The Potential for Small-Scale Milk Production in Eastern and Southern Africa

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THE POTENTIAL FOR SMALL-SCALE MILK PRODUCTION
IN
EASTERN AND SOUTHERN AFRICA

A workshop attended by participants from nine countries
in eastern and southern Africa:
Botswana, Burundi, Ethiopia, Kenya, Malawi,
Swaziland, Tanzania, Zambia and Zimbabwe
19-21 September 1983
Nairobi, Kenya

Edited by
Jackson A. Kategile, March 1984

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Country papers were delivered by participants and discussed. The important highlights in specific areas are indicated below:

**Milk Production, Imports and Demands**

The papers highlighted estimated quantities of milk produced and consumed. In all nine participating countries, it was noted that:

- the traditional sector produced the bulk of the milk consumed with the exception of Zimbabwe where data on milk production in the communal sector is lacking;

- the traditional sector also supplies most of the milk marketed except in Zimbabwe and Kenya where large-scale dairy farmers produce the bulk of the marketed milk, but the proportion of milk marketed by small-scale farmers is increasing in Kenya;

- the common types of cattle are zebus and Ankole Sanga, in the traditional sector. A substantial number of small-scale farmers in Kenya are keeping grade milk type of cattle and, to a smaller extent in other countries in the region, the propensity is towards using the zebu x exotic crosses for milk production. A recent study in Zimbabwe by the Dairy Marketing Board has shown that responses in the milk field by zebus was in the order of 0.9 litres per day when milking cows were fed a concentrate supplement at the rate of three kg per day. This reinforces the opinion that the local zebus in Africa are genetically inferior for milk production.

On the other hand, limited data in Zambia indicate that the Barotse type of cattle are good milk yielders producing up to 1000-1500 kg per lactation. It was felt that this should be investigated systematically.

- it was generally concluded that milk production and consumption among pastoralists were most favourable while the situation in arable cropping/livestock mixture, livestock and milk production suffered in the traditional system. Burundi recognizes that grazing land is declining at the rate of 30,000 ha per year and that, by the year 2000, there will be only 300,000 ha for grazing more than 600,000 head of cattle besides goats and sheep;

- milk consumption from the national herds per capita is (FAO estimates 1981): 109.4 kg in Botswana, 13.3 kg in Burundi, 19.6 kg in Ethiopia, 49.5 kg in Kenya, 5.5 kg in Malawi, 63.6 kg in Swaziland, 39.9 kg in Tanzania, 8.1 kg in Zambia and 24.3 kg in Zimbabwe. Most of these levels are unsatisfactory for the sustenance of human nutrition. These average figures do not reflect local variations within a country, especially milk-deficit pocket areas of urban centres and tsetse fly infested areas;
the general relationship between demand and supply in the region is a deficit in supplies, and respective governments have been importing powdered milk to augment inadequacies. However, reliance on imports put the countries in a vulnerable status; increased milk production and research were felt to be vital needs.

Current Milk Production Systems

The following systems were identified and characterized:

i) Pastoral;
ii) Arable cropping/livestock systems - communal grazing land and fallow offering grazing areas;
iii) Highly intensive cropping and livestock keeping;
iv) Large-scale commercial.

Systems i to iii were essentially regarded as small-scale farming systems. Determinant factors in the development of the systems were:

- land availability
- climate
- socio-economic
- history

Problems identified as constraints to development

In several presentations, the important problems were identified and in summary, the anticipated common factors listed as:

- Inadequate feed resources, especially during the dry season
- Bush fires destroying grazing in dry seasons
- Inadequate tested legume/grass strains for pasture establishment
- Scarcity of pasture seeds
- Lack of know-how on forage conservation on a small-scale (silage-making specifically)
- Communal land tenure, which makes it difficult to introduce improved grazing management systems
- Inadequate supplies of high quality feeds for high yielding cows
- Genetic composition of indigenous zebus poor for milk production
- Genetically superior exotic dairy breeds not readily adaptable to physical and other environmental factors
- In-breeding among the zebus in the traditional sector, which has negative influence on animal performance
- Difficulty in drawing and implementing a breeding program involving zebus and exotic cattle due to instability of F2 generation
- Technical and managerial capacity to run farms, especially large-scale farms

