ILCA 1993/94

Annual Report and Programme Highlights

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
ADDIS ABABA, ETHIOPIA

ILCA 1993/94:
Annual Report and Programme Highlights

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Contents

A new era for livestock research in the CGIAR

This is the last ILCA Annual Report and Programme Highlights. On 1 January 1995 a new livestock research institute came into being, bringing together elements of the work of ILCA and the International Laboratory for Research on Animal Diseases (ILRAD) with a new global mandate. The establishment of ILRI — the International Livestock Research Institute — was the culmination of a process that was first envisioned by the people who set up ILCA and ILRAD in the early 1970s.

When ILCA and ILRAD were established, the Consultative Group on International Agricultural Research (CGIAR) considered it likely that the two centres would eventually come together as a unified livestock research entity. This possibility again emerged with the external reviews of the two centres in 1991/92, when the review teams were asked to consider whether the plan to amalgamate the two centres should be revived.

At the same time that ILCA and ILRAD were developing their medium-term plans for 1994–98, the Technical Advisory Committee (TAC) of the CGIAR was developing and refining its proposals for priorities and strategies for livestock research in the CGIAR.

The key issue raised by TAC was that of how the CGIAR's livestock research could best address the needs outside sub-Saharan Africa. TAC's analyses had documented the important role of livestock in mixed crop–livestock systems in all the major regions of the developing world, and their considerable economic contribution in these regions. Further analyses indicated that the vast majority of the CGIAR's expenditure on livestock research was in sub-Saharan Africa, with lesser amounts in the Latin America and Caribbean (LAC) and West Asia and North Africa (WANA) regions, and virtually none in Asia, despite the importance of livestock in that region.

In May 1993 the CGIAR decided to develop a unified strategy for livestock research in the CGIAR system. It established a "Steering Committee on Livestock Research in the CGIAR" to "identify priority activities for international livestock research, which would be managed through a single institution and be constrained by the current proportion of CGIAR resources allocated to livestock."

The Steering Committee presented its proposals for discussion at International Centers Week 1993. The central element of its proposal was the establishment of a single livestock research institute which would bring together components of the programmes of ILCA and ILRAD. This report was endorsed by the ILCA and ILRAD Boards of Trustees in October 1993, before being presented at International Centers Week in Washington, DC, later that month. The report was subsequently approved by the CGIAR, and steps were taken to put it into effect.

Moves towards a new institute

Starting in December 1993 groups of scientists and research managers appointed by the Rockefeller Foundation, acting on behalf of the CGIAR, developed a global strategy for livestock research and research-related activities in the CGIAR and drafted an outline of the programme of research, training

and information activities for the new institute. This process culminated in the signing, in Berne, Switzerland, on 21 September 1994, of an international agreement and constitution officially creating ILRI.

The nucleus of the programme of ILRI is based on the animal health and production programmes of ILRAD and ILCA. Key elements of the programme will include strategic research on animal health, genetics, nutrition, physiology and reproduction, as well as research on livestock production systems, natural resource management and socio-economic and policy analysis. As with ILCA's programme, ILRI will focus, at least initially, on cattle, sheep and goats, although the feed requirements of pigs and poultry in and near urban centres may also be addressed in the future.

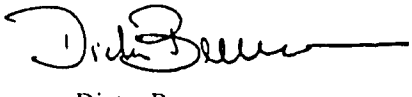
The major focus of ILRI's research will be on the needs of mixed crop–livestock production systems, particularly those in humid, subhumid and semi-arid regions of developing countries. The major change in research efforts will be away from the sub-Saharan focus of ILCA's and ILRAD's work and towards a global agenda. A series of meetings are being held in early 1995 to develop research agenda for Asia and the Latin America and Caribbean region, with a meeting for the West Asia and North Africa region to come later.

As with ILCA's work in the past, partnerships — with national agricultural research systems, with other CGIAR centres, with other national, international and regional bodies, and with research institutes in industrialised countries — will be a key to developing and achieving ILRI's programme of research and research-related activities. Partnerships will be even more crucial to the success of ILRI than they were to ILCA, given the new institute's expanded mandate.

Benefits for livestock producers world-wide

Livestock are part of smallholder agricultural systems world-wide. Until 1994, the CGIAR's commitment to livestock research was limited to the two specialised institutes in sub-Saharan Africa, with lesser amounts of work in Latin America and West Asia and North Africa. The recognition by TAC and the CGIAR of the world-wide importance of livestock has opened the way for the development of a global strategy for livestock research in the CGIAR.

From being largely isolated in its conviction that livestock are the key to more productive, sustainable farming systems, ILCA has seen its vision widely accepted in the CGIAR system. The challenges facing ILRI are enormous, but the potential benefits for smallholder farmers are equally large.



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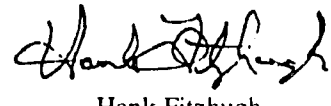

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Mixed crop–livestock systems

Traditional agricultural systems have supported rural and urban populations for millennia. But as the human population has increased, and the proportion living in urban areas has grown, farmers have been forced to intensify their production practices. Fallowing, a mainstay of traditional farming systems, has been reduced or eliminated as farmers have striven to produce enough food for themselves and their families. Without fallow periods, or with fallows that are too short, the soil is rapidly drained of its nutrients and its structure is destroyed.

Resource-poor farmers tend to harvest all of their crop materials, including the residues. Thus little if anything is returned to the soil. Since the farmers use little or no fertiliser, there is a drain on soil nutrients, or a negative nutrient balance.

ILCA has sought ways of meeting the seemingly conflicting demands of increased agricultural productivity and greater environmental protection through mixed crop–livestock systems. A key element of this is better management of animals to improve nutrient cycling, breaking the trend of taking nutrients out of the system and introducing mechanisms to replace nutrients. These mechanisms include growing leguminous plants as part of the cropping system, and making fuller use of animal manure and urine to return nutrients to the soil.

Collaboration with ICRISAT

ILCA has been collaborating with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in two widely differing environments — semi-arid West Africa and the African highlands. In both zones the work has focused on improving the role of livestock in the farming systems, through improved nutrient cycling in West Africa, and through animal traction in the highlands.

Semi-arid West Africa

ILCA's collaboration with ICRISAT in West Africa focuses primarily on improving crop–livestock integration in the millet-based cropping system of the semi-arid zone. Studies in 1993–94 included:

- investigating the feeding value of crop residues
- identifying and overcoming nutritional constraints
- optimising utilisation of natural feed resources
- examining the effects of grazing on millet yields, and
- a series of investigations into nutrient cycling.

Nutrient cycling

Some of the results of the studies on nutrient cycling were reported in *ILCA 1992: Annual Report and Programme Highlights*. Results in 1993–94 confirmed those reported, particularly the benefit of corralling animals on crop land rather than spreading manure by hand.

In the fourth year of a six-year trial to investigate the effects of corralling animals on crop land versus spreading the

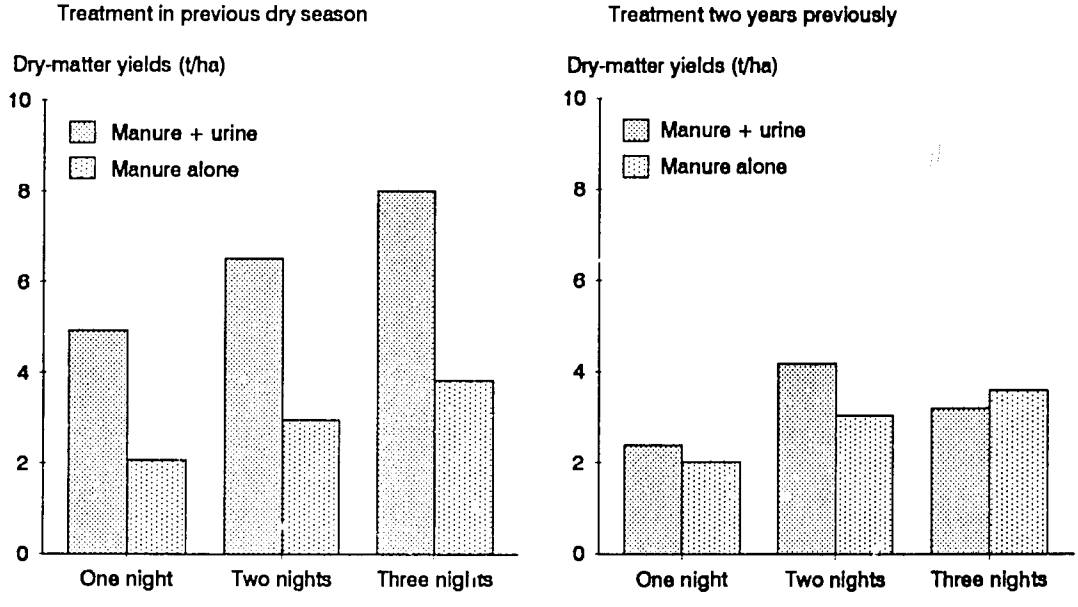
A goat browsing a leguminous shrub established in a windbreak in Niger. Such shrubs and small trees can protect the soil from wind erosion during the dry season as well as providing high-quality supplementary feed, particularly for goats.

equivalent amount of manure by hand, plots on which cattle were corralled during each of the past four dry seasons yielded more than twice as much above-ground dry matter as those on which manure had been spread by hand. This yield differential is due to the urine deposited by the animals when corralled on the land; when manure is spread by hand, no urine is included. This yield benefit was apparent even on plots that were manured two years previously.

In 1993, animals were corralled or manure was spread on plots that had been cropped for the previous three years but that had not received any manure treatments. Yields from plots on which cattle were corralled for one, two or three nights in the 1993 dry season (4.20, 6.09 and 5.63 t/ha, respectively) were similar to those from plots that had been manured in each of the previous three dry seasons.

These results again demonstrate the benefit of corralling animals on the crop land rather than spreading manure by hand, and indicate that manuring every three years is sufficient to maintain crop yields.

Corralling cattle on crop land dramatically increases yields in the following season. The effect of manuring is still apparent even in the second consecutive cropping season after manuring.



Untreated control plots gave an average yield of 0.96 t/ha.

Improving animal feeding

Millet stover is the main feed for ruminants during the dry season in the millet-based cropping system in semi-arid West Africa. ILCA and ICRISAT have been collaborating to determine the nutritive value of a range of millet germplasm. In 1993, the work investigated the feeding value of millet accessions with two "traits" — brown mid-rib (*bmr*) and trichomeless (*tr*).

At grain harvest, leaves and stems from 120 progenies of either *bmr* or normal millet and 20 progenies of either *tr* or normal millet were collected. The samples were analysed for ashless neutral-detergent fibre (NDF), acid-detergent fibre (ADF), lignin and organic-matter content, and *in sacco* OM disappearance.

Results of the analyses indicate that leaves and stems from millet with the *bmr* and *tr* traits are better livestock feed than those from normal millet.

Accessions with the *bmr* trait contained less lignin and were more digestible than non-*bmr* accessions. However, *bmr* accessions produced less stover than non-*bmr* accessions (174.4 vs 187.3 g DM/plant). Thus, while the feeding value of stover from *bmr* accessions was similar to that of forage millet accessions, this is achieved at the expense of stover quantity.

In contrast, accessions with the *tr* trait produced more leaf and stem than normal accessions (123.0 vs 95.3 g DM/plant and 191.7 vs 152.4 g DM/plant, respectively). Both the leaves and the stems of *tr* accessions were more digestible than those from normal accessions (leaves, 670 vs 645 g/kg; stems, 521 vs 441 g/kg). This increased digestibility was related, in part, to the higher organic-matter content of the leaves of *tr* accessions and the lower lignin content of the stems of *tr* accessions relative to the non-*tr* accessions.

Thus, millet accessions with the *tr* trait could provide more and better quality feed for livestock. Further investigations are needed to determine the grain yield and agronomic qualities of *tr* and *bmr* accessions, with a view to developing millet cultivars that give high yields of grain together with high-quality stover for animal feeding.

East African highlands

ILCA and ICRISAT have a long history of collaboration in work on Vertisols in the Ethiopian highlands. In 1994, this

The benefits of growing a crop on broadbeds (background) are obvious. But farmers' actions affect their neighbours, and a new project building on the Joint Vertisols Project is examining the effects of the broadbed-and-furrow technology within the context of a whole catchment area.

work entered a new phase, with the development of a project on watershed management.

The work of the Joint Vertisols Project (JVP), involving ICRISAT, ILCA, the Ethiopian Institute of Agricultural Research (IAR) and Alemaya University of Agriculture, Ethiopia, demonstrated that better management of Vertisols could substantially increase the productivity of these soils (see *ILCA 1992: Annual Report and Programme Highlights*). But farmers who used the technology and techniques developed by the JVP ran into difficulties when their neighbours were not also using them. In particular, better drainage from using broadbeds and furrows resulted in increased waterlogging on fields below.

In 1994, the JVP changed its focus from plot or farm-level studies to encompass the whole of a catchment area. The project identified a 350-ha catchment area near Ginchi, west of Addis Ababa in the Ethiopian highlands. Roughly half of the catchment area consists of Vertisols.

The aim of the research within this catchment area is to develop integrated land-management practices to boost the productivity of all farms within the catchment, not just those on Vertisols. Research is addressing three major areas:

- Resource management: including land preparation and tillage, cropping schemes, water-use efficiency and discharge, feed improvement and use, off-farm grazing pressure and vegetative cover, and stocking rate and livestock species composition in relation to land and water quality
- Implementation mechanisms: including research to improve technology transfer through public and private agencies
- Institutional arrangements: including building community consensus towards collective responsibility for water management and soil conservation.

The main focus of this research is on flat or gently sloping land, where the dangers of erosion are least. Boosting the productivity of this land will reduce the pressure on farmers to crop steeper slopes, thereby reducing the danger of land degradation. Further plans are under way for research on alternative, sustainable uses for steeper slopes.

Institutional collaboration promotes whole-system research

Collaboration between institutes is vital to research on mixed crop–livestock systems, to avoid waste of resources and duplication of efforts and to make sure that all the concerns of the farmers are addressed. ILCA's experience in collaborating with other centres in the CGIAR system, particularly ICRISAT and the International Institute of Tropical Agriculture (IITA), has shown these benefits and provides a model to build on for the future.

Market-oriented smallholder dairying

The highlands of Ethiopia are generally fertile and well watered, making them ideal for livestock production. Several organisations, including the World Bank, the Ethiopian Ministry of Agriculture (MoA) and the Finnish international development agency, Finnida, have over a number of years promoted the use of crossbred dairy cows to increase farm productivity and income in the highlands.

Studies by ILCA in the early 1980s showed that keeping crossbred dairy cows instead of the smaller local zebu cattle did increase farm productivity and income, but it also increased women's workloads. The bigger crossbred cows needed more feed than the smaller local cows, and much of this feed was grown or gathered by women. Later studies by Finnida showed that men's workloads also increased, by even more than did the women's.

There were also indications that the change from keeping local cows to keeping crossbred cows affected income distribution within households. In households with local cows, women churned most of the surplus milk into butter, which they then sold. The women, who controlled the income from butter sales, spent most of their income on food for the household. Households with crossbred cows tended to sell more milk fresh, rather than churning it to butter, and it was mostly men who sold the fresh milk and controlled the income from it.

Since 1991, ILCA has been investigating the effects of keeping crossbred cows on the availability of food in farm households in the Selale area of Ethiopia, about 150 km north of Addis Ababa. Between 1988 and 1991 the MoA introduced crossbred cows and complementary management, feed production and feeding strategies in the Selale area, in a project supported by Finnida. ILCA was also involved in the project, providing research support. ILCA's study examined food availability in 60 households in the Selale area, 30 with only local cattle (LBC) and 30 with crossbred cows (CBC).

Taking milk to market in Selale, Ethiopian highlands. Recent studies show that food availability is much greater in households with crossbred cows than in those with only local cattle.

The results showed dramatically greater food availability in households with crossbred cows than in those with only local cattle. Translated into monetary terms, food availability per person in CBC households was almost 68% greater at Birr 886, compared with Birr 529 in LBC households. Although CBC households had more milk and dairy products available to them, the largest difference between the households was in availability of cereals and other crops. And although CBC households were "wealthier" than LBC households, they actually spent less on non-farm goods and services than did LBC households. Thus, even if the income from fresh milk sales was controlled by men, apparently it was spent on increasing the availability of food for the household.

Somewhat surprisingly in light of earlier reports, households with crossbred cows also reported having more than twice as many "leisure days" as households with only local cattle (35 vs 17). A breakdown of the labour used in the households showed that the increase in leisure days was attributable to a reduction in the labour input of children in households with crossbred cows. This suggests that children

Keeping crossbred cows dramatically increases annual food availability (expressed in Ethiopian Birr) and appears to reduce workloads, particularly of children.

	Annual availability of consumption items (Birr)	
	LBC owners	CBC owners
Major staple crops (barley, teff, wheat)	258	505
Other crops	146	244
Non-dairy livestock and livestock products	63	43
Milk	15	20
Butter	35	57
Cheese	12	17
Total food availability	529	886
Non-farm goods and services	160	143
Leisure days	17	35

in households with crossbred cows may be more readily able to go to school, but this has yet to be confirmed.

These findings are based on information gathered through a food production and expenditure survey. Food availability was taken as the net of production after sales, barter, gifts etc plus expenditure on food.

These preliminary findings of the benefits of keeping crossbred cows leave a number of questions unanswered. These include the food intake of individual household members in CBC and LBC households and the nutritional and health consequences; the effects of the new technologies on off-farm income-generating activities, and on the income and household- and child-care activities of women; and what happens to the increased leisure time of children. These and other questions are being addressed in a collaborative project involving the new International Livestock Research Institute (ILRI), the Ethiopian Nutrition Institute, the Ethiopian Institute of Agricultural Research and the International Food Policy Research Institute.

Standardising dairy research

Dairying is already an important source of income to many smallholders in sub-Saharan Africa, particularly those close to

urban centres. Urban centres are growing rapidly, from both population increase and migration of people from rural to urban areas. This trend is increasing demand for food in urban centres, and changing food demand patterns; urban populations tend to consume more foods of animal origin than do rural populations. This demand, coupled with falling imports, is encouraging the development of peri-urban dairying, mostly among smallholders.

Smallholder milk producers, however, face numerous problems, from identifying the best types of animal to use, through how best to manage them, to producing enough feed to allow them to achieve their potential milk production. Approaches to solving these problems are numerous and closely linked to the production systems used.

Developing methodologies for characterising dairy systems

In 1992 and 1993, ILCA and its partners developed a conceptual framework for research in smallholder dairying that provides a common basis for characterising and understanding smallholder dairy systems and identifying researchable and development issues. The framework has four components:

- general characterisation of dairy systems
- characterisation of dairy sub-systems
- identifying solutions to enhance the development of specific dairy systems and
- synthesis of information across sites.

During 1993 and 1994, work on developing methodologies focused on those needed to characterise specific dairy systems. Priority was given to this because of the needs of ILCA's partners in the Cattle Research Network.

The conceptual framework formulated a total of 46 hypotheses relating to factors influencing development of market-oriented smallholder dairying and factors affecting farm productivity. In characterising dairy systems, 33 of these need to be addressed, covering such aspects as:

- demand/consumption
- supply/processing/markets
- economics of production/intensification
- sociology
- policy
- feed resources and utilisation strategies

Smallholder dairy systems take many forms, and studies examining them are equally diverse. The research framework being developed by ILCA and its partners aims at standardising the approach used to study dairy systems, permitting comparisons between studies.

- breeds and breeding strategies
- disease and reproduction.

Identifying data needs and collection methodology

Working from these hypotheses, ILCA scientists determined the information needed to address the hypotheses; identified the possible sources of this information; determined how the information could be collected from each source; developed the field instruments, including questionnaires and a sampling method; and elaborated the analytical method to be used.

In addition to gathering data to test the hypotheses given above, it was decided to collect data covering two other aspects: key criteria for the functioning of the system (functional parameters or practices), and parameters needed to judge the efficiency of the production system (indicator parameters).

Together, these sets of data are considered to be the minimum data set needed to characterise a market-oriented

dairy production system. Most of the data for this minimum data set is to be collected at the individual farmer level.

Testing the methodology

In 1993, the methodology was tested in the Addis Ababa milk shed — the area supplying milk to the Addis Ababa market. A multi-stage sampling procedure was used to select a sample of 147 farmers in the area; these farmers were then surveyed using a questionnaire covering 45 measures of farm resources and parameters reflecting farm functioning. The data were analysed using correspondence and cluster methods. These analyses identified seven categories of market-oriented smallholder dairy farmer in the milk shed. The key features of these are outlined below.

Traditional crop–livestock farms in rural areas: The survey identified a sample of 10 traditional crop–livestock farms in rural areas. These are small farms with an average of four cows. The farmers use little or no specialised inputs (improved breeds, feed, housing, veterinary care). They sell fresh milk to the Dairy Development Enterprise (DDE) and butter to local consumers. Farms in this category were between 25 and 130 km from Addis Ababa (average 68 km) in the high-altitude part of the milk shed.

Crop–livestock farms with an intensified dairy element in remote rural areas: The sample of 30 farms that fell into this category were similar to traditional crop–livestock farms except for their intensified dairy operation. Examples of these

A smallholder dairy farm in the Ethiopian highlands. The framework has been tested in the Addis Ababa milk catchment area to assess its efficacy.

farms are those in the Selale area, 100 km from Addis Ababa. Intensification in dairying is largely linked to use of crossbred (European dairy breeds x local breeds) cows, artificial insemination, supplementary feed, bucket-feeding of calves and early weaning. Land holdings are half the size of the traditional crop–livestock farms, but cattle and cow numbers are the same as the larger traditional farms and farm milk production is 15% greater.

Crop–livestock farms with intensive cropping in the Addis Ababa dairy belt: The 23 sample farmers who fall into this category have farms and herds that are, on average, 25% larger than those of traditional crop–livestock farmers. Although they use few specialised inputs in their dairy enterprises, they use more supplementary feed than other farmers. They sell fresh milk to the DDE, and rarely process milk themselves. This specialisation in selling fresh milk is linked to their proximity to Addis Ababa: all of these farms were between 25 and 60 km from the city. A major feature of this type of farm is its more intensive cropping system, in particular frequent use of fertiliser. All of the farms in this category are less than 2600 m above sea level.

Specialised dairy farms: The survey sample covered nine specialised dairy farms in the Addis Ababa milk shed. All were located within the dairy belt, between 15 and 60 km from the city. The farms are large, averaging 8.9 hectares and 17 cows, and commonly use inputs such as crossbred animals, artificial insemination, fodder crops, a whole range of supplementary feeds and housing for the animals. They sell large quantities of fresh milk — over 30 litres a day from each farm — primarily to the local market or to DDE. The owners of most of these farms have off-farm activities, which often generate more income than the farm.

Peri-urban producers in secondary towns of the dairy belt: This category of sampled producers comprises 20 farms in and around towns 25 to 50 km from Addis Ababa. The main inputs to the dairy system are improved animals (43.8% of cattle were improved genotypes, although farmers do not use artificial insemination) and improved feeding (various by-products to supplement grazing and stall-fed roughage).

Intra-urban farms in Addis Ababa: The survey identified 24 dairy farms in Addis Ababa itself. These farms are specialised production units employing intensive production

practices based on zero grazing crossbred cows. These farms have almost no access to grazing, and feeding is based on purchased hay and concentrates. The level of exotic blood in the herd (approximately 7/8) was among the highest found in the sample. Annual milk production per cow is high at an average of 3000–3600 kg. Most of the milk produced by these farms is sold directly to the local market.

Intra-urban farms in secondary towns: A sample of 31 intra-urban farms were also found in towns around Addis Ababa. Farmers in these towns have more access to grazing than do those in Addis Ababa; animals were thus less dependent on stall-feeding than were those on farms in the city. The level of exotic blood is high, but the herd is the smallest of all the farm types identified at an average of only two cows per farm. These farmers both sell milk fresh to local consumers or to DDE or process it and sell the processed products. Most of these farmers have an off-farm activity; for two-thirds of the farmers this provided more income than did the dairy unit.

Does the information gathered address all the hypotheses?

This first part of the analysis focused on describing and classifying the current dairy production systems. But this is only part of the information that can be gained from the methodology being used. The same data set can be used to test the hypotheses concerning the dairy system, and identify the hierarchy of constraints affecting different types of system.

