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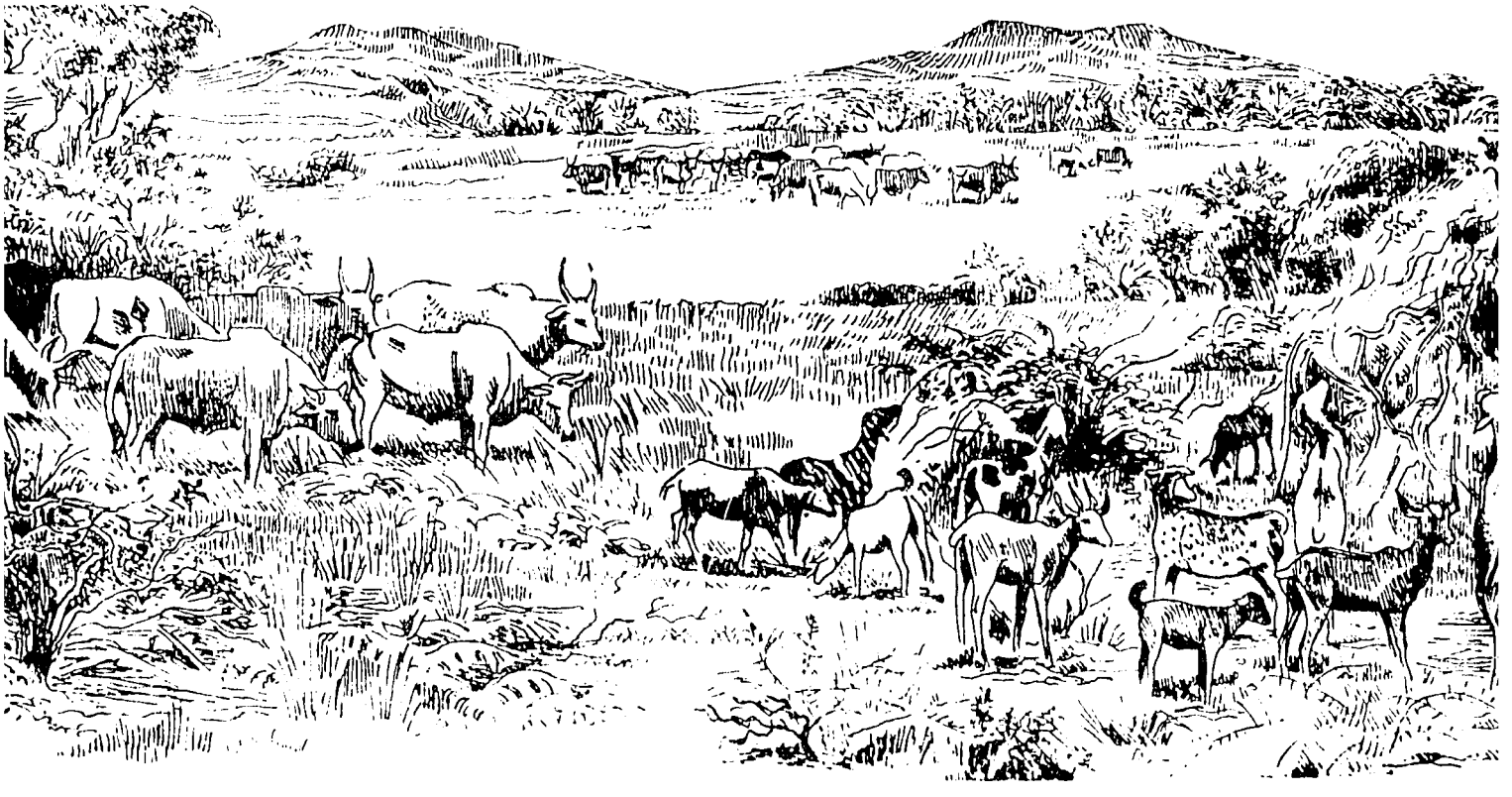

Milk production in Africa and Asia

Dairy development and marketing in sub-Saharan Africa

Livestock productivity in Kenyan group ranches

Cropping by agropastoralists in Nigeria

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The *ILCA Bulletin* is a quarterly publication of the International Livestock Centre for Africa. It provides an up-to-date account of aspects of the Centre's work. Contributions to the Bulletin are invited from other livestock researchers in Africa whose work is closely associated with that of ILCA. The *ILCA Bulletin* is distributed to 1500 researchers, policy makers, donors and extension agents throughout sub-Saharan Africa and elsewhere in the world.

ILCA is one of 13 international centres for agricultural research whose work is funded by the Consultative Group on International Agricultural Research (CGIAR). The 13 centres have been established by the CGIAR to provide long-term support for agricultural development in the Third World.

PREFACE

The first two articles in this issue of the *ILCA Bulletin* focus on the possibilities for dairy development in sub-Saharan Africa. These are complemented by articles on studies of pastoralism and agropastoralism in Kenya and Nigeria respectively.

The first article summarises the three main approaches to dairy development that have been attempted in the developing world. The authors draw attention to five interrelated issues that need particular attention in any dairy development strategy: the supply of dairy stock, animal health, fodder systems, marketing arrangements and the training of farmers. The article stresses the need for appropriate research to support dairy development efforts. The authors conclude that the future food production and prosperity of Asia and Africa alike will largely be determined by asking the right research questions, by building an appropriate research structure and by being able to put new technology into practice.

The second article reviews dairy development and marketing in sub-Saharan Africa over the past two decades and discusses the impacts of different policies on the dairy subsector. The author, who works in ILCA's Livestock Policy Unit at headquarters, discusses the recent trend of increased imports of dairy products into the region and the possibilities for reducing imports by increasing domestic production. A common feature of the dairy economy in the countries of sub-Saharan Africa is its domination by the primitive marketing arrangements of the traditional livestock sector. Better prices are the goal of most programmes for improving dairy production and marketing; another goal is to improve efficiency.

The third article summarises the results of a study made by ILCA's Kenyan Rangelands Programme of three group ranches of the Maasai pastoralists in southeast Kenya. The team is working closely with the Kenyan Government in assessing the effectiveness of recent development strategies among the Maasai pastoralists, in defining the current constraints to increased production and in determining the most promising areas for future development.

The fourth article is by two members of ILCA's Subhumid Zone Programme in Kaduna, Nigeria. This team is developing improved livestock and crop production systems in the subhumid zone of West Africa, and several of the proposed innovations are aimed at the Fulani agropastoralists in central Nigeria. Cropping has assumed an important role in the production systems of the Fulani. The article summarises the results of a study on the extent and methods of crop production in the Fulani agropastoral system and the possibilities of increasing forage resources for the Fulani by cropping.

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Stimulating milk production in milk-deficit countries of Africa and Asia*

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SUMMARY

MOST DEVELOPING *countries have a growing trade deficit in dairy products and Africa now accounts for about 25% of the world's annual dairy imports. Strikingly contrasting situations exist among continents and countries in the growth of livestock and food grain production, and an association between the two commodity groups is apparent.*

Three main approaches to dairy development have been used in the developing world: large parastatal dairy farms, medium-sized dairy farms in the commercial sector, and organised milk collection from large numbers of subsistence farmers.

Five interrelated issues need attention in any dairy development strategy, the supply of dairy stock, animal health, fodder systems, marketing arrangements and training of farmers.

Dairy development must be supported by adequate research. It is emphasised that the research problems presented by the different organisational forms of milk production are very different, and that there is a need to predict what future production patterns are likely to be. Traditional smallholder farming seems likely to continue to predominate in both Asia and Africa, and a cooperative association of smallholder milk producers is probable.

The importance of asking the right questions, of building a research structure appropriate to current farming patterns, and of being able to put new technology into practice will largely determine the future food production and prosperity of Africa and Asia.

INTRODUCTION

In 1980 developing countries were responsible for one third of the world imports of dairy products (Table 1), and almost all of them have a large and growing deficit in these products.

Table 1. *World trade in dairy products*, 1980.

Region/economy	Trade (US$ million)		
	Exports[a]	Imports[b]	Balance
Developing market economies	167	4713	-4546
Africa	3	1133	-1130
Far East	87	796	-709
Latin America	59	1112	-1053
Near East	18	1615	-1597
Asian centrally planned economies	136	101	+35
Developed market economies	12891	8516	+4375
Eastern Europe and USSR	427	647	-220
World total	13587	14001	-414

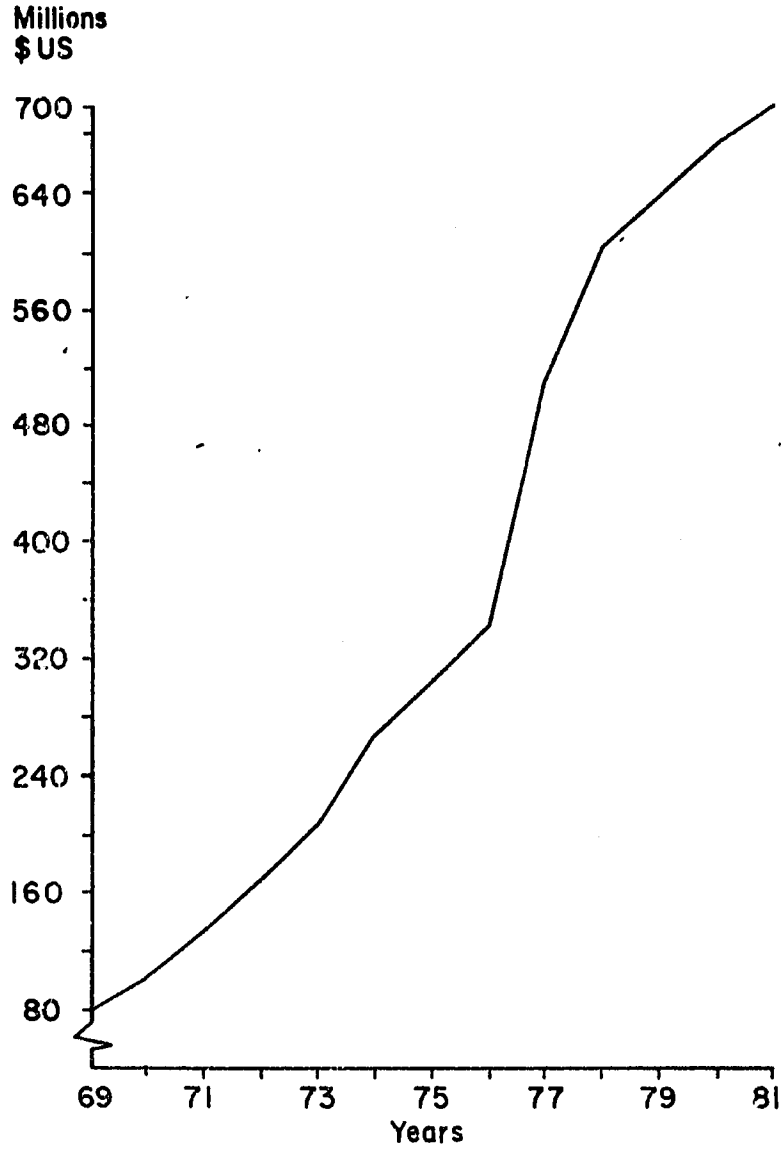
[a] FOB values
[b] CIF values
Source: FAO, 1983.

The dependence of sub-Saharan Africa on imports to satisfy the increasing demand for dairy products has been growing rapidly (Figure 1).

Government policies in milk-deficit countries are frequently oriented towards maintaining low milk prices for urban consumers, thereby discouraging domestic production and encouraging an increasing reliance on imports in order to stabilise prices. Given the oversupply of dairy products on the international market and the policy of subsidising exports by developed countries, these imports have been relatively cheap. However, the decrease in foreign exchange reserves, the need to improve nutritional standards and the wish to diversify and intensify agricultural production are now inducing some governments to consider domestic dairy production as a substitute for imports (Frankel, 1982). Nevertheless, with a few outstanding exceptions, progress in dairy development has been slow.

* *The original version of this paper was presented at the International Conference on Milk Production in Developing Countries organised by the Centre for Tropical Veterinary Medecine, University of Edinburgh, Scotland, U.K., from 2 to 6 April 1984. The paper will appear in the proceedings of the conference.*

Figure 1. *Imports of dairy products by the countries of sub-Saharan Africa,* 1969–1981.



Source: *FAO trade yearbooks* 1970, 1973, 1976, 1979 and 1982.

DAIRY DEVELOPMENT AND FOOD GRAIN PRODUCTION

In 1983 India experienced a record-breaking harvest of 145 million tonnes of cereal grain and an all-time high in milk production of 35 million tonnes. By contrast, Africa's food and livestock production appears to be moving towards a crisis; official estimates of the rates of increase in annual production average less than half the rate of the increase in population, and imports of livestock products alone now cost about US$ 2500 million each year. Changes in per caput production of food in Asia, South America and Africa are summarised in Figure 2.

Is there any lesson to be learnt from these contrasting situations? In India's case it is clear that the large increases in milk production in recent years, far from hampering increases in cereal production, may in fact have been a stimulating and contributory factor. In the case of Africa it is also clear that those countries which have shown the highest increases in output of livestock products are the same countries that have the fastest rates of increase in food grain production (ILCA, 1983).

The issue of whether or not livestock compete for scarce food production resources in Africa and India is now less contentious as the available evidence shows a complementarity between livestock production and food grain production, generated in a major part by the additional cash that smallholder milk production so frequently provides.

Historical precedents for this causality abound in the agricultural history of Europe, North America and Australia. The reasons behind it relate to the impact that small increments in the cash income of subsistence farmers have on fertilizer use, the role of cattle in land cultivation, the high income elasticities for meat and milk, and the importance of crop residues in livestock feeding.

In both Asia and Africa farmers and pastoralists keep cattle for many reasons, including milk, manure, draught power, meat and capital savings. Attempts to increase milk production must take account of these multiple functions; they must also take account of the use of livestock as the catalyst in generating increased cash income, enabling greater expenditure on improved crop seeds, fertilizer, pest control measures and a greater variety and quantity of foodstuffs for the household.

This paper attempts to give an overview of some of the issues and options for dairy development in the milk-deficit countries of Africa and Asia, and discusses organisational issues, production incentives, technical constraints and the need for various support services. The paper concludes with a critical evaluation of the role of research in stimulating dairy development.