* the symbol F2: "second generation" (F = Filial)
- Marketing - lack of infrastructure and organization and in some cases the marketing organizations have problems
- Distance to the markets and milk collection, milk pricing policy and competition with hawkers
- Extension services - difficulty in communicating with the farmers effectively and bringing about rapid development
- Importation of powdered milk, which may be a negative factor
- Lack of capital for initial investment in milk production enterprise
- AI* services not running smoothly due to infrastructure, transport, equipment, technical and/or heat detection problems
- Breakdown in routine animal disease control measures
- Technical know-how appropriate to small-scale farmers
- Scarcity of land in intensively cultivated areas
- Labour scarcity especially under labour-intensive zero grazing
- Farmers' attitude (i.e. as seen from the specialist's point of view)

Research Priorities

Three panel groups were set out to discuss three themes

i) Socio-economics and management;
ii) Animal genetics and breeding;
iii) Animal nutrition and health.

The groups discussed the above and came up with specific recommendations for research priorities in small-scale milk production. These recommendations were discussed by the workshop and amendments were incorporated in the final recommendations listed below:

* AI (artificial insemination)
The Panel

- summarized observations made during the workshop on the relative contribution to milk production of indigenous, exotic and crossbred cattle;
- reviewed the options available for breeding systems;
- identified gaps in our knowledge that can be addressed by research;

(a) Genetic Manipulation

i) Indigenous cattle: It was observed that, for the majority of zebu breeds, there is insufficient variation to warrant lengthy and costly selection programmes (for milk production). There are notable exceptions, e.g. Barotse cattle of Zambia;

Nonetheless, selections should not be neglected and should be encouraged to prevent the decline of the zebus in the traditional sector due to in-breeding. Selection will also assist the identification of females (with desirable physical characteristics) for crossbreeding to an exotic dairy-type animal;

It was observed that a sub-optimal environment inevitably prejudices the performance of indigenous cattle and hides their true production potential;

There is also a need to know the heritability of milk traits in indigenous cattle. Selection for milking ability amongst the zebus and Ankole will inevitably bring about improvement in breed production due to increased milk supplies to the calves;

ii) Exotic (purebreed, high grade): A wide range of exotic dairy breeds is available, but use of a particular purebreed should reflect the physical, managerial, availability of feed resources and economic environment into which that breed is to be introduced. Factors such as heat tolerance, metabolic efficiency, ability to convert low-quality forages into milk, need to be identified;

iii) Crossbreeding: It was observed that smallholder management capacity should determine the type of breed used for crossbreeding, whether it be zebu X Indicus or zebu X taurus, e.g. Indicus X Indicus (local zebu X Sahiwal) would appear to be most appropriate under an extensive system (pastoral) and a semi-intensive system. This will result in an offspring with higher milking ability than the local zebu.
An example of an Indicus X Taurus cross would be local zebu X Ayrshire producing a dairy animal suitable for an improved semi-intensive system and for stall feeding under an intensive system;

A problem common to all countries engaged in dairy crossbreeding arises in the F2 generation when positive gains from heterosis have been exploited. Up-grading is to be avoided and crossing back to the indigenous animal (unless that breed has been selected) is likely to be counterproductive. Crossing the half-bred animal to the Sahiwal appears to be a logical step, stabilizing the F2 generation;

In some countries, much of the evaluation work necessary to assess the crossbred potential could be conducted at farm level; elsewhere, the role is better suited to state or parastatal farms or institutes;

In compiling a regional inventory of knowledge, a common recording system should be established, and co-ordinated preferably by the International Livestock Centre for Africa (ILCA).

Recommendations

i) encourage selection for milking traits of indigenous cattle;
ii) investigate the heritability of milking traits;
iii) introduce purebreed dairy animals to reflect the environment and management system into which they are to be introduced;
iv) encourage research (on-and off-station) into milk potential of crossbred cattle; compile inventory, preferably based on a common regional record system;
v) investigate breeding systems that address the problem of the F2 generation.

Interim Recommendations

i) advise farmers on better management of female animals;
ii) sponsor workshop (ILCA) on recording for dairy production;
iii) sponsor (IDRC) documentation on breeding for dairy production; organize workshop.