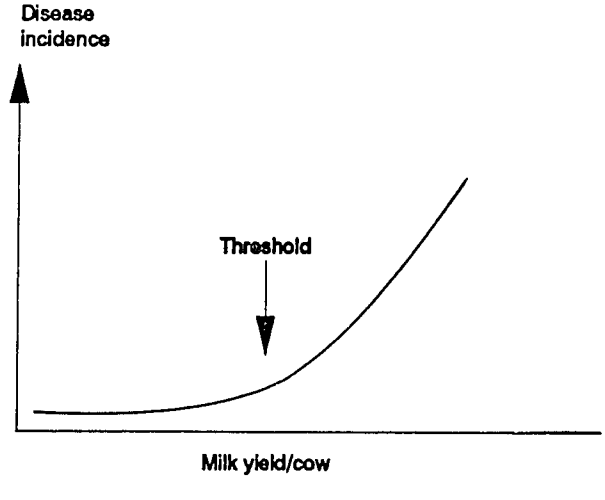
Having used the questionnaire for the first time, ILCA's scientists addressed the question of whether the information it provided was sufficient to address all the hypotheses to be tested in this research phase. Some shortcomings were found in the data set, and the questionnaire is being revised, both by ILCA scientists and their colleagues in national agricultural research systems (NARS) to better fit local conditions.

In addition to testing the methodology in the Addis Ababa milk shed, the Cattle Research Network (CARNET) introduced the methodology to the four NARS collaborating in a peri-urban dairy project in West Africa. This project is funded by the International Development Research Centre (IDRC), Canada. Scientists working in the project are using the methodology to characterise some peri-urban production

and consumption sub-systems in their countries. A workshop will be held in mid-1995 at which the NARS scientists will present their results, identify constraints to peri-urban dairying in their countries, and suggest areas needing further research attention.

Comparisons between locations

A major advantage of adopting a standardised methodology for studying dairy systems in different places is that the results will be readily comparable between sites. As a base of data is developed from several studies, the inferences drawn from the results can be extrapolated to cover situations that have not been studied in detail. Further, if patterns of results are similar between similar types of system in different locations, these patterns can be used to rapidly assess the likely hierarchy of constraints affecting systems that are to be studied. For example, if the results from several sites indicate that, in a particular type of production system, the incidence of diseases of intensification increases rapidly when milk yield reaches a certain "threshold", this would allow researchers to use milk yield as an indicator of the likely importance of these diseases as a constraint to production.



If similar patterns emerge across several locations and systems, these can be used to rapidly assess research needs in new locations and systems. For example, if diseases of intensification are found to be important only above a certain threshold milk-yield level, a rapid survey of milk yield would indicate whether such diseases are likely to be an area requiring research attention.

Developing the methodology

Most of the early work focused on the production component of the dairy system, but in 1994 efforts were directed to developing the methodology for use in studying the consumption component. This resulted in the publication of a working document giving details of the approach and its application.

By providing a comprehensive framework for studying all aspects of market-oriented smallholder dairying, this work will help strengthen national research efforts in this field and promote sustainable increases in milk production in sub-Saharan Africa.

Conservation of biodiversity

Refer to "conserving biodiversity" and most people think of storing seeds in gene banks. But one of the most effective ways of ensuring the future survival of forage genetic resources is to make sure that farmers use indigenous forages in appropriate production systems. Much of ILCA's forage research aims at identifying germplasm that matches farmers' needs in Africa's diverse environments. Over the years, this work has identified well-adapted accessions of different plant species that are useful to farmers. But if those farmers cannot obtain seed of these accessions, they cannot plant them.

ILCA's Forage Genetic Resources Section routinely provides small samples of seeds to researchers wishing to test the material held in the gene bank. However, it cannot — nor should it attempt to — supply the amounts of seed needed if farmers are going to grow an accession. Producing the amounts of seed needed for widespread adoption is dependent upon specialised seed production, either by national programmes or by commercial producers. While several African countries have effective seed production organisations, these work only on commercial crops, such as cereals. There is little or no forage seed production activity in the continent. If the forage development work of ILCA was to see wider application, action was needed to remedy this situation.

ILCA established a Herbage Seed Unit in 1989, with funding from the Swiss Development Corporation, specifically to try to improve smallholder forage seed production in sub-Saharan Africa. At a planning workshop held in 1989, representatives from national programmes insisted that information and training were by far the highest priorities for the new Unit, not research.

Training — key to developing national capacities

Training began in 1990 with one full seed-production course, which covered field multiplication through to distribution, and

Training has been a cornerstone of the Herbage Seed Unit's activities since its establishment in 1989.

one for research scientists to teach them to determine seed-production potential of new accessions. ILCA subsequently held collaborative courses with the International Center for Tropical Agriculture (CIAT) in 1990 and the International Maize and Wheat Improvement Center (CIMMYT) in 1991/92. Collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA), Syria, began in 1992 with a course in Ethiopia, followed by courses in Sudan and Ethiopia in 1993.

A forage seed production training manual, focusing on techniques for smallholder farmers, was developed in collaboration with ILCA's Training Materials and Methods Section and used during the 1993 course in Ethiopia. Following comments from trainees and teachers, the manual was revised and finalised in 1994. The Unit also developed several audio-visual training modules in collaboration with ICARDA.

Seed multiplication — foundation for national programmes

The Unit began multiplying seeds of promising accessions in 1989. It established seed production plots at ILCA's station at Debre Zeit, Ethiopia, on a 1.5 ha irrigated site. Seed from these plots was to provide basic seed to establish seed production in national programmes. ILCA's programme at Kaduna, Nigeria,

also produced limited quantities of seed for national agricultural research systems in West Africa.

Building on this base, ILCA collaborated in establishing seed production in Zambia in 1990 and in Cameroon in 1992. By 1993, the Zambian site was producing eight tonnes of seed of 10 promising forage species.

In 1993, the Unit planted a further two hectares at Debre Zeit to accommodate 24 accessions of medics, clovers, oats, vetch and lupins adapted to the cool tropics and seven accessions of fodder trees. In 1993 alone, the Unit distributed 265 samples of seeds in response to 44 requests from national programmes to establish seed production activities in 16 African countries.

In 1994, the Unit increased the area planted to seed crops by a further hectare, the additional land being allocated to oats and vetch. This was in support of a research project being conducted in the Holetta area of Ethiopia by the Institute of Agricultural Research and ILCA. This project is studying the use of crossbred dairy cows as draft animals and involves on-farm production of feed based on oat/vetch mixtures.

Germplasm health

Both the gene bank and the Seed Unit distribute seed and other plant materials for planting elsewhere, but this carries the risk of spreading pests and diseases. Starting in 1993, with funding from Germany, ILCA began developing its ability to screen germplasm for diseases and to eliminate those diseases found. This work is carried out in collaboration with three other international centres — CIAT, Colombia, the International Institute of Tropical Agriculture (IITA), Nigeria, and the International Plant Genetic Resources Institute (IPGRI), Italy.

Plants that are propagated from vegetative cuttings, such as Napier grass (*Pennisetum purpureum*), pose a particular problem, in that they are even more prone to carrying pests and diseases than are seeds. To overcome this, the Forage Genetic Resources Unit conducted research on *in vitro* culture of these materials to provide germplasm free from fungi and bacteria. The section developed a technique for culturing young nodal cuttings using axillary buds excised from mature plants. Adding fungicides and antibiotics to the plant growth medium controlled fungal and bacterial contamination.

An IPGRI staff member provides training in disease screening at ILCA's headquarters facility in Addis Ababa, Ethiopia.

In 1993, the Centre built an aphid-free screen house to use in the virus screening and elimination programme and began testing the Napier grass collection for virus infection.

Other areas of research

The Seed Unit carried out research into a number of areas relating to seed production, including studies of seed production potential of various legumes and grasses and post-harvest and processing technology. Results from these provide seed producers with information needed to plan their operations and to avoid losses of the seed they produce.

Looking to the future

Despite the efforts of the Herbage Seed Unit over the past five years, more still remains to be done to increase forage seed production in sub-Saharan Africa. In 1994 ILCA and ICAR-

DA held a research planning workshop to develop work plans for the next five years. Recommendations arising from the workshop indicate the need to direct efforts along three lines: developing and strengthening regional and national seed production; training; and technical support.

Increasing forage seed production will give smallholder farmers the opportunity to adopt improved forages in their efforts to increase the productivity of their mixed crop–livestock farms.

ILCA's biodiversity work unique in the CGIAR

ILCA is unique among the CGIAR centres in that it has programmes on conserving both plant and animal genetic resources. It is a key partner in the global livestock genetic resources initiative led by the Food and Agriculture Organization of the United Nations (FAO) and in the CGIAR's Systemwide Genetic Resources Programme.

Some of ILCA's earlier work on characterising and conserving livestock genetic resources was reported in *ILCA 1992: Annual Report and Programme Highlights.* In 1993/94 there was a considerable expansion of these activities. Key among these activities were:

- the development of the Domestic Animal Genetic Resources Information Database (DAGRID) to document animal genetic resources

Pilot projects in Ghana, Nigeria and Kenya are field-testing methodologies for collecting breed characterisation data on farms.

- research to quantify the genetic diversity between and within domestic animal species, including the genetic profile of different breeds and strains and their micro-evolutionary relationships, and
- pilot projects in Ghana, Nigeria and Kenya for on-farm characterisation of indigenous animal genetic resources, aimed at field-testing methodologies for collecting breed characterisation data.

Until recently, conservation of animal genetic resources has tended to focus on wild animals, rather than domesticated species. Yet these domesticated species provide much of the world's food, especially protein. Characterising and conserving lesser-known breeds and strains is vital for the future of livestock production in a changing world. ILCA is at the forefront of the movement to characterise and protect livestock genetic resources for future generations of farmers everywhere.

Biological efficiency of livestock

Research on animals is time-consuming and resource-intensive. But research underway at ILCA's Debre Birhan station in the Ethiopian highlands is demonstrating how to get the most out of restricted resources.

In 1991, ILCA started a long-term project studying genetic resistance to gastro-intestinal parasites in small ruminants. Initial studies examined possible genetic resistance to endoparasites in Red Maasai sheep at the Kenya coast (see *ILCA 1992: Annual Report and Programme Highlights*, pages 29–36). Work in Ethiopia with the Menz and Horro sheep breeds started in May 1992, and studies on Fulani and Djallonké sheep and Sahel and West African Dwarf goats started in Senegal in July 1992. This report focuses on work at Debre Birhan, where the study of endoparasite resistance is part of a multidisciplinary programme involving quantitative genetics, parasitology, epidemiology, economics, nutrition and reproductive physiology.

The flocks of Menz and Horro sheep at Debre Birhan were originally established to provide the basis for a study aimed at identifying and quantifying intra- and inter-breed differences in resistance to, or tolerance of, internal parasites in these breeds. But assembling a large number of animals for a single study is costly. So other projects have been developed that make broader use of the same animals or their offspring or both. These projects cover studies of the epidemiology of internal parasites, assessment of the relationship between parasitism and reproductive performance of both male and female animals, and characterisation of these breeds in terms of growth, physical features, feed intake, efficiency of feed use, fat deposition and the strategic use of body reserves.

One core flock, many studies

The core project is using about 500 ewes of each breed each year. The ewes are treated to synchronise their oestrus cycles, and half are mated in May to lamb at the end of the wet season (October) and half in January to lamb at the end of the dry

Sheep grazing on ILCA's Debre Birhan station in the Ethiopian highlands. Several linked studies are being conducted on the flocks at the station, making best possible use of the resources available.

season (June). Twenty ewes of each breed are not mated at each mating season, and serve as controls unstressed by pregnancy. Ten rams of each breed are used for two breeding seasons (i.e. one wet-season lambing and one dry-season lambing), after which seven or eight of them are replaced with new rams. Retaining two or three rams across breeding cycles provides a basis for comparisons over years. The rams are penned with the ewes at night for 30 days during each mating period; all the ewes graze together during the day. After mating the ewes are given a concentrate supplement until lambing to ensure good average body condition.

Studies on breeding ewes

Studies on the ewes include evaluation of the effect of genotype on reproductive parameters (oestrus, ovulation, conception and pregnancy rate) and an investigation of the impact of endoparasites focusing on the periparturient rise in faecal egg counts in the breeding ewes.

Studies on growing lambs

From birth to 12 months old, the lambs from these matings are the subject of detailed breed characterisation studies focusing on body growth and pubertal development.

Resistance to endoparasites: This study is providing estimates of the heritabilities and other genetic parameters associated with resistance to endoparasites. Monitoring covers faecal egg counts (FEC, eggs per gram of faeces), packed cell volume (PCV, %), live weight (at birth, weaning and 12-months old) and mortality and survival rates.

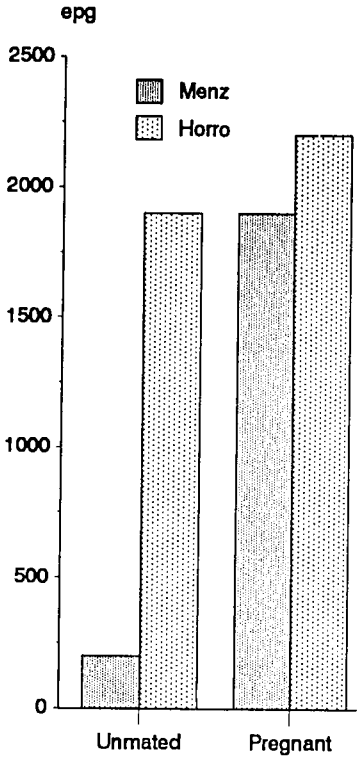
FEC and PCV are measured on all lambs at one and two months old and at weaning at three months old. Individual animals are drenched if their FEC is greater than 2000 eggs per gram (epg) or their PCV is less than 15% at one of these routine screenings. (These criteria are set to avoid animal deaths.) At weaning, 50 "monitor" lambs are selected at random; samples are then taken from these animals each week. When these monitor lambs reach an average FEC of 2000 epg, samples are taken from all the lambs on the next two consecutive days, following which all the lambs are treated against endoparasites. This procedure is followed until the lambs are 12 months old.

Growth, body measurements and male fertility: Running in parallel with the endoparasite resistance study is a study of physical attributes of the two breeds. In addition to the weights recorded as part of the endoparasite trial, measurements are taken each month of the animals' height at withers, heart girth, body length, chest depth and pelvic width. Semen samples are taken from the male lambs to determine the onset of puberty and functional sexual maturity. Similarly, sterilised rams are used to monitor the onset of sexual maturity in female lambs.

Fat deposition study

Once the lambs reach 12 months of age, the male lambs are transferred to a fat deposition study which is investigating interactions between nutrition and genotype. For this study, the animals are fed a medium-quality roughage diet supplemented with a daily allowance of 400 g of a concentrate mix providing 260 g of crude protein and 10.5 MJ of digestible energy per kilogram of concentrate dry matter. Roughage and

water are available *ad libitum*. Feed intake is recorded daily during the feeding trial. At the end of a three- to four-month feeding period, the animals are slaughtered and body-fat content is determined by whole-body dissection.



At the end of the rainy season unmated Menz ewes had much lower endoparasite burdens than their unmated Horro counterparts. Pregnant ewes of both breeds had higher worm burdens at parturition, but the increase was much greater in Menz than in Horro ewes, indicating that the stress of pregnancy broke down their ability to control the parasites. Worm burdens at the end of the dry season were lower, and pregnancy had a lesser effect.

Differences in endoparasite burdens in breeding ewes

Preliminary results coming out of this trial suggest that Menz sheep are more resistant to endoparasites than are Horro sheep, although variation in endoparasite resistance within the breeds is greater than that between the breeds.

At lambing at the end of the wet season, unmated Menz ewes had an average FEC of 200 epg, compared with 1900 epg for unmated Horro ewes. Both breeds showed periparturient increases in FEC, to 1900 epg in Menz ewes and to 2200 epg in Horro ewes. The differences, both between breeds and between pregnant and unmated ewes, were much less marked during the dry season; FECs for unmated ewes were 200 epg in Menz and 300 epg in Horro, compared with 250 and 500 epg, respectively, for pregnant or lactating ewes of the Menz and Horro breeds. This corresponds with the findings of the epidemiology studies, which showed peak development and survival of larvae of four economically important nematode species (*Ostertagia trifucata, Trichostrongylus colubriformis, Haemonchus contortus* and *Dictyocaulus filaria*) in August, during the rainy season, and no larval development between December and June, during the dry season.

Interestingly, even during the rainy season larvae survived on pasture for only six to eight weeks. This short survival period would allow farmers to adopt a clean grazing system, with a rotation of only eight weeks between grazings — a period short enough to be practical under farm conditions.

Early signs of genetic resistance to endoparasites in Menz and Horro breeds

Preliminary results from the endoparasite resistance study show signs of being able to determine heritabilities for

within-breed variation in FEC and PCV in lambs of only two or three months old. This contrasts with findings from Kenya, where Red Maasai lambs did not show these differences until at least 10 months old.

Heritability estimates for PCV were higher in two-month-old lambs than in three-month-old lambs (0.23±0.12 vs 0.01±0.01), although estimates for log FEC were similar in the two age groups (0.32±0.16 vs 0.29±0.14). The heritability estimates in two-month-old Menz and Horro lambs are thus similar to those obtained in 10-month-old Red Maasai lambs, and are high enough to offer prospects of progress in a selection programme aimed at breeding for increased endoparasite resistance. The early expression of resistance in the Ethiopian breeds will also allow earlier screening than is possible with the Red Maasai.

Following on from the promising results of the work at the Kenya coast, these findings hold out the promise of benefits for the millions of smallholder farmers in Africa, and elsewhere in the tropics, who keep small ruminants.

Interbreed differences in reproductive and productive performance

Marked differences were found between the breeds, particularly in ram fertility and age at puberty. Large differences were also found between rams in terms of the growth and body parameters of their offspring.

The fertility of individual rams varied from 47 to 100%, but there was also a clear difference in fertility between the breeds. While half of the Menz rams had fertility rates exceeding 82%, the highest fertility rate recorded among the Horro rams was 72%. The greater fertility of the Menz rams resulted in 80% of the Menz ewes conceiving at their first oestrus, compared with only 64% of Horro ewes.

Menz ewes had larger litters than Horro ewes (1.16 vs 1.13 lambs per ewe). Horro lambs were significantly heavier than Menz lambs both at birth (2.6±0.03 vs 2.3±0.02 kg, respectively) and at weaning (9.8±0.1 vs 9.1±0.1 kg). Although there were no significant differences within breeds in the birth weight of progeny of the different sires, sire had a

significant effect on weaning weight. In the Menz breed, progeny of the sire whose offspring had the highest mean weaning weight (the "heaviest sire") were, on average, 1.5 kg heavier than the progeny of the "lightest sire". In the Horro breed the difference was larger, at 2.6 kg.

Age at puberty is important to farmers, because it determines how soon lambs become productive breeding stock. These studies showed a marked difference in age at puberty between Menz and Horro sheep. Menz lambs reached puberty at an average of 258±3 days old, compared with 284±4 days for Horro lambs.

Among the lambs born in 1993/94, 13% died before weaning, while a total of 23% died before reaching one year old. Half of the lambs that died before weaning died in the first week after being born. The main causes of death were pneumonia (25%), starvation-mismothering-exposure (the SME syndrome) (17%), septicaemia (16%) and gastro-intestinal problems (11%).

Mortality rate was higher in Horro lambs than in Menz lambs, this despite the fact that, overall, lamb birth weight had

Ewes and lambs grazing together in the wet season at Debre Birhan, Ethiopian highlands. Studies show marked differences in performance between Menz and Horro lambs.

a significant effect on peri-natal survival — heavier lambs generally had higher peri-natal survival rates — and Horro lambs had a higher average birth weight than Menz lambs. The Horro lambs were still at greater risk of dying from pneumonia, gastro-intestinal problems and septicaemia at one month old and at weaning than were the Menz lambs.

Initial results strongly suggest that the variation in mortality rate between and within the Horro and Menz breed may be genetically influenced, although not related to resistance to endoparasites. Further studies are needed to investigate the processes of maturation and functional development of vital organs such as the lungs and gut in these breeds, and to examine the effects of stresses on peri-natal survival.

Feed intake and fat deposition

The Horro sheep were significantly heavier than the Menz sheep both at the start (28 vs 27 kg) and at the end (34 vs 32 kg) of the 123-day feeding period. Tail volume, measured by water displacement, was not significantly different between the breeds either at the beginning or the end of the feeding period. Tail volume increased over the feeding period by 146%, from 774 to 1903 cm^3, in the Horro sheep and by 167%, from 732 to 1952 cm^3, in the Menz sheep. This compares with increases in live weight of 21.4% and 18.5%, respectively, for the two breeds. The Horro sheep consumed significantly more hay (502 vs 435 g/day) and concentrate (372 vs 367 g/day) than the Menz sheep; however, live-weight gain and feed-conversion ratio did not differ significantly between the two breeds. There were significant differences among sires within breeds in average daily gain and feed conversion ratio of their offspring.

Total body fat accounted for 21% of cold carcass weight in Horro sheep and 22% in Menz sheep. The correlation between tail volume measured on the live animal and weight of tail fat at slaughter was 0.80; correlation of tail volume measured on the live animal and total cold carcass fat was 0.44. This was not significantly different from the correlation between tail fat at slaughter and total carcass fat (0.46). All the correlation coefficients were significantly different from zero.

These preliminary results thus indicate that tail volume is a good indicator of body fat and can usefully be included in regression equations to predict body fat in live animals.

Promise for the future

Although these are early days for the work at Debre Birhan, already there are indications of genetic differences between the breeds that hold promise for increasing farm productivity in the future. And the beauty of this work is that all these studies use a single group of animals and their offspring, making full use of the resources available.

Livestock production under trypanosomiasis risk

Diseases and parasites are major constraints to animal production in the subhumid zone and the non-forested portions of the humid zone. Trypanosomiasis is arguably the single most important of these. Trypanotolerant livestock — animals that can survive and produce in tsetse-infested areas without the aid of trypanocidal drugs — offer one of the most sustainable options for boosting agriculture and rural development.

If trypanotolerant animals are to play their part in meeting West and central Africa's large and growing demand for meat and milk, more needs to be known about the conditions determining their more extensive and more effective use. For example, major constraints to putting genetic resistance to trypanosomiasis to practical use have been related to the difficulties in the definition and measurement of trypanotolerance.

Successful strategies for controlling animal trypanosomiasis must be based on an integrated approach in which both proven and novel methods are selectively employed to protect livestock. These strategies must be based on accurate appraisals of the impacts of the disease constraints on village farming systems and the development of cost-effective, sustainable disease control packages which can be adopted by producers.

Some countries that have had a policy for livestock development based on the more extensive use of N'Dama cattle have experienced annual increases of up to 10%, while other countries have had very little or no growth in their populations of N'Dama. Research is thus needed to determine the opportunities for, and constraints to, wider use of trypanotolerant livestock.

Trypanotolerant livestock are often combined with tsetse control and trypanocidal drugs in integrated trypanosomiasis control strategies. Research is needed to assess the sustainability of the control strategies themselves, the resulting increases in livestock production, and the subsequent impacts on land use, the natural environment and human welfare.

Field-based strategic research on trypanotolerance of N'Dama cattle

Major focuses of the research on trypanotolerant livestock continue to be on field-based strategic research to elucidate mechanisms underlying trypanotolerance and identification, evaluation and use of indicators of trypanotolerance. This research uses quantitative approaches to the genetic improvement of disease resistance and productivity. It ranges from developing reliable indicators of genetic parameters for use in selection programmes for trypanotolerance and increased productivity to evaluating relationships between these indicators and markers or genes for trypanotolerance and production traits. Its aim is to provide information of direct practical value for animal breeding and selection programmes.

Results coming out of work in 1993/94, building on the information reported in *ILCA 1992: Annual Report and Programme Highlights*, have shown further significant differences in responses of calves and adult cattle to different trypanosome species, and have demonstrated significant differences between calves and adult cattle in the relative importance of some indicators of trypanotolerance.

Epidemiology of trypanosomiasis in N'Dama cattle

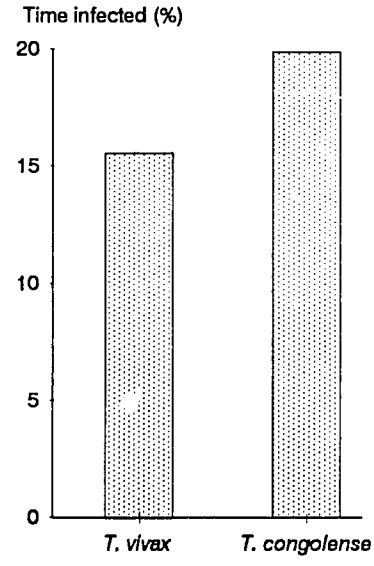
The report on the epidemiology of trypanosomiasis in *ILCA 1992: Annual Report and Programme Highlights* focused on differences between calves and adult cattle in their apparent ability to control infections by *Trypanosoma congolense* and *T. vivax*. That report concluded that N'Dama cattle in Zaire improve their ability to control the development of parasitaemia following *T. vivax* infection, but apparently cannot improve their control of *T. congolense* infection.

Analyses of data from these trials continued in 1993/94, focusing on matching animal health and performance data recorded over the 10 months from parturition to calf weaning in 256 calves and their dams. This again showed major differences between calves and cows, in terms of the overall prevalence of trypanosome infection, the main trypanosome

species affecting them and the animal's response to infection by the different trypanosome species.