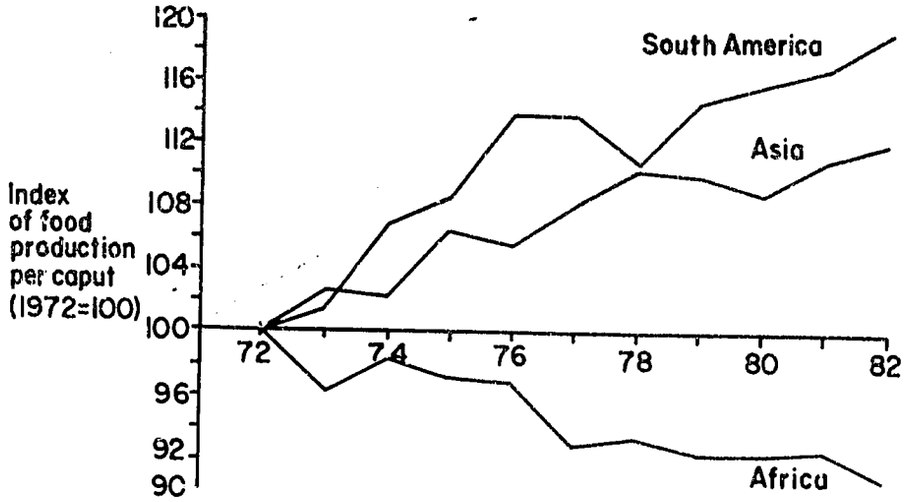
ORGANISATIONAL ISSUES

Three main approaches have characterised schemes for dairy development in the developing world:

- large parastatal dairy farms with high-yielding dairy cattle;
- medium-sized dairy farms in the commercial sector located near major urban centres; and
- organised milk collection from large numbers of traditional subsistence farmers, usually associated with some upgrading of cattle breeds.

Large parastatal farms offer, in principle, considerable opportunities for maximising

Figure 2. *Index of food production per caput in Africa, South America and Asia,* 1972–1982.



Source: *FAO production yearbooks* 1973, 1976, 1979 and 1982.

the impact of specialised management skills, minimising transport and input-supply problems, and for effecting substantial economies of scale. In practice, however, parastatal farms usually have very high costs of milk production and require subsidies to ensure continued operation (Brumby, 1983).

The problems such farms face are often associated with high labour costs, reliance on purchased feedstuffs rather than pastures and fodder crops, and their capital intensity and poor management. Parastatal farms can, however, play a valuable role in a dairy development strategy by guaranteeing minimal milk supplies, by acting as focal points for the collection and processing of more widespread milk supplies, as service centres and cooperatives for artificial insemination (AI), and by producing female stock for distribution to smallholders.

The smaller dairy units of the private sector are usually more efficient and may generate a rapid increase in a country's milk production if the market incentives are sufficiently attractive. These commercial dairy farms are often located on the edge of major towns, thereby minimising transport costs. However, they have relatively high production costs due to their capital intensity, and they incur many of the purchased feed costs that traditional smallholder farmers are able to avoid.

The organisation of dairy development on the basis of milk collection from a large number of small farms is a third alternative. The most successful experience of dairy development to date in a developing country is found in India and is based on the so-called Anand model, a concept that began 30 years ago with the establishment of a small dairy producers' cooperative in the town of Anand, 480 km north of Bombay. The success of this small cooperative quickly led to the establishment of similar groups at the grass-roots level in many other Indian states. Now more than 10 000 Indian village dairy cooperatives with 2 million members collect and process some 2.5 million litres of milk daily (Brumby, 1983). The Anand pattern of cooperation is a three-tier structure. It consists of a large number of small village milk producers' cooperatives aggregated into district unions (each of about 400 village dairy societies) and a federation of the several unions in each state. The whole system is owned by the primary milk producers who are peasant farmers of small areas of land and landless labourers owning one or two cows. Two semi-autonomous government agencies – the National Dairy Development Board and the Indian Dairy Corporation – provide technical and financial assistance to the system.

This cooperative structure provides an integrated system for marketing and processing milk. The basic unit is the village milk producers' cooperative. Each cooperative has as its area of operation the village in which it was formed (Halse, 1980). The village cooperative buys milk twice a day from its 100 to 200 members on a commission basis at its village collection centre. The milk is immediately tested for fat content and quality and taken by truck, without cooling, to the union dairy where it is pasteurised, cooled and either transported to distant urban markets or processed into dried milk and butter. The union dairies are relatively large modern plants with capacities of 100 000 to 400 000 litres per day. The entire supply of each union dairy comes from the large number of smallholder farmers making up the basic village societies (Brumby, 1983).

Members of village cooperatives have access to an AI service, to veterinary services, concentrate feed supplements and forage crop seeds. The essence of the success of the movement is a reliable and profitable outlet for all milk produced, immediate cash payment based on milk quality which is determined by individual fat tests, technical assistance and economies of scale at critical points in the marketing system.

Another example of a successful smallholder dairy development programme, also based on an integrated approach, is found in Kenya. This programme is built on the land reform policy implemented at the end of the colonial era, when about 50 000 smallholdings were formed from 700 000 ha of farmland previously owned by expatriates. Various factors have contributed to the success of the Kenyan dairy development programme, including an effective marketing system based on a cooperative structure, the provision of technical services, a national AI scheme emphasising smallholder services, a reform in the pricing policy that abolished supply quotas (which discriminated against smallholders), the presence of large high-grade herds, a national tick control/dip construction programme, and an agricultural infrastructure which was relatively well developed. Average annual per caput milk consumption in Kenya is 75 litres compared with less than 30 litres for sub-Saharan Africa as a whole, and about 75% of the country's total market supply comes from smallholder mixed farms.

PRODUCTION ASPECTS

In the technical production aspects of a dairy development strategy, five inter-

related issues need attention. These are: the supply of dairy stock, animal health, fodder systems, marketing arrangements, and training of farmers. It is important to stress the interrelated nature of these issues. For example, the introduction of upgraded stock without improving the management or the feed regime may leave the farmer worse off than before.

Supply of dairy stock

Although some of the developing world's indigenous breeds of cattle, such as the Sahiwal, combine adaptability to a tropical environment with an ability to produce substantial amounts of milk, genetic improvement of local stock is usually essential if returns comparable to those of food crops are to be obtained from dairying. Selection for improved milk yields within indigenous breeds is possible, but it is an expensive and long-term process. As a result, crossbreeding is the most common method of genetic improvement. Large farms are generally able to organise their own genetic upgrading systems, using either improved bulls or AI systems. AI for smallholders requires an efficient field operation and good management skills from both the farmer and the operating agency. A decision to establish an AI system should recognize the need for a reliable communication system and for an all-weather road network in the area (Frankel, 1982). An incentive scheme for the inseminators increases substantially the efficiency of the AI service, and liquid rather than frozen semen services are much easier to implement. Where the reliability of the AI service is in question, bull camps are likely to be a better proposition for small-scale dairy systems.

Animal health

Intensive vaccination campaigns have been effective in freeing much of the developing world from the major epidemic diseases of livestock. However, disease control remains a major concern, especially for dairy cattle. Upgraded cows are usually much more susceptible to disease than indigenous animals. A competent veterinary service is essential to control disease problems in improved dairy animals, but a major constraint in developing countries is the shortage of veterinary staff and the lack of cheap animal health treatments. Some countries, such as India and Ethiopia, have tried to overcome the shortage of trained manpower by using lower level staff such as animal health assistants, and this has proved to be an effective and low-cost approach to providing animal health services when supported by competent professional advice.

Veterinary assistance should be provided under a system of cost recovery or by the service cooperative of which the farmer is a member. In Africa the dairy industry continues to experience heavy losses from tick-borne diseases, East coast fever (ECF) and babesiosis in particular. In Kenya, ECF accounts for the deaths of between 50 000 and 80 000 head of cattle annually (FAO, 1981). A disease which is commonly overlooked in Africa but which has serious economic consequences is mastitis. In Kenya its incidence has been reported to be as high as 50% in some areas, while for Ethiopia it has been estimated that milk production from exotic cattle in the state farms would increase by 20% if an effective mastitis treatment campaign was launched.

More than 40% of Africa's land area is infested with tsetse flies which transmit trypanosomes; livestock production based on temperate breeds has therefore not been possible in tsetse-infested areas. An important development option for these areas appears to be the use of trypanotolerant livestock. ILCA's studies with trypanotolerant livestock in 10 African countries have indicated that the growth and reproduction of these animals under conditions of low to medium trypanosomiasis risk are much higher than has hitherto been acknowledged. Little work on their potential contribution to milk production has been carried out to date.

Feeding systems

Most of the feed energy for milk production under traditional management in developing countries is provided by natural grazing of rangelands and pastures, crop residues and grasses along roadsides. Although such rations are usually sufficient for maintenance, increasing milk production beyond subsistence levels requires the provision of higher quality feedstuffs or supplementation with concentrate feeds. If available, concentrates are the easiest option for the farmer in order to meet the high protein needs of dairy cattle; but concentrates are often in limited supply, costly and their distribution system is rarely efficient.

The scope for increasing pasture production is substantial, but the constraint is usually inadequate research support at the national level. The introduction of special-purpose fodder crops at the smallholder level is constrained by the priority that smallholder farmers give to growing subsistence food crops, the unavailability of forage seeds, and seasonal labour shortages. In some areas fodder trees and shrubs are often an attractive alternative.

The role of research in developing appropriate feeding systems is particularly important. Research at the International Agricultural Research Centres (IARCs) needs to be complemented with adaptive and applied research by national organisations. Few experimental results are available on the optimal integration of crops and livestock in smallholder mixed farming systems.

Marketing systems

The success of any dairy development scheme depends to a large extent on marketing and pricing arrangements. The prices received by farmers for certain products largely determine which activities are undertaken on the farm. An efficient milk collection and distribution system to bring milk from the farmer to the consumer is a critical factor in dairy development. In a review of dairy development projects financed by the World Bank, Frankel (1982) found that where milk collection and cooling centres had been established to cater for groups of consumers, smallholder participation in dairy development had flourished. The Indian and Kenyan experiences serve as outstanding examples in this respect.

Milk processing and packaging plants require capital investments of at least US$ 10 per litre of daily capacity. Because of large seasonal variations in supply and in production costs, efficient plants require both a manufacturing capacity, usually for butter and skim milk powder, as well as the capability of processing liquid milk for urban markets.

An important aspect of pricing is the margin available between the purchase and

sales prices. This margin is often squeezed by the conflict between policies which try to provide milk at low prices to urban consumers, and those which seek to maintain attractive producer prices. Pricing policies need not only to encourage increased sales, but also to ensure regular supplies to processing centres. In Africa only a minor fraction of milk production enters the official commercial sector and many processing plants operate well below their designed capacity. Even in Kenya, a country with an efficient marketing system, only an estimated 10 to 15% of the total milk production, or just over half the amount available for marketing, is sold through KCC (Owiro, 1980). For smallholders in more remote areas, local processing of milk into storable products such as ghee or boiled curd cheese is required, a subject on which very little research has been undertaken.

Training of farmers

In most countries of Africa and Asia where the environment is suitable for dairy production, there are large numbers of smallholder farmers and landless labourers who have the potential to engage in dairy production. Many of these farmers already operate mixed crop-livestock farms in which cattle are used mainly to provide draught power and manure. The development of dairy production at the smallholder level requires some change in the management methods of the farmer, which calls for training in new techniques. Higher yielding cows require higher standards of management, the provision of adequate feeding and watering regimes, disease control, profitable calf rearing, simple housing and the maintenance of an acceptable breeding cycle. Husbandry standards adequate for local stock usually lead to failure if applied to improved stock. Any dairy development strategy must therefore involve improvements in the knowledge and management skills of smallholder producers. Simple and low-cost training techniques can be readily established, as the Indian experience amply demonstrates.

INSTITUTIONAL SUPPORT

Advisory and extension services

A shift towards dairy development requires more support from advisory services. These services are essential to provide on-farm advice on animal husbandry and fodder crops, to organise field days and demonstrations, provide courses in farmer training centres, and act as an effective link with research services. Training must be low-cost, and group extension activities have often been shown to be effective ways of improving animal husbandry practices. The main constraint in providing good advisory services in animal husbandry has been the limited knowledge of advisory officers in farm management. Farmers are reluctant to follow advice on good husbandry practices unless they are convinced first that taking the advice will lead to significant increases in productivity and income.

Provision of credit

The development of dairy production activities usually requires substantial additional investment, principally for constructing processing and marketing facilities. Credit for smallholder farmers is not an essential part of dairy development. In Kenya only about 10% of the national dairy herd has been financed through credit, yet the country has made substantial advances in dairy production. In India, provision of credit to encourage small farmers to move to increased milk production is unusual. Relatively large investments and high risks are involved when smallholders buy improved stock on credit. It is therefore essential to have a professional link between lenders and borrowers to appraise loan applications, and to supervise loan disbursement and the progress of borrowers after disbursement. The institution of a cow insurance system also reduces the risk for the borrower.

In Malawi the provision of credit for smallholder dairy development proved very successful when it was integrated with the milk collection system, and credit repayments were automatically deducted from payments for milk delivery. But the Indian experience is the reverse; tied credit can easily lead to a diversion of the supply of individual producers to other market outlets.

THE ROLE OF RESEARCH IN STIMULATING MILK PRODUCTION

Dairy development must be supported by adequate research, whose role is to develop cheaper and better methods of increasing agricultural productivity.

Many problems of dairy production are location-specific and require adaptive research at the local level. Among common problems encountered at the smallholder level are dry season feed strategies, profitable calf-rearing methods, practical breeding policies, small-scale processing techniques, socio-economic adoption issues and animal health factors.

In considering livestock research priorities it is important to establish what type of organisation of livestock production is likely to prevail in the next 20 to 30 years. The research problems presented by the alternative forms of milk production outlined earlier in this paper are very different, and it makes little sense to embark on specific research programmes without having a clear concept of what future production patterns are likely to be. Traditional smallholder farming is likely to continue to predominate in both Asia and Africa and it seems probable that a structure of service cooperatives will emerge. Based on this assumption, let us consider what type of milk production research is likely to be the most efficient in terms of cost, and how it might best be organised.

