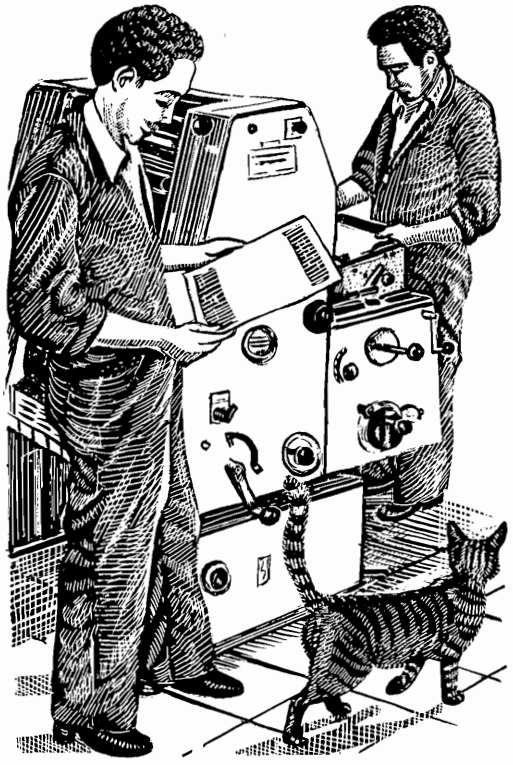


Figure 15. The percentage of ILCA Newsletter recipients[1] and the percentage of donations to ILCA by selected donor countries[2] in 1985.



[1] Outside Africa [2] Excluding multinational donors, e.g. World Bank and EEC, and donors with <0.2% of newsletter recipients and donations; including special fund donations.

Publications Section



Introduction

Nineteen-eighty-five was a year of technical and professional development for the Publications Section at ILCA, leading to greater efficiency than in previous years. As a result, the quality and quantity of ILCA's published output once again increased.

Improvements

One step towards improved quality was the revision of procedures for the pre-publication review of papers written by ILCA staff. Reviewing procedures are difficult to sustain at international centres because of the wide geographical dispersion of staff and slow communications between headquarters and field programmes. The new procedures have caused some delay in publication and added to the workload of senior staff, but have nevertheless proved workable and gained general acceptance. To complement the reviewing of scientific publications, pretesting[1] has been introduced for manuals.

Two technical improvements were introduced during 1985. The first was word-processing using HP 150 microcomputers linked by a Linotype-Computer-Interface to the Section's typesetting equipment. The link allows documents prepared on word-processors to be transferred directly to the typesetting equipment, eliminating the need for re-entering, saving time both for typesetters and for proofreaders. The second improvement, still under trial, consisted of using the Linotype to produce films directly for plate-making. This bypasses three stages of work – paste-up, camerawork and film assembly – and, when fully introduced, should considerably reduce the time required to prepare documents for printing.

Staff development in 1985 included the replacement of the team's expatriate designer with a local staff member trained at the London College of Printing, and the training of a typesetter at Linotype in London. In addition, senior members of the team attended three professional meetings overseas, one for scholarly publishers in Africa, one for information officers in international agricultural research and one for technical communicators throughout the world. A short consultancy to advise on publishing activities was carried out for the International Center for Agricultural Research in the Dry Areas (ICARDA), and ILCA information staff also advised Ethiopia's Institute of Agricultural Research on their equipment and manpower needs.

Output

New titles produced in 1985 are listed in the Annex to this report. The number of publishing jobs completed increased from 70 in 1984 to 78 in 1985, an increase of 11%. Print passes also rose sharply (up 80%), partly reflecting another large increase in ILCA's mailing list (up 24%) and partly an increase in multi-colour printing and the average number of pages per publication. Production during the last quarter of the year was especially strong, as the improvements and training initiatives outlined above began to take effect.

[1] Pretesting is the release of a document to selected users before publication, so that their comments can be built in to the final version.