Several differences were found between infections by the two trypanosome species. *Trypanosoma vivax* accounted for only a third of instances of parasitaemia in cows, but half of the instances in calves. The percentage of time that infected animals were detected as parasitaemic differed markedly between trypanosome species in cows, but not in calves; cows infected with *T. vivax* were detected as parasitaemic for a significantly shorter time than those infected with *T. congolense* (15.6 vs 19.9%). The intensity of *T. vivax* infections was significantly greater in calves than in cows (parasitaemia score of 3.06 vs 2.27), whereas the intensity of *T. congolense* infections was identical in the two age groups.

These results strengthen the indication of the apparent ability of N'Dama cattle in this region to improve their control over *T. vivax* infections.

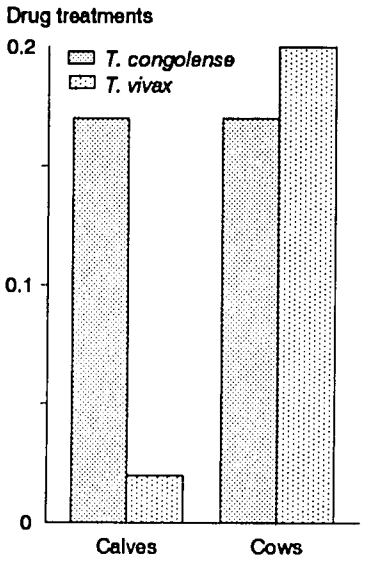


Cows infected with T. vivax *were detected as parasitaemic for a significantly shorter time than those infected with* T. congolense. *There was no significant difference between trypanosome species in calves.*

Criteria of trypanotolerance and their linkage with performance of N'Dama cattle

The report on criteria of trypanotolerance in *ILCA 1992: Annual Report and Programme Highlights* noted that "changes in trypanosome species, length of time parasitaemic, intensity of parasitaemia and average PCV [a measure of anaemia] each have approximately equal effects on daily liveweight gain." This was based on a study of animals over two years following weaning at 10 months old.

Analyses in 1993/94 used the same matching health and performance data as the study reported above. The results showed significant differences between calves and cows in the relative importance of the indicators of trypanotolerance. *Trypanosoma vivax* infections had no significant effect on average PCV or lowest PCV reached in either calves or cows, whereas *T. congolense* infections significantly reduced both measures in both age groups. The overall length of time animals were infected with trypanosomes of either species had a very similar effect on both PCV measures in both age groups. However, the length of time infected by *T. congolense* had a significant effect on PCV measures in calves but not in cows,



In calves, T. congolense *infections required significantly more trypanocidal drug treatments than did* T. vivax *infections, whereas in cows* T. vivax *infections required at least as many treatments as* T. congolense *infections.*

while length of time infected by *T. vivax* had a significant effect in cows but not in calves.

When all four indicators were evaluated simultaneously in relation to the number of trypanocidal drug treatments that were needed, trypanosome species by age-group interactions were again found. In calves, *T. congolense* infections required significantly more treatments than did *T. vivax* infections (0.17 vs 0.02), whereas in cows *T. vivax* infections required at least as many treatments as *T. congolense* infections (0.22 vs 0.17). Parasitaemia score had similar effects in both calves and cows, *T. congolense* infections requiring more treatments per unit increase in parasitaemia score than did *T. vivax* infections.

These results clearly demonstrate the need to identify the trypanosome species involved in infections, and to take this into account in assessing trypanotolerance in animals of different ages.

Impacts of tsetse control on livestock productivity

Research in northern Côte d'Ivoire and south-west Ethiopia has shown that controlling tsetse populations can lead to marked, and statistically significant, increases in calf growth and cow productivity.

In recent years, many projects have studied the use of various tsetse-control measures and their effects on animal health and productivity. However, while it has been quite easy to measure the effects of these control techniques on tsetse populations, demonstrating improvements in livestock productivity has been more difficult. The reason for this is that it is impossible to apply the control measures in the form of a controlled experiment — it is not possible to subdivide herds and allocate animals at random to treated and control groups. During 1993 and 1994, data from two tsetse-control campaigns were analysed in an effort to determine the effects of tsetse control on animal productivity. One of the campaigns was in the Boundiali area in northern Côte d'Ivoire, where biconical traps impregnated with alpha-cypermethrin insecticide were used to control trypanosomiasis in mainly trypanotolerant cattle. The second was in the Ghibe valley in south-west Ethiopia, where a cypermethrin "pour-on" insecticide

was applied to trypanosusceptible zebu cattle regularly treated with the trypanocidal drug diminazene aceturate.

The cattle at Ghibe have been monitored regularly since 1986, but the tsetse-control programme started only in 1991. By December 1993, the tsetse-control programme had reduced the relative density of tsetse flies by over 90% compared with mean values for 1986–90, and reduced trypanosome prevalence in cattle by 74%. The growth rates of young cattle over the wet season were 20% higher following the tsetse-control programme (259 vs 216 g/day), but this difference was not significant when a simple t-test was used because of large fluctuations in growth rates from year to year.

At Boundiali, the comparison was between data for 1987, before the tsetse-control programme started, and 1988 and 1989, during the tsetse-control programme. The control programme reduced trypanosome prevalence in cattle by 80%, and increased wet-season calf growth rate by 11%, from 246 to 274 g/day, but the number of years was too few to test the significance of this.

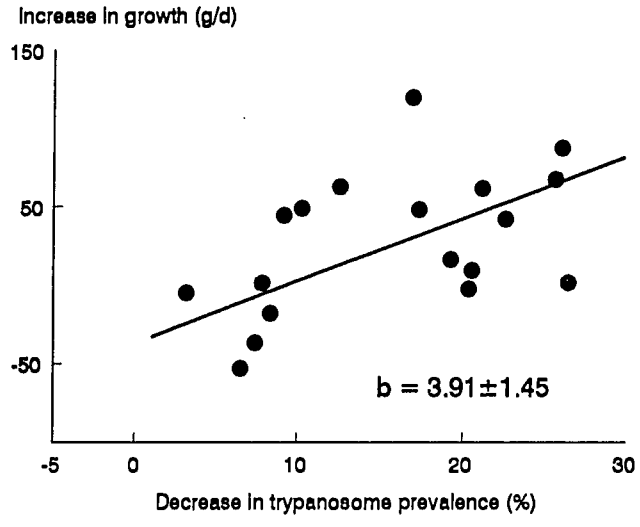
Alternative statistical methods were needed.

At Ghibe only one herd of 90 cattle was monitored to assess the impact of tsetse control. However, data from herds in a neighbouring site that were monitored at the same time were used to correct for year-to-year variations in growth rate. While it was not possible to be certain that such variations were not sometimes confounded with other managerial factors, the correction nevertheless increased the level of statistical significance to P=0.02.

At Boundiali the study covered 21 herds. This enabled an alternative statistical method to be applied, using herd-to-herd variations in the "primary impact" of the intervention — i.e. changes in trypanosome prevalence — to investigate "secondary impacts" on productivity.

This method indicated that controlling the tsetse population increased calf growth rate by 26% (63 (SE 23) g/day); this effect was associated with a decrease of 16 percentage units in trypanosome prevalence. It also showed that the reduction in trypanosome prevalence was associated with a significant increase in the number of cows calving between January and June and conceiving within six months of calving. Regression analysis indicated that the reduced level of trypanosomiasis was also associated with an increase in cow body weight of 4.4 (SE 2.0) kg, and it was this increase in body

Plotting increases in growth rate from 1987 to 1988/89 at Boundiali against decreases in mean trypanosome prevalence indicated a significant increase of 13.4±5.0 kg in live-weight gain due to an average decrease of 16 percentage units in trypanosome prevalence.



weight that appeared to be primarily responsible for the increased conception rate.

The analysis demonstrated that the increases in livestock productivity were statistically significant. However, since the comparisons were among herds rather than within herds, the actual estimates of productivity responses are imprecise. Reliable estimates of impacts of animal health interventions on productivity are essential for valid assessments of economic losses due to disease. Novel approaches to statistical analysis need to be used in conjunction with field studies to fully quantify the likely impacts of tsetse control on livestock productivity.

Differences in susceptibility in East African cattle

Reports of East African cattle showing different degrees of resistance to trypanosomiasis have been made since the early 1900s. Preliminary studies on differences in susceptibility to trypanosomiasis in several populations of zebu cattle in East Africa indicate that there may be some genetic control over these differences, opening up opportunities for selecting for "trypanotolerance" among these animals.

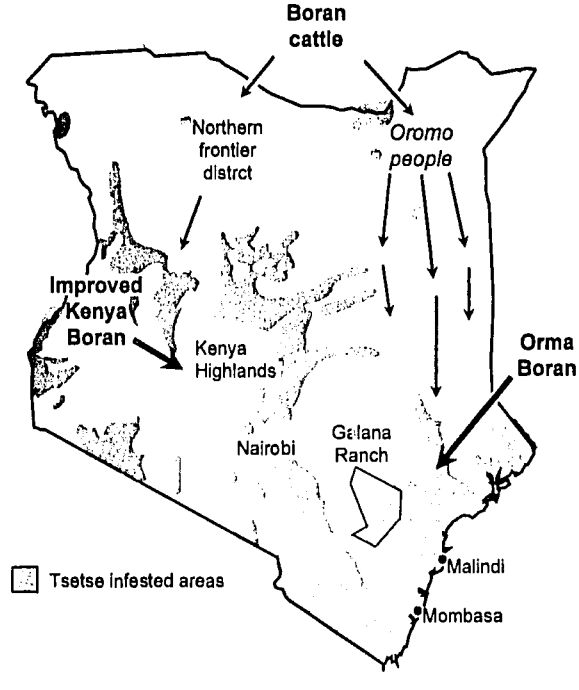
During 1993/94, two sets of data accumulated over several years were analysed at ILCA. These covered East African

village zebu cattle in the Ghibe valley in south-west Ethiopia, and studies by the Kenya Trypanosomiasis Research Institute (KETRI) on two strains of Boran cattle kept at Galana Ranch in Kenya.

A novel approach was used to analyse the Ghibe data. Instead of using measurements made at the same age, mean values of PCV and frequency of parasitaemia were calculated for dams and their offspring over the same six-month periods.

A statistical "animal model" that considered all family relationships gave estimates of heritability of 0.08±0.05 (SE) for frequency of parasitaemia, 0.32±0.07 for PCV and 0.18± 0.07 for PCV corrected for frequency of parasitaemia and frequency of treatment. The last value, although below the range of heritabilities for PCV reported in the literature, indicates that the ability of some animals to maintain PCV at higher levels than others when infected is under genetic control. Further analyses showed that this ability was also linked to improved reproductive performance.

Results from KETRI's studies on Orma and improved Kenya Boran at the Galana Ranch also indicate genetic differ-



The Orma Boran cattle migrated into Kenya during the 15th century with the Oromo people and are found in tsetse-infested areas. The Improved Kenya Boran was developed in the Kenya highlands in the 20th century from Ethiopian Boran cattle and has been less exposed to trypanosomiasis.

ences in trypanosusceptibility. All the trials indicated that the Orma Boran are less susceptible to trypanosomiasis than are the Kenya Boran. This "trypanotolerance" was found in cows, calves and steers, and was independent of previous exposure to the disease. The resistance thus appears to be innate rather than acquired. The Orma Boran had lower trypanosome prevalence rates (17 vs 31%) and lower pre-weaning mortality rate (7 vs 17%) and needed fewer treatments with trypanocidal drugs than did the improved Borans. Fitting the "animal model" to average PCV from birth to weaning in Orma Boran calves gave a heritability estimate for PCV of 0.34 ± 0.14, similar to that in the Ethiopian cattle.

The findings from both studies indicate the need for further research into differences in susceptibility within East African cattle breeds.

Farmers show willingness to contribute to tsetse control

Studies in 1993/94 in south-west Ethiopia and in Kenya's Western Province showed that farmers and other rural people are willing to pay, in cash or in kind, for tsetse control if they are convinced of its benefits. In both locations researchers conducted a "contingent valuation study" to determine whether local residents would be prepared to provide cash or labour, or both, to support tsetse-control activities.

In the study in Ethiopia, only 4% of local residents were unwilling to provide either cash or labour; 58% of respondents offered both cash and labour, 26% offered only labour and 12% offered only money. Several household-level factors affected decisions on contributions to tsetse control. Male heads of household offered more labour and cash than female household heads. Household heads who had paid jobs off the farm offered less labour than those who worked only on their farm. The number of cattle owned had a positive, but not significant, influence on the household's willingness to contribute labour and money. People who participated in local groups were more willing to contribute labour. The importance of creating awareness of the benefits of tsetse control were clear; people whose animals were monitored by ILCA scientists working in the area offered more labour and money than those whose animals were not monitored, and those who were covered by the

Drama was used in Busia in Kenya's Western Province to convey information about tsetse and trypanosomiasis to the local people.

information campaign prior to the study volunteered more labour, but less money, than those who were less well-informed about the benefits of the project.

In Kenya, ILCA collaborated on a study led by KETRI. The study focused on Busia, a district in Kenya's Western Province that has had Kenya's worst outbreaks of human sleeping sickness over the last five years. Animal trypanosomiasis is also a problem and livestock are a reservoir for the human disease. The first phase of the study was conducted in six villages selected to represent different ethnic groups and disease risks. Posters and drama presentations were used to convey information about tsetse and trypanosomiasis to the local population.

Focus-group interviews indicated that most people considered trypanosomiasis to be the second or third most important health problem for both people and animals. Many people thought that trypanosomiasis was a supernatural phenomenon, caused by witchcraft, although most people thought that some type of biting fly — not necessarily tsetse — was involved in the disease. In each village about 150 men, women and children attended the play and poster session explaining trypanosomiasis.

A contingent valuation study showed that 96% of those interviewed were willing to make monthly contributions of money or labour or both. Fifty-eight per cent of respondents volunteered both labour and money, 28% volunteered only labour and 10% volunteered only money. Results from a probit model indicate that the probability that a household was willing to contribute both money and labour depended on its

size, income, experience with human and animal trypanosomiasis and knowledge of the disease. Results from a linear regression model indicate that households headed by women were willing to contribute significantly more money than were households headed by men. These differences appear to result from the greater responsibilities that women have for health care in their families and the fact that women feel at greater risk of contracting human trypanosomiasis than do men.

Two villages, Rukada and Apatit, were chosen to receive help in implementing a pilot programme of tsetse control using traps. An unexpected result of having two villages involved in the pilot programme is that competition has developed between the villages; people in Apatit have adopted "Beat Rukada" as their motto.

Both communities decided that all households should contribute equal amounts of money to buy materials for the tsetse traps. In one community, the contribution turned out to be twice as much as the average contribution volunteered during the contingent valuation study. In the other community,

Making tsetse traps in Busia, western Kenya.

the size of contribution needed was about 20% less than the average amount volunteered in the first study.

A survey of contingent contributions conducted immediately after the group decision had been taken showed the following:

- The variation in the levels of contributions volunteered was reduced. Most households that indicated relatively large contributions during the first survey volunteered lesser amounts in the second survey, while those that had indicated small contributions in the first survey volunteered greater amounts in the second survey.
- Most of the households that had volunteered only labour in the first survey volunteered both money and labour in the second survey.
- In the second survey, only about half of the households indicated contributions of money equal to the amount required.

These results suggest that community decisions do influence individual values but do not determine them completely.

Potential impact

The potential impact of research into livestock production under trypanosomiasis risk is vast. More extensive use of trypanotolerant livestock can open new areas to animal production and reduce farmers' dependence on using imported drugs to control both the disease and the vector.

This research will identify the contribution that trypanotolerant livestock can make to integrated strategies for trypanosomiasis control and livestock development, leading to relevant and appropriate combination of chemotherapy, trypanotolerance and vector control into control strategies that are in themselves sustainable and that contribute to sustainable improvements in livestock production.

Livestock and resource management policy

Food production in sub-Saharan Africa must increase to stave off increasing food shortages. But most of the continent's arable land is already being cropped, and there is little room for increases in the area of land that farmers can use. The most likely route for increased food production is thus to intensify agriculture, which in smallholder farming systems will tend to increase interactions between crop and livestock production.

The encroachment of livestock into agricultural areas and of cropping into pastoral areas are frequent sources of conflict in rural areas. Established resource-management institutions such as property rights are often modified or replaced as crop–livestock interactions increase. Faced with likely increases in these interactions, policy makers need to develop policies that support agricultural intensification without damaging the physical or socio-economic environment.

Tsetse control and its effect on land management

ILCA and the International Laboratory for Research on Animal Diseases (ILRAD) have been studying the effects of tsetse- and trypanosomiasis control programmes in the Ghibe valley in the south-west of Ethiopia since 1991 (see *Livestock production under trypanosomiasis risk*). In the Ghibe–Abelti area the project used insecticide-impregnated targets, while in the Gullele–Tollay area it used a pour-on insecticide applied to cattle. Initial results with the targets were promising, with fly numbers falling to low levels, but many of the targets were subsequently stolen and fly numbers and incidence of trypanosomiasis increased to former levels. The pour-on insecticide has proved more successful, and fly numbers have fallen to very low levels in the Gullele–Tollay area.

Communal herds of cattle that graze different parts of the valley were followed from July 1992 to November 1993 to

The Ghibe valley, south-west Ethiopia, where ILCA and ILRAD have been collaborating in a study of the effects of tsetse and trypanosomiasis control on land use.

establish patterns of resource use and presumptive rights to grazing, and the effects that tsetse control has had on these aspects. Household surveys in areas where tsetse-control measures had been applied included several questions about how people gain access to land for cropping.

In 1991 there were three main types of resource use and tenure in the study area. A substantial amount of the land was state property that was exploited directly by agencies of the central government. This included a commercial forest, a state citrus farm and an agricultural project in collaboration with Yemen (the Ethio-Yemen project). Individual farmers had their own plots of land on which they grew crops. This land was allocated to the households by peasant associations that were established by the national government. The remainder of the land — the majority — was public-domain land used by local residents for grazing livestock, collecting wood for fuel, charcoal and building materials and other activities. The central government controlled the use of this land and restricted such activities as hunting, tree-cutting and charcoal-making.

Almost all of the interactions between crops and livestock are positive. Oxen provide the tractive power that is needed to

cultivate the heavy clay soils, and crop residues are an important source of feed at the end of the dry season.

Reducing trypanosomiasis risk increases demand for arable land

The study showed that tsetse and trypanosomiasis control was beginning to affect resource use, changes that will ultimately demand new land-tenure arrangements. During 1992 the average number of cattle per household at Ghibe–Abelti — where tsetse control had failed — declined from 5.3 to 3.9 head. In contrast, at Gullele–Tollay, where tsetse control had reduced fly population dramatically, cattle holdings increased from 4.9 to 5.5 head per household. The stocking rate in the Gullele–Tollay area is double that in the Ghibe–Abelti area.

The changes in the number of cattle, especially oxen, led to changes in the demand for cultivable land. Between 1991 and 1992, 26% of households in Ghibe–Abelti and 30% of households in Gullele–Tollay increased the area of land they cultivated. Between 1992 and 1993, however, 44% of households in Ghibe–Abelti and 62% of households in Gullele–Tollay planned to increase the amount of land they cropped. The increase relative to 1991/92 reflects the relaxation of controls under the new government, whereas the difference between the locales reflects the ability to crop more land conferred by a growing cattle population.

There is still ample land available in the Ghibe valley and thus there is little competition for land between crops and livestock. Oxen are essential for crop cultivation and crop residues are an important source of dry-season feed for livestock. The reduction in tsetse populations has also opened up new areas for grazing, reducing pressure of traditional grazing areas. However, as trypanosomiasis control reduces the threat of the disease, livestock holdings and cropping intensity will continue to increase. This will lead to increased competition for land and increased crop–livestock integration.

The study of the effects of tsetse and trypanosomiasis control coincided with a number of other changes that affected land use in the area. These were largely related to the change of government in 1991. By the end of 1993 the citrus farm was beginning to allow its employees to cultivate some of its unused land, and much of the land that had been held by the Ethio-Yemen project was taken over by outside investors.

Some of the peasant associations continued to govern the allocation of arable land used by peasants, but the authority of others was severely weakened. But the biggest changes were in the management of public-domain land. As the political basis for governance of this land weakened people from both within and outside the area cut more wood, made more charcoal and hunted more on the public-domain land. A few wealthy investors were given rights to cultivate large tracts of the former public-domain land. The main conflicts were thus not between livestock and cropping activities, but between residents and "immigrants".

Applying a pour-on insecticide in the Gullele–Tollay area of the Ghibe valley, south-west Ethiopia. Using the pour-on has markedly reduced tsetse populations in the area, and farmers have increased the number of animals they keep.

This study has clearly demonstrated a range of factors that can influence land-use patterns and property rights even within a small area and a short time span, highlighting the need to include property rights issues in agricultural research programmes.

Looking at the past, planning for the future

ILCA has a long history of research on policy issues relating to livestock production in Africa. One key issue addressed is that of the effect of property rights on uptake of technology. In 1994 the Centre increased its links with the International Food Policy Research Institute (IFPRI), the lead institute for policy research in the CGIAR.

Scientists from ILCA and IFPRI met in 1994 to plan collaborative research on the relationships between property rights, risk, technology and productivity in sub-Saharan Africa. Both ILCA and IFPRI have conducted research on property rights and have identified property rights as an important area for future research.

The objectives of the meeting were to summarise the results of studies previously conducted by ILCA and others; identify priorities for future research; provide guidance for future research — problem, methodology, locations and resource requirements; and to consider specific proposals for future research and evaluate the areas of complementarity and/or overlap with other past or current projects.

The review of past research on property rights indicated several implications for future research:

- Although the evidence on the influence of property rights on technological adoption is mixed, the results of several studies suggest that, under certain conditions, property rights can have an influence. Studies of property rights should therefore be included in several stages of the research and development process, including when assessing the potential for technology adoption and when determining the factors influencing adoption.
- Studies of the adoption of a specific technology or land-improving investment (e.g. fodder bank) should consider property rights as only one of the many factors that might affect adoption. A study of adoption can only be effec-

tively done where the technology has been made available to a large number of people and a considerable number of people have adopted it. Multivariate analysis that compares adoption with non-adoption can separate the effects of various factors, including property rights. Such studies must, therefore, be timed to occur after a period of diffusion and adoption.

- Any study in which investment is important must be able to measure investments in quantitative terms. Binary measures (e.g. trees vs no trees) are too blunt and too often lead to inconclusive results.
- Productivity studies need to consider long-term versus short-term productivity and sustainability, normal versus drought years, and common versus private lands.
- A strength of previous studies of private land holdings is that property rights can be identified according to a single measure (e.g. tenure security) or assigned to one of a small number of categories (e.g. owned or rented). Researchers face a difficult challenge to find similar measures for property rights to collective resources. The size of the group of resource users and the right to exclude outsiders are important dimensions of common-property regimes.
- The empirical work on tenure–productivity linkages that has been conducted to date is based on relatively simple conceptual models. These studies would be better if they were based on household optimisation models and testable equations.
- Thought must be given to a research approach that will deal with the endogenous nature of property rights. While property rights influence productivity, changes in economic conditions also affect the types of property that prevail. Thus property rights reflect economic conditions. One approach would be to gather data from a large number of sites so that there is cross-sectional variation in the factors that are thought to be important determinants of property rights. The collection of such data will, however, be a formidable task, since the minimum data set may include population density and growth; degree of commercialisation; the productivity of the land (all resources) and changes over time; drought and other risks; ability to cope with drought; externalities such as the poverty reduction benefit from common property; changes in property

The broadbed maker at work in the Ethiopian highlands. Studies show that property rights can have a marked effect on adoption of new technologies.

rights and investment over time; and group action and organisation.

The ILCA/IFPRI meeting identified three major issues to be addressed through collaborative research:

- Development of methodologies for integrating property rights dynamics into technology development and the determination of recommendation domains.
- Investment in livestock production and the productivity of extensive livestock systems and mixed crop–livestock systems.
- Development of a model that better integrates the dynamics of property rights, climatic risk, equity of income

and opportunity and community structure. The model should be validated with a combination of data from secondary sources (including GIS), historical analyses and extensive and intensive surveys.

A major outcome of the meeting was a detailed proposal on "Property rights, risk and the sustainable development of livestock production systems in sub-Saharan Africa".

Property rights crucial to success of agricultural development

In Africa there is mixed evidence of the influence of property rights on the uptake of new technologies and farmers' willingness to invest. Empirical analysis of agricultural productivity should indicate under what conditions property rights constrain investments in agriculture and resource management. This information can guide government policy-making and extension efforts, and help direct research.

Conversely, future research should also address changes occurring in property rights. If property rights can be shown to evolve, and thus to reflect economic factors rather than just legal structures, ILCA can continue to tailor its research and technology development to agro-ecological and economic factors, rather than local land-tenure conditions. An understanding of the evolution of local property rights will also help governments to provide a level of tenure security that promotes investment in new agricultural techniques.