In all African and Asian countries calving patterns show marked seasonal variation; peak calving periods are influenced greatly by seasonal patterns of rainfall and feed supplies. Milk supplies and, more importantly, production costs show similar seasonal variations. Do we accept this situation, do we try to modify it by supplementary feeding and new forage crops, or do we produce milk only for that part of the year when feed is plentiful, conserving the seasonally surplus milk, as is done in New Zealand?

Cheap milk production can be achieved by feeding cows low energy diets based on crop residues and byproducts, supplemented with leguminous fodder and a small quantity of feed concentrate. The optimal milk yield per cow depends on its breed type, the overall stress of the environment, and the relative prices of cattle, inputs and outputs. The optimal feeding level and balance of feed types in these varying circumstances is largely unexplored, while for crossbred animals little is known about the relationship between incremental feeding and incremental milk yields.

The much discussed question of what degree of crossbreeding is desirable now

seems to have been answered for a number of systems. On smallholder farms, animals with about 50% of exotic blood usually outperform higher level crosses, but how this level can best be maintained is an unresolved practical issue. Should F_1 (50%) bulls be used for each generation? Should a new breed be fashioned by intermating of the crossbreds? Would 'crisscrossing' be practical? And how do we maintain a draught capability? Genetic interactions and maternal effects also complicate the analysis of crossbreeding data, as does the small size of the herds for which field records are obtained. Rarely are 'within herd' comparisons possible in small herds and the use of records across farms adds many other possible sources of variation. ILCA's results show that milk records from small herds in Africa have coefficients of variation of about 30%. This high variability makes selection methods largely impractical and necessitates large numbers of animals in any field experimentation.

In both Asia and Africa we know that, in the better environments, crossbred cows outperform and are more efficient than most local stock; we know that livestock can catalyse agricultural growth; we know that smallholders make up the bulk of all producers; and we know that certain ways of organising milk production have a much better success record than others. We also know that a careful analysis of farm production systems is essential to identify those constraints, both technical and non-technical, that limit present output and whose identification is essential to the most cost-effective use of research funds.

Unattractive prices and inappropriate policy directives frustrate production increases in many situations. Important as these are, the increase in food output so badly needed depends greatly on the development and adoption of new and simple technology. It also depends on whether or not research workers are promoting and supporting the organisational and entrepreneurial systems needed to put better technology into productive effect. The importance of asking the right research questions, of building a research structure appropriate to the farming patterns currently in use, and of being able to put better technology into practice on a widespread scale will largely determine the future food production and prosperity of both Africa and Asia.

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Dairy development and dairy marketing in sub-Saharan Africa: Some preliminary indicators of policy impacts*

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SUMMARY

OVER THE PAST TWO DECADES, sub-Saharan Africa experienced relatively low growth rates in the production of dairy products compared with the average for all developing countries. Total consumption of dairy products grew relatively much faster during the same period. However, available data suggest that the consumption of goat and sheep milk declined in East Africa between 1963 and 1980 and that of camel's milk stagnated. Only the consumption of cow's milk increased fairly rapidly in the whole of sub-Saharan Africa over the last two decades.

During the 1970s the population of sub-Saharan Africa grew at a rate of 2.9% per annum. Over the same period dairy production grew at a rate of about 1.9% per annum, while the consumption of dairy products increased at a rate of 2.1% per annum.

The trade deficit in dairy products in sub-Saharan Africa increased alarmingly over the last two decades: while in 1963 the dairy trade deficit for the region was about US$ 39 million, the figure had risen to about US$ 81 million by 1970 and to US$ 575 million by 1980. The major components of the imports were milk and butter and to a lesser extent cheese.

The systems of dairy development and dairy marketing in most countries of sub-Saharan Africa have one common feature: the dairy economy is dominated by a relatively underdeveloped dairy marketing subsystem in the traditional livestock subsector. Most countries in the region have both a formal dairy marketing subsystem, which caters primarily for urban milk supplies, and an informal marketing subsystem, which operates especially in the rural areas. There is some evidence that the informal marketing subsystems tend to be low-cost operations and that they are in a position to pay higher prices to producers.

With milk production in sub-Saharan Africa being well below the effective demand for milk and milk products, the region will continue to depend on dairy imports to close the dairy deficit in the foreseeable future. Measures to improve the marketing infrastructure in order to facilitate the distribution of recombined fluid milk derived mainly from imported milk powder and butter oil, will also be needed. The need to link rural and urban areas in a more efficient milk distribution network must therefore receive top priority.

Most food policies in developing countries, and especially those in sub-Saharan Africa, appear to be aimed at providing cheap food to urban populations. A strategy of dairy development through the creation of producer incentives, with producer prices and price controls as the main policy instruments, is limited chiefly by the need to strike a balance between the producer price and the retail price. The pricing problem appears to be at the core of programmes for improving dairy development and dairy marketing.

Governments are often sensitive to the level of food prices, particularly for the urban poor. Variations in the quality of the products offered for sale, whereby consumer prices are differentiated, could help achieve certain nutritional objectives. For instance, the introduction of 'toned' (more expensive) and 'double-toned' (less expensive) liquid milk in India has made it possible to sell pasteurised milk to both higher-income and lower-income groups in the metropolitan areas. Generally, sub-Saharan Africa could learn from the experience of dairy development in India, where petty milk traders have been integrated into the overall milk collection and distribution system, thus creating a complementary rather than a competitive relationship in the operations of the country's dairy industry.

* *This article is a summary version of 'Dairy development and internal dairy marketing in sub-Saharan Africa', Working Paper No. 5 of ILCA's Livestock Policy Unit.*

INTRODUCTION

Sub-Saharan Africa is a food-deficit region, with dairy products being particularly in short supply. It is therefore appropriate to assess the importance of the livestock sector of the region in terms of its contribution to food production. Sub-Saharan Africa's food production per caput is generally below the world average, except in the case of non-cereal staple food crops. Even though sub-Saharan Africa contains about 8% of the world's human population, the region produces only about 4% and slightly over 1% of the world's meat and milk respectively (Addis Anteneh, 1984). Projections of food production and effective demand in sub-Saharan Africa for the year 2000 indicate a staggering food deficit, particularly in the major livestock products (meat, eggs and milk). The deficit in the case of milk is projected to be over 10 million tonnes of whole milk equivalents by the year 2000, a deficit which can be reduced only if the growth in milk production during the 1980s and 1990s far surpasses that of the last two decades (Paulino and Yeung, 1981).

The existing and the projected food production and food balance situation in sub-Saharan Africa calls for a concerted and intensified effort to accelerate the rate of development of agricultural economies if the region is to avert a major food crisis. Milk constitutes a significant proportion of livestock food products in the region, and dairy development will continue to play an important part in bridging the food gap in sub-Saharan Africa.

The development of dairy production must be accompanied by developments in marketing infrastructure to ensure that dairy products reach as many people as possible, especially those in urban areas. The purpose of this paper is to examine the marketing of domestically produced dairy products, including imported but locally reconstituted whole milk powder and recombined skimmed milk powder and butter oil. The paper also briefly examines trends in the imports of other dairy products over the last two decades. The aim is to assess what impacts various dairy development and dairy marketing policies by governments have had on the production and consumption of dairy products in sub-Saharan Africa. An understanding of these policy impacts can help in the formulation of more appropriate policies for future dairy development in the region.

TRENDS IN DAIRY PRODUCTION

Over the past two decades, sub-Saharan Africa experienced relatively low growth rates in the production of dairy products compared with the average for all developing countries. For instance, taking liquid milk as the major dairy product, it is found that the rate of growth in world milk production for the period 1963–1980 was about 1.7% per annum. During the same period, the annual growth rates in milk production in developing countries and sub-Saharan Africa were 2.9% and 1.6% respectively (Table 1). Although most of the growth in dairy production during the 1970s occurred in developing countries and in Eastern Europe and the U.S.S.R., the other developed countries accounted for about 45% of the world dairy production by the late 1970s. The share for Eastern Europe and the U.S.S.R. was about 31% of world milk production and that for developing countries about 24%. These percentages are not expected to change significantly during the 1980s (FAO, 1978).

Production of such products as dried, evaporated and condensed milk generally reflects production of sufficient amounts of liquid whole milk. Table 1 indicates a generally declining rate of growth in the production of milk products other than liquid whole milk in sub-Saharan Africa, a situation which reflects the increasing scarcity of liquid milk to satisfy the increased demand in most parts of the region during the past two decades, particularly during the 1970s. For instance, in the late 1960s and early 1970s Kenya was able to produce substantial amounts of dried whole cow's milk and evaporated and condensed milk, but by the end of 1970s the country had to import dried skimmed milk and butter oil for recombination in order to satisfy the local market demand for fluid milk.

Subregional production

Dairy production statistics for the various subregions of sub-Saharan Africa indicate that the production of liquid whole milk from small ruminants expanded more rapidly than cow's milk production over the past two decades. However, data on the production (and consumption) of milk

Table 1. *Growth rates in the production of dairy products in seven regions or subregions, 1963–1970 and 1970–1980.*

Region	Average annual growth rate (%)							
	Liquid whole cow's milk		Dried whole cow's milk		Cheese		Butter and ghee	
	'63–70	'70–80	'63–70	'70–80	'63–70	'70–80	'63–70	'70–80
World	1.8	1.6	7.8	5.4	1.1	4.0	0.9	1.6
All developing countries	3.2	3.1	19.4	5.8	–9.8	2.3	2.3	2.5
Sub-Saharan Africa	1.6	1.3	29.8	–3.4	18.5	0.2	1.6	0.9
East Africa	1.9	1.3	23.6	–5.0	10.6	3.2	–0.9	0.2
Central Africa	–1.1	1.6	0	0	37.2	3.0	0.3	2.4
West Africa	2.8	1.6	n.a.	–1.6	30.1	0.7	6.6	2.1
Southern Africa	–0.5	0.7	0	0	27.4	–0.3	0.4	–1.3

n.a. = not applicable (since value at base period was zero).

Source: Calculations based on data compiled from *FAO production yearbooks* (1973; 1981) by the author.

from smallstock are notoriously unreliable and cannot be used with any confidence, while data on the production of camel's milk are not normally available (Table 2).

Table 2. *Milk production in sub-Saharan Africa by ruminant livestock species, 1975.*

Ruminant livestock species	1975 milk production (1000 t)	% of total production
Camels[a]	2 200	23.6
Cattle	5 627	60.3
Sheep and goats	1 507	16.1
Total	9 334	100.0

[a] Estimates based on yield of 200 kg milk per head.

Source: Adapted from Jahnke (1982).

The production of liquid whole cow's milk has made some significant but not adequate gains since the 1960s, the changes in absolute values over the period from 1963 to 1980 being 30% for East Africa, 9% for central Africa, 42% for West Africa, and 13% for southern Africa. The overall change in the absolute amount of cow's milk produced in sub-Saharan Africa as a whole was 27% over the same period. Sheep milk production made the highest gain in terms of expansion in production, particularly in East Africa, followed by central and southern Africa.

In terms of total liquid milk production East Africa produced nearly three times as much milk as West Africa, the next largest subregional producer, over the last two decades (Table 3). Central Africa and southern Africa recorded negative growth rates in liquid milk production during the 1960s. During the 1970s these two subregions made only a moderate recovery in liquid milk production compared with the performance of the rest of sub-Saharan Africa over the same period (Tables 1 and 3).

TRENDS IN CONSUMPTION

Available data suggest that the consumption of goat and sheep milk declined in East Africa between 1963 and 1980. The consumption of camel's milk, which is relatively more important in the arid and semi-arid areas, especially in Ethiopia and Somalia, also stagnated during the same period. However, the consumption of cow's milk increased fairly rapidly, especially in Nigeria, over the last two decades.

The consumption of dairy products (expressed in whole milk equivalents) in sub-Saharan Africa grew at the rate of about 2.1% per annum over the last two decades. However, some countries in the region experienced relatively low consumption growth rates (e.g. Kenya) while others (e.g. Nigeria) experienced relatively high rates over the same period (Table 4). In fact, Nigeria recorded a growth rate in the consumption of dairy products which was about three times that for sub-Saharan Africa as a whole during the 1961–1977 period.

Uses

Most of the milk (both locally produced and imported) in sub-Saharan Africa is used as human food, but some is probably used as feed for livestock although data on this are hard to find. The use of milk for non-food purposes in sub-Saharan Africa apparently declined over the last two decades, a factor which can be attributed to the declining per caput milk production and the fact that the food market for dairy products tends to be satisfied first before any surplus milk and milk products can be diverted to non-food uses. The fact that dairy products in sub-Saharan Africa are used primarily as human food implies that any shortages in dairy products in the region may affect adversely the nutrition of the people of the region. Generally, the proportion of milk and milk products that is used for food in sub-Saharan Africa appears to have remained relatively stable (at about 90% of all milk and milk products) over the last two decades (Paulino and Yeung, 1981).

Growth rates

During the 1970s the population of sub-Saharan Africa grew at the rate of about 2.9% per annum. Over the same period, dairy production grew at the rate of 1.9% per annum while the consumption of dairy products grew at the rate of 2.1% per annum. It is therefore not surprising that

Table 3. *Production of fresh whole milk in sub-Saharan Africa and its subregions, 1963, 1970 and 1980.*

Region (no. of countries)	Source of milk	Production (1000 t)		
		1963	1970	1980
East Africa	Cows	2 787	3 186	1.93
(9)	Sheep	102	256	299
	Goats	551	731	860
Central Africa	Cows	261	242	284
(8)	Sheep	1	2	2
	Goats	13	9	16
West Africa	Cows	784	949	1 117
(16)	Sheep	89	110	115
	Goats	302	272	291
Southern Africa	Cows	606	584	626
(11)	Sheep	0	1	1
	Goats	13	19	20
Sub-Saharan Africa	Cows	4 438	4 961	5 651
(44)	Sheep	192	369	417
	Goats	879	1 031	1 187

Source: *FAO production yearbooks* (1973; 1981).