Breeding Systems

Irrespective of breed type, the regular breeding and conception of milking cows are essential components of dairy production.

Natural service of dairy animals may be appropriate in certain cases (scattered human and animal population) but AI is more commonly adopted and governments should be encouraged to promote this service. The use of fresh or frozen semen will depend on conditions prevailing in a country as will the use of AI camps or on-farm insemination.
The detection of heat was observed as a common difficulty, with economic implications. Pregnancy diagnosis was also noted as an important husbandry tool. Training of farmers and extension staff in this area is vital.

The presence of progesterone in milk is an early indicator of pregnancy, and justifies research to evaluate its application in smallholder production systems.

**Recommendations**

i) national AI authorities should collect and store semen to safeguard against disruptions of external supplies;

ii) research should be made into progesterone as an indicator of pregnancy;

iii) the sound management of the cow for fertility should be encouraged.

**Research Capacity/On-Farm Studies**

Research capacity should be assessed for its ability to address problems and constraints identified in respect of genetic manipulation and breeding systems, viz:

i) conduct literature review on subject;

ii) assess the production potential of indigenous and crossbred stock in different environments. The ability to record indigenous cattle under traditional management should be stressed;

iii) develop a suitable, comprehensive and objective recording system, conducted - where resources permit - at farm level.

Where research capacity is limited, assistance should be sought from ILCA (as a co-ordinating body) and donor agencies (as a sponsor of training, research programs, etc.).

**Non-Cattle Dairy Animals**

The role of goats, sheep and camels was briefly discussed. A general consensus was that work evaluating the potential of the goat should be encouraged, emphasizing the adaptation of exotic dairy goats to the local environment.
Background: The panel noted that nutrition was the single most important environmental factor determining phenotypic expression of genetic potential of livestock productivity. The observed low growth rates, high calf mortality rates and low milk production among the traditional herds are mostly an expression of poor nutrition. Improved feeding systems will go a long way in increasing productivity.

Feed Resources: Variation in climatic zones and seasons has overriding effects on the quality and quantity of feeds. In the arid and semi-arid areas, the quantities of forages produced are small and limits productivity per unit area of land. During the dry seasons there are chronic feed shortages whereas during wet seasons there is some surplus feed. When one refers specifically to the small-scale farming systems there are distinct differences in the nature of animal feeding problems:

i) Pastoral - quantities available depend on stocking rates and also on "movements to grazing" but generally dry seasons are mean periods. Quality is a problem but animals can produce at satisfactory level with mineral supplements only and sometimes nitrogen supplementation has been beneficial. Concentrate supplementations are economically questionable propositions. The status of communal grazing and land tenure make innovations difficult to penetrate;

ii) Semi-intensive - quantity and quality are satisfactory during the wet seasons. In the dry seasons both quality and quantity are inadequate. Stocking rates are usually higher than optimum. With conducive land tenure system and favourable economic climate it is possible to introduce a crop/forage rotation system with benefits to both crops and livestock. With animals of medium and high genetic potential for milk production it should be possible to use limited supplementary feeds (energy, protein and minerals) but the economic implications have to be examined;

iii) Intensive - as these areas are intensively cropped (coffee, tea, bananas, etc.) land is the most limiting factor and there are chronic shortages of animal feeds. Forage production has to be intensified and other feed resources have to be sought.

Roughage Feeds Resources: As roughages (grazing or stall-fed) are the cheapest feeds and the only ones which can normally sustain ruminants without other feeds, it is crucial that due attention be paid to this. It is also evident that, if one plans introducing improved cattle breeds/types, the need for pasture improvement is selfevident. Again, land tenure has a big role to play in pasture improvement programs. Where communal grazing is practised, there is usually no pasture management and overgrazing is the main feature.
It was noted that to-date the most commonly planted grasses, legumes and fodder trees under large-scale farms are:

Grasses: Rhodes grass, Napier, Cynodon and Eragrostis
Legumes: Centrosema, Desmodium, and Siratro
Fodder trees: Leucaena

The panel felt that the list was small and more research in forage production needed to be undertaken in the following areas:

Major Areas of Research Priorities

i) Screening of species and strains suited for respective climatic and edaphic conditions;
ii) Finding of optimum mixtures of legume/grass for respective climatic and edaphic conditions;
iii) Development of suitable crop and forage rotation in various areas for optimum land use;
iv) Evaluation of forages produced by feeding to milking cows and development of feeding plans for small-scale milk herds;
v) Investigations into other options for increasing feed resources and productivity. A chart* which was presented to the panel was discussed and it was noted that option 2, 4, 8, 9, 10, 11 and 12 should receive emphasis. The major constraints are identified in the chart.