Outreach activities were stepped up in 1985. At least 30 articles about ILCA were published in the popular press, many of them based on material in the *ILCA Newsletter*. To promote African awareness of ILCA's work, a four-page supplement describing the Centre and its activities was published in a high-circulation African magazine. The publications team also organised an exhibit of publications from 16 international agricultural research centres at the Harare bookfair, resulting in an offer from the Zimbabwe Publishing House to represent the publications of ILCA and other international centres throughout southern Africa.

Lastly, the health and safety of the workers in ILCA's print-shop was investigated. Various improvements were made as a result, including the training of staff in first aid and fire fighting.

Audio-Visuals and Mapping Section

Introduction

With the incorporation of ILCA's cartographic staff, the Audio-Visuals Section became the Audio-Visuals and Mapping Section at the end of 1984. The aims of the Section are to produce audio-visual presentations in order to better inform visitors, collaborators, donors and potential donors about the Centre's activities, and to improve the standard of presentations by ILCA staff at meetings and in training courses. The Section also provides photographic and cartographic assistance to research groups and original artwork for ILCA publications.

Tape/slide presentations

The English version of the ILCA Slide Show was revised during 1985, and was made available in multi-projector and single-projector forms. The existing multi-projector French version was also made available as a single-projector version. These tape/slide presentations are shown to visitors to ILCA headquarters, are distributed to interested organisations and are loaned to ILCA staff when travelling to attend conferences.

During the year the Section also produced three tape/slide presentations on the work of ILCA's Highlands Programme. These are shown to visitors to ILCA headquarters and to the Debre Berhan and Debre Zeit research stations.

Graphics and artwork

The use of computer graphics techniques was further developed during 1985 with the purchase of additional computer equipment and software. Such techniques are used for the production of overhead transparencies and 35 mm slides. Text charts (including tables) and line, bar and pie charts are now predominantly prepared using microcomputers. During the year the Section also produced posters for display at conferences and

field days, notices, labels and photographic displays.

Mapping and drafting

The Section's draftsmen prepared a number of maps of ILCA's research sites and study areas and of African countries at the request of ILCA staff, including maps of the Debre Berhan and Debre Zeit stations, the headquarters site, Ethiopia, Nigeria, Mali and Kenya, as well as various maps of continental Africa. They also prepared technical drawings and building specifications for internal use.

Photography

The Section took photographs of experimental plots, research sites, laboratory work and techniques for the research programmes, and took group photographs for all ILCA training courses and meetings. The photo laboratory dealt with requests for developing and printing black-and-white and colour photographs.

Presentation techniques

During 1985 the Section started a series of seminars for ILCA staff aimed at improving their techniques of presenting papers at meetings and conferences. Such seminars were given for staff at headquarters and for the staff of the Subhumid Zone Programme in Kaduna, Nigeria. Topics covered included preparation, speaking techniques and use of visual aids.

Abbreviations

AAME	active adult male equivalent
ACIAR	Australian Centre for International Agricultural Research
ACSAD	Arab Centre for Studies of Arid Zones and Dry Lands
ADC	Agricultural Development Corporation (Zimbabwe)
AGRICOLA	NAL data base
AGRIS	FAO agricultural information system
ALPAN	African Livestock Policy Analysis Network
ARNAB	African Research Network for Agricultural Byproducts
ARO	Agricultural Research Organisation (Israel)
a.s.l.	above sea level
AVHRR	Advanced very high resolution radiometer
BRAC	branched-chain volatile fatty acids
CAB	Commonwealth Agricultural Bureaux (UK)
CABO	Centre for Agro-Biological Research (The Netherlands)
CESAR	Centro per lo Sviluppo Agricolo e Rwale (Italy)
CFA	Communauté financière africaine
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CILSS	Comité inter-Etats de lutte contre la sécheresse dans le Sahel
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CP	Crude protein
CRSP	Collaborative Research Support Programme (USAID)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DDE	Dairy Development Enterprise
DHP	3-hydroxy-4 (H)-pyridone
DM	dry matter
EB	Ethiopian Birr
EEC	European Economic Community
FAO	Food and Agricultural Organisation
FLAG	Forage Legume Agronomy Group
FSR	Farming systems research
GE	gross energy
GEMS	Global Environmental Monitoring System (UNEP)
GIMMS	Global Inventory Monitoring and Modelling Section (NASA)
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HP	Hewlett-Packard
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Association (World Bank)
IDEAS	ILCA Data Entry and Analysis System
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
INRZFH	Institut National de Recherches Zootechniques, Forestières et Hydrobiologiques (Mali)