Table 4. *Consumption of milk for countries and country groups in sub-Saharan Africa, 1963 and 1977.*

Region, country or country groups	Milk consumption[a b] (1000 t/year)		% growth rate in consumption (1963–1975)
	1963[c]	1975[d]	
Sub-Saharan Africa	5 183.0	6 661.8	2.1
Ethiopia	658.3	780.2	1.4
Kenya	723.1	701.0	-0.3
Madagascar	47.7	49.8	0.4
Nigeria	320.0	691.6	6.6
Somalia	570.8	705.9	1.8
Tanzania	590.2	753.4	2.1
Uganda	256.7	362.8	2.9
Zimbabwe	223.8	268.1	1.5
Sahel group[e]	921.1	1 058.1	1.2
Other countries	871.4	1 291.0	3.3

[a] Includes cow's, sheep, goat and camel milk and milk products in whole milk equivalents.
[b] Refers to total domestic use.
[c] 1963 figures are averages of the years 1961–65.
[d] 1975 figures are averages of the years 1973–77.
[e] Includes Chad, Gambia, Mali, Mauritania, Niger, Senegal and Upper Volta.
Source: Adapted from Paulino and Yeung (1981) with some calculations by the author.

the imports of dairy products into sub-Saharan Africa grew relatively rapidly during the last decade (Table 5).

The consumption of fresh milk increased slightly in all four subregions of sub-Saharan Africa during the 1970s. Consumption of fresh liquid milk increased most in central Africa and least in southern Africa, with the East and West African subregions each recording an average annual growth rate of 1.4%. Consumption of dried milk (dried skimmed milk, buttermilk and whole cow's milk) recorded the highest increase during the 1970s. The subregional range of growth rates in the consumption of dried milk during the 1970s was from 7.9% per annum (for southern Africa) to 15.9% per annum (for East Africa), while the average for sub-Saharan Africa was 13.5% per annum.

Demand and imports

Massive imports of dried skimmed milk into sub-Saharan Africa during the 1970s reflected the growing demand for dairy products in the region. Dried skimmed milk is normally recombined with appropriate amounts of butter oil in order to produce liquid milk; in sub-Saharan Africa such milk has primarily been distributed through urban fluid-milk markets. Hence the consumption of butter and ghee (which includes imported butter oil) also showed a significant growth during the 1970s for most subregions of sub-Saharan Africa. However, the consumption of cheese and curd in the region declined during the same period, with East Africa being the only subregion where a significant growth in the consumption of these dairy products occurred. The growth rate in the consumption of cheese and curd in West Africa during the 1970s was close to zero, while the rates for central and southern Africa were negative. Consequently, the consumption of cheese and curd in sub-Saharan Africa as a whole did not increase at all during the 1970s.

The aggregate demand for dairy products in sub-Saharan Africa is increasing, with the overall growth rate in the consumption of milk and milk products being estimated to be about 2.1% per annum (Table 4). This trend is expected to persist in the foreseeable future, and it is estimated that the deficit in dairy products in sub-Saharan Africa will be about 60% of effective demand by the year 2000 (Paulino and Yeung, 1981).

The income elasticity of demand for milk in developing countries generally lies between zero and one. However, one can expect large variations in the value of this parameter between countries, depending on the differences in the levels of disposable income per caput. In 1975 the income elasticity of demand for milk in sub-Saharan Africa was estimated to be about 0.8, but the range in the value of this parameter in the subregions varied from 0.5 for the Sahel group of countries in West Africa to 1.1 for central Africa (Table 6). Since the income elasticity of demand in most of the countries of the region is positive and close to one, the effective demand for milk in the region can be expected to continue to increase as individual countries progress towards higher income levels.

TRENDS IN PRICES

International prices for dairy products can be viewed as the composite of FOB prices[1] of the major dairy-exporting countries of

[1] FOB = free on board, which refers to prices payable at the port from which shipments of exports are made.

Table 5. *Growth rates in exports and imports of dairy products, sub-Saharan Africa, 1970–1980.*

Product	Average annual growth rate (%), 1970–1980		
	Exports	Imports	Net imports
Fresh liquid milk	-15.2	11.1	26.4
Dried milk (skimmed whole)	-19.5	13.9	14.5
Evaporated and condensed milk	-8.5	8.6	8.9
Cheese and curd	-37.0	-2.5	-1.9
Butter and ghee	-19.4	8.2	10.7

Source: Calculations based on data compiled from *FAO production yearbooks* (1973; 1981) and *FAO trade yearbooks* (1973; 1981) by the author.

Table 6. *Income elasticities of demand for milk in subregions and selected countries of sub-Saharan Africa based on projections for the period 1975 to 2000.*

Region/country	Income elasticity of demand for milk
West Africa	
Sahel	0.53
Nigeria	1.20
Other countries	1.23
Central Africa	1.09
East Africa	
Sudan	0.90
Other countries	0.77
Southern Africa	0.95
Sub-Saharan Africa	0.82

Source: Adapted from Jahnke (1982).

the world. As far as dairy importing countries are concerned, the prices at which they obtain the imports of dairy products must include the costs of insurance and freight (CIF) in addition to the FOB prices at the port from which shipments are made. Hence the CIF prices differ between importing countries.

The farm price support programmes for dairy production in Western Europe and North America have led to a situation whereby the production of milk has saturated the commercial outlets, leading to the stockpiling of dairy products, primarily in the form of dried skimmed milk and butter oil. Such stockpiles reached record levels in the mid-1970s. A major consequence of the stockpiling of dairy products in developed countries was the lowering of prices in international dairy trade during the 1970s, except for two relatively short periods during the first half of the decade (FAO, 1978). The situation has not improved much since the 1970s as both the EEC and North America continue to support milk producer prices.

Marketing subsystems and prices

As a net dairy-import region, sub-Saharan Africa would be expected to benefit from the depressed international prices for dairy products. However, a survey of internal dairy product prices in various countries within the region revealed that the range of milk prices in sub-Saharan Africa is much wider than that on the world market (ILCA, 1979). Most countries in sub-Saharan Africa have both a formal dairy marketing subsystem (the official channel), which caters primarily for urban milk supplies, and an informal (traditional) marketing subsystem. Government-controlled prices operate in the formal marketing subsystem while prices in the traditional or informal marketing subsystem are generally characteristic of a 'free marketing system' and usually tend to be much higher than the official prices.

With most countries in sub-Saharan Africa being net importers of dairy products, and with the formal and informal marketing subsystems operating at the same time in each country, one can deduce that there are basically three sets of prices for dairy products in each country:

- The official producer and consumer prices;
- The traditional market prices, which operate mainly in rural areas and which often are both producer and consumer prices (as producers will often sell directly to consumers); and
- The CIF prices – the prices at which imports are secured.

The three sets of prices can differ substantially both within and between countries, and the greatest variations may be expected to occur in the prices prevailing in the traditional marketing subsystem.

Generally, there is a greater stability of prices in the official dairy marketing subsystem within any country. This situation arises out of the concern by governments to keep dairy produce prices low in order to ensure that the urban population can get their requirements cheaply. Even though the data necessary for a systematic analysis and comparison of the marketing margins and prices in the official and the traditional marketing subsystems are lacking, it is well known that the traditional market prices are more unstable and that they are usually above the official market prices.

A survey of dairy prices by ILCA suggests that the ratio between the traditional and official market prices can fluctuate between 1:1 and 3:1 in certain areas of West Africa, e.g. Ghana and Nigeria, and between 3:2 and 2:1 in Sudan, Mali and Tanzania. A comparison of local and world market prices for dairy products also suggests that there is greater variability in local market prices, and that the local prices can be as high as two to three times the world market prices. Market prices for milk and other dairy products increased much faster in sub-Saharan Africa than in the rest of the world during the late 1960s and the 1970s (ILCA, 1979).

Generally, there is a lack of data on prices which would facilitate a systematic appraisal of differences in prices and trading margins between the official and the traditional marketing subsystems of sub-Saharan Africa. This situation also hinders a meaningful analysis of the trends in real prices for dairy products in the region. However, one issue appears to be clear: African governments have been slow in responding to changing cost structures in dairy production by revising official prices to keep in line with the prices in informal or traditional markets. One hypothesis, which should be examined, is that the traditional market prices are more competitive and that they reflect actual market conditions. These prices should thus be taken into account in the decision-making process if the development of the dairy industries of sub-Saharan Africa is to be accelerated.

Given the scarcity and limitations of the available data on the operation and performance of both the official and traditional dairy marketing subsystems, country-specific case studies should be undertaken to appraise the performance of the different markets. There is no doubt that the governments of sub-Saharan Africa are now faced by relatively low CIF prices for dairy products, and the idea of cheap dairy imports, which can facilitate cheap social programmes to feed the undernourished groups within the society, is attractive. However, the impact of the differentials in domestic and world market dairy prices and cheap dairy imports on the development of the local dairy industry in the different countries of the region is still uncertain.

TRENDS IN TRADE

The trade deficit in dairy products in sub-Saharan Africa grew alarmingly over the past two decades. In 1963 the dairy trade deficit for the region was about US$ 39 million, but the figure had risen to about US$ 81 million by 1970 and US$ 575 million

by 1980. Inflation is estimated to account for no more than 33% of this increase, so that at least 67% of the increase is attributable to the increased imports of dairy products into the region (Addis Anteneh, 1984).

Subregional imports

Absolute amounts of dairy imports into sub-Saharan Africa grew relatively faster during the 1970s. The major components of these dairy imports were milk (mainly as dried milk) and butter, with smaller amounts of cheese. During the same period, the West African subregion became the largest importer of dairy products in the region, its share of dairy imports being about 60% by the late 1970s. The large increases in dairy imports into the West African subregion are attributed to the fast growth of dairy imports into Nigeria during the 1970s. The volume of dairy imports into Nigeria was about 33% of the total volume of dairy imports into the West African subregion during this decade. By 1980 dairy imports had become the single most important item among Nigeria's imports (FMOA/GRNC, 1981).

Cost and volume of imports

The cost of dairy imports into sub-Saharan Africa grew from about US$ 41 million in 1960 to about US$ 104 million in 1970 and US$ 705 million in 1980. In 1980 the imports of milk alone accounted for about 88% of the value of all dairy imports into the region. Except for West Africa, where the major components of dairy imports were evaporated and condensed milk, the bulk of the dairy imports into sub-Saharan Africa consisted of dried milk during the 1970s.

There was a trade deficit in dairy products for all subregions of sub-Saharan Africa in 1980. However, the volume of dairy imports varied from country to country during the 1970s. The volume of imports may be an indicator of a country's ability to finance imports, which in turn may reflect a generally good economic performance. Therefore, the level of dairy imports in some countries of sub-Saharan Africa may be low simply because they have not been able to finance dairy imports. For instance, the relatively fast growth in the volume of dairy imports into Nigeria is associated with the strength of Nigeria's external account and its ability to finance all food imports, particularly during the latter part of the 1970s when Nigeria's economy benefitted from the oil boom.

DAIRY DEVELOPMENT AND MARKETING POLICIES

The systems of dairy development and dairy marketing in most countries of sub-Saharan Africa exhibit one common feature: the dairy economy is dominated by a relatively underdeveloped dairy marketing subsystem in the traditional livestock subsector. The more developed or modern dairy marketing subsystem is relatively small in terms of the amount of dairy produce that it receives from local production for processing and distribution. For example even in Kenya, which has a relatively better organised dairy industry than most other countries of sub-Saharan Africa, the formal dairy marketing subsystem handles only about 25% of the estimated total milk production in the country.

The traditional livestock subsector is dominated by indigenous livestock breeds, while the modern subsector often has improved livestock breeds, either exotic or crossbred animals. Production in the traditional subsector is geared toward self-sufficiency for family consumption, and only surplus milk production over immediate family requirements is sold, often as sour milk or processed milk products (butter, ghee or cheese). Such sales are effected primarily through a rural inter-household marketing system or through trading in rural villages or local trading centres. Production and marketing in the modern subsector reflect attempts to organise the dairy industry along the lines of commercial dairying in developed countries.

Marketing and producer incentives

Improvements in the production system call for complementary improvements in the marketing system in order to ensure that there are sufficient outlets for producers' milk and milk products. Official producer prices, which are subject to government control, must also be fixed at levels that ensure adequate financial returns to producers. Therefore, government policies should not only focus on the installation of a modern marketing infrastructure (to facilitate milk collection, processing and distribution), but must also ensure that the official producer prices will encourage investments in the dairy industry.

Marketing systems

There is some evidence that traditional marketing systems tend to be low-cost operations, and that they are in a position to pay higher prices to producers. Often, modern marketing systems cannot compete with traditional marketing systems for raw milk supplies, especially if the official prices are fixed and not reviewed regularly. For instance, the Bujumbura dairy plant in Burundi is said to face stiff competition from milk traders, and the plant is often forced to seek out raw milk supplies from distant rural areas, while the producers in the peri-urban areas supply their milk to the traders who are able to pay more. Such a situation, of course, increases the plant operating costs.

Future needs

With milk production in sub-Saharan Africa being well below the effective demand for milk and milk products, the region will continue to depend on imports to close the dairy deficit in the foreseeable future. Most countries will thus continue to import dried milk and butter oil in order to supply recombined fluid milk, particularly in the urban areas. Measures to improve the marketing infrastructure in order to facilitate the distribution of recombined fluid milk will also be needed. In this regard the linking of rural and urban areas in a more efficient milk distribution network must receive top priority.

POLICY OPTIONS AND IMPACT

Few countries in sub-Saharan Africa appear to have well documented, national

dairy development and marketing policies, quite apart from overall food policies. However, an indication of what these policies are can often be derived from the broad statements in the national development plans and/or government sessional papers on development prospects and problems. Meaningful policy analysis is often hampered by lack of data or documentation.

The term 'policy' can be defined in various ways. For analytical purposes one can consider policy as referring to any set of actions through which a given societal situation is to be changed to one that corresponds better to a society's goal (Jahnke and Kirschke, 1983). However, for the purposes of the discussions in this paper the term 'policy' will be defined simply as a 'set of government decisions, often embodied in legislation, taken at a national level and which usually apply to a country as a whole rather than to one part of it'.

Policy objectives

The possible ways in which governments can influence the dairy marketing system are listed below. The choice of any specific measure will depend on the policy objectives being pursued and the targets of the objectives.

Policy objectives associated with dairy marketing are:

- To provide higher prices to producers;
- To provide more stable prices to producers;
- To secure reliable milk supplies for urban areas at reasonable prices;
- To reduce marketing costs;
- To improve hygiene and quality of products;
- To ensure minimum nutrition levels to certain groups of the population through the implementation of programmes for easy and cheap access to milk;
- To raise and channel investment funds into dairy production by using profits made from the resale of concessional imports or food aid; and
- To provide convenient services to the consumer at prices he can afford and is willing to pay.