Utilization and Feeding Plans

It was noted that:

Grazing: in most of the small-scale farming areas (communal) overstocking is common. Rotational grazing should be investigated where land area is not limiting;

Stall-feeding: in areas where stall-feeding is practised, labour and technological packages are the major constraints;

Forage conservation: appropriate technology for hay and silage making for small-scale farmers is not well developed;

Use of crop residues: optimum feeding methods for small-scale farmers is not well developed;

Supplementations

Due to relatively rather low feed intake by ruminants for milk production and certain nutrient deficiencies in tropical forages, it is sometimes necessary to supplement with concentrates. As expected availability and prices for concentrates are variable, emphasis should be placed on home-made or village-produced processing by-products rather than on commercially compounded feeds.

* See chart "Options and Constraints in Improved Ruminant Feeding Systems in Developing Countries" on page 18.
Also suggested were non-conventional feed resources such as chicken manure for nitrogen and mineral supplementation. It was identified that the area of non-conventional feedstuff be investigated.

Government Interventions

In view of the fact that some problems can only be resolved through respective governments' good will, the panel specifically recommended government intervention in the following areas:

- Land tenure system;
- Credit facilities for financing capital outlay and some recurrent in livestock improvement programs;
- Co-operative movement - to facilitate input flow and marketing;
- Extension service and farmers' education - important for effective transfer of technological packages to the farmers;

Disease Control

The major diseases that affect animal production are known, as well as the origin, methods of infection, prophylactic measures and treatments. There is little that the small-scale farmers can do in the way of disease control except through the Veterinary Department. However, the emphasis should be on prevention of diseases as a means of control rather than treatment. The latter is more expensive. The control of disease before the introduction of the "improved" animal was stressed.

Major Types of Diseases

1. **Nutritional:** e.g. milk fever, bloat, ketosis. Inadequate nutrition is the major disease in most production systems. However, with improved feed resources and good supplementation programs, nutritional diseases can be offset.

2. **Vector-borne diseases:** (a) Tickborne diseases are the big killers of cattle and the small-scale farmer can contribute to their control by fencing off his piece of land and observing dipping routine. (b) Trypanosomiasis - this is usually controlled by efficient bush clearing.

3. **Reproductive Diseases:** e.g. brucellosis, vibriosis. The farmer will always depend on the Veterinary Services for their control.

4. **Management Diseases:** The major one is mastitis which can be overcome with education of the farmer coupled with a good extension service.

5. **Parasitic Diseases:** Internal parasites are a menace to cattle in most parts of this region, especially the *Haemonchus* group.
The small-scale farmer can contribute to their control by practising rotational grazing where land is not limiting and by drenching regularly.

Research Emphasis

a) Dips and dipping – the management of dips should be investigated.

b) Evaluation (economic) of disease infection, e.g. parasitic infection.
1. **A Systems Approach**

The panel gave strong support to the "systems approach" to agriculture and livestock research currently being followed by several research institutes, such as ILCA in its work on pastoral systems. The panel emphasized that in many cases sound research on dairy issues was unlikely to be carried out except in the context of a systems approach that includes:

i) a sound understanding of the natural and social factors that determine the present system;

ii) a careful diagnosis of the constraints which limit the development of the present system;

iii) an appropriate identification of the potential innovations - technical, economic or social - which may overcome these constraints;

iv) the development and testing of appropriate innovations - this testing always needs to be done on the farms of the region's main classes of dairy farmers and it sometimes must also be done on research stations;

v) the introduction of these innovations on a larger scale of farmers attended by careful monitoring of the social and economic as well as physical effects of the adoption of these innovations.