ISCTRC	International Scientific Council for Trypanosomiasis Research and Control
IT	intermediate technology
ITC	International Trypanotolerance Centre (The Gambia)
IVOMD	in vitro organic matter digestibility
LH	legume hay
ME	metabolisable energy
MPEV	Multi-Programming Executive operating system V
N	nitrogen
NAL	National Agricultural Library (USA)
NAPRI	National Animal Production Research Institute (Nigeria)
NASA	National Aeronautic and Space Agency (USA)
NDF	neutral-detergent fibre
NGO	non-governmental organisation
NLPU	National Livestock Project Unit (Nigeria)
NOAA	National Oceanic and Atmospheric Administration (USA)
OAU	Organisation of African Unity
ODI	Overseas Development Institute (UK)
OGAPROV	Office Gabonaise d'Amélioration et de Production de Viande
P	phosphorus
PANESA	Pasture Network for Eastern and Southern Africa
PCV	Packed red cell volume
PGRCE	Plant Genetic Resources Centre of Ethiopia
PPR	*Peste des petits ruminants*
SADCC	Southern African Development Coordination Conference
SDI	Selective dissemination of information
t	metric tonne
TCRV	tissue culture rinderpest vaccine
TLU	tropical livestock unit
TS	teff straw
TSP	triple superphosphate
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAM	vesicular arbuscular mycorrhizal fungi

Annexes

Staff List

(Supervisory and professional staff, at 1 May 1986)

DIRECTOR GENERAL'S OFFICE

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

RESEARCH DEPARTMENT

K J Peters, *Director of Research*
J Greiling, *Assistant to Director of Research*

Zonal Research Division

Highlands Programme

F M Anderson, *Agricultural Economist and Team Leader*
Abate Tedla, *Forage Agronomist*
Abiye Astatke, *Senior Technical Assistant*
E Akyeampong, *Forage Agronomist (Post-doctoral Associate)*
Getachew Assamenew, *Agricultural Economist*
S Jutzi, *Forage Agronomist*
Tadesse Tessema, *Debre Zeit Station Coordinator*
M Wagenaar-Brouer, *Human Nutritionist*
Woldeab Wolde Mariam, *Debre Berhan Station Coordinator*

Humid Zone Programme

L Reynolds, *Animal Scientist and Team Leader*
A Atta-Krah, *Agronomist*
P Francis, *Agro-Economist*

Subhumid Zone Programme

R von Kaufmann, *Agricultural Economist and Team Leader*
R Otsyina, *Forage Agronomist (Post-doctoral Associate)*
M A Mohamed-Saleem, *Forage Agronomist*
G Tarawali, *Forage Agronomist (Post-doctoral Associate)*

Arid and Semi-arid Zones Programme

K Diallo, *Animal Scientist and Team Leader*
P Bartholomew, *Forage Agronomist*
H Baur, *Agricultural Economist*
M I Cissé, *Ecologist*
S Cissé, *Sociologist*
L Diarra, *Ecologist*
M Dicko, *Animal Nutritionist (Niger)*
K Fofana, *Chief Accountant*
P Hiernaux, *Ecologist*
H Hulet, *Agronomist*
S Maiga, *Veterinarian*
S Soumare, *Sociologist*
A Tall, *Administrative Officer*
A Traoré, *Veterinarian*