Strengthening national research capacities

Africa has a wealth of expertise in livestock research. Yet many of the scientists in Africa's national programmes know little, if anything, of each other's work and may not even know of each other's existence. This can lead to duplication of effort between countries, and hence waste of resources.

This situation became apparent early in ILCA's life, with professional isolation of national scientists being identified as a problem in the many meetings ILCA organised with national programmes to set its research agenda. Networking was seen as a way of overcoming this isolation and building groups of scientists addressing common problems across national boundaries.

ILCA's involvement in networking dates back to 1980, when the African Trypanotolerant Livestock Network was formed. This was followed by the African Research Network on Agricultural Byproducts (ARNAB) in 1981, the Forage Network in Ethiopia (FNE) in 1983, the Small Ruminant and Camel Group network in 1984, and the African Livestock Policy Analysis Network (ALPAN) and the Pasture Network for Eastern and Southern Africa (PANESA), both in 1985.

In 1991, ARNAB and PANESA came together to form the African Feed Resources Network (AFRNET). A Cattle Research Network (CARNET) began in 1989 with the formation of a network for West and central Africa; this was followed in 1990 with an East and southern African network. The Small Ruminant and Camel Group network became the Small Ruminant Research Network (SRNET) in 1989. These three networks, CARNET, SRNET and AFRNET, have evolved to become strong collaborative research networks.

The networks still in operation in 1994 were CARNET, SRNET, AFRNET, ALPAN and the African Trypanotolerant Livestock Network, operated in collaboration with the International Laboratory for Research on Animal Diseases (ILRAD). Of these networks, three — CARNET, SRNET and AFRNET — are collaborative research networks, and thus fall within the theme of "Strengthening National Research Capacities". ALPAN is an information-exchange network, set up on the

recommendation of participants in a 1984 workshop. The African Trypanotolerant Livestock Network was established to provide access to the range of environments needed to evaluate trypanotolerant livestock; participants follow common protocols to ensure that results from the different sites are comparable and can be used in across-site analyses.

The networking concept

ILCA's emphasis on networking was based on a desire to bring together scientists throughout Africa to promote the progress of agricultural research.

ILCA believed that the lack of peer-group contacts among scientists in national programmes in sub-Saharan Africa was leading to duplication of efforts and hence waste of resources. The Centre saw networking as a way of overcoming this, and as a way of creating a "critical mass" of scientific expertise that would enable common goals to be achieved faster by focusing effort on mutual problems. The networks were the primary mechanism through which the Centre carried out research in partnership with African institutions.

ILCA saw its role in networks as being to:

- assist in priority setting and planning their research agenda and working structure
- disseminate research methodologies and new technologies
- provide training opportunities to colleagues in national agricultural research systems (NARS)
- help set up steering committees
- help organise regular meetings of participating scientists to review research results
- improve information exchange through newsletters, conference proceedings and the publication of research results and
- help attract financial support for in-country implementation of research projects by national network cells.

The networks

The three collaborative research networks — CARNET, SRNET and AFRNET — have similar organisations, with the following characteristics:

Networking brings scientists together to work on common problems, such as improved use of feed resources.

- A steering committee of NARS scientists elected by members of the network. The committee defines the research, training and information programmes of the network and, most importantly, evaluates the implementation of the programmes.
- An ILCA staff member is employed as coordinator for each network. The coordinator ensures the rigour of the peer-review process used by the steering committee; convenes steering committee meetings and ensures that committee decisions are acted upon; convenes and organises scientific meetings and edits the proceedings; and produces a network newsletter.
- The network coordinator also acts as a link between the network and ILCA, informing the Centre of training and information needs identified by the network and taking a leading role in ensuring that the Centre responds to those needs.

The key to the success of the networks is in their emphasis on peer-review among NARS scientists. The networks "belong" to the NARS, not to ILCA.

Projects submitted to the networks for funding undergo a rigorous selection process. All projects submitted are first reviewed at regional planning and review workshops. Those selected by the workshop are then reviewed by the steering committee. Grants are awarded based on the creativity and quality of the science of the proposed projects, their relevance to network priorities, applicability to existing production systems and their potential contribution to sustainable animal agriculture at the national and regional levels.

Grants are made from "in-trust funds" from donors that are held by ILCA on behalf of the NARS. Project implementation is carefully monitored and evaluated by teams of experts, selected from among network members. These teams also provide guidance for the projects where necessary. Results of network research are presented at network workshops, conferences or symposia, with the proceedings providing for wide dissemination of the results.

External review of networking

In 1994, at ILCA's request, a team representing the International Development Research Centre (Canada), the German Agency for Technical Cooperation (GTZ), the Overseas Development Administration (UK) — principal donors supporting networking at ILCA — and the US Agency for International Development evaluated the three collaborative research networks. This review covered the achievements of the networks and the constraints they face and aimed at determining the role of the networks in the new global International Livestock Research Institute.

The team interviewed network participants in Ethiopia, Ghana, Kenya, Niger and Zimbabwe, made field visits in these countries, and reviewed network documents.

The review found that the networks fulfil a key role in breaking the sense of isolation of African scientists and provide access to information and a means of exchanging experiences. They have the potential to contribute to the strengthening of agricultural research and finding technological alternatives for the improvement of livestock productivity. However, the team found the networks have been constrained by lack of money. They also found that the networks need to improve the way in which they communicate

with their members to strengthen and deepen participation in all their activities. The team made a number of recommendations in these respects, including planning based on three-year cycles, rather than the current yearly planning and budgeting.

Looking to the future, the team saw advantages for the current networks.

Achievements

Probably the most important achievement of the networks is in helping develop a confident, self-reliant cadre of scientists in the NARS of sub-Saharan Africa. All the networks have contributed to training scientists and research workers and to disseminating information. Other specific achievements include:

- AFRNET: distribution of hundreds of forage legume accessions and identification of highly productive forage materials adapted to various ecosystems.
- CARNET: research under this network is expected to result in improved packages that will reduce age at puberty and first calving; reduce calving intervals; increase the efficiency of feed utilisation at the smallholder level; and lead to sustainable increases in milk and meat output in sub-Saharan Africa.
- SRNET: research under way is expected to provide solutions to key constraints on small ruminant production in the areas of feeds and feeding systems; production and management systems; and breed characterisation and improvement.

ILCA research protocols and programme activities, 1993/94

Mixed crop–livestock systems

Feed resource use and nutrition of ruminants in crop–livestock systems of semi-arid West Africa

Feed-production strategies and resource management in mixed crop–livestock systems

Crop–forage integration and nutrient management in the cool tropics

Feed resources for smallholder dairy production in coastal semi-humid Kenya: Agronomic practices

Soil-surface management using forage legumes*

Sustainable crop–livestock production and natural resource management in semi-arid West Africa

Nutrient Cycling Conference: "Livestock and sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa"*

Nutrient cycling in legume-based cereal–livestock systems

Nutrient and water-use studies in tree/grass mixtures in the sandy soils of coastal semi-humid Kenya*

Animal-drawn implements for Vertisols

Watershed management for improving and sustaining crop and livestock production of Vertisols in the Ethiopian highlands**

Trends in productivity and management of Sahelian rangelands

Resource assessment

Market-oriented smallholder dairying

Development of a conceptual framework and methodologies for peri-urban dairy systems research in sub-Saharan Africa

Market distribution and consumption dynamics of regulated and unregulated smallholder dairy systems

Technology development and testing for smallholder dairy systems in lowland Kenya

Peri-urban dairy production systems in the subhumid zone

Development of dairy-based peri-urban mixed farming

Peri-urban dairy production: Identification of factors affecting on-farm milk production potential of cross-bred cows in the Ethiopian highlands farming system — Selale area

Development of feeding and management systems for different classes of dairy cattle in the Ethiopian highlands

Investigation of techniques and systems for milk processing and preservation

Impact of diseases of intensification and reproductive wastage on the efficiency of African peri-urban milk production systems

Conservation of biodiversity

Characterisation and conservation of indigenous African animal genetic resources

* Ended in 1993; ** Started in 1994.

The use of biotechnology tools in livestock production

Forage genetic resources

Selecting and testing forage legumes for sustainable agriculture and livestock production in subhumid West Africa

Biological efficiency

Strategies to evaluate and match nutritional requirements of livestock exposed to fluctuating feed supply

Development and testing of functional models in crop–livestock systems

Measuring the sustainability and economic viability of crop–livestock systems*

Genetic resistance to gastro-intestinal parasitism in small ruminants

Epidemiology, control and impact of gastro-intestinal endoparasites on input/output relationships in Ethiopian sheep

Evaluation and improvement of reproductive efficiency in cattle production

Strategies for nutrient partitioning for milk production, reproduction and body reserves in low and high milk producing tropical cows

A study of anti-nutritional factors in foliage of multi-purpose trees fed to ruminants: Their effects on the rumen ecosystem and strategies to improve ruminant nutrition from the foliage

Effects of work and its associated heat stress on nutrient intake, digestion and body condition of draft oxen in the semi-arid zone of Niger

Alternative sources of draft animals — cross-bred dairy cows for traction

Effects of work on oxen in different body conditions used for traction

Livestock production under trypanosomiasis risk

Epidemiology of trypanosomiasis in ruminants in sub-Saharan Africa

Trypanotolerance and the use of trypanotolerant livestock within integrated strategies for livestock production under trypanosomiasis risk

Socio-economic evaluation and impact assessment of trypanosomiasis control measures

Socio-economic assessment of strategies for improved livestock production under trypanosomiasis risk in West Africa

Genetic parameters and other markers for trypanotolerance and genetic improvement and performance of trypanotolerant livestock

Livestock and resource management policy

The role of credit in promoting the uptake of livestock technology in sub-Saharan Africa

Analysis of the economic and socio-demographic factors affecting the demand for sheep in Ethiopia

Role of peri-urban dairy in economic development

Policies, markets and technical change: Factors affecting technology transfer

Factors affecting demand for veterinary services in Ethiopia: Policy implications**

Land tenure institutions and agricultural productivity

* Ended in 1993; ** Started in 1994.

Economic and environmental effects of crop–livestock integration

Impact assessment**

Policy services

Livestock policy comparisons in sub-Saharan Africa to determine critical success factors

The structure of demand for animal products in selected sub-Saharan African countries

Identification of the policy factors affecting diffusion of the broadbed maker

Appropriate resource tenure policies in situations of increased crop–livestock interactions*

Economic and environmental effects of crop–livestock integration

Strengthening national research capacities

Training

Information

Publishing

Cattle Research Network

African Small Ruminant Research Network

African Feed Resources Network

* Ended in 1993; ** Started in 1994.

Research collaborators, 1993/94

Africa

Botswana

Botswana College of Agriculture
Ministry of Agriculture

Burundi

Institut des sciences agronomiques du Burundi

Burkina Faso

Centre international de recherche–développement sur l'élevage en zone subhumide

Cameroon

Institut de recherche zootechnique

Côte d'Ivoire

Centre ivoirien de recherches économiques et sociales
Institut des savanes
Projet de lutte anti-tsé-tsé
Société de développement de la production animale

Ethiopia

Alemaya University of Agriculture
Ethiopian Nutrition Institute
Institute of Agricultural Research
Ministry of Agriculture
Ministry of State Farm Development

Ghana

Animal Research Institute
University of Ghana, Legon
University of Science and Technology, Kumasi

Kenya

Kenya Agricultural Research Institute
Kenya Trypanosomiasis Research Institute
University of Nairobi

Mali

Institut d'économie rurale

Malawi

Bunda College of Agriculture

Morocco

Institute of Agriculture and Veterinary Science, Hassan II University

Niger

Institut national de recherches agronomiques du Niger
University of Niamey

Nigeria

National Animal Production Research Institute
National Livestock Projects Department
University of Agriculture, Abeokuta
Ahmadu Bello University
University of Ibadan
Obafemi Awolowo University

Rwanda

Institut des sciences agronomiques du Rwanda

Senegal

Centre de recherches zootechniques, Kolda
Institut sénégalais de recherche agricole
Laboratoire national d'élevage et de recherches vétérinaires

Tanzania

Livestock Production Research Institute
Sokoine University of Agriculture

Swaziland

University of Swaziland

Togo

Projet national petits ruminants
University of Benin, Togo

Uganda

Makerere University
Namulonge Research Station

Zaire

Compagnie J. van Lancker

Zimbabwe

Dairy Development Project
Department of Research and Specialist Services
University of Zimbabwe

Outside Africa

Australia

Commonwealth Scientific and Industrial Research Organization
The University of Adelaide
University of New England

Belgium

Ghent State University
Université de Liège

France

Centre de coopération internationale en recherche agronomique pour le développement-Département d'élevage et de médecine vétérinaire des pays tropicaux

Germany

Hohenheim University
University of Kassel

New Zealand

Agricultural Research, Dunedin
Lincoln University, Canterbury

The Netherlands

University of Wageningen

United Kingdom

Natural Resources Institute
Overseas Development Administration
Rowett Research Institute
Scottish Agricultural College, Aberdeen
The University of Edinburgh
University of Glasgow
University of Reading
Strathclyde University

United States of America

Cornell University
Iowa State University
University of Pennsylvania
Washington State University
University of Wisconsin-Madison
Winrock International

International Organisations

International Center for Agricultural Research in the Dry Areas
International Centre for Research in Agroforestry
International Crops Research Institute for the Semi-Arid Tropics
International Fertilizer Development Centre
International Food Policy Research Institute
International Institute of Tropical Agriculture
International Laboratory for Research on Animal Diseases
International Trypanotolerance Centre

Staff List, 1993/94

Professional and supervisory staff

DIRECTOR GENERAL'S OFFICE

H Fitzhugh, *Director General*

J Walsh, *Director General**

Antonio Silla, *Internal Auditor*

R von Kaufmann, *Assistant to the Director General and Director of Donor and Board Secretariat*

P Fajersson, *Special Assistant to Director General*‡

Tehout Workalemahu, *Executive Secretary*

I Alipui, *Executive Assistant (Donor and Board Secretariat)*

RESEARCH DEPARTMENT

M Kamuanga, *West African Regional Economist*‡

J Kategile, *Regional Representative, East/Southern Africa***

M Sall, *Regional Representative, West and Central Africa*

A Tall, *Research Operations Manager*

Animal Science Division

Animal Nutrition and Management

A Lahlou-Kassi, *Head, Animal Science*

D Anindo, *Associate Scientist*

O I Kurdi, *Animal Scientist (Post-doctoral Associate)***

Mebratu Ogbai, *Chief Laboratory Technician*

M A Mohamed, *Dairy Chemist (Post-doctoral Associate)***

C B O'Connor, *Dairy Technologist*

A N Said, *Animal Nutritionist***

Tekalign Tadesse, *Chief Research Assistant**

Animal Breeding and Production Section

J E O Rege, *Head, Animal Breeding and Production Section*

B Rey, *Veterinarian/Animal Production Scientist (seconded from the Institut d'élevage et de médecine vétérinaire des pays tropicaux, France)***

C L Tawah, *Associate Scientist*

Y C Valentine, *Animal Scientist (Post-doctoral Associate)*‡

Animal Reproduction and Health

E G Mukasa-Mugerwa, *Animal Scientist*

S Tembely, *Associate Scientist*

Tekeleye Bekele, *Research Veterinarian***

R Torto, *Animal Scientist (Post-doctoral Associate)*‡

Plant Science Division

Genetic Resources

J Hanson, *Head, Forage Genetic Resources Section*

J H Heering, *Agronomist (Associate Expert)***

A M Mih, *Plant Virologist (Post-doctoral Associate)*‡

K M'Ribu, In-Vitro *Culture Specialist (Post-doctoral Associate)*‡

M van de Wouw, *Zwai Site Coordinator*

Herbage Seed Unit

R Griffiths, *Head, Herbage Seed Unit**

Mare Tsega, *Agronomist (Post-doctoral Associate)**

Soils and Plant Nutrition

I Haque, *Soil Scientist (Head of Section)***

* Left ILCA in 1993; ** Left ILCA in 1994.

† Joined ILCA in 1993; ‡ Joined ILCA in 1994.

Socio-Economic Sciences Division

S Ehui, *Head, Socio-Economic Sciences Division*
E Betubiza, *Agricultural Economist (Post-doctoral Associate)**
H A Freeman, *Associate Scientist*‡
S Gavian, *Research Associate*†
M A Jabbar, *Agricultural Economist*
B Shapiro, *Agricultural Economist*

Research Support Division

Computer Science and Biometrics

E Bruns, Head, *Computer and Biometrics**
S Nokoe, Head, *Computer and Biometrics*†/**
L M Diedhiou, *Biometrician*
J Sherington, *Biometrician**
Yohannes Yehualashet, *Project Supervisor*

Experiment Station – Debre Birhan

S Sovani, *Animal Scientist***

Experiment Station – Debre Zeit

N N Umunna, *Station Manager*‡
A Odenyo, *Rumen Microbial Ecologist (Post-doctoral Associate)*‡
I V Nsahlai, *Associate Scientist*
H Khalili, *Animal Nutritionist (Associate Scientist)***
M T Daura, *Animal Scientist (Post-doctoral Associate)***

Cattle Research Network

E A Olaloku, Cattle Research Network Coordinator

Zonal Research Sites

Highlands — Ethiopia

M A Mohamed-Saleem, *Agronomist (Team Leader)*
Abate Tedla, *Forage Agronomist*
Abiye Astatke, *Agricultural Engineer*
Getachew Asamenew, *Agricultural Economist**
Negussie Akalework, *Station Coordinator/Project Supervisor**
A El Wakeel, *Forage Agronomist (Post-doctoral Associate)*
E Zerbini, *Animal Scientist*

Humid Zone — Nigeria

J Smith, *Animal Scientist (Team Leader)*
A Larbi, *Forage Agronomist*

Subhumid Zone — Nigeria

D Little, *Animal Nutritionist (Team Leader)**
K Agyemang, *Animal Production Scientist*
O A Ikwuegbu, *Animal Scientist***
Zegeye Hailu, *Associate Agricultrural Economist*†
G Tarawali, *Forage Agronomist***
M Peters, *Agronomist (Post-doctoral Associate)*†

Subhumid/Semi-arid Zone — Mali

D Diakite, *Administrator**
L Diarra, *Ecologist**
K Fofana, *Chief Accountant**

Trypanotolerance/Subhumid Zone — Kenya

R L Baker, *Animal Scientist*
G d'Ieteren, *Trypanotolerance Thrust Coordinator*
S Lebbie, *Small Ruminant Research Network Coordinator*
P N de Leeuw, *Ecologist**
G Mullins, *Associate Agricultural Economist*
S M Nagda, *Biological Data Analyst*
J Ndikumana, *Feed Resources Network Coordinator*
M Oriaro, *Administrative and Finance Officer***
J M Rarieya, *Senior Biological Data Analyst**

* Left ILCA in 1993; ** Left ILCA in 1994.
† Joined ILCA in 1993; ‡ Joined ILCA in 1994.

L Reynolds, *Small Ruminant Meat and Milk Thrust Coordinator**

G J Rowlands, *Animal Production Scientist*

Y Steiger, *Veterinarian (Post-doctoral Associate)*

B M Swallow, *Agricultural Economist*

W Thorpe, *Animal Scientist*

Semi-arid Zone — Niger

J M Powell, *Agro-ecologist (Team Leader)***

S Fernandez-Rivera, *Animal Scientist (Team Leader)*

P Hiernaux, *Ecologist*

P Lawrence, *Animal Scientist**

Z C Somda, *Animal Scientist (Post-doctoral Associate)***

M Turner, *Research Associate*†

T O Williams, *Livestock Economist*

Network Sites

Network site – Trypanotolerance, Ethiopia

Woudyalew Mulatu, *Project Supervisor*

TRAINING AND INFORMATION DEPARTMENT

M E Smalley, *Director of Training and Information*

L Padolina, *Assistant to the Director of Training and Information*

Training

B R Tripathi, *Head, Training Section***

C Igodan, *Agricultural Educator (Post-doctoral Associate)**

Werqu Mekasha, *Training and Conference Officer**

Information Services

P K Sinha, *Head of Information*

Azeb Abraham, *Librarian*

Marcos Sahlu, *Supervisor, Documentation*

Publications

P J H Neate, *Head of Publications*

S Adoutan, *Translator/Editor*

D Niang, *Revisor/Editor**

A M Nyamu, *Science Writer/Editor*

C De Stoop, *Assistant Translator***

ADMINISTRATION

E J English, *Director of Administration*

General Services

Ephraim Bekele, *Liaison Service Officer***

Ghebru Beine, *Catering Officer*

F Leone, *Physical Plant Manager*

B R R Rao, *Manager, Housing and Catering*

Tafesse Akale, *Protocol Officer*

Tekeste B Habtu, *Procurement Officer***

Tesfaye Mekoya, *Chief Safety Officer**

Personnel

B K Johri, *Personnel Manager***

Ahmed Osman, *Assistant Personnel Officer*

Michael Abebe, *Medical Officer*

Tadesse Mi[illegible], *Assistant Personnel Officer*

Finance

G O'Donoghue, *Financial Controller*†

Belayhun Wondimu, *Chief Accountant*

Emmanuel Tesfa Mariam, *Budget Officer*

Negussie Abraham, *Supervisor, General Accounts*

Techalew Negash, *Supervisor, Disbursement and Collection*

* Left ILCA in 1993; ** Left ILCA in 1994.

† Joined ILCA in 1993; ‡ Joined ILCA in 1994.

Post-doctoral and Graduate Associates at ILCA in 1993/94

Post-doctoral Associates

Start	End	Name/ nationality	Project title	Thrust/ country
1991	1993	Mare Tsega, Ethiopian	Determination of optimum forage seed harvest dates and their drying and storage characteristics	IMMP/ Ethiopia
1991	1993	David O Anindo, Kenyan	Development of feed evaluation models	IPE/Ethiopia
1991	1993	Eustacius Betubiza, Ugandan	Influence of producer cooperatives in technology diffusion across smallholder farming communities in the Ethiopian highlands	IMMP/ Ethiopia
1991	1994	Zana C Somda, Burkinabe	Nutrient cycling by ruminants in mixed farming systems in semi-arid sub-Saharan Africa	IMMP/ Niger
1992	1993	Chris Igodan, Nigerian	Development of self-instruction materials for forage evaluation and forage seed production	SNRC/ Ethiopia
1992	1994	Saidou Tembely, Malian	Resistance/tolerance to gastro-intestinal nematodes in sheep/goats	IPE/Ethiopia
1992	1994	Newton Lupwayi, Malawian	Research on rhizobium and decomposition and mineralisation studies on forage, browse legumes and crop residues	IRM/ Ethiopia
1992	1994	Ignatius Nsahlai, Cameroonian	Mechanisms of protein and energy utilisation by ruminants fed diets made of low quality feed stuffs	IMMP/ Ethiopia
1992	1994	Chi Lawrence Tawah, Cameroonian	Breed characterisation of indigenous livestock in sub-Saharan Africa	IMMP/ Ethiopia
1992	1994	Mohamed Muctar Ali, Somali	Chemistry of cheese and milk	IMMP/ Ethiopia
1992	1994	Omar Kurdi, Sudanese	Development of feeding and management systems for milk and meat production using feed resources	IPE/ Ethiopia
1992	1994	Moses Daura, Zambian	The effect of work on fattening oxen used for traction	IPE/ Ethiopia
1992	1995	Ahmed S El Wakeel, Sudanese	Growth rules for forage crops and technology verification using intelligent geographic information system	IRM/ Ethiopia
1993	1995	Michael Peters, German	Selecting and testing forage legumes for sustainable agriculture and livestock production in subhumid West Africa: Special emphasis on legume–legume combination	IRM/ Nigeria

IMMP = Increasing Milk and Meat Production; IPE = Improving Production Efficiency; IRM = Improving Resource Management; SNRC = Strengthening National Research Capacities.