Ways of achieving objectives are:

- Setting up of monopoly/monopsony private (e.g. cooperatives) or parastatal organisations in order to:
  - secure economies of scale;
  - operate monopsonistic/monopolistic trading practices;
  - achieve improvements in hygiene/quality of products by direct government action through controlled parastatal corporations.
- Licensing and inspecting of competing traders to ensure minimum hygiene and quality standards as stipulated in law (or rules and regulations that govern trade in dairy products);
- Provision of subsidies to producers and/or consumers;
- Encouraging competition by easing access to information, skills and capital;
- Provision of processing and storage facilities (e.g. for butter), constructed at government expense, to private traders at cost or at subsidised prices; and
- Use of milk-buying chains to distribute dairy production inputs.

Given the problem of obtaining well documented accounts of dairy development and marketing policies, the following discussion draws heavily on mission reports made by the ISCDD[2] of the FAO for a number of countries in sub-Saharan Africa and on an interim report of an FAO expert consultation on 'Agricultural price policies'[3].

Existing policies

Most governments in sub-Saharan Africa follow policies aiming at the development of local dairy production, even where the potential for such development would appear to be relatively low. In many countries, dairy development is geared to higher levels of self-sufficiency in dairy products. Dairy imports make up a high proportion of the total food imports of many countries in sub-Saharan Africa. It is therefore not surprising that the aim of dairy development and marketing policies in these countries is import substitution. Implicit in the instruments used to implement dairy development and marketing policies is the need to improve rural standards of living, since dairying is expected to generate income to smallholders, create employment in the rural sector, and provide highly nutritious dietary ingredients.

Unlike the policies pursued in most developed countries, especially those of Western Europe and North America where the agricultural policies are principally geared to the support of farm prices and the stabilisation of producer income, most food policies in developing countries, and especially in sub-Saharan Africa, aim at providing cheap food to urban populations. This situation leads to policy conflicts. On the one hand, African governments wish to create producer incentives through attractive producer prices in order to promote local food production. On the other hand, the same governments wish to appease the urban populations by ensuring that food is available at reasonably low prices.

A strategy of dairy development through the creation of producer incentives, with producer prices and price controls as the main policy instruments, is limited chiefly by the need to strike a balance between the producer price and the retail price. Consumers must ultimately pay for the cost of the products they buy, unless governments are in a position to support farm prices and subsidise consumption. More often than not, governments in developing countries have found food subsidies too costly and have formally declared their intent not to subsidise agriculture. However, many governments still try to pursue a pricing policy to promote local food production while keeping prices of food for urban consumers low, a strategy which in practice often tends to keep producer prices depressed.

Cheap imports

The availability of cheap food imports and food aid, for instance from the EEC, the United States and the World Food Programme (WFP), has often made food imports an attractive alternative to the intensification of local food production, especially in the face of increasing domestic demand. This situation seems to have permeated the dairy industry of sub-Saharan Africa, as the WFP and the EEC have

[2] International Scheme for Coordination of Dairy Development (ISCDD). Country mission reports (various countries and years). FAO, Rome.

[3] The consultations were held in Rome, Italy, from 26 November to 2 December 1983; final report not yet published.

made it particularly easy for many countries to establish modern dairy-processing facilities in major urban areas to recombine dried milk and butter oil. Such dairy recombination materials have often been imported as food aid (from the WFP) or as 'imports at concessionary rates' (from the EEC).

There are serious risks in establishing modern dairy plants in urban areas just because cheap imports of dried milk and butter oil for recombination can be secured to keep the plants operating. Modern dairy plants entail heavy investment, and they should be installed only if there are good prospects of obtaining raw material for processing from local sources in the medium- or long-term future. A steady flow of imported material can not always be guaranteed. This situation may have crippled Madagascar's one dairy plant in the mid-1970s. Recent tendencies in most countries of sub-Saharan Africa to depend heavily on cheap dairy imports could easily lead to a situation whereby local dairy production and dairy marketing development projects in rural areas are no longer given priority.

It should be noted here, however, that WFP food aid in dairy products is usually geared to the support of the recipient country's efforts in local dairy development; yet a number of countries have failed to use the WFP commodities to achieve that objective. There is a need to identify what went wrong in such instances and see whether more appropriate policies could have led to success in the development of local dairy industries.

Policy choices

Countries and subregions differ substantially in terms of their potential for dairy production, a factor that is primarily attributable to geoclimatic as well as biotechnical conditions. Hence there may be no one policy instrument which will prove successful in stimulating dairy development under different productive potential conditions. Dairy development objectives may be similar in most of the countries of sub-Saharan Africa, but policy instruments to achieve these objectives must be based on the potential of individual countries for dairy production.

Under the general policy of local dairy production and marketing development, countries in sub-Saharan Africa have adopted a range of policy measures to achieve that policy objective. These measures have included the establishment of public agencies (parastatals) that are given monopoly powers to control dairy trade, imposition of restrictive and protectionist trade practices, and the encouragement of relatively free trade (a more or less *laissez faire* trade policy).

The case of Kenya

Effects of different policy measures or instruments on dairy development in sub-Saharan Africa may be expected to differ between countries. Hence detailed policy analysis must be relegated to country-specific case studies. However, we should mention briefly here the experiences in Kenya where dairy development and marketing policies appear to have had some success. The broad objectives of Kenya's latest dairy development and marketing policies are embedded within the framework of the objectives of Kenya's national food policy, which are:

- To maintain a position of broad self-sufficiency in basic foodstuffs;
- To ensure a reasonable degree of food security in all regions of the country; and
- To ensure that every citizen has access to a nutritionally balanced diet, through improvements in the marketing infrastructure and the distributive process, and through social welfare programmes[4].

Kenya's dairy development policies are to be implemented through a combination of the promotion of increased rural production of milk and improvements in the dairy marketing system. With smallholder dairy farmers now being the main milk producers (accounting for nearly 90% of total production) in Kenya, dairy development programmes aim to strengthen smallholder milk production through the provision of artificial insemination (AI) and veterinary and extension services. Through a pricing policy, dairy producers are guaranteed a price review once a year to ensure that the prices they get for their products reflect changing cost structure and are sufficiently remunerative to encourage increased dairy production. Consumer prices for milk and milk products are also adjusted simultaneously to reflect changes in milk producer prices, which ensures the economic viability of milk processing and marketing institutions. Failure to reconcile the two prices can have damaging effects. For instance in the mid-1970s, a 6-month delay in the adjustment of consumer prices of dairy products, after the milk producer price had been increased, adversely affected the operation and profitability of the Kenya Cooperative Creameries Ltd (KCC), the main dairy processing and marketing corporation in Kenya.

The Government of Kenya also encourages the development of regional cooperative dairies which are expected to enhance improvements in dairy marketing. Promotion of stall-feeding (zero-grazing) systems in areas of high potential and high population densities is also seen as a means of sustaining the growth in dairy production.

Despite the progress that Kenya made during the 1970s in dairy development, the country has also had problems similar to most other countries in sub-Saharan Africa. After the Government of Kenya inaugurated the school milk scheme (SMS) in May 1979, the country experienced a severe drought during the following season, and production of all major agricultural commodities declined substantially. Any carry-over stocks were depleted rapidly. With shortages of basic foods, it was difficult to maintain the new SMS, and local milk supplies had to be supplemented through imports of milk powder and butter oil, which were recombined and distributed as liquid milk. Towards the end of 1983, the KCC claimed that Kenya was producing more raw milk than could be disposed of on the local market. However, the same dairy marketing corporation was quoted as stating that consumers would have to put up with reconstituted fluid milk effective April 1984 until such a time when raw milk supplies, which have been adversely affected by the dry weather, are forthcoming from the producers (*Kenya Times*, April 6, 1984).

The experiences of dairy development in Kenya show how the vagaries of weather can throw a market that was relatively stable out of balance. Of course the extra demand for milk created through the SMS in 1979 further aggravated the situation. The question that faces planners is what to

[4] Sessional Paper No.4 of 1981 on Kenya's National Food Policy (Government Printer, Nairobi, Kenya).

do in order to cope with such unforeseen circumstances. Kenya was able to cope with the situation through emergency imports of dairy products (dried skimmed milk and butter oil), but can this always be a viable solution to such a situation? The answer to this question must be sought through country-specific case studies, since the answer has to be based on the dairy production potential and other socio-economic conditions in individual countries.

CONCLUSIONS

The pricing problem appears to be at the core of programmes for improving dairy development and dairy marketing. Prices determine the attractiveness of investments in dairying. Yet many developing countries appear to encourage dairy development and dairy marketing along the lines which make modern dairy plants high-cost operations, and this tends to erode the potentially high prices that could be paid to producers in the face of a government policy not to allow urban milk consumer prices to exceed certain upper limits. In the face of these problems, many governments in developing countries have found it easier to ban the sales of raw milk (thus attempting to eradicate the more competitive traditional marketing system) in order to protect supplies of milk to the modern dairy plants. However, this line of attack raises some fundamental questions which are the subject of policy analysis. For instance, does the ban on raw milk sales solve the milk marketing problems of developing countries? What other options are available? Should the private/traditional marketing channel be free to compete along with or complement the activities of the official marketing channel, and under what conditions?

Regardless of the complexity of policy-related problems, one of the major goals in development is the improvement of efficiency and productivity. If there are significant seasonal supply fluctuations and differences in product quality, then a price which does not reflect supply variations or which does not give a premium for quality differences can hardly be expected to enhance investments in the industry.

Modern dairy plants often view milk producers as suppliers of raw material, which should be procured at prices as low as possible, and little meaningful contacts or interactions exist between the milk processors (modern dairy plants) and the milk producers. This kind of sentiment has often been voiced by the critics of the KCC in Kenya. Such critics have included individual milk producers, politicians and observers. Apart from the need to consider ways of reducing costs, for instance through simpler dairy processing and packaging methods and paying more to the producers for their milk, the dairy plants must actively involve producers and be involved themselves in the collection of milk in the rural areas. If possible, producer price differentials based on differences in quantities of milk delivered by a given client (i.e. quantity premiums) could be considered. Such quantity premiums would probably encourage large group or cooperative participation in dairy marketing, and the move might even stimulate large-scale dairying.

Governments are often sensitive to the level of food prices, particularly for the urban poor. Rather than perpetually depress producer prices in order to ensure cheap food supplies to the urban dwellers, such alternatives as variations in the quality of products offered for sale, whereby consumer prices are differentiated, could help achieve certain nutritional objectives. For example, the introduction of 'toned' (more expensive) and 'double-toned' (less expensive) liquid milk in India has made it possible to sell pasteurised milk to both higher-income and lower-income groups in the metropolitan areas of India. In fact the model of dairy development in India has met with such success that it is considered worthwhile to try and evaluate the model and assess it for its applicability to the countries of sub-Saharan Africa (see Brumby and Gryseels, p.2 of this *ILCA Bulletin*). In particular, the Indian dairy industry has been able to integrate the petty milk traders into the overall milk collection and distribution system, thus creating a complementary rather than competitive relationship in the operations of the dairy industry.

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Aspects of livestock productivity in Maasai group ranches in Kenya*

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SUMMARY

A STUDY WAS MADE *of livestock productivity in three group ranches of the Maasai pastoralists in southeast Kenya. Eighty households were studied in detail, and the size of the production unit was found to affect most important production parameters. The output of animal products was measured by cattle and small-stock productivity studies and through household studies. The cow–calf operation of the Maasai pastoralists was found to produce an annual growth of 20 to 30%, which is higher than production indices measured in West African pastoral systems.*

The total livestock output from Olkarkar, the northernmost ranch studied, was 29 kg/ha of which 11 kg/ha was 'real' offtake for sales and slaughter. Since the stocking rate averaged 80 kg LW/ha, the real offtake was about 14% of the total biomass. The gross income from livestock products was equivalent to Ksh 176/ha. Maasai productivity per unit of land was shown to be similar to that of a commercial ranch, but production in the Maasai system is at a much lower cost, with household labour being the major investment.

INTRODUCTION

Research was conducted among Maasai pastoralists in three group ranches[1] located in the Kajiado district of southeast Kenya during the period 1981 to 1983. The aim of this research was:

- To determine how the Maasai in these semi-arid rangelands manipulate their livestock to achieve their production goals;
- To elucidate the causal relations within the production system; and
- To identify the constraints on production and the opportunities for increased output.

Pastoral systems appear technically simple, but are organisationally complex and represent sophisticated forms of adaptation to highly variable and risky environments. A systems approach to research was therefore adopted (ILCA, 1981).

In this paper the environment of the group ranches is briefly described together with the major parameters of the human and livestock populations. An analysis of the output of the Maasai pastoral system is attempted: first in terms of output per animal, and of household cash and subsistence income from livestock for large- and small-scale producers; and second in terms of output per unit of pastoral land.

THE SETTING

People and livestock

The total study area covers 1600 km^2 and supports an estimated population of 3500 pastoralists who own about 50 000 cattle and 30 000 sheep and goats. Thus, the average population density is 2.2 people per km^2, and the average livestock holding is 12.6 livestock units (LSU) per caput.

Land availability within the ranches ranges from 250 ha per household and 3 ha per LSU in the north to 650 ha per household and 4 ha per LSU in the south. However, pastoralists are often forced to move away from their registered ranches during prolonged dry seasons. In 1982, over 70% of people having households in the southern area moved to better grazing outside their territory (Peacock et al, 1982).

Rainfall

The study area includes parts of the arid and semi-arid zones as defined by Braun (see Sombroek et al, 1982). Rainfall is bimodal with peaks in November/December and April/May, followed by a 4- to 5-month dry season from June to October. The mean annual total varies from 750 mm in the north to 450 mm in the south. There was a large seasonal and spatial variability in rainfall during the 30 months of the study, with the number of dry months ranging from 11 to 17 (out of 30) from north to south.

Soils

The landscape of the area consists of undulating plains at an average altitude of 1200 m a.s.l. and hills rising from 100 to 200 m above the plains. Although the area is underlain by a Precambrian basement complex, large parts are covered by more recent lava flows and volcanic ash deposits. Over these basaltic parent materials, soils range from stony cambisols on the upper slopes to cracking vertisols in valleys and bottomlands, while on the basement complex lighter textured reddish luvisols predominate. Further south the plains feature dark clays with vertic and saline-sodic properties, whereas the foothills in the southeast show mixtures of andosols, cambisols and luvisols (Sombroek et al, 1982).