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*
W Migongo-Bake, *Forage Agronomist (Post-doctoral Associate)*
M J Nicholson, *Animal Scientist*

Kenya 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 Financial Officer*
I ole Pasha, *Sociologist*
J M Rarieya, *Biological Data Assistant*

Animal Science Division

J C M Trail, *Deputy Director of Research (Animal Science)*

Animal Nutrition Section

D Little, *Head of Section*
Aklilu Askabe, *Farm and Grounds Manager*
M Nuwanyakpa, *Forage Agronomist (Post-doctoral Associate)*
J D Reed, *Animal Nutritionist*
Tekaligne Tadesse, *Analytical Chemist*
H Soller, *Animal Nutritionist (Post-doctoral Associate)*

Animal Reproduction and Health Section

O Kassali, *Head of Section*
G Cecchini, *Biochemist (Research Associate)*
M Mattoni, *Veterinarian (Research Associate)*
E Mukassa-Mugerwa, *Animal Scientist*
Tekleye Bekele, *Veterinarian*

Livestock Productivity and Trypanotolerance Group

J C M Trail, *Animal Geneticist and Head of Group*
M Alberro, *Animal Scientist and Team Leader (ITC, Gambia)*
K Agyemang, *Animal Scientist (ITC, Gambia)*
G D'Ieteren, *Veterinarian and Network Coordinator*
H Maehl, *Animal Production Specialist*
Woudyallew Mulatu, *Project Supervisor*

Small Ruminant and Camel Group

R T Wilson, *Animal Scientist and Head of Group*
D Bourzat, *Animal Scientist*
C N Karue, *Visiting Scientist*

Dairy Technology Group

F O'Mahony, *Dairy Technologist*

Plant Science Division

J Tothill, *Deputy Director of Research (Plant Science)*

Forage Legume Agronomy Group

J Tothill, *Head of Group*
J R Lazier, *Forage Agronomist*
A Russell-Smith, *Forage Agronomist*
J M Kahurananga, *Plant Ecologist*

Soil Science and Plant Nutrition Section

I Haque, *Soil Scientist*
Tekalign Mamo *Soil Scientist (Post-doctoral Associate*

Pastoral Ecology Section

N de Ridder, *Range Management Expert*
K T Wagenaar, *Animal Scientist*

Resource Survey Unit

J Meunier, *Pilot*
Tassew G Medhin, *Pilot*

Livestock Economics Division

S G Sandford, *Deputy Director of Research (Economics)*

Livestock Economics Unit

S G Sandford, *Head of Unit*
Addis Anteneh, *Economist*
S Debrah, *Economist (Post-doctoral Associate)*
J McIntire, *Economist*
G Rodriquez, *Economist*

Computer Unit

J Durkin, *Computer Manager*
E Kontrohr, *Scientific Programmer*
G Roscoe, *Administrative Programmer*
A R Sayers, *Biometrician*
E Richardson, *Biometrician*

TRAINING AND INFORMATION DEPARTMENT

R G Scholtens, *Director of Training and Information*
R A Stewart, *Deputy Director of Training and Information*

Training

L Padolina, *Administrative Assistant*
Werqu Mekasha, *Training Officer*

Information

Library and Documentation

Michael Hailu, *Head of Section*
Marcos Sahlu, *Head of Information Processing*
Azeb Abraham, *Librarian*

Publications Section

S D Chater, *Head of Section*
I Alipui, *Assistant Editor*
A Leymarie, *Editor/Translator*
Manyahlishal Kebede, *Production Manager*
P J H Neate, *Editor*
D Niang, *Revisor/Editor (French)*
R A Stewart, *Science Writer*