2. **Market Structure**

A system for the reliable and low cost collection of milk from farmers and distribution to consumers is prerequisite for the development of a small-scale dairy industry. In different countries, several different systems are currently in use; often more than one system exists to serve the same region or production system. In some cases parastatals collect, process and retail, in others private traders or co-operatives; in yet other cases these different organizations work in parallel or in competition. A study is required to examine the merits and disadvantages - for producers, for consumers, for government - of different systems and to throw light on the factors which may make one system more appropriate in one set of circumstances and a different one in another.

3. **Dairy Imports**

In some countries, imports of dairy products account for a very high proportion of total dairy consumption; in other countries, imports play only a marginal or negligible role. Some imports are on commercial terms - others on "grant" or highly concessional terms. These imports affect levels both of domestic consumption and of domestic output.
The effect on output arises in two ways. The level of imports affects the domestic price level; and profits or taxes raised by governments from selling milk imported on concessional terms are sometimes used to invest in the expansion of local dairy output. The concessional terms on which imports are obtainable at present depend on current agricultural policies in developed countries, especially the EEC.* There is a possibility that these policies may change in the future and this would cause acute difficulties to a government that had become overdependent on concessional imports.

A study is required of the effect of imports on the consumption, income, production and welfare of different groups in African countries, and of the risks involved in order to provide guidance to policy makers to help them make the best decisions in the light of their own circumstances.

**Dairy Records**

Good record keeping at farm level is an indispensable tool to enable farmers and extension and research workers to increase efficient dairy output. For whatever purpose records are required, the need is for a cheap system which provides an adequate degree of coverage and accuracy and which can be kept operating and useful by the country's own resources in the long term. However, somewhat different recording systems will be required depending on their purpose, on the production system and on the sophistication of farmers and government services involved. At present, different countries use different systems which appear to have been devised without the benefit of experience already gained in other countries. Far too often such systems generate a mass of low quality data which is then not properly analysed or made use of and the system proves unviable in the long run. A study is required of past and present experience which will provide evidence of the advantages and disadvantages of different recording systems and which will help African governments choose a system best suited to local needs and circumstances.

5. **Land Tenure**

An appropriate system of land tenure is essential for dairy development. A study is required of experience in Africa to throw light on the effects of different land tenure systems, not only on long-term overall productivity but also on the speed with which specific innovations are adopted by farmers.

6. **Management Systems and Production Parameters**

While research carried out at research stations is one source of information on improved management practices, another source is to observe the actual practices being implemented by the best farmers.

* EEC (European Economic Community)
There is enormous variation between the productivity of cattle in different herds which have access to basically the same feed and water resources. This variation is due to differences in quite inexpensive management practices. Calf rearing systems would be one area where differences in practice and performance can be easily observed. Research into such on-farm differences in practice and performance would be one source of additional information for farmers and extension officers. At the same time, such research could provide useful information on the sort of "targets", in respect of technical parameters (e.g. yields, calving rates, etc.), which small farmers would usefully aim at; in contrast to the somewhat out-of-reach targets provided by performance at research stations.

7. Extension and Livestock Services

Substantial sums of money are already being spent in Africa on livestock extension and other livestock services, e.g. veterinary; and more money will need to be spent in this way in the future if dairy industries are to be developed. However, the performance of these services is very variable, and in some cases poor, and this is not simply a question of the amount of money available, or of the availability of the technology or of the receptiveness of dairy farmers. The performance of livestock services is also determined by their own organization and management. Although some empirical studies have been carried out in the past on these issues in relation to other crop-related agricultural services, no significant work has been carried out in the context of the special requirements or circumstances of livestock services. It seems likely that the following management variables are important in the social closeness of field workers to farmers:

- the basic educational level of field workers;
- the extent to which control over field workers' programs of work is centralized or decentralized;
- the style of approach of field workers to farmers;
- the material and non-material incentives offered to field workers in direct relation to their performance;

Some empirical studies are now required to throw light on the appropriate management of livestock service, directed at dairy development under different circumstances. Such studies will not only improve the efficiency of the present level of resources devoted to these services, but provide powerful arguments with which the heads of livestock services can convince national budget authorities that effective steps are being taken to increase present levels of efficiency and the services are therefore worth further expansion;
8. The Nutritional and Social Consequences of Commercializing Dairy Output