[1] Olkarkar and Merueshi are located in the north and Mbirikani in the south of the study area.

* *The original version of this paper was presented at the International Savanna Symposium held at Brisbane, Australia, 28–31 May 1984. The paper will appear in the proceedings of the symposium.*

Range resources

In spite of this diversity of soils, the vegetation has a fairly uniform appearance. Over half of the area is covered by grassland. Woody cover rarely exceeds 20%; dense woods and shrublands are confined to the granitic hills, to lava flows at higher altitudes and to steep-sloped river valleys. Grasslands consist mainly of perennial grasses admixed with variable proportions of annual grasses, forbs and dwarf shrubs. On the better drained soils, short to medium tall perennial grasses (*Digitaria*, *Chloris* spp.) predominate, while on heavier soils these are replaced by the taller, coarse *Pennisetum* spp. Further south the cover is much more sparse, in particular on saline-sodic soils where small, tufted grasses (*Sporobolus* spp.) are common. The woody cover is rich in species; species of *Acacia* are the most common and increase in importance towards the south.

Herbaceous plant cover varies with season, site and grazing use. Bare ground is mainly found in 'sacrifice' areas around settlements, water points and along cattle tracks. Low-altitude aerial surveys showed that in the north 10 to 20% of the land had little ground cover (0 – 10%) and 25 to 30% was well covered (<50%). In the south, due to the greater aridity and poorer soil conditions, at least half the land area is sparsely covered (Peacock et al, 1982).

Because of the variable rainfall, the amount of biomass available for grazing was difficult to estimate. After the peak rainfall (200–400 mm) in late 1982, standing biomass of 1.5 to 3.5 t DM/ha was measured in the short and medium range types. This range of yields is within the limits predicted from relationships between rainfall and herbage growth in similar areas (Braun, 1973; Sinclair, 1979). The same holds true for the nutritive value of the biomass. In general, the shorter grasses are relatively leafy, in particular when grazed regularly (McDowell et al, 1983). Crude protein content in grazed herbage rarely falls below 5%, but digestibility only exceeds 50% for 3 to 6 months of the year.

Water resources

The study area is well endowed with man-made and natural water facilities. These include a high-capacity spring in the northernmost ranch, a pipeline with several public and private water connections, four boreholes and a cluster of shallow wells along the principal seasonal river. However, the proportion of grazing land within 5 km of permanent water points varies from 30 to 90% between ranches. Rainfed water points comprise shallow pools in riverbeds and ponds. These seasonal sources account for only 20 to 25% of total use.

PRODUCTIVITY

Size of operation

Out of the 280 producer units in the study area a sample of 80 households was chosen and stratified into large-, medium- and small-scale categories on the basis of the number of livestock owned in proportion to the number of people supported.

Table 1 shows that the size of the production unit affected virtually every important production parameter. In the northernmost ranch (Olkarkar), small-scale producers, who accounted for 35% of the households, owned only 10% of the livestock units whereas large-scale producers, who accounted for 30% of all households, owned 73%. Small-scale producers had proportionally more smallstock, showing a smallstock to cattle ratio of 1.5 as compared with 0.7 for large-scale producers.

On average, 37% of the animals in a herd were adult females and 20% were young females more than 1 year old (King et al, 1983). Herd composition varied with cattle wealth in that large-scale producers kept more weaned steers (23%) than small-scale producers (16%). These cattle herd structures are characteristic of a subsistence mode of production with milk as the primary output on a year-round basis combined with a high and frequent offtake of male animals to satisfy cash needs.

Large-scale producers had more household members, but because they had far more animals per worker (25 cattle per worker as compared with 5 for small-scale producers), they sent fewer children to school and worked longer hours on livestock management. They benefitted both from economies of scale and from their ability to marshall non-household labour. Whereas each worker of small-scale producer units devoted more than 1 hr/day/LSU, workers of large-scale producer units spent only 0.25 hr/day/LSU.

System output

The output of animal products from the system was measured in two ways. First, cattle and smallstock productivity studies measured reproductive parameters such as cow and calf mortality, growth of offspring and milk offtake for human consumption. Second, household studies determined animal offtake and acquisition, and subsistence consumption of livestock and milk.

The first study produced data which were integrated in a cow production index as shown in Table 2. Because of lower cow and calf mortality, faster calf growth and higher milk offtake, the reproductive efficiency in the northern ranches was 39%

Table 1. *Demographic parameters of small-scale and large-scale producers in the Olkarkar ranch.*

Parameter	Producer type[a]	
	S–S	L–S
No. of households	14	12
Percentage of total households	35	30
No. of residents/household	7.6	14.3
No. of adult men and women/household	2.6	5.8
No. of cattle/household	35	367
No. of smallstock/household	54	252
Percentage of total ranch livestock ownership	10	73
Total no. of workers/household	6.3	11.1
No. of cattle/worker	5	40
No. of LSU/caput	4.3	21.0

[a] S–S = small-scale producers; L–S = large-scale producers.
Source: Grandin (1983).

higher than in the southern one. Average milk offtake was about 24% of the total lactation yield, if 1 kg of calf growth is equivalent to 9 litres of milk. However, seasonal fluctuations in milk consumption were large, particularly for the large-scale producers (Table 3). In general this means that the cow–calf operation of Maasai pastoralists produces an annual growth of 20 to 30%, which is higher than the production indices measured in West African pastoral systems which range from 17 to 22% (de Leeuw and Konandreas, 1982).

The components of income derived directly from livestock show marked differences between producers (Table 4). The large-scale producers can afford to increase their herds, as they need proportionally less of their resources for subsistence in spite of their much higher milk and meat consumption (Table 3). Large-scale producers have to sell a smaller proportion of their animals to support their higher levels of expenditure.

In the northernmost ranch there was a rise in livestock numbers of 14% p.a., indicating that herds are still expanding even though their numbers have regained the levels recorded before the 1976 drought (Njoka, 1979). In the southern ranch cattle numbers dropped by 2 to 5% because of a minor drought during 1982.

Little milk was sold: most was consumed by the household. If income from livestock sales and home consumption of meat are taken at market value and combined, they account for half of the total income; the other half consists of milk consumed by the household.

Table 3. *Milk consumption per adult equivalent for small-scale and large-scale producers in the three ranches studied.*

Producer type	Milk consumption (litres/adult/day)		
	Wet season	Dry season	Mean
Small-scale	0.84	0.66	0.75
Large-scale	1.75	1.03	1.39
Mean	1.30	0.84	1.07

Source: ILCA (unpublished data).

Output of land

The determination of the output of a pastoral system per unit area of land is usually difficult because of the mobility of stock and people in semi-arid environments. However, on the northernmost ranch studied the members rely almost entirely on its fixed land area. For this ranch the total livestock output was 29 kg/ha of which 11 kg/ha was 'real' offtake by sales and slaughter (Table 5). Since the stocking rate during the period 1981 to 1983 averaged 80 kg LW/ha, real offtake was close to 14% of the total biomass. Gross income from livestock products was equivalent to Ksh 176/ha (US$ 13.5/ha).

This output is difficult to compare with that from other livestock enterprises such as commercial ranches, which usually consist of a mixed cow – calf enterprise and fattening of purchased steers (Semenye and Chabari, 1980). However, in this case a comparison is worthwhile with a commercial cow – calf ranch in the Athi Plains of Kenya, where the climate and range conditions are similar to those of the group ranches (McDowell et al, 1983). This ranch was planned to be stocked at 3.6 ha/LSU for a herd consisting of 600 Boran cows producing an offtake of steers, surplus heifers and culled cows. Expected gross output was calculated at 25 kg LW/ha or Ksh 178 (at Ksh 7/kg) while costs were Ksh 143/ha, leaving a net revenue of Ksh 35/ha. This comparison shows that the Maasai productivity is similar to that of a commercial ranch, but production is at a much lower cash cost, household labour being the major input. Actual cash expenditure amounted to only Ksh 12.4/ha, of which 55% was used for the purchase of drugs and animal health care, while the remainder was spent on the acquisition of livestock.

Table 2. *Productivity indices for the northern and southern group ranches.*

Productivity index	Northern ranches	Southern ranch
Calving (% p.a.)	63	62
Cow survival (% p.a.)	98	90
Calf survival (% p.a.)	95	87
Calf weight at 1 year (kg)	98	90
Cow weight[a] (kg)	240	253
Milk offtake per cow to weaning (kg)[b]	193	172
Productivity per 100 kg cow per year[c] (kg)	29	21

[a] Weaning at 7 months.
[b] Cow weight from King et al (1983).
[c] Calculation of productivity per 100 kg cow per year taken from Trail and Gregory (1981).

Source: Semenye and de Leeuw (1984).

DISCUSSION

This analysis has shown that in spite of over a decade of development efforts aimed at commercialisation, the production strategies of the Maasai pastoralists are still geared primarily to satisfying their subsistence needs with a relatively low level of market offtake (Tables 4 and 5). However, distinct trends in management patterns have emerged recently which point to accelerated changes in traditional production goals. These are:

- A much greater reliance on purchased grain in the diet, particularly during the dry seasons when subsistence milk is in short supply (cf. Table 3);

Table 4. *Annual income per household from livestock for small-scale and large-scale producers at Olkarkar.*

Income from livestock	Producer type[a]		
	S–S	L–S	Total for ranch
Gross income ('000 Ksh)	15.2	90.8	1810.2
Of which:			
Herd and flock increase (%)	33	54	45
Livestock sales (%)	26	21	24
Subsistence consumption (%)	41	25	31

[a] S–S = small-scale producers; L–S = large-scale producers.
Source: ILCA (unpublished data).

- Contraction of grazing orbits within ranch boundaries and an increasing reluctance to grant grazing rights to non-ranch members; and
- A trend towards privatisation of grazing land and watering facilities, particularly by the large-scale producers. Claims to exclusive grazing rights in reserved grazing areas for calves and smallstock have become recognized, while investment in private water pipelines is increasing.

However, contrary to developments elsewhere in Africa (e.g. Botswana), a difference in producer goals between small-scale and large-scale producers is not yet apparent. Although differences in livestock wealth have become more pronounced with time, large-scale producers are no more commercialised than small-scale producers (cf. Table 4). The question of whether this is due to a lack of alternative investment possibilities or is linked to low livestock prices in Kenya needs further analysis.

It is difficult to ascertain whether the land tenure reform through the creation of group ranches has led to better resource utilisation. At present herds and flocks are increasing in size, the few largest producers increasing their share of ranch resource use. If there is an irreversible trend towards further privatisation of land use, a major question will be how group resources are shared among group ranch members. If each producer is allotted an equal share of the ranch territory (i.e. 250 to 600 ha per household), a redistribution and possibly a reduction in total livestock holding may result as the large-scale producers are forced to invest in the purchase of land or grazing rights and therefore must increase their offtake, at least temporarily. If, on the contrary, the land is subdivided according to family size or stock wealth (which are highly correlated with one another), the process will force out the small-scale producers and will concentrate resource management and allocation in the hands of a few large-scale producers. In the long term both scenarios may lead to a more balanced and conservative use of grazing resources at the expense of small-scale producers.

Table 5. *Annual productivity per ha on the Olkarkar ranch.*

Source	Productivity	
	kg/ha/year	Ksh/ha/year
Increase in herd	17.6	79
Livestock sales	9.3	42
Subsistence slaughter	1.8	8
Total livestock[a]	28.7	129
Subsistence milk[b]	14.8	47
Total productivity per ha		176

[a] LW price/kg = Ksh 4.50
[b] Milk price/kg = Ksh 3.20
Source: ILCA (unpublished data).

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Cropping by Fulani agropastoralists in central Nigeria

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SUMMARY

THIS PAPER *presents the results of a survey to determine the extent and methods of crop production in the Fulani agropastoral system in central Nigeria, and to identify the possibilities for increasing forage resources for the Fulani by cropping.*

Central Nigeria is a region in which the pastoral Fulani are increasingly becoming settled farmers. ILCA's aerial surveys have revealed a positive correlation between cattle and cultivation densities up to cultivation levels of 20 to 40%. The two areas studied were around Abet and Kurmin Biri. Abet is an area where the Fulani have settled among farming groups. In contrast, the Kurmin Biri area lies within a government grazing reserve where the Fulani are being encouraged to settle.

Cropping has become important to the Fulani, since their cattle do not then have to be sold in order to purchase grain. The area under cultivation among the 25 Fulani households studied ranged from 0.23 to 2.19 ha with an average of 0.87 ha/household. Positive correlations were found between farm size and household size in both Abet and Kurmin Biri, indicating that farm size increased with household consumption needs or with household labour supply.

Sorghum and maize, either sole cropped or grown in combination, accounted for about 70% of the total area cultivated. Cattle manure was widely used by keeping herds overnight on the land which was to be cropped. Almost all the Fulani used some chemical fertilizer although application was confined to small areas and little was apparently known about application rates or timing. With cattle manure, Fulani agropastoralists were obtaining grain yields comparable to those of the neighbouring specialised crop farmers who rely mainly on chemical fertilizer.

Crop residues are a highly valued feed resource and were ranked by the Fulani, along with the early rainy period, as being responsible for increased cattle productivity. However, the quantity of crop residues produced from the Fulani cropping system is insignificant, so they continue to rely on grazing the harvested fields of neighbouring farmers.

Herd size relative to cultivated area becomes an important consideration in improving cattle nutrition through crop and forage integration. Because the areas cultivated by the Fulani are small, any increase in forage production is likely to be minimal. It appears that innovations aimed at increasing feed resources from cultivated land would be best addressed to agropastoralists, either ex-herders or ex-farmers, who cultivate enough land to ensure that forage growing would have a noticeable effect on animal nutrition.

INTRODUCTION

Improved animal nutrition during the 6-month dry season is essential for raising cattle productivity in the subhumid zone of West Africa (ILCA, 1979). Under growing population and cultivation pressures, and the consequent reduction in grazing areas, an increase in fodder resources from cropped land is needed to maintain even current levels of animal production. ILCA's team has found it difficult to induce agricultural landowners to try new methods of cropping which would increase fodder production; there is no incentive for them to grow forage for cattle owned by the Fulani pastoralists. Where cattle raising and cropping are under the same ownership, as in the case of Fulani agropastoralists, the benefits from increased forage production are immediately appreciated.