Audio-Visuals and Mapping Section

R A Stewart, *Head of Section*
Admassu Wondafrash, *Senior Draftsman*

OUTREACH DEPARTMENT

M Sall, *Director of Outreach*
G Gryseels, *Deputy Director of Outreach*
Amde Wondafrash, *National Liaison Officer*
Ephraim Bekele, *Liaison Service Officer*
Alemayehu W Giorgis, *Travel Officer*
Tafesse Akale, *Protocol Officer*

ADMINISTRATION

K F M Geerts, *Head of Administration*
A M Conti, *Personnel Officer*
Ahmed Osman, *Assistant Personnel Officer*
F Leone, *Maintenance Engineer*
Pietro Monaia, *Senior Maintenance Assistant*
Sahle Kebede, *Catering Officer*
Shiferaw Kebede, *Registry Supervisor*
Tekeste B Habtu, *Procurement Officer*
J A T Thersby, *Warden*

FINANCE

A H Thabit, *Financial Controller*
Belayhun Wondimu, *Chief Accountant*
Emmanuel Tesfamariam, *Budget Officer/Internal Auditor*
Negussie Abraham, *Disbursement and Collection Supervisor*

Publications

Annual report

ILCA Annual Report 1984.

Research report

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15th International Grassland Congress, Kyoto, Japan, August 1985.

18th Meeting of the OAU/ISCTRC, Harare, Zimbabwe, March 1985.

22nd Annual Conference of the Nigerian Veterinary Medical Association, Vom, Nigeria, November 1985.

23rd Trypanotolerance Seminar, Salford, UK, September 1985.

25th Meeting of the Nigerian Livestock Development Committee, Port Harcourt, Nigeria, March 1985.

36th Annual Meeting of the European Association for Animal Production, Greece, September–October 1985.

Financial summary

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
BALANCE SHEET at December 31, 1985

(US$ '000)

ASSETS

Current assets	**1985**	**1984**
Cash	7 237	1 762
Receivable from - donors	938	995
- employees	34	56
- others	501	610
Inventories	540	380
Deposits and prepayments	117	102
Total current assets	9 367	3 905
Fixed assets		
Buildings	8 820	8 055
Research and laboratory equipment	1 972	1 635
Computer	978	695
Furnishings and office equipment	2 345	2 125
Vehicles and aircrafts	1 831	1 682
Other	127	116
Total fixed assets	16 073	14 308
Total assets	25 440	18 213

LIABILITIES AND FUND BALANCES

Current liabilities		
Bank overdraft	–	2
Accounts payable employees	362	177
Other payables and accruals	3 702	2 686
Contribution received in advance	4 040	142
Total current liabilities	8 104	3 007
Fund balances		
Invested in fixed assets	16 073	14 308
Working capital	1 063	487
Special projects	–	(151)
Capital development fund	200	562
Total fund balances	17 336	15 206
Total liabilities and fund balances	25 440	18 213

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
STATEMENT OF REVENUE, EXPENDITURE AND FUND BALANCES
for the year ended December 31, 1985

(US$ '000)