Some participants felt that encouraging marketing of rural dairy output carried with it the risk that rural nutrition, particularly of children and of mothers, might suffer as a consequence of the diversion of milk from rural to urban consumers. Other participants felt that there were many urgent needs of rural families and that parents might be the best judges of whether to consume milk in the household or to use it to raise cash to meet some of the urgent needs. However, it was agreed that too little is actually known of the consequences, in this respect, of dairy development and that properly conducted research on these aspects would be of use to policy makers.

9. Farmers' Attitudes

There was considerable discussion on the extent to which farmers' attitudes are themselves a substantial constraint on dairy development.

There was considerable agreement that what often seemed to be a conservative and almost irrational reluctance by farmers to adopt innovations was, in reality, often well founded on objective reasons as to why the innovations are not as favourable to farmers as the extension and research services initially believed. There was some agreement also, however, that the reluctance was sometimes based on subjective factors rather than on objective ones and that it would be useful to know how conservative attitudes can be changed.

10. Multidisciplinary Approach

It was recommended that development oriented research should be multidisciplinary as farmers are involved in many activities which are not confined to one enterprise.
OPTIONS AND CONSTRAINTS
IN IMPROVED RUMINANT FEEDING SYSTEMS IN DEVELOPING COUNTRIES

INCREASED PRODUCTION AND AVAILABILITY OF FEEDS

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Milk and milk products have an important place in the Ethiopian traditional diet and the demand remains largely unsatisfied. The pastoralists, especially the nomads and semi-nomads, depend mostly on milk from cattle, sheep, goats and camels as their staple food. In the cultivated lands of the mid-altitudes and the highlands, although the emphasis is on crop production, there is a tendency to keep more draught oxen. Cows are also kept to provide milk for the family. Generally, the rural population consume nearly all the milk that is produced and only a small proportion is marketed, mostly in the form of traditional butter or ghee. Dairy production on a commercial scale is found only in and around big cities like Addis Ababa and Asmara. Here, consumption is usually low mainly due to shortage of supplies and low income levels.

Types of Cattle

Numerically, the cattle population of Ethiopia is considered to be the largest (27 million) in Africa and amongst the top ten in the world. They are mainly the zebu type with some Sanga type existing in the eastern and northern parts of the country. A small number of exotic dairy cattle and their crosses (about 10,000) mainly of Friesian origin and some Brown Swiss, Jersey and Ayrshire have been introduced into the country and are found mainly within and around Addis Ababa, Asmara and teaching and research institutions. The indigenous animals are generally low producers of milk. A production of not more than 120 kg of milk in a very short lactation can be expected from the indigenous cow under the peasant farmer's management conditions. Under experimental conditions, cows adequately fed and managed were able to yield 500-600 litres per lactation which is still very low. Usually cows do not calf until they are 3-4 years old and every two years thereafter. Calving rate is also very low (about 50%) and calf mortality is high. In general, the genetic capacity of the indigenous breeds for milk production is so low that additional expenses of intensive feeding and good management for the purpose of dairying cannot be justified unless backed by some genetic improvement.

Milk Producing Areas

The milk producing areas can be divided into the following three major areas:

1) The Rural Settlement Crop Farming Areas: cover the cultivated lands where 90% of the country's human population live. It ranges in altitude from 1,500 m to well above 2,500 m and has a rainfall of above 700 mm per year. The major part of the highlands is rolling country with wide shallow valleys that are poorly drained and not cultivable but serve as a major source of seasonal hay making and follow-up grazing;
The people of these areas are engaged mainly in crop production on the arable lands alongside the slopes of the hills and on the well drained high table lands. Cattle are kept mainly for draught purposes but a small breeding herd is also raised to replace the draught oxen and to provide the family with milk and butter. Since the draught oxen are the most important, breeding cows represent only 15-20% of the herd, while about 50-55% of the cattle population (5.7 million) of the highlands and 23% of the whole cattle population is draught oxen;