Post-doctoral Associates (cont'd)

Start	End	Name/ nationality	Project title	Thrust/ country
1993	1994	Eustace A Iyayi, Nigerian	Development of small-scale dairying systems based on crop residues, pastures etc	IMMP/ Nigeria
1994	1996	Afui Mathias Mih, Cameroonian	Characterisation and conservation of forage germplasm and evaluation for development of livestock feeds	IRM/HQ Ethiopia
1994	1996	Rita Torto, Ghanaian	Physiology of non-disease adaptive traits in small ruminants (Ethiopian highland sheep)	IPE/HQ Ethiopia
1994	1996	Valentine C Yapi, Ivoirien	Classification and characterisation of African small ruminants genetic resources	IPE/HQ Ethiopia
1994	1996	Kaburu M'Ribu, Kenyan	*In-vitro* cultivation of Napier grass and the molecular characterisation of *Sesbania* accessions and of Napier grass	IRM/HQ Ethiopia
1994	1996	Agnes A Odenyo, Kenyan	Rumen manipulation to enhance fibre utilisation	IMMP/ Ethiopia

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Graduate Associates

Start date	End date	Name/ nationality	University/ institute	Degree	Project title	Thrust/ country
1990	1993	Daniel Dauro, Ethiopian	University of Montpellier, France	PhD	Competition and regeneration patterns of selected trifoliums under natural pasture and intercropped situations in the Ethiopian highlands	IPE Ethiopia
1990	1993	Felix N Ikpe, Nigerian	Rivers State University of Science and Technology, Nigeria	PhD	Manure management for cropping	IPE/ Niger
1990	1993	Calvin Antonza II, Nigerian	Ahmadu Bello University, Nigeria	PhD	Social and economic constraints to the introduction of animal traction in the SHZ of Nigeria	IPE/ Nigeria
1991	1994	Michael Bonsi, Ghanaian	University of Science & Technology, Ghana	PhD	Mechanisms of protein and energy utilisation by ruminants fed low quality feedstuffs	IMMP/ Ethiopia
1991	1993	Victor Okoruwa, Nigerian	University of Ibadan, Nigeria	PhD	Economics of alternative cattle production systems in SW Nigeria	IMMP/ Nigeria
1991	1994	Paul A Iji, Nigerian	Ahmadu Bello University, Nigeria	PhD	Productivity of goats on improved pasture	IPE/ Nigeria
1991	1994	Tesfaye Wolde-Michael, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Effect of work on oxen of different body condition used for traction	IMMP/ Ethiopia
1992	1994	Suliman El Hassan, Sudanese	University of Aberdeen, UK	PhD	Rumen microbiology	IPE/ Ethiopia
1992	1994	Jomo V Johns, Liberian	Iowa State University, USA	PhD	Development and management systems for productions of milk and meat	IMMP/ Ethiopia
1992	1994	Esubalew Abate, Ethiopian	Alemaya University of Agriculture, Ethiopia	PhD	Effect of work and diet supplementation on reproductive performance of crossbred dairy cows used for draft	IPE/ Ethiopia
1992	1994	John Omiti, Kenyan	University of New England, Australia	PhD	Potential contribution of the livestock subsector to farm income and environment protection in SSA: Implications for policy	IRM/ Ethiopia
1992	1994	Steven Staal, American	University of Florida, USA	PhD	Livestock policy comparisons: Peri-urban dairy systems surrounding Nairobi and Addis Ababa	IMMP/ Ethiopia

IMMP = Increasing Milk and Meat Production; IPE = Improving Production Efficiency; IRM = Improving Resource Management.

Graduate Associates (cont'd)

Start date	End date	Name/ nationality	University/ institute	Degree	Project title	Thrust/ country
1992	1993	Mamadou A Ba, Senegalese	Ecole national vétérinaire d'Alfort, France	MSc	Milk production for crossbred goats	IPE/ Burundi
1992	1995	François Toe, Burkinabe	Institut agronomique et vétérinaire Hassan II, Morocco	PhD	Testicular size and reproduction traits as selection and management criteria in sheep	IMMP/ Ethiopia
1992	1994	Kassahun Awgichew, Ethiopian	Technische Universität Berlin, Germany	PhD	Compensatory growth and body fat deposition in two Ethiopian highland sheep	IMMP/ Ethiopia
1992	1994	Shuikat Ali Abdulrazak, Kenyan	University of Aberdeen, UK	PhD	Nutrition of dairy cows in a smallholder zone in Kenya	IMMP/ Kenya
1992	1994	Charles Chakoma, Zimbabwean	University of Zimbabwe	PhD	Feeding packages based on *Pennisetum* species (Zimbabwe) for smallholder dairy cattle	IRM/ Zimbabwe
1992	1993	Yemi Akinbamijo, Nigerian	Wageningen Agricultural University, The Netherlands	PhD	Studies on aspects of trypanosomiasis and West African Dwarf sheep production	IPE/Ethiopia
1993	1993	Guillaume Duteurtre, French	Montpellier University, France	MSc	The provision of dairy products in Addis Ababa Ethiopia: Consumption, marketing and production aspects	IPE/ Ethiopia
1993	1993	J-Marie Le Horgne, French	CIRAD–EMVT DESS, France	MSc	Study of peri-urban dairy production systems in Addis Ababa, Ethiopia	IPE/ Ethiopia
1993	1993	Aderie Adugna, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Identification of the farm-level factors affecting adoption potential of the broad-bed maker	IPE/ Ethiopia
1993	1993	Harald Kramer, German	University of Hohenheim, Germany	MSc	Evaluation of a collection of *Centrosema brasilianum* accessions	IRM/ Nigeria
1993	1994	Abdou Fall, Senegalese	The University of Edinburgh, UK	MSc	Effect of work and its associated heat stress on nutrient intake, digestion and body condition of draft oxen	IPE/ Niger
1993	1995	Kimberly Swallow, American	University of Wisconsin, USA	PhD	Local socio-economic institutions and their influence on smallholder farmers in coastal region of Kenya	IMMP/ Kenya

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Graduate Associates (cont'd)

Start date	End date	Name/ nationality	University/ institute	Degree	Project title	Thrust/ country
1993	1994	Pokou Koffi, Ivoirien	CIRES	PhD	Economic analysis of livestock production with tsetse control, multiple species and multiple breeds	IPE/ Côte d'Ivoire
1993	1994	Verena Kaleja, German	University of Hohenheim, Germany	MSc	Collection of indigenous forage species in northern Nigeria	IRM/ Nigeria
1993	1994	Neijat Mohamed, Ugandan	University of Adelaide, Australia	MSc	Evaluate the feeding value of a pea straw based diet in ruminant feeds	IMMP/ Ethiopia
1993	1994	Temesgen Wallelign, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Feeding sorghum stover to Ethiopian cattle: The effect of variety and level of offer on intake, digestibility and body weight gain	IMMP/ Ethiopia
1993	1994	Seyoum Bediye, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Evaluation of forage legumes, browse species and oilseed cakes using *in-vitro* techniques	IMMP/ Ethiopia
1993	1996	Adewumi M Kolawole, Nigerian	University of Ibadan, Nigeria	PhD	Management of feed resources for smallholders in West Africa	IMMP/ Nigeria
1993	1996	Ademola M Raji, Nigerian	University of Ibadan, Nigeria	PhD	Forage production for smallholder production	IRM/ Nigeria
1994	1994	Augustin Brusselmans, Belgian	Institute for Land and Water Management, Belgium	MSc	Study of geomorphology off-farm and traditional farming system of a watershed in Taro, Jemjem, Ginchi, Ethiopian highlands	IRM/ Ethiopia
1994	1994	Wouter van Muysen, Belgian	Institute for Land and Water Management, Belgium	MSc	Study of geomorphology off-farm and traditional farming system of a watershed in Taro, Jemjem, Ginchi, Ethiopian highlands	IRM/ Ethiopia
1994	1994	Teferi Gedlu, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Effect of organisms on forage seed germination, and fungicides for seed treatment	IRM/ Ethiopia
1994	1995	Getachew Gebru, Ethiopian	University of Wisconsin, USA	PhD	Assessment of feed resource base and the factors that affect access to feed resources in the crop–livestock system of the Ethiopian highlands	IRM/ Ethiopia
1994	1995	Sisay Gezahegne, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Breed characterisation project	IRM/ Ethiopia

IMMP = Increasing Milk and Meat Production; IPE = Improving Production Efficiency; IRM = Improving Resource Management.

Graduate Associates (cont'd)

Start date	End date	Name/ nationality	University/ institute	Degree	Project title	Thrust/ country
1994	1995	Solomon Mamo, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Peri-urban dairy production: On-farm feed production priorities, feeding regime and behaviour, work output of oxen and lactation performance of cows	IRM/ Ethiopia
1994	1995	Hailemariam Tefera, Ethiopian	Alemaya University of Agriculture, Ethiopia	MSc	Adoption of improved management and feeding strategies for crossbred dairy cows: A whole farm evaluation	IRM/ Ethiopia
1994	1996	Ika Darnhofer, Austrian	Vienna University of Agriculture, Austria	PhD	Feed resource use and farmers' perceptions	IRM/ Ethiopia
1994	1994	Anne-Marie Soderstrom, Finnish	University of Helsinki, Finland	MSc	Water intake and its effect on the milk yield of purebreed and crossbred cows in the Selale area, Ethiopia	IRM/ Ethiopia
1994	1994	Peter Ogore, Kenyan	Egerton University, Kenya	MSc	Genetic and environmental variation in infestation and infection with ticks and gastro-intestinal helminths in Dorper, Red Maasai and crossbred sheep in semi-arid subhumid zone of Kenya	IMMP/ Kenya
1994	1994	Okeyo Mwai, Kenyan	University of Nairobi, Kenya	PhD	Phenotypic and genetic trends of growth and reproductive traits in Kenyan improved Boran cattle	IMMP/ Ethiopia
1994	1994	Juergen Anthofer, German	University of Kassel, Germany	MSc	Study of the variation of phytochemicals in the ILCA collection of woody plant germplasm	IRM/ Ethiopia
1994	1994	Siboniso Moyo, Zimbabwean	University of Pretoria, South Africa	PhD	Evaluation of the productivity of indigenous cattle and some exotic beef breeds and crosses in Zimbabwe	IMMP/ Ethiopia
1994	1995	Lambert Muhr, German	University of Hohenheim, Germany	MSc	Potential of selected forage legumes planted on fallow land and fodder production soil improvement in integrated crop–livestock systems	IRM/ Nigeria
1994	1995	Pascal Atse Atse, Ivoirien	Liege State University, Belgium	PhD	Etude de la productivité des ruminants élevés spis rosque de trypanosomias en Côte d'Ivoire	IPE/ Côte d'Ivoire

IMMP = Increasing Milk and Meat Production; IPE = Improving Production Efficiency; IRM = Improving Resource Management.

Graduate Associates (cont'd)

Start date	End date	Name/ nationality	University/ institute	Degree	Project title	Thrust/ country
1994	1995	Jimoh Olanite, Nigerian	University of Ibadan, Nigeria	PhD	Evaluation of promising grass–legume mixtures for feeding to early weaned calves, thereby allowing small-scale dairy farmers to collect and sell more of the milk from the dams of the calves	IRM/ Nigeria
1994	1996	Robert Kaitho, Kenyan	Wageningen Agricultural University, The Netherlands	PhD	Nutritive value of MPTs and shrubs as protein supplement to poor-quality roughages	IMMP/ Ethiopia
1994	1996	Augustine Ayantunde, Nigerian	Wageningen Agricultural University, The Netherlands	PhD	Livestock-mediated nutrient transfers in SAWA landscape	IRM/ Niger
1994	1996	Denis Mpairwe, Ugandan	Makerere University, Uganda	PhD	Evaluation of two mixed cropping systems of smallholder dairy production	IMMP/ Ethiopia

IMMP = Increasing Milk and Meat Production; IPE = Improving Production Efficiency; IRM = Improving Resource Management.

Publications by ILCA staff in 1993/94

Annual reports

ILCA 1992: Annual report and programme highlights. 86 pp.

Le CIPEA en 1992: rapport annuel et synthèse des programmes. 87 pp.

ILCA annual programme report 1992. 228 pp.

ILCA (International Livestock Centre for Africa). 1994. *Improving livestock production in Africa. Evolution of ILCA's programme 1974–94.* ILCA, Addis Ababa, Ethiopia. 212 pp.

Newsletters

ILCA Newsletter Vols 12 and 13 (Nos 1–4)

CIPEA Actualités Vols 12 and 13 (Nos 1–4)

Strategy and Long-term Plan

ILCA (International Livestock Centre for Africa). 1993. *ILCA's long-term strategy, 1993–2010.* ILCA, Addis Ababa, Ethiopia. 114 pp.

ILCA (International Livestock Centre for Africa). 1993. *Sustainable production from livestock. ILCA's medium-term plan, 1994–98.* Draft for submission to TAC/CGIAR. ILCA, Addis Ababa, Ethiopia. 217 pp.

ILCA (International Livestock Centre for Africa). 1993. *Sustainable production from livestock. ILCA's medium-term plan, 1994–98. Executive summary.* Draft for submission to TAC/CGIAR. ILCA, Addis Ababa, Ethiopia. 18 pp.

Research Reports

Williams T O. 1993. *Impact of livestock pricing policies on meat and milk output in selected sub-Saharan African countries.* ILCA Research Report 20. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 88 pp.

Williams T O. 1993. *Impact des politiques des prix du bétail sur la production de viande et de lait dans certains pays de l'Afrique subsaharienne.* CIPEA Rapport de recherche n° 20. CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 88 pp.

Manuals

Hansen J and Perry B. 1994. *The epidemiology, diagnosis and control of helminth parasites of ruminants. A handbook.* ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, FAO (Food and Agriculture Organization of the United Nations), Rome, Italy, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 171 pp.

ILCA (International Livestock Centre for Africa). 1994. Forage seed production training *manual.* ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

ILCA (International Livestock Centre for Africa) and ICARDA (International Center for Agricultural Research in the Dry Areas). 1994. *Tropical forage seed production training module.* ILCA, Addis Ababa, Ethiopia, and ICARDA, Aleppo, Syria.

O'Connor C. 1993. *Traditional cheesemaking manual.* ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 43 pp.

O'Connor C B and Tripathi B R. 1993. *Techniques de transformation du lait fermenté.* Série Techniques de transformation du lait en milieu rural. Cours audiotutoriel — Module 2. CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 20 pp.

Osuji P O, Nsahlai I V and Khalili H. 1993. *Feed evaluation.* ILCA Manual 5. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 36 pp.

Systems Study

Coppock D L. 1993. *The Borana plateau of southern Ethiopia: Synthesis of pastoral*

research, development and change, 1980–91. Executive summary. ILCA Systems Study 5. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 20 pp.

Proceedings

Ehui S and Lipner M E (eds). 1993. *Livestock and resource management policy: Issues and priorities for research.* Proceedings of the Research Planning Workshop held in Addis Ababa, Ethiopia, 24–27 March 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 161 pp.

Kategile J A and Mubi S (eds). 1993. *Future of livestock industries in East and southern Africa.* Proceedings of the Workshop on the Future of Livestock Industries in East and Southern Africa, Kadoma, Zimbabwe, 20–23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 227 pp.

de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds). 1994. Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 346 pp.

Handbook

ILCA (International Livestock Centre for Africa). 1993. *Handbook of African livestock statistics.* ILCA, Addis Ababa, Ethiopia. 63 pp.

Indexes

Mekonnen Assefa (Compiler). 1993. *Index to livestock literature microfiched in Malawi.* ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 139 pp.

Mekonnen Assefa (Compiler). 1994. *Index des documents microfichés au Burkina Faso.* CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 105 pp.

Bibliography

Haque I, Pthak P, Lupwayi N Z, Tsige Amare and Asgelil Dibabe. 1994. *Vertisols and associated soils: Bibliographic database with special reference to sub-Saharan Africa.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. 83 pp.

Refereed papers, books and chapters of books

Abate Tedla, Sherington J and Mohamed-Saleem M A. 1994. Integration of forage and food crops grown sequentially on Vertisols under rainfed conditions in the mid-altitude Ethiopian highlands. *Experimental Agriculture* 30(3):291–298.

Abenet Belete, Dillon J L and Anderson F M. 1993. Efficiency of small-scale farmers in Ethiopia: A case study in the Baso and Warana sub-district. *Agricultural Economics* 8(3):199–209.

Aboagye G S, Tawah C L and Rege J E O. 1994. Shorthorn cattle of West and central Africa. III. Physical, adaptive and special genetic characteristics. *FAO World Animal Review* 78(1):22–32.

Agyemang K, Clifford K and Little D A. 1993. An assessment of the biological and economic efficiency in conversion of milk to growth in N'Dama calves. *Animal Production* 56(pt. 2):165–170.

Agyemang K, Little D A, Mattioli R, Sonko E W and Janneh L. 1993. Effects of trypanosome infection and postpartum liveweight change on resumption of reproductive activity in N'Dama cows. *Theriogenology* 39(4):985–995.

Akinbamijo O O, Reynolds L and Gort G. 1994. Effects of *Trypanosoma vivax* infection during pregnancy on feed intake, nitrogen retention and liveweight changes in West African Dwarf ewes. *Journal of Agricultural Science* 123(pt. 3):379–385.

Akinbamijo O O, Reynolds L, Sherington J and Nsahlai I V. 1994. Effects of postpartum *Trypanosoma vivax* infection on feed intake,

liveweight changes, milk yield and composition in West African Dwarf ewes and associated lamb growth rates. *Journal of Agricultural Science* 123(pt. 3):387–392.

Andargachew Kebede and Brokken R F. 1993. Intra-annual sheep price patterns and factors underlying price variations in the central highlands of Ethiopia. *Agricultural Economics* 8(2):125–138.

Azage Tegegne and Franceschini R. 1993. Evaluation of luteolysis and oestrous synchronization using a prostaglandin analog (Prosolvin) in Boran x Friesian crossbred heifers in Ethiopia. *Journal of Applied Animal Research* 4:107–114.

Azage Tegegne, Aberham Geleto and Tesfu Kassa. 1993. Short luteal phases and ovulations without oestrus in primiparous Borana (*Bos indicus*) cows in the central highlands of Ethiopia. *Animal Reproduction Science* 31(1–2):21–31.

Azage Tegegne, Entwistle K W and Mukasa-Mugerwa E. 1993. Factors affecting the reproductive performance of Boran (*Bos indicus*) cows in a single-sire mating system. *Tropical Agriculture (Trinidad)* 70(2):174–178.

Azage Tegegne, Entwistle K W and Mukasa-Mugerwa E. 1993. Plasma progesterone and blood metabolite profiles in post-partum small East African Zebu cows. *Tropical Animal Health and Production* 25(2):101–110.

Azage Tegegne, Franceschini R and Sovani S. 1994. Superovulatory response, embryo recovery and progesterone secretion in Boran (*Bos indicus*) cows after treatment with either Pergovet or Pluset. *Theriogenology* 41(8): 1653–1662.

Azage Tegegne, Osuji P O, Lahlou-Kassi A and Mukasa-Mugerwa E. 1994. Effect of dam nutrition and suckling on lactation in Borana cows and growth in their Borana x Friesian crossbred calves in an early weaning system in Ethiopia. *Animal Production* 58(pt.1):19–24.

Azage Tegegne, Yifat Dembarga, Tesfu Kassa and Franceschini R. 1994. Effect of plane of nutrition and season on body and testicular growth and on semen characteristics in Boran and Boran x Friesian bulls in Ethiopia. *Animal Reproduction Science* 36(3–4):197–209.

Azage Tegegne, Aberham Geleto, Osuji P O, Tesfu Kassa and Franceschini R. 1994. Influence of dietary supplementation and partial suckling on body weight and on lactation and reproductive performance of primiparous Boran (*Bos indicus*) cows in Ethiopia. *Journal of Agricultural Science* 123(2):267–273.

Bartholomew P W, Khibe T, Little D A and Ba S. 1993. Effect of change in body weight and condition during the dry season on capacity for work of draft oxen. *Tropical Animal Health and Production* 25(1):50–58.

Bartholomew P W, Khibe T and Little D A. 1994. Effect of liveweight and body condition on work output from draft oxen. *Tropical Animal Health and Production* 26(1):58–64.

Bonsi M L K, Osuji P O, Nsahlai I V and Tuah A K. 1994. Graded levels of *Sesbania sesban* and *Leucaena leucocephala* as supplements to teff straw fed to Ethiopian Menz sheep. *Animal Production* 59(2):235–244.

Cobbina J. 1994. Strategies for increased fodder production from *Leucaena* and *Gliricidia* to eliminate dry season feed shortages in the humid tropics. *International Tree Crops Journal* 8(1):27–35.

Codjia V, Woudyalew Mulatu, Majiwa P A O, Leak S G A, Rowlands G J, Authie E, d'Ieteren G D M and Peregrine A S. 1993. Epidemiology of bovine trypanosomiasis in the Ghibe valley, southwest Ethiopia. 3. Occurrence of population of *Trypanosoma congolense* resistant to diminazene, isometamidium and homidium. *Acta Tropica* 53(2):151–163.

Coppock D L. 1993. Grass hay and *Acacia* fruits: A local feeding system for improved calf performance in semi-arid Ethiopia. *Tropical Animal Health and Production* 25(1):41–49.

Deem S L, Perry B D, Katende J M, McDermott J J, Mahan S M, Maloo S H, Morzaria S P, Musoke A J and Rowlands G J. 1993.

Variations in prevalence rates of tick-borne diseases in Zebu cattle by agroecological zone: Implications for East Coast fever immunization. *Preventive Veterinary Medicine* 16(3): 171–187.

Duteurtre G. 1993. *Essai d'analyse dynamique de la filière produits laitiers à Addis-Abeba (Ethiopie). Diplôme d'études approfondies* et Diplôme d'agronomie approfondie, Ecole nationale supérieure agronomique de Montpellier, France. 105 pp.

Dwinger R H, Agyemang K, Kaufmann J, Grieve A S and Bah M L. 1994. Effects of trypanosome and helminth infections on health and production parameters of village N'Dama cattle in the Gambia. *Veterinary Parasitology* 54(4):353–365.

Dwinger R H, Agyemang K, Snow W F, Rawlings P, Leperre P and Bah M L. 1994. Productivity of trypanotolerant cattle under traditional management conditions in the Gambia. *Veterinary Quarterly* 16(2):81–86.

Ehui S and Polson R. 1993. A review of the economic and ecological constraints on animal draft cultivation in sub-Saharan Africa. *Soil and Tillage Research* 27(1–4): 195–210.

Ehui S K and Spencer D S C. 1993. Measuring the sustainability and economic viability of tropical farming systems: A model from sub-Saharan Africa. *Agricultural Economics* 9(4):279–296.

Fernandez-Rivera S. 1994. Seasonal variation in the microbial digestive activity, rumen ammonia concentration and diet ingested by grazing ruminants in the Sahel. *Proceedings of the Society of Nutritional Physiology* 3:324.

Fernandez-Rivera S, Midou A and Marichatou H. 1994. Effect of food allowance on diet selectivity and intake of pearl millet (*Pennisetum glaucum*) stover leaves by sheep. *Animal Production* 58(pt.2):249–256.

Girma Getachew, Said A N and Sundstol F. 1994. The effect of forage legume supplementation on digestibility and body weight gain by sheep fed a basal diet of maize stover. *Animal Feed Science and Technology* 46(1–2):97–108.

Hanson J. 1994. A rich trove of sub-Saharan Africa's forage genetic resources conserved at ILCA. *Diversity* 9(4) & 10(1):43–45.

Haque I, Aduayi E A and Sibanda S. 1993. Copper in soils, plants and ruminant animal nutrition with special reference to sub-Saharan Africa. *Journal of Plant Nutrition* 16(11):2149–2212.

Heering J H. 1994. The reproductive biology of three perennial *Sesbania* species (*Leguminosae*). *Euphytica* 74:143–148.

Heering J H and Hanson J. 1993. Karyotype analysis and interspecific hybridisation in three perennial *Sesbania* species (*Leguminosae*). *Euphytica* 71:21–28.

Hiernaux P, de Leeuw P N and Diarra L. 1994. Modelling tillering of annual grasses as a function of plant density: Application to Sahelian rangelands productivity and dynamics. *Agricultural Systems* 46(2):121–139.

Hiernaux P, Cissé M I, Diarra L and de Leeuw P N. 1994. Fluctuations saisonnières de la feuillaison des arbres et des buissons sahéliens. Conséquences pour la quantification des ressources fourragères. *Revue d'élevage et de médecine vétérinaire des pays tropicaux* 17(1):117–125.

Iji P A, Taravali G and Baba M. 1993. The influence of stage of development and sowing depth on seed quality and seedling emergence of *Gliricidia sepium*. *Seed Science and Technology* 21(1):197–202.

Itty P, Swallow B M, Rowlands G J, Agyemang K and Dwinger R H. 1993. Economics of village production of N'Dama cattle in the Gambia. *Quarterly Journal of International Agriculture* 32(3):293–307.

Jabbar M A. 1993. Evolving crop–livestock farming systems in the humid zone of West Africa. *Outlook on Agriculture* 22(1):13–21.

Jabbar M A. 1993. Research on cow traction in Africa: Some lessons to be learned. *FAO World Animal Review* 74–75/1–2:58–63.

Jabbar M A and di Domenico C M. 1993. Demand for dairy products among the

indigenous population of southern Nigeria. *Indian Journal of Dairy Science* 46(8):363–370.

Jabbar M A, Larbi A and Reynolds L. 1994. Profitability of alley farming with and without fallow in southwest Nigeria. *Experimental Agriculture* 30(3):319–327.

Jansen H G P. 1993. Ex-ante profitability of animal traction investments in semi-arid sub-Saharan Africa: Evidence from Niger and Nigeria. *Agricultural Systems* 43(3): 323–349.

Jutzi S C. 1993. Animal feed research in eastern and southern Africa priorities and trends. *Animal Research and Development* 37:59–78.

Kamuanga M and Fobasso M. 1994. Role of farmers in the evaluation of an improved variety: The case of S35 sorghum in northern Cameroon. *Journal of Farming Systems Research–Extension* 4(2):93–110.