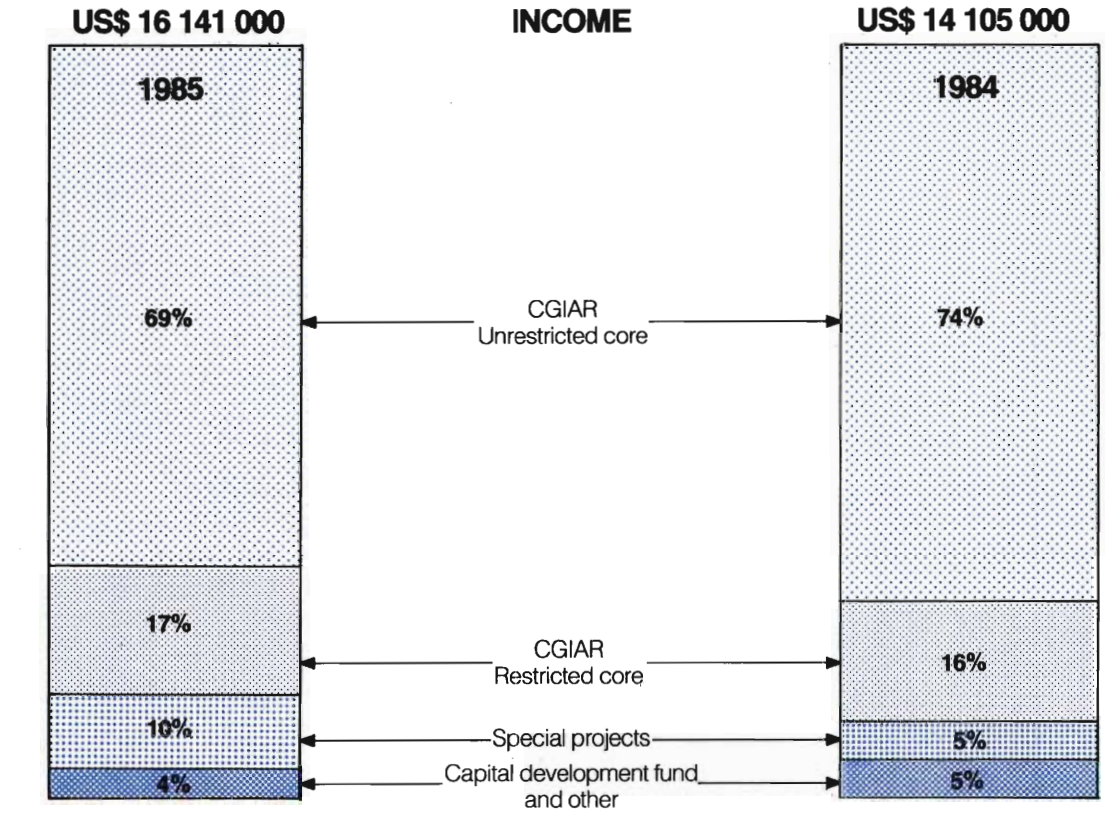
	1985	1984
Revenue		
CGIAR contributions	13 803	12 641
Special project grants	1 675	775
Capital development fund	470	562
Earned income	193	127
Total revenue	16 141	14 105
Operating expenditure		
Research	8 362	7 472
Information & training	2 203	2 006
General administration	411	592
HQ operations and maintenance	1 138	1 171
Board and management	506	569
Total operating expenditure	12 620	11 810
Capital expenditure	1 765	1 803
Special projects	1 391	1 178
Total expenditure	15 776	14 791
Excess/(deficit) of revenue over expenditure	365	(686)
FUND BALANCES		
Opening balances		
Core	487	1 332
Special projects	(151)	252
Capital development fund	562	–
Total opening balances	898	1 584
Excess/(deficit) of revenue over expenditure	365	(686)
Closing balances		
Working capital	1 063	487
Special projects	–	(151)
Capital development fund	200	562
Total closing balances	1 263	898