This paper presents the results of a survey to determine the extent and methods of crop production by the Fulani agropastoralists studied by ILCA in central Nigeria. The study examined the present methods of crop production in order to identify the potential for and possible limitations to increasing forage resources by cropping. The growing tendency of Fulani cattle owners to settle permanently and develop links with indigenous farming groups are discussed in light of the growing competition for access to and control of land for cropping.

STUDY AREA

Previously considered a dry season retreat for Fulani transhumant herders, central Nigeria is now a region of increasing Fulani settlement. Some of the Kachichere Fulani have been settled in southern Kaduna State for generations, although they may change their exact locations every few years. ILCA's aerial surveys have revealed a positive correlation between cattle and cultivation densities up to cultivation levels of 20 to 40% (Bourn and Milligan, 1984). Some farmers also keep cattle, and Fulani herders are evidently attracted to areas that are already cultivated by indigenous crop farmers: besides the feed resources, principally crop residues and fallow land grazing, and the social and economic advantages of living close to farmers, the Fulani are now seeking good cropland for themselves.

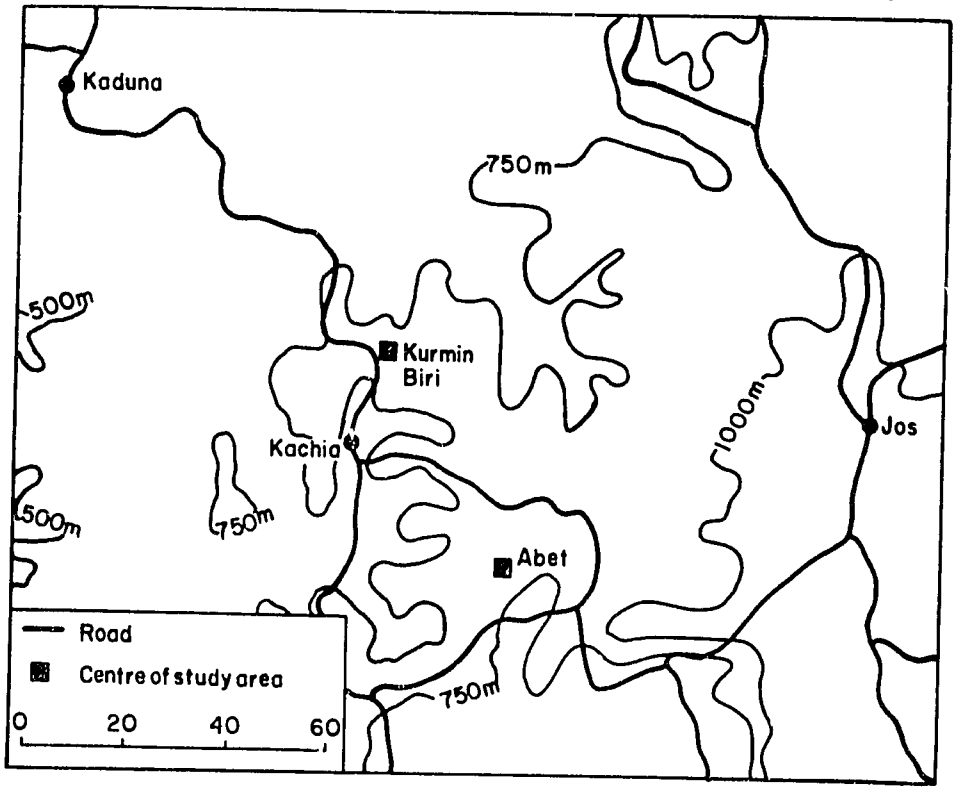
The Subhumid Zone Programme's two case study areas of Fulani settlement in central Nigeria, Abet and Kurmin Biri (Figure 1), have similar soils and climates but different livestock and cultivation densities. Average rainfall in both areas is about 1300 mm.

Abet (9°40'N, 8°10'E) represents an area where the Fulani have settled among farming groups. The population and cultivation densities in an area of 2475 km^2 around Abet are relatively high at 70 people/km^2 and 24% of the available area respectively (Milligan et al, 1979). Settled Fulani comprise approximately 10% of the total population in the 60 km^2 area immediately around Abet (Waters-Bayer and Bayer, 1984). Land is held by the indigenous farming groups Kaje and Kamantan, with whom the Fulani negotiate for settlement and cultivation rights.

Kurmin Biri (10°5'N, 8°0'E) lies within a government grazing reserve where the Fulani are being encouraged to settle. Over a 2500 km^2 area which includes the grazing reserve, the population density is 12 persons/km^2 and the cultivation density is 15% (Milligan et al, 1979). However, on the grazing reserve alone, which covers 12% of this total area, population and cultivation densities are lower. The 35 Fulani households now settled on the 31 000 ha reserve have immigrated from nearby areas during the past 5 years in search of permanent land rights. Crop farmers in this region own few livestock, most of these being goats and pigs.

The traditional practice between the separate livestock-owning and farming populations has been the exchange of their respective resources – meat, milk and manure for grain and land. However, as the Fulani seek more land for cultivation from the farming landowners, and consequently purchase less grain, these formerly complementary interactions are being weakened. At the same time, the farmers are becoming less dependent on the Fulani for manure because of the widespread use of subsidised chemical fertilizer. Conflicts over crop damage and land requirements have already prompted the movement of some Fulani from relatively densely cultivated areas into the less heavily populated grazing reserve.

Figure 1. *The location of the Abet and Kurmin Biri study areas in the subhumid zone, central Nigeria.*



THE STUDY

The study was initially conducted in Abet during October and November 1982 with the heads of 13 Fulani households. One to four households live together in a *ruga*[1]; cattle may be jointly managed and cooked food may be shared, but household heads generally farm individually and control separate stores of grain. Fulani women are involved only slightly in farming.

Cultivated areas were estimated by pacing the perimeter of blocks, and information on inputs, cultivation practices and constraints to production was obtained through structured interviews and observations.

In November 1983 the same procedure was followed with 12 Fulani households in Kurmin Biri. The cropping data for the two sites thus represent two successive years. In 1983, harvest yields of the main crops were estimated from 100 m^2 plots at each site.

RESULTS AND DISCUSSION

Cropping pattern

The majority of the 25 Fulani had been farming for most of their lives, even though on a limited basis. However, their cropping had expanded over the years to offset the rising price of food grains. Cropping became important as a way of avoiding the necessity of selling livestock in order to buy grain. The purpose was not to produce marketable products, though surplus supplies were sold and a few Fulani were experimenting with soya bean as a cash crop. The similarity in cultivation practices between the Fulani and the local crop farmers, as well as the Fulani's own comments, indicate that the Fulani have learned their farming techniques from the neighbouring crop farmers.

Cultivated area

The area under cultivation by the 25 Fulani household heads ranged from 0.23 to 2.19 ha, with an average of 0.87 ha/household. This was about one third of the crop area cultivated by the Kaje farmers in the area. Delgado (1979) found that in central Upper Volta, Fulani were cultivating an average of 2.46 ha/household or about two thirds of the crop area of neighbouring farmers.

[1] *Ruga* is a Hausa word meaning a Fulani encampment including people, buildings and livestock.

Farm size, household size and herd size for Abet and Kurmin Biri are given in Table 1. Positive correlations were found between farm size and household size in both Abet ($r = 0.55$; $P < 0.05$) and Kurmin Biri ($r = 0.70$; $P < 0.01$). In Kurmin Biri there was a positive correlation ($r = 0.68$; $P < 0.01$) between farm size and the number of working males in the household. This relationship did not hold for Abet, perhaps due to the lack of land to engage available males in farming, the greater availability of labour for hire so that men did not have to farm and/or the greater opportunities for off-farm employment. Although the sample was small, the negative but not significant correlation ($r = -0.42$) between farm size and herd size found in Kurmin Biri may indicate competition between cropping and cattle husbandry for labour.

Table 1. *Fulani farm, household and herd sizes in Abet (1982) and Kurmin Biri (1983).*

Location	No. of households	Household size: No. of persons	Household size: No. of active males	Farm size (ha/household)	Herd size[a] (cattle/household)
Abet	13	mean: 9	3	0.67	49
		range: 2–19	1–6	0.23–1.19	10–182
Kurmin Biri	12	mean: 12	4	1.10	53[b]
		range: 3–22	1–7	0.40–2.19	4–86

[a] Fulani herds also include about 20% of sheep.
[b] Calculated for nine herds because six households combined herds into three management units.

The average cultivated area per household in Kurmin Biri was nearly twice that of Abet. Household size was somewhat larger in Kurmin Biri than in Abet, but the difference in average farm size is largely explained by the greater availability of land in Kurmin Biri.

Settlement rights

In Abet all land is claimed by the indigenous farming groups, and a relatively high percentage of the land is already under cultivation. When a Fulani settles in Abet, he is expected to negotiate with the farming landowner, or the chief in cases of settlement on unoccupied land, for settlement rights which are usually for an indefinite time period although considered by both parties to be temporary.

Preferred settlement sites include land close to the *ruga* suitable for cultivation. Additional land may be acquired from crop farmers often on a yearly and per field basis and for a payment of ₦ 4 to 6 (US$ 5 to 8) or a bag of fertilizer or manure deposited on the respective farmer's cropland. The Fulani in Abet stated that their farming would expand if more land could be acquired. Unoccupied land requires considerable work for initial clearing, and farmers may then reclaim it. The Fulani therefore prefer to lease previously cultivated land for cropping.

One of the prime motives for settling in the Kurmin Biri grazing reserve where more land is available, is the desire to acquire an adequate area of land for cropping; but the area which can be cropped depends on the labour available for land clearing and subsequent crop management tasks. Once the initial high labour investment is made to clear land, the Fulani in Kurmin Biri expect to have secure and permanent rights to the land, which is not the case in Abet.

Crop enterprises

In Kurmin Biri 22 crop enterprises involving 12 different crops were identified, compared to 12 crop enterprises with 10 different crops in Abet (Table 2). Sorghum *(Sorghum bicolor)* and maize *(Zea mays)*, either sole cropped or in combination, accounted for about 70% of the total area cultivated by the 25 Fulani. Millet *(Pennisetum typhoides)* ranked third with 13% of the total area under cultivation. The concentration on these cereal crops, which are staples in the Fulani diet, is in keeping with the Fulani's aim to meet household consumption needs. Rice and yams are also important in the Fulani diet but are considered special foods; in the main they are still purchased, owing to the limited availability of low-lying land suited to rice cultivation and the hard work required in preparing yam ridges.

The other cereal crop grown by the Abet Fulani, namely iburo *(Digitaria iburua)*, was planted by broadcasting seed in scattered small plots where cattle had been kept overnight. It involved no cultivation or subsequent management. Iburo was not grown by the Fulani in Kurmin Biri; resources such as manure were rather used for sorghum, maize and millet. Sweet potato *(Ipomoea batatas)* was the predominant tuber in Kurmin Biri, followed by yam *(Dioscorea rotundata)* and cocoyam *(Xanthosoma sagittifolium)*.

Sole cropping versus intercropping

In Kurmin Biri the Fulani devoted 46% of the area under cultivation to sole cropping – mainly sorghum and a late variety of millet transplanted from nurseries – and 51% to two-crop mixtures compared with 57% and 41% respectively in Abet. In contrast to the Fulani, indigenous crop farmers in Abet practised more typical mixed cropping; 38% of the total cultivated area was sown to two-crop, 26% to three-crop, 6% to four-crop, and 5% to five-crop mixtures and only 25% to sole crops (Powell, 1981).

The greater reliance on sole cropping in the Fulani system, and the absence of the diverse mixtures commonly sown by crop farmers in the region, are attributed to the higher yields for less labour (an expressed Fulani aim) obtained in sole cropping, and a greater dependence on the three staple grains. Delgado (1979) likewise found the Fulani in Upper Volta practising a less labour-intensive mode of cultivation than the farming groups, principally because of conflicts in labour requirements between cropping and herding[2]. In northern Nigeria mixed cropping required a 62% higher annual labour input/ha than sole cropping, although this difference fell to 29% during the peak labour period (Norman et al, 1982).

[2] Delgado reported an average herd size of 43 head compared with 49 and 53 in this study. Even though 60% of the cattle within the herd were entrusted cattle, the labour required for cattle management in the two studies is comparable.

Table 2. *Crop enterprises of the settled Fulani in Abet (1982) and Kurmin Biri (1983).*

Crop enterprise	Abet			Kurmin Biri		
	No. of plots	Cultivated area (ha)	% of total cultivated area	No. of plots	Cultivated area (ha)	% of total cultivated area
Sorghum/maize	13	3.38	39	18	6.12	46
Sorghum	9	1.80	21	17	2.89	22
Millet	9	1.41	16	18	1.52	12
Rice	26	0.78	9	1	0.01	<1
Sweet potato	10	0.29	3	17	0.68	5
Maize	4	0.57	7	6	0.54	4
Others	21[a]	0.47	5	28[b]	1.43	11
Total	92	8.70	100	105	13.19	100

[a] Maize/cocoyam and iburo represented 2% and 1% respectively of the total cultivated area; 21 other enterprises representing less than 1% each involved the above-mentioned crops plus yams, okra (*Hibiscus esculentus*) and spinach (*Amaranthus* spp.).

[b] Yam represented 3% of the total cultivated area; 28 other enterprises representing less than 1% each involved the above-mentioned crops plus cassava (*Manihot esculenta*), cocoyam, cowpea (*Vigna unguiculata*), soya bean (*Glycine max*), pepper (*Capsicum annuum*) and tomato.

Management techniques

Traditional crop varieties are used exclusively in Abet and Kurmin Biri, except for an improved variety of maize which has been distributed through the local political party and is widely cultivated. Like the crop farmers, the Fulani commonly establish millet nurseries in mid-July and transplant seedlings during August and September in order to spread the work more evenly. In Abet the Fulani either received their transplants free from the neighbouring farmers, or obtained from them the goat manure used for fertilizing nurseries since they themselves generally do not keep goats. The Fulani in Kurmin Biri planted their own nurseries and used cattle manure – a less favoured fertilizer as it is thought to stimulate fast growth resulting in weak transplanted plants which are susceptible to lodging and breaking.