Khalili H. 1993. Supplementation of grass hay with molasses in crossbred (*Bos taurus x Bos indicus*) non-lactating cows: effect of level of molasses on feed intake, digestion, rumen fermentation, and rumen digesta pool size. *Animal Feed Science and Technology* 41(1):23–38.

Khalili H and Osuji P O. 1994. The effect of replacement of wheat bran by graded levels of molasses on digestion, degradation and digestion kinetics of fibre and rumen digesta pool size in crossbred (*Bos taurus x Bos indicus)* steers fed native grass hay. *Animal Feed Science and Technology* 47(3–4):213–223.

Khalili M, Lindgren E and Varvikko T. 1993. A survey of mineral status of soils, feeds and cattle in the Selale Ethiopian highlands. I. Macro elements. *Tropical Animal Health and Production* 25(3):162–172.

Khalili M, Lindgren E and Varvikko T. 1993. A survey of mineral status of soils, feeds and cattle in the Selale Ethiopian highlands. II. Trace elements. *Tropical Animal Health and Production* 25(4):193–201.

Khalili H, Varvikko T and Osuji P O. 1993. Supplementation of grass hay with molasses in crossbred (*Bos taurus x Bos indicus*) non-lactating cows: effect of timing of molasses supplements on feed intake, digestion, DM degradation and rumen fermentation. *Animal Feed Science and Technology* 41(1):39–50.

Khalili H, Osuji P O, Umuna N N and Crosse S. 1994. The effects of forage type (maize–lablab or oat–vetch) and level of supplementation (wheat middlings) on food intake, diet apparent digestibility, purine excretion and milk production of crossbred (*Bos taurus* x *Bos indicus*) cows. *Animal Production* 58(pt.3):321–328.

Kouamé C N, Powell J M, Renard C A and Quesenberry K H. 1993. Plant yields and fodder quality related characteristics of millet–stylo intercropping systems in the Sahel. *Agronomy Journal* 85(3):601–605.

Lahlou-Kassi A, Rey B and Faye B. 1994. Maladies d'élevage dans les systèmes laitiers péri-urbains d'Afrique subsaharienne: l'approche du CIPEA. *Veterinary Research* 25(2–3):331–337.

Larbi A, Lazier J and Ochang J. 1993. Fodder production and nutritive value of six shrubs on acid soil in southern Ethiopia. *Tropical Agriculture (Trinidad)* 70(1): 13–15.

Larbi A, Osakwe I I and Lambourne J W. 1993. Variation in relative palatability to sheep among *Gliricidia sepium* provenances. *Agroforestry Systems* 22(3):221–224.

Larbi A, Thomas D and Hanson J. 1993. Forage potential of *Erythrina abyssinica*: Intake, digestibility and growth rates for stall-fed sheep and goats in southern Ethiopia. *Agroforestry Systems* 21(3):263–270.

Larbi A, Thomas D and Ochang J. 1993. Agronomic evaluation of *Chamaecrista roundifolia* accessions under grazing in southern Ethiopia. *East African Agricultural and Forestry Journal* 59(1): 75–78.

Larbi A, Jabbar M A, Orok E J, Idiong N B and Cobbina J. 1993. *Alchornea cordifolia*, a promising indigenous browse species adapted to acid soils in southeastern Nigeria for integrated crop–livestock agroforestry production systems. *Agroforestry* 22(1):33–41.

Larbi A, Jabbar M A, Atta-Krah A N and Cobbina J. 1993. Effect of taking fodder crop on maize grain yield and soil chemical properties in *Leucaena* and *Gliricidia* alley farming systems in western Nigeria. *Experimental Agriculture* 29(3):317–321.

Lawry S, Stienbarger D and Jabbar M A. 1994. Land tenure and the potential for the adoption of alley farming in West Africa. *Outlook on Agriculture* 23(3):183–187.

Leak S G A and Woudyalew Mulatu. 1993. Advance of *Glossina morsitans submorsitans* and *G. pallidipes* along the Ghibe river system in southwest Ethiopia. *Acta Tropica* 55(1/2):91–95.

Leak S G A, Woudyalew Mulatu, Authie E, d'Ieteren G D M, Peregrine A S, Rowlands G J and Trail J C M. 1993. Epidemiology of bovine trypanosomiasis in the Ghibe Valley, southwest Ethiopia. 1. Tsetse challenge and its relationship to trypanosome prevalence in cattle. *Acta Tropica* 53(2):121–134.

Little D A, Wassink G J, Riley J A, Agyemang K, Badjie B and Dwinger R H. 1994. Feed supplementation of village-based N'Dama calves. *Tropical Agriculture (Trinidad)* 71(3):219–222.

Little D A, Wassink G-J, Agyemang K, Leperre P, Janneh L and Badjie B. 1994. Feed supplementation of lactating N'Dama cows under village husbandry. *Tropical Agriculture (Trinidad)* 71(3):223–228.

Majiwa P A O, Thattni R, Moloo S K, Nyeko J H P, Otieno L H and Maloo S. 1994. Detection of trypanosome infections in the saliva of tsetse flies and buffy-coat samples from antigenaemic by aparasitaemic cattle. *Parasitology* 108:313–322.

Menwyelet Atsedu, Coppock D L and Detling J K. 1994. Fruit production of *Acacia tortilis* and *A. nilotica* in semi-arid Ethiopia. *Agroforestry Systems* 27(1):23–30.

Moffor F M N, Yonkeu S, Tawah C L, Mbah D A and Pano E T. 1994. Mineral and crude protein content of natural pastures on Adamawa Highlands, Cameroon. *Discovery and Innovation* 6(2):184–188.

Mugwira L M and Haque I. 1993. Screening forage and browse legumes germplasm to nutrient stress: I. Tolerance of *Medicago sativa* L. to aluminium and low phosphorus in soils and nutrient solutions. *Journal of Plant Nutrition* 16(1):17–35.

Mugwira L M and Haque I. 1993. Screening forage and browse legumes germplasm to nutrient stress: II. Tolerance of *Lablab purpureus* L. to acidity and low phosphorus in two acid soils. *Journal of Plant Nutrition* 16(1):37–50.

Mugwira L M and Haque I. 1993. Screening forage and browse legumes germplasm to nutrient stresses: III. Tolerance of *Sesbania* to aluminium and low phosphorus in soils and nutrient solution. *Journal of Plant Nutrition* 16(1):51–66.

Mugwira L M and Haque I. 1993. Screening forage and browse legumes germplasm to nutrient stresses: IV. Growth rates of *Sesbania* as affected by aluminium and low phosphorus in soils and nutrient solutions. *Journal of Plant Nutrition* 16(1):67–83.

Muinga R W, Thorpe W and Topps J H. 1993. Lactational performance of Jersey cows given Napier fodder (*Pennisetum purpureum*) with and without protein concentrates in the semi-humid tropics. *Tropical Animal Health and Production* 25(2):118–128.

Mukasa-Mugerwa E and Mutiga E R. 1993. Peripubertal plasma progesterone patterns in Ethiopian Menz ewe lambs. *Journal of Applied Animal Research* 3:31–38.

Mukasa-Mugerwa E, Anindo D, Lahlou-Kassi A, Mutiga E R and Sovani S. 1993. Seasonal variation in ovarian and oestrous activity of tropical Menz sheep as affected by plane of nutrition. *Reproduction, Nutrition, Development* 33(6):585–595.

Mukasa-Mugerwa E, Negussie A and Said A N. 1994. Effect of post-weaning level of nutrition on the early reproductive performance and productivity indices of Menz sheep. *Journal of Applied Animal Research* 5:53–61.

Mukasa-Mugerwa E, Said A N, Lahlou-Kassi A, Sherington J and Mutiga E R. 1994. Birth

weight as a risk factor for perinatal lamb mortality, and the effects of stage of pregnant ewe supplementation and gestation weight gain in Ethiopian Menz sheep. *Preventive Veterinary Medicine* 19(1):45–56.

Mukasa-Mugerwa E, Sovani S, Toe F and Lahlou-Kassi A. 1994. Reproductive responses associated with ram introduction in mature tropical Menz ewes after a period of isolation. *Animal Reproduction Science* 36(3–4):243–251.

Mureithi J G, Tayler R S and Thorpe W. 1994. The effects of alley cropping with *Leucaena leucocephala* and of different management practices on the productivity of maize and soil chemical properties in lowland coastal Kenya. *Agroforestry Systems* 27(1):31–51.

Mureithi J G, Thorpe W, Tayler R S and Reynolds L. 1994. Evaluation of *Leucaena* accessions for the semi-humid lowland tropics of East Africa. *Tropical Agriculture (Trinidad)* 71(2):83–87.

Murphy M, Khalili H and Huhtanen P. 1993. The substitution of barley by other carbohydrates in grass silage based diets to dairy cows. *Animal Feed Science and Technology* 41(4):279–296.

Mutiga E R, Mukasa-Mugerwa E and Azage Tegegne. 1993. Luteolytic effect of prostaglandin F_{2x} in Boran and Boran x Friesian cross-bred heifers. *Journal of Agricultural Science* 120(1):103–106.

Ngategize P K, Tekelye Bekele and Getachew Tilahun. 1993. Financial losses caused by ovine fasciolosis in the Ethiopian highlands. *Tropical Animal Health and Production* 25(3):155–161.

Nnadi L A, Haque I and Mugwira R M. 1993. Phosphorus response and mineral composition of Ethiopian highland *Trifolium* (clover) species. *Communications in Soil Science and Plant Analysis* 24(7&8):641–656.

Nokoe S and Agbavwe C. 1993. Determining the optimum number of strata for sampling a normally distributed forest population. *Discovery and Innovation* 5(4):301–305.

Nsahlai I V, Siaw D E K A and Osuji P O. 1994. The relationships between gas production and chemical composition of 23 browses of the genus *Sesbania*. *Journal of the Science of Food and Agriculture* 65(1):13–20.

O'Connor C B, Mezgebu S and Zewdie Z. 1993. Improving the efficiency of butter-making in Ethiopia. *FAO World Animal Review* 77/4: 50–52.

Osuji P O and Khalili H. 1994. The effect of replacement of wheat bran by graded levels of molasses on feed intake, organic matter digestion, rumen fermentation and nitrogen utilization in crossbred (*Bos taurus* x *Bos indicus*) steers fed native grass hay. *Animal Feed Science and Technology* 48(1–2):153–163.

Osuji P O, Sibanda S and Nsahlai I V. 1993. Supplementation of maize stover for Ethiopian Menz sheep: effects of cottonseed, noug (*Guizotia abyssinica*) or sunflower cake with or without maize on the intake, growth, apparent digestibility, nitrogen balance and excretion of purine derivatives. *Animal Production* 57(pt.3):429–436.

Ouologuem B, Reese A A, Traore A and Debrah S K. 1994. Profitability of replacing milk with a concentrate for calves of cows requiring calf at foot for milking. *Tropical Animal Health and Production* 26(1):37–48.

Peters M, Tarawali S A and Alkamper J. 1994. Evaluation of tropical pasture legumes for fodder banks in subhumid Nigeria. 1. Accessions of *Centrosema pascuorum, Chamaecrista rotundifolia* and *Stylosanthes hamata*. *Tropical Grasslands* 28(2):65–73.

Peters M, Tarawali S A and Alkamper J. 1994. Evaluation of tropical pasture legumes for fodder banks in subhumid Nigeria. 2. Accessions of *Aeschynomene histrix, Centrosema acutifolium Centrosema pascuorum, Stylosanthes guianensis* and *Stylosanthes hamata*. *Tropical Grasslands* 28(2):74–79.

Powell J M and Fussell L K. 1993. Nutrient and structural carbohydrate partitioning in pearl millet. *Agronomy Journal* 85(4):862–866.

Powell J M, Fernandez-Rivera S and Hofs S. 1994. Effects of sheep diet on nutrient

cycling in mixed farming systems of semi-arid West Africa. *Agriculture, Ecosystems and Environment* 48:263–271.

Rege J E O. 1994. International Livestock Centre preserves Africa's declining wealth of animal biodiversity. *Diversity* 10(3):21–24.

Rege J E O and Famula T R. 1993. Factors affecting calving date and its relationship with production traits of Hereford dams. *Animal Production* 57(pt.3):385–395.

Rege J E O and Moyo S. 1993. Effect of birth date on growth performance of calves of seasonally-bred range cattle. *Journal of Animal Breeding and Genetics* 110(3):209–227.

Rege J E O, Aboagye G S and Akah S. 1993. A method for estimating between-breed differences in crossbreeding parameters and their sampling variances. *Livestock Production Science* 33(3,4):327–340.

Rege J E O, Aboagye G S and Tawah C L. 1994. Shorthorn cattle of West and Central Africa. I. Origin, distribution, classification and population statistics. *FAO World Animal Review* 78/1:?-13.

Rege J E O, Aboagye G S and Tawah C L. 1994. Shorthorn cattle of West and Central Africa. II. Ecological settings utility, management and production system *FAO World Animal Review* 78/1:14–21.

Rege J E O, Aboagye G S and Tawah C L. 1994. Shorthorn cattle of West and Central Africa. IV. Production characteristics. *FAO Word Animal Review* 78/1:33–48.

Rege J E O, von Kaufmann R R and Mani R I. 1993. On-farm performance of Bunaji (White Fulani) cattle. 1. Herd structures and cattle disposal. *Animal Production* 57(pt.2): 199–209.

Rege J E O, von Kaufmann R R, Mwenya W N M, Otchere E O and Mani R I. 1993. On-farm performance of Bunaji (White Fulani) cattle. 2. Growth, reproductive performance, milk offtake and mortality. *Animal Production* 57(pt.2):211–220.

Rege J E O, Aboagye G S, Akah S and Ahunu B K. 1994. Crossbreeding Jersey with Ghana shorthorn and Sokoto Gudali cattle in a tropical environment: Additive and heterotic effects for milk production, reproduction and calf growth traits. *Animal Production* 59(pt. 1):21–29.

Rey B and Jacob U. 1993. Modalité d'exploitation des caprins dans la province de Ngozi, Burundi. *Revue d'élevage et de médecine vétérinaire des pays tropicaux* 46(4):637–644.

Reynolds L and Adediran S. 1994. Composition of village goat herds in southwest Nigeria. *Small Ruminant Research* 13(1):49–53.

Reynolds L and Jabbar M. 1994. The role of alley farming in African livestock production. *Outlook on Agriculture* 23(2):105–113.

Rowlands G J, Woudyalew Mulatu, Authie A, d'Ieteren G D M, Leak S G A, Nagda S M and Peregrine A S. 1993. Epidemiology of bovine trypanosomiasis in the Ghibe Valley, southwest Ethiopia. 2. Factors associated with variations in trypanosome prevalence, incidence of new infections and prevalence of recurrent infections. *Acta Tropica* 53(2): 135–150.

Rowlands G J, Woudyalew Mulatu, Authie E, d'Ieteren G D M, Leak S G A and Nagda S M. 1994. Effects of trypanosomiasis on growth and mortality of young East African Zebu cattle exposed to drug-resistant trypanosomes. *Preventive Veterinary Medicine* 21(1):87–101.

Rowlands G J, Woudyalew Mulatu, Authie E, d'Ieteren G D M, Leak S G A and Nagda S M. 1994. Effects of trypanosomiasis on reproduction of East African Zebu cows exposed to drug-resistant trypanosomes. *Preventive Veterinary Medicine* 21(3):237–250.

Ruredzo T J and Hanson J. 1993. Plant recovery from seedling-derived shoot tips *of Faidherbia albida* grown *in vitro*. *Agroforestry Systems* 22(1):59–65.

Said A N and Adugna Tolera. 1993. The supplementary value of forage legume hays in sheep feeding: feed intake, nitrogen retention and body weight change. *Livestock Production Science* 33(3,4):229–237.

Shapiro B I, Sanders J H, Reddy K C and Baker T G. 1993. Evaluating and adapting new

technologies in a high-risk agricultural system — Niger. *Agricultural Systems* 42 (1&2):153–171.

Siaw D E K A, Osuji P O and Nsahlai I V. 1993. Evaluation of multipurpose tree germplasm: the use of gas production and rumen degradation characteristics. *Journal of Agricultural Science* 120(pt.3):319–330.

Sibanda S, Osuji P O and Nsahlai I V. 1993. The degradation of oilseed cakes and their effects on the intake and rumen degradability of maize stover given to Ethiopian Menz sheep. *Animal Production* 57(pt.3):421–428.

Staal S and Shapiro B I. 1994. The effects of recent price liberalization on Kenyan peri-urban dairy. *Food Policy* 19(6):533–549.

Swallow B M and Bromley D W. 1994. Co-management or no management: The prospects for internal governance of common property regimes through dynamic contracts. *Oxford Agrarian Studies* 22(1): 3–16.

Swallow B M and Woudyalew Mulatu. 1994. Evaluating willingness to contribute to a local public good: application of contingent valuation to tsetse control in Ethiopia. *Ecological Economics* 11(2):153–161.

Tarawali S A. 1994. Evaluating selected forage legumes for livestock and crop production in the subhumid zone of Nigeria. *Journal of Agricultural Science* 123(pt.1):55–60.

Tarawali S A. 1994. The yield and persistence of selected forage legumes in subhumid and semi-arid West Africa. *Tropical Grasslands* 28(2):80–89.

Tawah C L, Mbah D A, Rege J E O and Oumate H. 1993. Genetic evaluation of birth and weaning weight of Gudali and two-breed synthetic Wakwa beef cattle populations under selection in Cameroon: Genetic and phenotypic parameters. *Animal Production* 57(pt.1):73–79.

Tawah C L, Rege J E O, Mbah D A and Oumate H. 1994. Genetic evaluation of birth and weaning weight of Gudali and two-breed synthetic Wakwa beef cattle populations under selection in Cameroon: Genetic and phenotypic trends. *Animal Production* 58(pt.1):25–34.

Tekelye Bekele, Bruns E, Kasali O B and Mutiga E R. 1993. The effects of endoparasites on the reproductive performance of on-farm sheep in the Ethiopian highlands. *Indian Journal of Animal Sciences* 63(1):8–12.

Thorpe W, Kang'ethe P, Rege J E O, Mosi R O, Mwandotto B A J and Njuguna P. 1993. Crossbreeding Ayrshire, Friesian, and Sahiwal cattle for milk yield and preweaning traits of progeny in the semiarid tropics of Kenya. *Journal of Dairy Science* 76:2001–2012.

Thorpe W, Morris C A and Kangethe P. 1994. Crossbreeding of Ayrshire, Brown Swiss, and Sahiwal cattle for annual and lifetime milk yield in the lowland tropics of Kenya. *Journal of Dairy Science* 77:2415–2427.

Toe F, Lahlou-Kassi A and Mukasa-Mugerwa E. 1994. Semen characteristics of Ile-de-France rams of different age and physical condition. *Theriogenology* 42(2):321–326.

Touré A S, Grandtner M M and Hiernaux P Y. 1994. Relief, sols et végétation d'une savane soudano-sahélienne du Mali central. *Phytocoenologia* 24:233–256.

Trail J C M, d'Ieteren G D M, Murray M, Ordner G, Yangari G, Collardelle C, Sauveroche B, Maille J C and Viviani P. 1993. Measurement of trypanotolerance criteria and their effect on reproductive performance of N'Dama cattle. *Veterinary Parasitology* 45(3–4):241–255.

Trail J C M, Wissocq N, d'Ieteren G D M, Kakiese O and Murray M. 1994. Patterns of Trypanosoma vivax and *T. congolense* infection differ in young N'Dama cattle and their dams. *Veterinary Parasitology* 55(3): 175–183.

Trail J C M, Wissocq N, d'Ieteren G D M, Kakiese O and Murray M. 1994. Quantitative phenotyping of N'Dama cattle for aspects of trypanotolerance under field tsetse challenge. *Veterinary Parasitology* 55(3):185–195.

Varvikko T and Khalili H. 1993. Wilted tagasaste (*Chamaecytisus palmensis*) forage as a replacement for a concentrate supplement for lactating crossbred Friesian x zebu (Boran) dairy cows fed low quality native hay. *Animal*

Feed Science and Technology 40(2–3):239–250.

Williams T O. 1993. Livestock pricing policy in sub-Saharan Africa: Objectives, instruments and impact in five countries. *Agricultural Economics* 8(2):139–159.

Williams T O. 1994. Identifying target groups for livestock improvement research: The classification of sedentary livestock producers in western Niger. *Agricultural Systems* 46(2): 227–237.

Woji A Y, Little D A and Ikwuegbu O A. 1994. Prevalence of coccidial infections in the West African Dwarf goat in the subhumid zone of Nigeria. *Tropical Animal Health and Production* 26(1):1–6.

Zerbini E, Gemeda T, Tegegne A, GebreWold A and Franceschini R. 1993. Effects of work and diet on progesterone secretion, short luteal phases and ovulations without estrus in postpartum F_1 crossbred dairy cows. *Theriogenology* 40(3):571–584.

Zerbini E, Gemeda T, Franceschini R, Sherington J and Wold A G. 1993. Reproductive performance of F_1 crossbred dairy cows used for draught: Effect of work and diet supplementation. *Animal Production* 57(pt.3): 361–368.

Non-refereed papers and articles

O'Connor C. 1993. Traditional cheesemaking in West Africa. *Dairy Technology Paper* 3(2): 14–18

Mullins G. 1994. Kenya agriculture in the 21st century: Peri-urban dairying presents new opportunities for Coast farmers. *Kenya Farmer* 63:28–32.

Powell J M. 1994. Livestock and nutrient cycling: Report on an international conference. *ILEIA Newsletter* 10(2):16.

Turner M. 1994. Grazing options to intensify land use. *ILEIA Newsletter* 10(2):14–15.

Papers in proceedings

Abate Tedla and Getachew Asamenew. 1993. Food and feed production strategies for Vertisols. In: *Report of the annual meeting on AFRICALAND Management of Vertisols in Africa, held in Accra, Ghana, 11–13 June 1992.* IBSRAM Network Document 3. IBSRAM (International Board for Soil Research and Management), Bangkok, Thailand. pp. 85–94.

Abate A, Dzowela B H and Kategile J A. 1993. Intensive animal feeding practices for optimum feed utilisation. In: Kategile J A and Mubi S (eds), *Future of livestock industries in East and southern Africa.* Proceedings of a workshop held at Kadoma Ranch Hotel, Zimbabwe, 20–23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 9–19.

Abiye Astatke. 1993. Research on the draught animal power systems in Ethiopia. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 199–204.

Abiye Astatke and Mohamed-Saleem M A. 1994. Experiences with the use of a single ox for cultivation in the Ethiopian highlands. In: Starkey P, Mwenya E and Stares J (eds), *Improving animal traction technology.* Proceedings of the first workshop of the Animal Traction Network for Eastern and Southern Africa, held in Lusaka, Zambia, 18–23 January 1992. CTA (Technical Centre for Agricultural and Rural Coop-

eration), Wageningen, The Netherlands. pp. 301–305.

Aboud A A, Owen E, Reed J D, Said A N and McAllan A B. 1993. Feeding sorghum stover to Ethiopian goats and sheep: Effect of amount offered on intake, selection and performance. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 202–203.

Aboud A A O, Owen E, Reed J D, Said A N and McAllan A B. 1993. Feeding sorghum stover to Ethiopian goats and sheep: Effect of amount offered on growth, intake and selection. In: Lokeshwar R R (ed), *Recent advances in goat production.* Proceedings of the Fifth International Conference on Goats held in New Delhi, India, 2–8 March 1992. Published in collaboration with the International Goat Association, Utah, USA/ International Development Research Centre, Ottawa, Canada/Food and Agriculture Organization of the United Nations, Rome, Italy/Indo-Swiss Goat Development and Fodder Production Project, Rajasthan, India. pp. 791–793.

Adeoti A A, Tarawali S A and Mohamed-Saleem M A. 1994. Development of management strategies for stylo with emphasis on pests and diseases. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 123–128.

Agyemang K, Little D A and Dwinger R H. 1994. Salvaging the image of the N'Dama breed: Productivity evidence from village production systems in the Gambia. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 123–133.

Baker R L and Rege J E O. 1994. Genetic resistance to diseases and other stresses in improvement of ruminant livestock in the tropics. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments.* Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Ontario, Canada. pp. 405–412.

Baker R L, Reynolds L, Mwamachi D M, Audho J O, Magadi M and Miller J E. 1993. Genetic resistance to gastrointestinal parasites in Dorper and Red Maasai x Dorper lambs in coastal Kenya. In: *Proceedings of the 11th Small Ruminant–CRSP Scientific Workshop.* Small Ruminant Collaborative Research Support Programme, Nairobi, Kenya. pp. 228–241.

Baker R L, Mwamachi D M, Audho J O and Thorpe W. 1994. Genetic resistance to gastrointestinal nematode parasites in Red Maasai sheep in Kenya. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments.* Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Ontario, Canada. pp. 277–280.