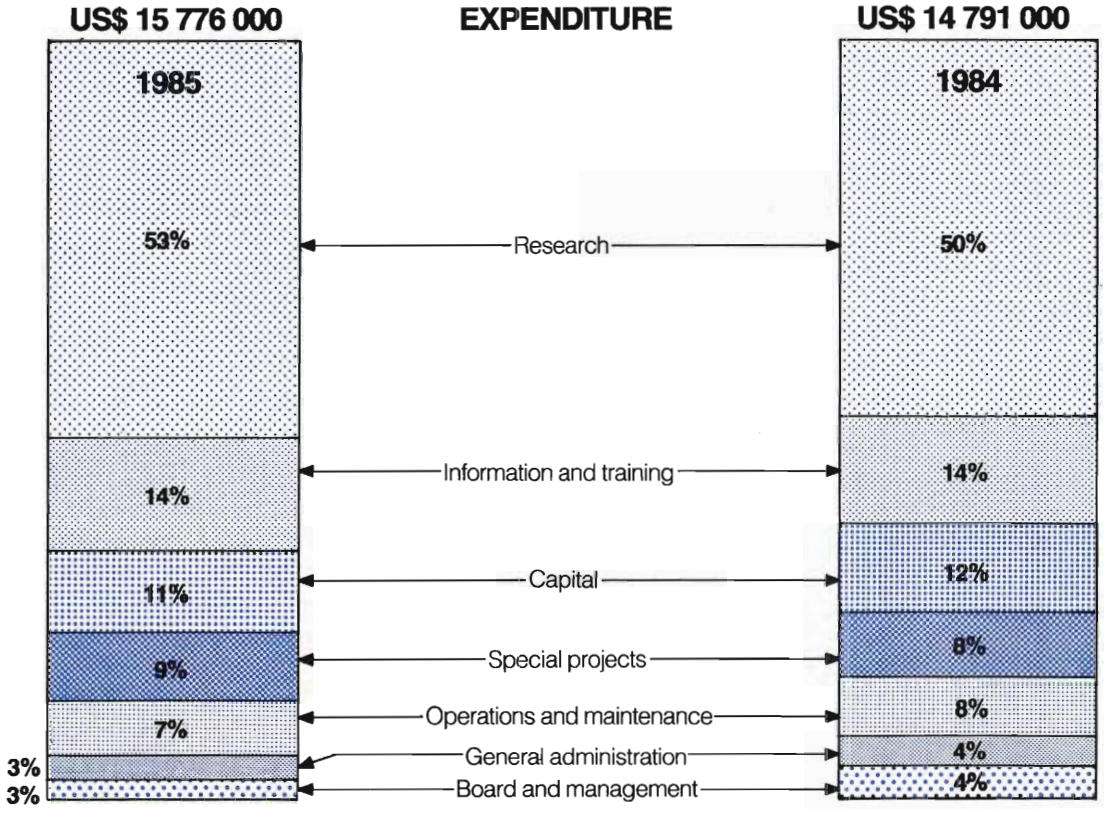
INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
SCHEDULE OF CGIAR CONTRIBUTIONS AND SPECIAL PROJECT GRANTS
for the year ended December 31, 1985

(US$ '000)

CGIAR Contributions	1985	1984
Australia	281	279
Belgium	481	354
Canada	549	495
China	33	33
Denmark	184	224
Finland	250	250
France	117	95
Germany - Federal Republic	626	678
India	–	50
International Development Association (World Bank)	3 450	2 680
International Development Research Centre (IDRC)	143	156
International Fund for Agricultural Development (IFAD)	500	500
Ireland	172	178
Italy	1 681	1 205
Netherlands	244	253
Nigeria	167	260
Norway	283	248
Sweden	251	184
Switzerland	612	661
United Kingdom	302	298
United States of America (USAID)	3 175	3 200
Stabilization Fund	302	360
Total CGIAR contributions	13 803	12 641
Special project grants		
Australia (ACIAR)	7	–
Canada	25	–
CARE – Ethiopia	40	–
Deutsche Gesellschaft Für Technische Zusammenarbeit (GTZ)	130	254
Egyptian Technical Cooperation Fund for Africa	17	17
Ethiopia	–	134
European Economic Commission (EEC)	423	–
Ford Foundation	56	107
International Board for Plant Genetic Resources (IBPGR)	47	11
International Development Research Centre (IDRC)	186	61
National Animal Production Research Institute (NAPRI)	–	13
Nigeria (FLD)	304	30
Tufts University/USAID	256	–
United Nations Environmental Programme (UNEP)	15	–
United States of America (USAID)	91	148
World Vision	78	–
Total special project grants	1 675	775

Source and application of funds, 1985 and 1984





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