Striga (*Striga hermonthica*), a parasitic weed associated with low fertility conditions, was a major problem in established sorghum and maize fields in Abet, but not in Kurmin Biri where land has more recently come under cultivation. The crop farmers rotate sorghum and/or maize with millet to suppress striga, a practice widely adopted by the Fulani as well. Head smut (*Sphacelotheca reiliana*) on sorghum and downy mildew (*Sclerospora graminicola*) on millet were also more prevalent in Abet than in Kurmin Biri. Many Fulani used seed dressing, but the prevalence of these diseases suggests incorrect usage.

Cropping inputs

Labour

In general, the Fulani have become skilled cultivators. Only three of the 25 Fulani interviewed expressed a disdain for cultivation and had hired out all farm work apart from planting and harvesting, the latter taking place at a time of acute shortage of hired labour. Twelve of the 25 Fulani hired no labour, either because it was not available, or because their small farms needed only household labour, or because money was lacking. Only a few Fulani, however, worked in the fields throughout the day; most confined their farm work to the morning hours. The Fulani employed one or more of four systems:

- Self: all work was done by the man with perhaps some help from children and/or wife (wives);
- *Adashe:* an arrangement among a group of relatives or friends who cooperated in cultivating each individual's farm in turn; usually comprises only the strenuous tasks such as ridging and weeding;
- *Gaiya:* group work for a specific task with food and drink given in return; the group did not necessarily include only Fulani; and
- Contract: labour was hired, generally by the job; might include tractor hire.

Labour costs varied with the crop, the operation and soil conditions, and ranged from ₦ 20 to 286 (US$ 26 to 380) per household, the highest figure being paid for tractor hire on the largest cultivated area. In 1983, two of the 12 Fulani interviewed hired tractors to prepare their land. Ridging and weeding were the operations most commonly hired out, especially yam ridging which requires considerable skill and labour.

Three labour peaks were identified: May to early June when land was being prepared for sorghum and maize planting; the end of July to September when sorghum and maize were being weeded and millet was being cultivated; harvest time when herding had to be the most closely supervised. As grazing areas are reduced during the cropping season, careful herding is necessary to prevent crop damage. Most of the Fulani had sons or hired herder boys skilled enough to manage the herds. Any household head who lacked herding help had to farm before 10:30 a.m. at which time, in the rainy season, the cattle were taken for grazing. During harvest, however, in the more densely cultivated areas such as Abet, most household heads

and all available labour helped with herding, with often three to four men and boys tending each herd in order to keep the cattle out of unharvested fields.

The ability of the individual household to meet the labour demands for combined cropping and livestock production appeared to be mainly a function of the number of non-schooled children in the household available to help with livestock management, principally herding. The Nigerian Universal Primary Education Programme, and the priority the Fulani give to the education of their children, meant that few children were available for herding. The Fulani have various ways of alleviating household labour shortages, including cooperative labour exchanges, joint herding, lending of family members, and employment of a herder in exchange for cattle. Nevertheless, all the Kurmin Biri Fulani gave labour conflicts between cropping and livestock management as the major constraint in cropping. They had land but needed extra labour; hired labour was unavailable because of the low farming population in the area.

Draught power

None of the Fulani interviewed had ever used animal draught power. Animal traction had been introduced in Abet and was being used as late as 1980 by one crop farmer. Only four other farmers in Abet had used animal draught power; the principal deterrents to continued use were the labour required to graze the animals and the inadequate extension support in providing training and replacement stock. None of the Fulani interviewed expressed any interest in using cattle for farming, citing as reasons for this their opinion that soils were heavy and studded with bush, equipment was expensive and cattle would suffer. Tractor hire was preferred but it was limited in availability.

Fertilization

Cattle manure was widely used by keeping herds overnight on fields to be cropped. Two systems of manuring were practised: during the early wet season the herd was tied in pairs for 2 to 3 nights at each location and was moved systematically to cover the crop area. The time spent in each field depended on the number of fields to be manured (ideally each field every second year), field size, herd size, and the time available between the first rains and planting. Dry season manuring was generally done on land which had not been farmed previously: animals were tied in pairs but were moved at intervals of 5 nights.

In Abet dry season manuring was most commonly done on farmers' fields, for which the Fulani were paid in cash or kind. In the 1982/83 dry season, half of the 22 farmers surveyed in Abet hired Fulani to manure the fields intended for ginger (a cash crop) cultivation; the Fulani earned a value, excluding settlement rights, of about ₦ 6.50 (US$ 8.50) per week (Powell and Waters-Bayer, 1984). When the rains began, the Fulani preferred to move their herds back to their own cropland. None of the Kurmin Biri Fulani manured farmers' fields; they used their herds on their own cropland during both the dry and the wet season. This was probably due to the smaller number of farmers living close to the Fulani in Kurmin Biri, and the lack of established cooperation.

Wet season manuring was valued by the Fulani more than dry season manuring, mainly because it was thought to have a superior effect on soil fertility and subsequent crop yields. However, wet season manuring was said to lead to soil compaction which made cultivation more difficult; hired labourers demanded higher wages for working such land. Dry season manuring was not thought to compact the soil, but it did not give the high yield response as wet season manuring and led to an increase in weeds. However, grain yields obtained by eight farmers in Abet on fields manured in the dry season were 25 to 115% higher than on the adjacent non-manured fields (Powell and Waters-Bayer, 1984).

Almost all of the Fulani (21 out of 25) used some chemical fertilizer, although applications were generally confined to small areas and little was known about the rates or timing of application. Most of the Fulani stated a preference for chemical fertilizer because it was considered to give higher grain yields than cattle manure. A disadvantage was that chemical fertilizer had to be applied annually, whereas manure had a residual effect lasting 2 to 3 years. The uncertain availability of fertilizer also meant that most of the Fulani continued to rely on cattle manure. Sorghum and maize received the greater part of the available fertilizer in keeping with their place as the most important crops.

Cropping output

Grain yields

Data recorded under traditional farmer management at three locations in central Nigeria from 1980 to 1982 showed average sorghum yields of 1040 kg/ha as a sole crop and 920 kg/ha as a single intercrop; maize yields of 860 kg/ha as a single intercrop; and millet yields of 650 kg/ha as a sole crop (Federal Ministry of Agriculture, 1983). The yields of sorghum, maize and millet from Fulani fields in 1983 did not attain these levels in either Abet or Kurmin Biri (Table 3) owing to an unusual rainfall pattern in both areas: the early rains were erratic and the rains ended abruptly 4 weeks earlier than normal. Although the total wet season rainfall (1310 mm) in Abet was close to average, this was due to an abnormally wet period in late July. In Kurmin Biri total rainfall (1060 mm) was below average.

Table 3. *Grain yields from Fulani fields in Abet and Kurmin Biri, 1983.*

Location	Cropping enterprise	No. of plots[a]	Mean grain yield[b] (kg/ha)		
			Sorghum	Maize	Millet
Abet	sorghum/maize	6	800 (170)	490 (170)	–
	millet	4[c]	–	–	370 (40)
Kurmin Biri	sorghum/maize	8	630 (120)	510 (230)	–
	millet	6[c]	–	–	530 (160)
	sorghum	3	740 (90)	–	–

[a] Number of 100 m^2 areas.
[b] Standard deviations are given in parentheses.
[c] Excludes 2 plots grazed by cattle.

In 1983 sorghum and maize intercrop yields in farmers' fields in Abet were lower by 21% and 52% respectively and those of sole cropped millet by 49% compared with the two previous (normal) wet seasons. Combined sorghum/maize yields of 1290 kg/ha and millet yields of 370 kg/ha obtained by the Fulani in Abet from the 1983 harvest were approximately the same as the sorghum/maize and millet yields (1410 kg/ha and 390 kg/ha) obtained by the local farmers.

In Kurmin Biri lower rainfall was blamed for the reduced sorghum/maize yields (1140 kg/ha). However, the millet yields (530 kg/ha) were 40% higher than those obtained by either the Fulani or the farmers in Abet. The higher millet yields obtained in Kurmin Biri were attributed to a more timely transplanting of millet.

These data indicate that the Fulani, who relied principally on cattle manure and whose cropping labour was in competition with cattle management, were obtaining yields comparable to those of neighbouring specialised crop farmers who used almost exclusively chemical fertilizer. Two millet fields at each site were grazed by the owners' herds just before harvest, reflecting a disadvantage of cropping and herding in close proximity.

Grain output and household energy needs

The average contribution of sorghum, maize and millet to annual household energy requirements was higher in Kurmin Biri than in Abet, although there was considerable variability in both areas (Table 4). The larger cultivated areas and subsequent greater overall grain output at Kurmin Biri would account for the higher contribution of these grains.

Five household heads in both areas said that their crop yields of sorghum, maize and millet were sufficient and that they would not need to buy these grains. Another seven Fulani said that they had met household requirements in either sorghum and maize or millet production. Of the five households that were reportedly self-sufficient in the three grain crops, one produced enough annually for sale. The percentage contributions of these cereals to the energy needs of the remaining four self-sufficient households were 25, 41, 44 and 75% respectively, perhaps reflecting different preferences for other foods.

It has been estimated that milk provides approximately 10% of the annual energy requirements of settled Fulani households (Waters-Bayer, 1984). Meat and 'backyard' food crops also supply some energy, but the bulk of the deficit must still be made up through purchases.

Crop residues

Crop residues are a highly valued feed resource and were identified by the Fulani, along with the early rainy period, as being responsible for increased cattle productivity. However, as the quantity of crop residues produced from the Fulani fields (8.7 ha in Abet and 13.2 ha in Kurmin Biri) was insignificant, they continued to rely on grazing the harvested fields of neighbouring farmers.

Using previously established relationships between sorghum/millet grain and DM yields and stover edibility (Powell, 1983), the quantities of stover available for grazing from both Fulani cropping systems could be estimated. Assuming an average cattle body weight of 200 kg and a daily intake of 5 kg DM/head with 70% of intake coming from stover, Fulani sorghum and millet fields in Abet would provide only 5 grazing days for the 13 herds, while in Kurmin Biri the 12 herds would deplete the stover on harvested fields in 9 days.

Besides grazing their own limited crop residues, the Fulani competed for access to farmers' harvested fields. In Kurmin Biri, where the cultivation levels in close proximity to the Fulani *rugas* were low, many Fulani sent their herds to nearby farming villages for a 2-week stay at the beginning (the most valuable time) of the crop residue grazing period. None of the Fulani stored crop residues for later dry season feeding, nor is there yet a market in the area for stored crop residues as there is further north. For these Fulani the expected benefit was not worth the labour required to harvest and store crop residues.

Table 4. *Sorghum, millet and maize grain contributions to annual household energy requirements in Abet and Kurmin Biri, 1983.*

Location	No. of households	Contribution[a] to annual energy requirements (%)	
		mean	range
Abet	13	33	9–90
Kurmin Biri	12	42	18–93

[a] Assumes 20% grain loss in storage, 18.8 MJ energy/kg of grain dry weight and annual energy requirement of 3500 MJ/adult equivalent.

CONCLUSIONS

The Fulani cannot be viewed solely as cattle keepers, as cropping is becoming increasingly important in their production system. The Fulani's involvement in grain production is changing their linkages with the indigenous farming groups: the Fulani are becoming less dependent on farmers for grain and the farmers are becoming more reliant on chemical fertilizer, although a decrease in the government's present fertilizer subsidy might modify this latter reliance[3].

Where the Fulani can secure land, as in the government grazing reserve or through guaranteed occupancy rights, labour supply for herding and cropping may become the next limitation if hired labour is seasonally unavailable. When land, hired labour and fertilizer are available, the Fulani appear willing to expend livestock earnings in order to increase crop production. In northern Nigeria around Zaria, for example, Norman et al (1982) found Fulani cattle owners cultivating larger farms than non-cattle-owning farmers (3.7 ha versus 2.2 ha), apparently because their livestock revenues made it possible for them to purchase usufructuary rights and to hire more labour.

Since meeting subsistence grain needs is a major goal, the Fulani are not likely to jeopardise food production in order to increase forage production if there are alternative dry season feed resources. Undersowing and inter-row sowing of *Stylosanthes* into sorghum stands substantially increases

[3] The 75% fertilizer subsidy is to be reduced to 50% in 1984 and to 25% in 1985 (Suleiman, pers. comm., 1984).

the quantity and quality of crop residue DM, but grain yields may be reduced (Saleem, 1980).

ILCA's research is now looking for ways to intercrop grain or dual-purpose legumes in order to increase both total grain and crop residue DM yields. The sole cropping and sorghum/maize intercropping currently practised by the Fulani may indicate a lack of available labour for more intensive mixed cropping. Maize is important in the Fulani system but, although the heads are harvested before the end of the rains, it is frequently intercropped, and the stover is subject to further weathering before it becomes available for grazing, and therefore is often not palatable. If a legume were undersown into maize prior to harvesting in September, the legume would benefit from 2 months' rainfall and stored soil moisture.

Most Fulani do not have access to any crop extension service; they learn their cropping techniques from neighbouring farmers and through their own experimentation. The extension of adaptable, high-yielding, pest-resistant cultivars along with information about sowing rates and methods, fertilizers and seed dressings, and improved crop management would increase both grain and crop residue DM yields.

Herd size relative to cultivated area becomes an important consideration in trying to improve cattle nutrition through integrating crop and forage production. But just as herders are taking up farming, so too are farmers investing in cattle (Toulmin, 1983; McCown et al, 1979; Diarra, 1975). Innovations aimed at increasing fodder production from cultivated land would be best addressed to agropastoralists, either ex-herders or ex-farmers, who have both cattle and land and who can cultivate sufficient land so that forage growing would have an impact on animal nutrition.

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LIST OF ABBREVIATIONS

AI	Artificial insemination
a.s.l.	Above sea level
cf.	Compare
CIF	Cost, insurance and freight
DM	Dry matter
ECF	East coast fever
EEC	European Economic Community
FOB	Free on board
ha	Hectare
IBRD	International Bank for Reconstruction and Development (USA)
ISCDD	International Scheme for Coordination of Dairy Development (FAO, Rome)
KCC	Kenya Cooperative Creameries Ltd
Ksh	Kenya shilling
LSU	Livestock unit (250 kg)
LW	Liveweight
SMS	School milk scheme (Kenya)
t	Metric tonne
WFP	World Food Programme (Italy)