Bartholomew P W and Khibe T. 1993. Recherches aux effets de poids vif et embonpoint des boeufs de labour sur la capacité de travail. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for devel-*

opment of animal traction in West Africa. Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 205–208.

Cisse M I, Hiernaux P and Diarra L. 1993. Intégration agropastorale au Sahel: dynamique et potentiel fourrager des jachères. In: *La jachère en Afrique de l'Ouest, Office de la recherche scientifique et technique outremer, Paris (France).* Atelier international sur la jachère en Afrique de l'Ouest, Montpellier (France), 2–5 décembre 1991. Colloques et séminaires de l'ORSTOM (France). pp. 407–413.

Coppock D L. 1993. Constraints to development of extensive livestock systems: Experiences from southern Ethiopia. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 87–92.

Coppock D L. 1993. Vegetation and pastoral dynamics in the southern Ethiopian rangelands: implications for theory and management. In: Behnke R H Jr, Scoones I and Kerven C (eds), *Range ecology at disequilibrium. New models of natural variability and pastoral adaptation in African savannas.* Overseas Development Institute, London, UK. pp. 42–61.

Diarra L and de Leeuw P N. 1994. Introduction de *Stylosanthes hamata* dans les systèmes agropastoraux au Mali: revue bibliographique. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 215–230.

Dolan R B, Alushula H, Munga L, Mutugi M, Mwendia C, Okech G, Sayer P D, Stevenson P G W, Baker R L and Magadi M. 1994. The Orma Boran — ten years of field observations. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 71–79.

Ehui S. 1993. Environmental degradation in sub-Saharan Africa: Issues for policy analysis. In: Ehui S and Lipner M E (eds), *Livestock and resource management policy. Issues and priorities for research.* Proceedings of the Research Planning Workshop, held at ILCA, Addis Ababa, Ethiopia, 24–27 March 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 119–126.

Ehui S K and Hertel T W. 1994. Models for assessing the impact of deforestation: A case study. In: *Proceedings of the XVIIth International Biometric Conference, Hamilton, Ontario, Canada, 8–12 August 1994.* Department of Mathematics and Statistics, McMaster University, Ontario, Canada. pp. 287–302.

Ehui S K, Williams T O and Swallow B M. 1994. Economic factors and policies encouraging environmentally detrimental land use practices in sub-Saharan Africa. In: *Proceedings of the XXIInd International Conference of Agricultural Economists on Agricultural Competitiveness: Market Forces and Policy Choice, Harare, Zimbabwe, 22–29 August 1994.* IAAE (International Association of Agricultural Economists), Illinois, USA. pp. IP–5A, 1–21.

Fitzhugh H A. 1993. Appropriate global strategies for developing animal agriculture. In: *Proceedings of the 7th World Conference on Animal Production held in Edmonton, Alberta, Canada, 28 June–2 July 1993. Volume 1, invited papers.* Department of

Animal Science, Alberta University, Edmonton AB, Canada. pp. 499–512.

Fitzhugh H A. 1993. Sustainability of animal agriculture in tropical Africa. In: *Proceedings of the 7th World Conference on Animal Production held in Edmonton, Alberta, Canada, 28 June–2 July 1993. Volume 1, invited papers.* Department of Animal Science, Alberta University, Edmonton AB, Canada. pp. 63–76.

Freeman H A. 1994. Population pressure, land use, and the productivity of agricultural systems in the West African Savanna. In: Breth S A (ed), *Issues in African rural development.* No. 2. Winrock International Institute for Agricultural Development, Virginia, USA. pp. 103– 114.

Gavian S and Gemechu Degefa. 1994. Commercial investors and access to land. In: Dessalegn Rahmato (ed), *Land tenure and land policy in Ethiopia after the Derg.* Proceedings of the Second Workshop of the Land Tenure Project, Addis Ababa, Ethiopia, 5–6 May 1994. Centre for Environment and Development, University of Trondheim, Norway. pp. 147–162.

Getachew Asamenew and Abate Tedla. 1993. Research on crop and livestock intensification on small farm Vertisols: ILCA's experience. In: *Report of the annual meeting on AFRICALAND Management of Vertisols in Africa, held in Accra, Ghana, 11–13 June 1992.* IBSRAM Network Document 3. IBSRAM (Inter- national Board for Soil Research and Management), Bangkok, Thailand. pp. pp. 121–130.

Getachew Asamenew, Zerbini E and Abate Tedla. 1993. Crop–livestock interactions and implications for animal traction research in the Ethiopian highlands. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991.* IAR/NLIC Proceedings 4. IAR (Institute of Agricultural Research), Addis Ababa, Ethiopia. pp. 29–36.

Griffiths R. 1993. Sustainable supplies of quality herbage seed for sub-Saharan Africa smallholders. In: *Proceedings of the XVII International Grassland Congress, New Zealand, 13–16 February 1993. Vol. V, no. 2.* New Zealand Grassland Association, New Zealand/Tropical Grasslands Society of Australia, Australia/ New Zealand Society of [illegible]al Production, New Zealand. pp. 1747–

Griffiths R G. 1994. *Stylosanthes* seed production management. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 299–307.

Hanson J. 1993. Fodder tree germplasm activities at ILCA. In: *Proceedings of the International Consultation on the Development of the ICRAF MPT-Germplasm Resource Centre, Nairobi, 2–5 June 1992.* ICRAF (International Centre for Research in Agroforestry), Nairobi, Kenya. pp. 137–143.

Hanson J (ed). 1994. *Seed production by smallholder farmers.* Proceedings of the ILCA/ ICARDA Research Planning Workshop held at ILCA, Addis Ababa, Ethiopia, 13–15 June 1994. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 56 pp.

Hanson J and Heering J H. 1994. Genetic resources of *Stylosanthes* species. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 55–61.

d'Ieteren G. 1994. Trypanotolerant livestock, a sustainable option for increasing livestock production in tsetse-affected areas. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA

(International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 3–11.

d'Ieteren G D M. 1994. Utilisation du test Elisa de détection des antigènes trypanosomiens pour l'amélioration génétique de bétail trypanotolérant. In: *Journées scientifiques du réseau Biotechnologies animales de l'UREF sur le thème "Biotechnologies du diagnostic et de la prévention des maladies animales", Liège (Belgique), 13–15 octobre 1993.* Organisées par l'UREF en collaboration avec la faculté de médecine vétérinaire, Université de Liège (Belgique). pp. 313–318.

d'Ieteren G and Trail J C M. 1993. Amélioration génétique du bétail trypanotolérant: programmes en cours et futurs du CIPEA. In: Chupin D, Wagner H and Wilson T (eds), *L'amélioration génétique des bovins en Afrique de l'Ouest.* Atelier sur l'amélioration génétique des bovins en Afrique de l'Ouest, Banjul (Gambie), octobre 1992. Etude FAO: production et santé animales 110. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. pp. 53–56.

d'Ieteren G D M and Trail J C M. 1994. Field research on measurement and use of trypanotolerance criteria to enhance trypanotolerant livestock productivity. 1. ILCA's achievements and future plans. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 23–28.

Ikwuegbu O A, Tarawali G and von Kaufmann R. 1993. Wet season supplementation of West African Dwarf (WAD) goats in the subhumid zone of Nigeria. In: Adamu A M, Mani R I, Osinowo O A, Adeoye K B and Ajileye E O (eds), *Forage production and utlization in Nigeria.* Proceedings of the Second NLPD Workshop on Forage Production and Utilization in Nigeria, Zaria, Nigeria, 11–14 February 1991. Ministry of Agriculture and Water Resources, Kaduna, Nigeria. pp. 157–165.

Ikwuegbu O A, Tarawali G and Iji P. 1994. Sustaining a crop–livestock farming system in the subhumid zone of Nigeria by matching feed from improved *Stylosanthes*-based pastures and livestock production. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 167–174.

Itty P and Swallow B. 1994. The economics of trypanotolerant cattle production in regions of origin and areas of introduction. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 103–114.

Jabbar M A. 1993. Market potential for increased small ruminant production in southwest Nigeria. In: Ayeni A O and Bosman H G (eds), *Goat production systems in the humid tropics.* Proceedings of the International Workshop on Goat Production Systems in the Humid Tropics, held in Ile-Ife, Nigeria, 6–9 July 1992. PUDOC Scientific Publishers, Wageningen, The Netherlands. pp. 97–107.

Jabbar M A. 1993. Research on cow traction in Africa: Some lessons to be learnt. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock

Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 263–268.

Jutzi S C and Tothill J C. 1993. Animal feed research in eastern and southern Africa: Historical and actual priorities. In: *Proceedings of the XVII International Grassland Congress, Rockhampton, Australia, 18–21 February 1993. Vol V, no. 3.* New Zealand Grassland Association, New Zealand/ Tropical Grasslands Society of Australia, Australia/New Zealand Society of Animal Production, New Zealand. pp. 2020–2021.

Kachelriess S and Tarawali S A. 1993. The potential of weed control to improve seed production in selected tropical forage legumes. In: *Proceedings of the XVII International Grassland Congress, New Zealand, 13–16 February 1993. Vol V, no. 2.* New Zealand Grassland Association, New Zealand/Tropical Grasslands Society of Australia, Australia/New Zealand Society of Animal Production, New Zealand. pp. 1650–1651.

Kachelriess S and Tarawali S A. 1994. The effects of row spacing and weed control on seed production of *Stylosanthes* in the subhumid zone of Nigeria. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 287–297.

Kategile J A and Smith O. 1993. Systems research experiences in Africa. In: *Proceedings of the 7th World Conference on Animal Production held in Edmonton AB, Alberta, Canada, 28 June–2 July 1993. Volume 1, invited papers.* Department of Animal Science, Alberta University, Edmonton, Alberta, Canada. pp. 349–366.

von Kaufmann R R and Fitzhugh H A. 1993. Technical constraints to ruminant livestock production in sub-Saharan Africa. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 13–24.

Khazaal K, Mueller-Harvey I, McAllan A B, Osafo E L K, Owen E and Said A N. 1993. Effect on harvesting at different stages of growth and long term storage on phenolics in sorghum stover. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 210–211.

Khibe T and Bartholomew P W. 1993. Recherches aux possibilités de conditionnement des boeufs de labour à base de paille de brousse enrichie à l'urée et évaluation de son impact sur leur capacité de travail. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 175–179.

Kouamé C N, Powell J M and Renard C A. 1994. Development of millet–stylo cropping systems for sandy soils in the Sahel. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 193–201.

Larbi A, Hanson J and Ochang J. 1994. *Stylosanthes* accessions for medium-altitude acid soils. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992.

ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 75–79.

Larbi A, Smith J W, Adekunle I O and Raji A M. 1994. Intra-species variation in forage quality among *Calliandra calothyrsus* provenances. In: *National Conference on Forage Quality, Evaluation and Utilization, University of Nebraska, Lincoln, USA, April 15–23, 1994.* Poster Session Abstract. p. 40.

Lawrence P R and Pearson R A. 1993. Experimental methods in draught animal research. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 187–198.

Leak S G A, d'Ieteren G and Rowlands G J. 1994. Factors affecting estimation of tsetse challenge and the expression of trypanotolerance. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 15–22.

Lebbie S H B. 1993. Small ruminants: What kind of development? In: Tacher G and Letenneur L (eds), *Livestock production and diseases in the tropics — "Animal production as an essential part of sustainable agriculture". Vol. I.* Proceedings of the Seventh International Conference, Institution of Tropical Veterinary Medicine, Yamoussoukro, Côte d'Ivoire, September 1992. German Foundation for International Development, Bonn, Germany. pp. 173–181.

de Leeuw P N. 1994. Stylo as forage and fallow: Synthesis and review. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 325–334.

de Leeuw P N and Mohamed-Saleem M A. 1994. Management options for increasing productivity of *S. hamata* in fodder banks and in smallholder leys in West Africa. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 129–135.

de Leeuw P N and Tothill J C. 1993. The concept of rangeland carrying capacity in sub-Saharan Africa — myth or reality? In: Behnke R H Jr, Scoones I and Kerven C (eds), *Range ecology at disequilibrium. New models of natural variability and pastoral adaptation in African savannas.* Overseas Development Institute, London, UK. pp. 77–88.

de Leeuw P N, Diarra L and Hiernaux P. 1993. An analysis of feed demand and supply for pastoral livestock: The Gourma region of Mali. In: Behnke R H Jr, Scoones I and Kerven C (eds), *Range ecology at disequilibrium. New models of natural variability and pastoral adaptation in African savannas.* Overseas Development Institute, London, UK. pp. 136–152.

de Leeuw P N, Roeleveld A and Agishi E. 1994. Population dynamics and yield of *Stylosanthes hamata* cv Verano pastures in northern Nigeria. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 105–111.

Little D A and Agyemang K. 1994. An assessment of stylo as a source of supplementary feeding. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 147–153.

Little D A, Tanner J C, Sonko E and Saho E. 1993. Strategic wet season supplementation of traditionally managed N'Dama cows using sesame cake produced in Gambian villages. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 156–157. Poster abstract.

Maloo S H, Thorpe W, Perry B D and Ngumi P N. 1994. Systematic epidemiological studies to identify and resolve health constraints to smallholder dairy production in coastal lowland Kenya. In: Rowlands G J, Kyule M N and Perry B D (eds), Proceedings of the 7th International Symposium on Veterinary Epidemiology and Economics, Nairobi, Kenya, 15–19 August 1994. *The Kenya Veterinarian* 18(2):359–361.

Mani R I, von Kaufmann R R, Egan A R, Oyedipe E O, Dixon R M and Holmes J. 1993. Optimal utilization of fodder banks for the reproductive efficiency of Bunaji cattle: Effect of dry season forage legume supplementation on weight and reproductive performance. In: Adamu A M, Mani R I, Osinowo O A, Adeoye K B and Ajileye E O (eds), *Forage production and utlization in Nigeria.* Proceedings of the Second NLPD Workshop on Forage Production and Utilization in Nigeria, Zaria, Nigeria, 11–14 February 1991. Ministry of Agriculture and Water Resources, Kaduna, Nigeria. pp. 135–150.

Mani R I, von Kaufmann R, Egan A R, Dixon R M and Holmes J H G. 1994. Development of grazing and utilisation strategies for stylo-based pasture supplies adapted to cattle production systems. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 155–165.

Matthewman R W, Dijkman J T and Zerbini E. 1993. The management and husbandry of male and female draught animals: research achievements and needs. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 125–136.

Metz T. 1993. Handling livestock performance data. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991.* IAR/NLIC Proceedings 4. Institute of Agricultural Research, Addis Ababa, Ethiopia. pp. 66–71.

Mgheni M, Mukhebi A W, Setshwaelo L L, Tsiresy P, Nyathi P, Osuji P and Kategile J A. 1993. Synthesis of constraints to livestock research and development and recommendations. In: Kategile J A and Mubi S (eds), *Future of livestock industries in East and southern Africa.* Proceedings of a workshop held at Kadoma Ranch Hotel, Zimbabwe, 20–23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 219–223.

Mohamed M A and O'Connor C B. 1994. Milk coagulating properties of *Calotropis procera* juice extract. In: *Brief Communications of the XXIV International Dairy Congress, Melbourne, September 18–22.* International Dairy Federation, Brussels, Belgium. p. 34.

Mohamed-Saleem M A. 1994. Stylosanthes for pasture development. An overview of ILCA's

experience in Nigeria. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop*. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 17–23.

Mohamed-Saleem M A and Fisher M J. 1993. Role of ley farming in crop rotations in the tropics. In: *Proceedings of the XVII International Grassland Congress, Rockhampton, Australia, 18–21 February 1993. Vol V, no. 3*. New Zealand Grassland Association, New Zealand/Tropical Grasslands Society of Australia, Australia/New Zealand Society of Animal Production, New Zealand. pp. 2179–2187.

Mohamed-Saleem M A and de Leeuw P N. 1994. Stylo-based feed production research: The implications for future development. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop*. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 317–323.

Mohamed-Saleem M A and de Leeuw P N. 1994. Stylo-based pasture development for agropastoral production systems. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop*. Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 139–145.

Moyo S, Rege J E O and Swanepoel F J C. 1994. Evaluation of indigenous, exotic and crossbred cattle for beef production in a semi arid environment. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments*. Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Guelph, Ontario, Canada. pp. 344–347.

Mukasa-Mugerwa E and Azage Tegegne. 1993. Reproductive performance in Ethiopian Zebu (*Bos indicus*) cattle: Constraints and impact on production. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991*. IAR/NLIC Proceedings 4. Institute of Agricultural Research, Addis Ababa, Ethiopia. pp. 16–28.

Mwamachi D M, Audho J O, Magadi M, Reynolds L and Baker R L. 1993. Evidence for multiple anthelmintic resistance of gastrointestinal nematodes in sheep in coastal Kenya. In: *Proceedings of the 11th Small Ruminant-CRSP Scientific Workshop, Nairobi, Kenya, 3–4 March 1993*. Small Ruminant Collaborative Research Support Programme, Nairobi, Kenya. pp. 136–140.

O'Connor C. 1994. Smallholder and village milk processing in the highlands of Ethiopia. In: Mann E J, Brookes B and Mpofu N (eds), *Dairy development policy and implementation. Sharing of experiences between Africa and Asia*. Proceedings of a seminar held in Harare, Zimbabwe, 12–16 July 1993. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. pp. 241–246

O'Connor C B and Tessema A. 1994. Effect of variations in the manufacturing process on the quality of *Ayib* cheese. In: *Brief Communications of the XXIV International Dairy Congress, Melbourne, September 18–22*. International Dairy Federation, Brussels, Belgium. p. 35.

O'Connor C B and Tessema A. 1994. The quality of butter and cheese sold in rural markets in Ethiopia. In: *Brief Communications of the XXIV International Dairy Congress, Melbourne, September 18–22*. International Dairy Federation, Brussels, Belgium. p. 35.

O'Connor C B and Tessema A. 1994. Effect of addition of spices on the quality of butter. In: *Brief Communications of the XXIV International Dairy Congress, Melbourne, September 18–22.* International Dairy Federation, Brussels, Belgium. p. 36.

Osafo E L K, Owen E, Said A N, Gill E M, McAllan A B and Kebede Y. 1993. Sorghum stover as ruminant feed in Ethiopia: Effect of cultivar, site of growth, pre-harvest leaf stripping and storage on yield and morphology. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 188–189.

Osafo E L K, Owen E, Said A N, Gill E M and McAllan A B. 1993. Feeding sorghum stover to Ethiopian sheep and cattle: Effect of chopping and amount offered on intake and selection. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 204–206.

Otieno L, Ackello-Ogutu C, Mullins C and Reynolds L. 1993. Evaluation of small ruminant marketing in coastal Kenya. In: *Proceedings of the 11th Small Ruminant–CRSP Scientific Workshop, Nairobi, Kenya, 3–4 March 1993.* Small Ruminant Collaborative Research Support Programme, Nairobi, Kenya. pp. 211–219.

Otieno L, Ackello-Ogutu C, Mullins G and Reynolds L. 1993. Farmers' reasons for owning small ruminants in a case study of small ruminant production and marketing in the semi-humid zone of Kaloleni Division, Coast province. In: *Proceedings of the 11th Small Ruminant–CRSP Scientific Workshop, Nairobi, Kenya, 3–4 March 1993.* Small Ruminant Collaborative Research Support Pro- gramme, Nairobi, Kenya. pp. 189–193.

Panin A and Brokken R F. 1993. Economic analysis of cow traction farm technology in the Ethiopian highlands. In: Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds), *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West Africa Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. pp. 221–226.

Peregrine A S, Woudyalew Mulatu, Leak S G A and Rowlands G J. 1994. Epidemiology of bovine trypanosomiasis in the Ghibe valley, Ethiopia: Multiple-drug resistance and its effective control. In: Rowlands G J, Kyule M N and Perry B D (eds), Proceedings of the 7th International Symposium on Veterinary Epidemiology and Economics, Nairobi, Kenya, 15–19 August 1994. *The Kenya Veterinarian* 18(2):369–371.

Rege J E O. 1993. A review of the origins of the indigenous African cattle and the Brahman cattle breed and their introduction into the African continent. In: *Proceedings of the First All Southern Africa Brahman Congress, held in Lusaka, Zambia, 25–26 May 1993.* Brahman Cattle Breeders Society of South Africa, Bloemfontein, South Africa. pp. 1–17.

Rege J E O. 1994. Issues and current developments in the conservation of indigenous African domestic animal diversity. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments.* Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Guelph, Ontario, Canada. pp. 439–446.

Rege J E O and Baker R L. 1994. Characterization, conservation and utilization of indigenous African animal genetic resources – ILCA's proposed program. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of*

research and future directions. Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 147–153.

Reid R S, Curry J J, Swallow B M, Mukhebi A W, Perry B D and Ellis J E. 1994. Ecological, social and economic impacts of trypanotolerance: collaborative research in Central and West Africa. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 135–144.

Rey B. 1993. Contribution of crossbred goats to milk production and social welfare in Burundi. In: Kategile J A and Mubi S (eds), *Future of livestock industries in East and southern Africa.* Proceedings of a workshop held at Kadoma Ranch Hotel, Zimbabwe, 20–23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 69–72.

Rey B and Ehui S. 1993. Offtake and milking strategies of goat farmers in Ngozi Province (Burundi). In: *Proceedings of the 11th SR-CRSP Scientific Workshop, Nairobi, Kenya, 3–4 March 1993.* Small Ruminant Collaborative Research Support Programme, Nairobi, Kenya. pp. 203–210.

Rey B and Jacob U. 1993. Participation in the Ngozi goat crossbreeding project (Burundi) and associated changes in the farming systems. In: Lokeshwar R R (ed), *Recent advances in goat production.* Proceedings of and papers presented at the Fifth International Conference on Goats, New Delhi, India, 2–8 March 1992. Published in collaboration with the International Goat Association, Utah, USA/International Development Research Centre, Ottawa, Canada/ Food and Agriculture Organization of the United Nations, Rome, Italy/Indo–Swiss Goat Development and Fodder Production Project, Rajasthan, India. pp. 427–433.

Reynolds L, Mureithi J, Mullins G and Thorpe W. 1993. Food resource availability and milk production on smallholder dairy farms in the sub-humid coastal region of Kenya. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 158–159.

de Ridder N and Breman H. 1993. A new approach to evaluating rangeland productivity in Sahelian countries. In: Behnke R H Jr, Scoones I and Kerven C (eds), *Range ecology at disequilibrium. New models of natural variability and pastoral adaptation in African savannas.* Overseas Development Institute, London, UK. pp. 104–117.

Rowlands G J. 1994. Assessing impacts of animal health interventions on productivity. In: Rowlands G J, Kyule M N and Perry B D (eds), Proceedings of the 7th International Symposium on Veterinary Epidemiology and Economics, Nairobi, Kenya, 15–19 August 1994. *The Kenya Veterinarian* 18(2):353–355.

Rowlands G J and Teale A J (eds). 1994. *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 189 pp.

Rowlands G J, Kyule M N and Perry B D (eds). 1994. Proceedings of the 7th International Symposium on Veterinary Epidemiology and Economics, Nairobi, Kenya. *The Kenya Veterinarian* 18(2).

Rowlands G J, d'Ieteren G D M, Authié E, Leak S G A, Woudyalew Mulatu and Nagda S M. 1994. Variations in susceptibility to the effects of trypanosomiasis in East African

zebu cattle. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 87–94

Sabiiti E N, Cobbina J and Lambourne J. 1993. Contribution of *Parkia biglobosa* to the feeding value of pasture systems in West Africa. In: *Proceedings of the XVII International Grassland Congress, Rockhampton, Australia, 18–21 February 1993. Vol V, no. 3.* New Zealand Grassland Association, New Zealand/Tropical Grasslands Society of Australia, Australia/New Zealand Society of Animal Production, New Zealand. pp. 2055–2056.

Shapiro B. 1993. Policy issues and priorities for ILCA technology research. In: Ehui S and Lipner M E (eds), *Livestock and resource management policy. Issues and priorities for research.* Proceedings of the Research Planning Workshop held at ILCA, Addis Ababa, Ethiopia, 24–27 March 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 63–70.

Sibanda S and Said A N. 1993. The role of crop residues and agro-industrial by-products as animal feed resources in sub-Saharan Africa. In: Adamu A M, Mani R I, Osinowo O A, Adeoye K B and Ajileye E O (eds), *Forage production and utlization in Nigeria.* Proceedings of the Second NLPD Workshop on Forage Production and Utilization in Nigeria, Zaria, Nigeria, 11–14 February 1991. Ministry of Agriculture and Water Resources, Kaduna, Nigeria. pp. 186–217.

Staal S J and Shapiro B I. 1994. The impact of policy liberalization on smallholder peri-urban dairy producers at Nyeri, Kenya. In: *Proceedings of the XXIInd International Conference of Agricultural Economists on Agricultural Competitiveness: Market Forces and Policy Choice, Harare, Zimbabwe, 22–29 August 1994.* IAAE (International Association of Agricultural Economists), Illinois, USA. pp. CS–2B, 1–13.

Steiger Y, Kenyanjui M and Thorpe W. 1994. A cross-sectional study of disease prevalence in Small East African Zebu cattle on smallholder farms in coastal Kenya. In: Rowlands G J, Kyule M N and Perry B D (eds), Proceedings of the 7th International Symposium on Veterinary Epidemiology and Economics, Nairobi, Kenya. *The Kenya Veterinarian* 18(2):375.

Swallow B. 1993. Environmental issues and ILCA research agenda. In: Ehui S and Lipner M E (eds), *Livestock and resource management policy. Issues and priorities for research.* Proceedings of the Research Planning Workshop held in Addis Ababa, Ethiopia, 24–27 March 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 127–138.

Swallow B M and Jabbar M A. 1994. Cattle breed preferences and breeding practices in southern Nigeria. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA, ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 115–121.

Tarawali G and Mohamed-Saleem M A. 1994. Establishment techniques for stylo-associated cropping systems. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 183–192.

Tarawali S A, Peters M and Jama A A. 1994. Species screening and multi-locational testing of *Stylosanthes* species in West Africa. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the

Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 81–95.

Tawah C L, Rege J E O and Mbah D A. 1994. Genetic analysis of preweaning growth in indigenous Gudali cattle under a long- term selection programme. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments.* Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Guelph, Ontario, Canada. pp. 324–327.

Tegegne A, Wirtu G, Mukasa-Mugerwa E and Kassa T. 1994. Oestrus phenomenon and oestrus detection efficiency using androgenised cows and entire bulls in Boran and Boran x Friesian crossbred cows. In: *Advances in tropical agriculture in the 20th Century and prospects for the 21st: TA 2000.* Trinidad and Tobago, 4–9 September 1994. p. 32 (abstract).

Tekalign Mamo, Abate Tedla and Teklu Erkosa. 1994. The effect of undersowing wheat with clovers on wheat yield, total crop residue yield and nutritive value of straw and fodder grown on Vertisols in Ethiopia. In: Tanner D G (ed), *Developing sustainable wheat production systems.* Proceedings of the Eighth Regional Wheat Workshop for Eastern, Central and Southern Africa, Kampala, Uganda, 7–10 June 1993. CIMMYT (International Wheat and Maize Improvement Centre), Mexico D.F., Mexico. pp. 201–207.

Tekelye Bekele. 1993. Epidemiology of endoparasites of small ruminants in sub-Saharan Africa. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991.* IAR/NLIC Proceedings 4. Institute of Agricultural Research, Addis Ababa, Ethiopia pp. 7–15.

Tening A S, Tarawali G, Adeoye K B, Mohamed-Saleem M A and Omueti J A I. 1994. Management and nutrient requirements of *Stylosanthes* in pasture and cropping systems in the subhumid zone of Nigeria: A review. In: de Leeuw P N, Mohamed-Saleem M A and Nyamu A M (eds), Stylosanthes *as a forage and fallow crop.* Proceedings of the Regional Workshop on the Use of *Stylosanthes* in West Africa, held in Kaduna, Nigeria, 26–31 October 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 113–122.

Thorpe W, Chabari F, Maloo S, Muinga R, Mukhebi A, Mullins G, Mureithi J, Mussukuya E, Nyambaka R, Maki M O, Otieno L, Perry B, Rugema E and Wekesa E. 1993. Smallholder dairy cattle production in coastal Kenya: Resource base assessment and constraint identification. In: Gill M, Owen E, Pollott G E and Lawrence T L J (eds), *Animal production in developing countries.* Occasional Publication–British Society of Animal Production 16. British Society of Animal Production, Edinburgh, UK. pp. 167–168.

Thorpe W R, Mullins G, Reynolds L, Maloo S H, Muinga R W, Mureithi J G, Njuni M and Ramadhan A. 1993. Research on smallholder dairy production in coastal lowland Kenya. In: Kategile J A and Mubi S (eds), *Future of livestock industries in East and southern Africa.* Proceedings of a workshop held at Kadoma Ranch Hotel, Zimbabwe, 20–23 July 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 33–44.

Trail J C M, Wissocq N and d'Ieteren G D M. 1994. Field research on measurement and use of trypanotolerance criteria to enhance trypanotolerant livestock productivity. 2. Recent results quantifying trypanotolerance indicators. In: Rowlands G J and Teale A J (eds), *Towards increased use of trypanotolerance: Current status of research and future directions.* Proceedings of a workshop organized jointly by ILRAD and ILCA,

ILRAD, Nairobi, Kenya, 26–29 April 1993. ILRAD (International Laboratory for Research on Animal Diseases), Nairobi, Kenya, and ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 29–32.

Umuna N N and Iji P A. 1993. The natural feed resources for ruminant animals in Nigeria. In: Adamu A M, Mani R I, Osinowo O A, Adeoye K B and Ajileye E O (eds), *Forage production and utilization in Nigeria.* Proceedings of the Second NLPD Workshop on Forage Production and Utilization in Nigeria, Zaria, Nigeria, 11–14 February 1991. Ministry of Agriculture and Water Resources, Kaduna, Nigeria. pp. 16–31.

Varvikko T. 1993. Nutrition constraint to improved smallholder milk production in the Ethiopian highlands: The Selale experience. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991.* IAR/NLIC Proceedings 4. Institute of Agricultural Researcl , Addis Ababa, Ethiopia. pp. 43–50.

Walsh J. 1993. Partnerships: The effective harnessing of research for the advancement of animal agriculture in developing countries. In: Mack S (ed), *Strategies for sustainable animal agriculture in developing countries.* Proceedings of the FAO Expert Consultation on Strategies for Sustainable Animal Agriculture in Developing Countries, Rome, Italy, 10–14 December 1990. FAO Animal Production and Health Paper 107. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy, pp. 173–184.

Williams T O. 1993. Scope for improvement of small ruminant production in the Sahel. In: Dvorak K A (ed), *Social science research for agricultural technology development. Spatial and temporal dimensions.* Proceedings of an International Institute of Tropical Agriculture (IITA)–Rockefeller Foundation workshop held at Ibadan, Nigeria, 2–5 October 1990. IITA, Ibadan, Nigeria. pp. 106–117.

Williams T O. 1993. Trade and pricing policies in the context of sustainable livestock production in sub-Saharan Africa. In: Ehui S and Lipner M E (eds), *Livestock and resource management policy. Issues and priorities for research.* Proceedings of the Research Planning Workshop held at ILCA, Addis Ababa, Ethiopia, 24–27 March 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 37–42.

Wilson R T, Traore A and Mukasa-Mugerwa E. 1993. Mortality and morbidity of African small ruminants under various management systems. In: Perrin G (ed), *Pathologie caprine et productions.* 2e Colloque international de Niort sur la pathologie caprine et productions, Niort (France), 26–29 juin 1989. Etudes et synthèses de l'IEMVT 42. IEMVT (Institut d'élevage et de médecine vétérinaire des pays tropicaux), Maisons-Alfort, France. pp. 208–236.

Yapi C V, Oya A and Rege J E. 1994. Evaluation of an open nucleus breeding programme for growth of the Djallonke sheep in Côte d'Ivoire. In: Smith C, Gavora J S, Benkel B, Chesmais J, Fairfull W, Gibson J P, Kennedy B W and Burnside E B (eds), *Proceedings of the 5th World Congress on Genetics Applied to Livestock Production. Vol. 20. Poultry breeding, avian biotechnology, behaviour genetics, reproductive biotechnology, immunogenetics and disease resistance genetics, breeding in the tropics and extreme environments.* Congress held in Guelph, Canada, 7–12 August 1994. University of Guelph, Guelph, Ontario, Canada. pp. 421–424.

Zerbini E and Takele Gemeda 1993. Effect of work on dry matter intake milk production and reproduction of multipurpose cows fed low quality roughage. In: Guo Tingshuang (ed), *Increasing livestock production through utilization of local resources.* Proceedings of the International Conference on Increasing Livestock Production through Utilization of Local Resources, Beijing, China, 18–22 October 1993. Bureau of Animal Production and Health, Ministry of Agriculture, Beijing, China. pp. 333–356.

Zerbini E and Getachew Asamenew. 1993. Potential of cow traction in the Ethiopian

highlands farming system. In: *Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, 13–15 Nov 1991.* IAR/NLIC Proceedings 4. Institute of Agricultural Research, Addis Ababa, Ethiopia. pp. 37–42.

Zerbini E, Takele Gemeda, Alemu Gebre Wold and Abiye Astatke. 1994. Effect of draft work on lactation of F_1 crossbred dairy cows. In: Starkey P, Mwenya E and Stares J (eds), *Improving animal traction technology.* Proceedings of the first workshop of the Animal Traction Network for Eastern and Southern Africa, held in Lusaka, Zambia, 18–23 January 1992. CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. pp. 130–135.

Refereed books and chapters from books

Abate Tedla, Mohamed-Saleem M A, Tekalign Mamo, Alemu Tadesse and Miressa Duffera 1993. Grain, fodder and residue management. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 103–137.

Abiye Astatke and Ferew Kelemu. 1993. Modifying the traditional plough — *maresha* — for better management of Vertisols. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 85–101.

Ehui S K. 1993. Country profiles: Côte d'Ivoire. In: *Sustainable agriculture and the environment in the humid tropics.* National Academy Press, Washington, DC, USA. pp. 352–392.

Getachew Asamenew, Hailu Beyene, Workeneh Negatu and Gezahegn Ayele. 1993. A survey of the farming systems of Vertisol areas of the Ethiopian highlands. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 29–49.

Getachew Asamenew, Hailu Beyene, Adugna Haile and Workeneh Negatu. 1993. Technology validation and transfer. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 139–146.

Haque I, Mesfin Abebe, Tekalign Mamo and Asgelil Dibabe. 1993. Nutrient management. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 51–73.

Mesfin Abebe and Jutzi S. 1993. The joint project on Vertisols management: Retrospect and prospects. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 147–157.

Powell J M and Williams T O. 1993. *Livestock, nutrient cycling and sustainable agriculture in the West African Sahel.* IIED Gatekeeper Series 37. IIED (International Institute of Environment and Development), Sustainable Agriculture Programme, London, UK. 15 pp.

Srivastava K L, Mesfin Abebe, Abiye Astatke, Mitiku Haile and Hailu Regassa. 1993.

Distribution and importance of Ethiopian Vertisols and location of study sites. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 13–27.

Srivastava K L, Abiye Astatke, Tekalign Mamo, Hailu Regassa and Selamyihun Kidanu. 1993. Land, soil and water management. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 75–84.

Swallow B. 1994. *The role of mobility within the risk management strategies of pastoralists and agro-pastoralists.* IIED Gatekeeper Series 47. IIED (International Institute of Environment and Development), Sustainable Agriculture Programme, London, UK. 27 pp.

Tekalign Mamo, Mohamed-Saleem M A and Abate Tedla. 1993. Development of coordinated research efforts. In: Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds), *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. pp. 1–11.

Tekalign Mamo, Abiye Astatke, Srivastava K L and Asgelil Dibabe (eds). 1993. *Improved management of Vertisols for sustainable crop–livestock production in the Ethiopian highlands: Synthesis report 1986–92.* Technical Committee of the Joint Vertisol Project, Addis Ababa, Ethiopia. 199 pp.

Network publications

ILCA (International Livestock Centre for Africa). 1993. *Research on Livestock production under trypanosomiasis risk. A year of progress and of transition.* Annual scientific report 1993. African Trypanotolerant Livestock Network, Nairobi, Kenya. 38 pp.

Aboud A A O, Owen E, Reed J D and Said A N. 1994. Influence of amount of feed offered on growth, intake and selectivity: observations on sheep and goats. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 157–162.

Akinbamijo O O and Reynolds L. 1994. Trypanosomiasis induced reproductive wastage in West African Dwarf sheep. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 95–102.

Ba M, Rey B and Mesfin Shibre. 1994. Mortalité des chevreaux croisés Alpine au Burundi. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 121–125.

Baker R L, Reynolds L, Lahlou Kassi A, Rege J E O, Tekelye Bekelye, Mukasa-Mugerwa E and Rey B. 1994. Prospects for breeding for resistance to endoparasites in small ruminants in Africa — a new ILCA research programme. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 223–227.

Bitende S N, Lugenja M M S and Dzowela B H. 1993. Initial screening and evaluation of *Sesbania* species germplasm in Tanga, coastal Tanzania. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 45–53.

Das S M, Rege J E O and Mesfin Shibre. 1994. Productivity of Blackhead Persian sheep in Tanzania. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 235–240.

Hanson J. 1993. Management of *Sesbania sesban* germplasm using *in vitro* culture. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 123–128.

Hatendi P R, Ndlovu L R, Smith T and Said A N. 1994. Metabolisable energy requirements for maintenance and growth of castrate Zimbabwean (Matabele) goats offered diets differing in roughage content either *ad libitum* or restricted. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 191–196.

Heering J H. 1993. The reproductive biology and interspecific relations in three perennial *Sesbania* species. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 117–122.

Ikwuegbu O A and Ofodile S. 1994. Wet season supplementation of West African Dwarf goats raised under traditional management in the subhumid zone of Nigeria. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 179–182.

Ikwuegbu O A, Tarawali G and Njwe R M. 1994. The role of the West African Dwarf goat in the economy of the smallholder arable farmer in the subhumid zone of Nigeria. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant

Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 19–22.

Kanyama-Phiri G Y, Dzowela B H and Kategile J A. 1993. Screening *Sesbania* for response to N and P combinations and adaptability in a medium-altitude environment in Malawi. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 71–90.

Kategile J A and Adoutan S B (eds). 1993. *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 128 pp.

Lawrence P R, Lawrence K, Dijkman J T and Starkey P H (eds). 1993. *Research for development of animal traction in West Africa.* Proceedings of the Fourth Workshop of the West African Animal Traction Network, held in Kano, Nigeria, 9–13 July 1990. Published on behalf of the West Africa Animal Traction Network by the International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. 306 pp.

Lebbie S H B, Rey B and Irunga E K (eds). 1994. *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. 268 pp.

Mureithi J G and Thorpe W. 1994. Alley cropping with leucaena for food and fodder production in smallholder farms in lowland coastal Kenya. *The African Feed Resources Network Newsletter* 4(1):3–7.

Nzioka S M, Minin L K and Dzowela B H. 1993. The evaluation of *Sesbania sesban* var *nubica* and *Sesbania goetzei* in a semi-arid environment in eastern Kenya. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 1–7.

Otieno K, Bryant H J, Onim J F M and Kategile J A. 1993. Effect of site and cutting frequency on forage DM yield of *Sesbania sesban* in western Kenya. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 55–61.

Rege J E O. 1994. Indigenous African small ruminants: a case for characterisation and improvement. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 205–211.

Reynolds L. 1994. Priority setting for small ruminant research. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen,

The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 29–34.

Siaw D E K A, Kahsay Berhe and Tothill J C. 1993. Screening of two *Sesbania* species for fodder potential and response to phosphorus application on an acid soil in Ethiopia. In: Kategile J A and Adoutan S B (eds), *Collaborative research on* Sesbania *in East and southern Africa.* Proceedings of an AFRNET Workshop held in Nairobi, Kenya, 9–14 September 1991. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp. 91–102.

Shapiro B I, Mohamed-Saleem M A and Reynolds L. 1994. Socio-economic constraints to strategic sheep fattening: Evidence from the Ethiopian highlands. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 9–14.

Tembely S, Bengaly K and Berckmoes W. 1994. Effect of strategic anthelmintic treatment on growth performance and survival rate of native lambs in the subhumid environment in Mali. In: Lebbie S H B, Rey B and Irunga E K (eds), *Small ruminant research and development in Africa.* Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network, AICC, Arusha, Tanzania, 7–11 December 1992. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia/CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands. ILCA, Addis Ababa, Ethiopia. pp. 133–136.

Programme documents

Bruns E, Yohannes Yehualashet and Abraham Tesfay. 1993. *ILCA LAN users guide.* Computer and Biometrics Section, ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Haque I. 1993. *Soil resource management in mixed crop–livestock systems of East and central African highlands: Research agenda and approaches.* ILCA Environmental Sciences Division Working Document 27. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 18 pp.

Haque I. 1993. *Nutrient management and feed improvement in crop–livestock systems of sub-Saharan Africa: Present status and future outlook.* ILCA Environmental Sciences Division Working Document 28. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Hiernaux P. 1993. *The crisis of Sahelian pastoralism: ecological or economic?* ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 15 pp.

ILCA (International Livestock Centre for Africa). 1994. *Tropical forage seed production management.* Environmental Sciences Division Working Document 29. Herbage Seed Unit, ILCA, Addis Ababa, Ethiopia.

ILCA (International Livestock Centre for Africa). 1994. *Seed equipment suppliers.* Environmental Sciences Division Working Document 30. Herbage Seed Unit, ILCA, Addis Ababa, Ethiopia.

Mbogoh S G and Negussie Tilahun. 1994. *Relative efficiency of alternative dairy marketing systems in Addis Ababa, Ethiopia based on household purchase patterns.* Socio-Economic Sciences Division Working Paper 19. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 52 pp.

Mullins G, Rey B, Nokoe S and Shapiro B. 1994. *A research methodology for characterising dairy product consumption systems.* Market-Oriented Smallholder Dairying Research Working Document 2. ILCA (International

Livestock Centre for Africa), Addis Ababa, Ethiopia. 40 pp.

Rey B, Thorpe W, Smith J, Shapiro B, Osuji P, Mullins G and Agyemang K. 1993. *Improvement of dairy production to satisfy the growing consumer demand in sub-Saharan Africa. A conceptual framework for research.* Market-Oriented Smallholder Dairying Research Working Document 1. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 13 pp.

Rey B, Thorpe W, Smith J, Shapiro B, Osuji P, Mullins G and Agyemang K. 1994. *Amélioration de la production des consommateurs en Afrique subsaharienne: un cadre conceptuel de recherche.* Recherche sur la petite production laitière à finalité commerciale. Document de travail 1. CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 14 pp.

Saka A R and Haque I. 1993. *Maize/annual forage legumes mixed cropping systems: Characterizing water and nitrogen dynamics in maize/vetch pure and mixed stands: II. Criteria for model selection and minimum data sets requirements for model use and verification.* ILCA Environmental Sciences Division Working Document B23. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 38 pp.

Saka A R and Haque I. 1993. *Manure studies in the Ethiopian highlands: I. Effect on* Medicago sativa *L. grown on an alfisol.* ILCA Environmental Sciences Division Working Document 25. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 97 pp.

Saka A R and Haque I. 1993. *Manure studies in the Ethiopian highlands: II. Effect on* Medicago sativa *L. and* Desmodium uncinatum *grown on an Ultisol.* ILCA Environmental Sciences Division Working Document 26. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 154 pp.

Saka A R, Haque I, Singh U and Thornton P K. 1993. *Maize/annual forage legumes mixed cropping systems: Characterizing water and nitrogen dynamics in maize/vetch pure and mixed stands: I. Procedures for collecting minimum data sets.* ILCA Environmental Sciences Division Working Document B22. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 105 pp.

Swallow B M (ed). 1994. *Evaluating the relationships between property rights, risk, technology and productivity in sub-Saharan Africa.* Proceedings of the ILCA/IFPRI Research Planning Workshop held at ILCA, Addis Ababa, Ethiopia, 31 August–1 September 1994. Socio-Economics and Policy Research Working Document 18. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 53 pp.

Theses

Abule Ebro. 1994. *Supplementation of Friesian x Boran crossbred calves fed teff* (Eragrostis tef) *straw with graded level of cowpea* (Vigna unguiculata) *and* Dolichos lablab (Lablab purpureus) *hay.* MSc thesis, Alemaya University of Agriculture, Alemaya, Ethiopia.

Daniel Dauro. 1994. Les trèfles annuels des hauts *plateaux éthiopiens: étude de la régénération des peuplements et utilisation agronomique.* Thèse, Académie de Montpellier, Université de Montpellier II, Montpellier, France.

Daniel Mebrate. 1994. *The effect of changes in dairy production technology on consumption and intrahousehold labor allocation.* MSc thesis, University of Addis Ababa, Ethiopia.

Echessah P. 1994. *Economics of milk marketing in Kilifi District, Kenya.* MSc thesis, Department of Agricultural Economics, University of Nairobi, Kenya.

Esubalew Abate. 1994. *Effect of work and energy supplementation on postpartum estrus cycle length and ovarian activity in crossbred cows used for draught.* MSc thesis,

Alemaya University of Agriculture, Alemaya, Ethiopia.

Kaleja V. 1994. *Genetic resources of indigenous tropical legumes in the subhumid zone.* MSc thesis, University of Hohenheim, Stuttgart, Germany (in German).

Kramer H. 1994. *Preliminary evaluation of a collection of the tropical pasture legume* Centrosema brasilianum *(L.) Benth. in the subhumid zone of Nigeria.* MSc thesis, University of Hohenheim, Stuttgart, Germany (in German).

Okoruwa V. 1994. *The economics of agro-pastoral production systems in the derived savannah of Oyo State, Nigeria.* PhD thesis, Department of Agricultural Economics, University of Ibadan, Nigeria.

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
BALANCE SHEET at 31 December 1994

(US$ '000)

ASSETS

	1994	1993	1992
Cash and banks	13 584	7 749	7 937
Received from:			
– donors	179	483	1 671
– employees	168	94	88
– others	680	504	1 163
Inventories	834	1 074	1 402
Deposits and prepayments	172	297	212
Total current assets	15 617	10 201	12 473
Construction work in progress	9	21	22
Fixed assets	9 053	9 585	10 313
Total assets	24 679	19 807	22 808

LIABILITIES AND FUND BALANCES

Accounts payable:			
– employees	243	340	293
– trade	737	558	629
– others	969	887	1 285
Contributions received in advance	2 671	933	1 236
In-trust accounts	326	762	511
Accruals	2 333	2 105	2 355
Total current liabilities	7 279	5 585	6 309
Working fund	8 347	4 637	6 186
Invested in fixed assets	9 053	9 585	10 313
Total fund balances	17 400	14 222	16 499
Total liabilities and fund balances	24 679	19 807	22 808

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
STATEMENT OF INCOME AND EXPENDITURE
for the year ended 31 December 1994

(US$ '000)

	1994	1993	1992
Revenue			
Donations	14 074	11 854	16 266
Other income	815	883	925
Total revenue	14 889	12 737	17 151
Operating expenditure			
Research	7 538	8 720	11 142
Information services	791	884	1 141
Training and conferences	641	880	1 301
General administration and operations	1 032	1 891	3 065
Board and management	643	793	1 034
Depreciation	991	1 138	1 419
Total operating expenditures	11 636	14 306	19 102
Surplus/(deficit) for the year	3 253	(1 569)	(1 951)

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
STATEMENT OF GRANT REVENUE
for the year ended 31 December 1994

(US$ '000)

Unrestricted	1994	1993	1992
Australia	106	110	114
Austria	150	150	150
Belgium	0	0	211
Canada	580	665	839
Denmark	546	519	610
Finland	86	0	196
France	132	234	184
BMZ/Germany	616	601	644
Ireland	0	0	339
Italy	100	0	136
Japan	583	541	462
The Netherlands	136	138	135
Nigeria	3	4	7
Norway	669	502	641
Sweden	191	204	308
Switzerland	1 040	1 071	1 184
United Kingdom	438	429	521
United States of America	1 900	2 250	2 975
World Bank	3 614	2 697	4 000
Sub-total	10 890	10 115	13 652
Restricted			
ACIAR – SR	24	9	0
African Development Bank (ADB)	316	37	50
Austria – Graduate Student	14	0	0
BMZ-GTZ – Forage Evaluation	159	149	75
– Forage Genetic Resource	457	38	0
– Trypanotolerance	0	0	192
– Multipurpose Trees	0	0	54

		1994	1993	1992
CIDA	– Workshop	0	8	0
	– ESA Livestock Industries Workshop	0	0	9
Denmark		481	0	0
EEC	– Tryps West Africa	154	14	0
	– Animal Traction	0	0	84
	– Training	0	0	664
	– Small Ruminant	0	0	123
France		76	0	0
IDRC	– AFRNET	14	223	50
	– CRNC	0	15	15
	– Rhizo	0	0	5
	– ESA Livestock Industries Workshop	0	0	43
IFAD		0	0	109
Ireland	– Dairy	185	181	0
	– Forage	154	152	0
Italy	– Animal Reproduction & Health	0	100	250
Luxembourg		0	125	0
The Netherlands		140	129	149
Netherlands	– JVP	236	0	0
OPEC	– Sahelian Research	25	35	30
Rockefeller		88	0	0
Sweden		306	0	0
Switzerland	– Training	22	53	34
	– Herbage Seed Unit	300	400	340
	– Vertisol Management	10	0	237
WFP		9	30	0
Sub-total		3 170	1 698	2 513
Complementary:				
OXFAM	– Vertisol Management	14	41	61
Total grants		14 074	11 854	16 226

Source and application of funds, 1992, 1993 and 1994