The feed resources in the highland mixed farming areas are mainly natural pastures which are communally used and usually overgrazed. Fallow crop lands and some crop residues also serve as a source of feed. In general, the total feed that originates from both natural pastures and crop residues does not meet the requirements of the livestock population in the highlands. The presence of numerous springs and permanent streams in the highlands greatly reduces the problem of water supply;

The land tenure system in the settled agricultural areas is either individually owned like in the case of the Southern and Central Highlands of the country or communally owned by close relatives in the case of the Northern Highlands. The holding per family is usually low. It is estimated that about 90% of the holdings are below 5 ha and 65% less than 1.5 ha. It is even worse in the case of the plantation areas which are densely populated and the land holding can be as low as 0.3 ha per family. In pre-revolution times, land ownership was concentrated in the hands of a few landlords with the majority of the cultivators as tenants operating on smallholdings as sharecroppers. Since the revolution, a land reform proclamation has been enacted and all the land has been nationalized with the opportunity for any Ethiopian wishing to engage himself in farming to own 10 ha of land. Today peasants farm their own land and are organized into peasant associations. The Government is also trying to organize farmers into a form of co-operatives. Some, including dairy co-operatives, have been formed already;

11) The Pastoralist Areas are the arid and semi-arid lowland area mostly in the north-eastern, south-eastern and southern part of the country with rainfall of less than 700 mm/year. It forms 45% of the country's area with only 8% of Ethiopia's human population. The people in this area are nomadic and semi-nomadic with a large number of cattle. A herd of about 100 cattle per family is common. Unlike in the cropping areas, cattle here are kept mainly to supply milk and milk products, which is the basic diet of the people. As a result, a large proportion of the herd (80-85%) is female and oxen are not utilized for draught purposes.
In addition to cattle, about 75% of the country's goats, 30% of the sheep and all the camel population are found in this area. Milk is also obtained from sheep and camels;

The area for grazing is vast but its utilization is hampered by scarce watering facilities, a seasonal distribution of rainfall and prolonged droughts. Thus, the livestock management system is governed by the permanent search for water and suitable grazing areas;

The land tenure system in the pastoralist area is not very well defined. Generally, the pastoralist people are divided into tribal groups, with each tribe or tribal unit having traditional grazing and watering rights on a defined territory usually considered as collective property. Since there are no definite boundaries within these tribal lands, these are inter-tribal disputes over grazing areas and watering rights;

iii) The Sub-Urban Areas are urban periphery areas where modern types of commercial dairy production are practised by state-owned farms, private farms, development programs, research institutions and teaching institutions. They are the main suppliers of milk to the urban population in the cities.

Milk Production Systems

Small-scale production: There are two patterns of small-scale production: the traditional type of milk production using mainly the indigenous breed and the improved type of production where exotic dairy animals are used.

In the traditional type of production, milk in both the cropping and pastoralist areas is produced mainly for home consumption and is not market oriented. In the cropping areas, small quantities of butter and cottage cheese (Eybe) are sold in the market. The types of cattle used are mainly the indigenous breed which are usually very low producers of milk. There is no specialized type of feeding. Animals are generally fed from overgrazed communal pastures and on some residues in the case of the cropping areas. Cultivation of fodder crops and the use of concentrates is not practised.

The other type of small-scale production is that of small-holders who own a small herd of graded dairy cows, either individually or in co-operatives. The first attempt to stimulate smallholder dairy farming with the use of exotic animals began in late 1967 with the establishment of the present Arsi Rural Development Project (ARDP), formerly known as Chilalo Agricultural Development Unit (CADU), with the aid of SIDA*. At the outset ARDP's program was a very comprehensive package approach that included all forms of inputs such as improved seeds, fertilizers, livestock improvement, home economics, water supply program, improved implements and marketing and credit services.

* Swedish International Development Aid
In its livestock program, 50% Friesian crossbred heifers in calf with a 75% exotic crossbred calf are sold on credit basis to farmers.

AI services are also given at subsidized prices and milk collection centres have been established. The project has its own crossbreeding ranch at Gobe with a capacity of producing 500 crossbred heifers per year for distribution to farmers.

Another similar type of project is the Wolayta Agricultural Development Unit (WADU) launched with a World Bank loan. Its livestock program was based on the use of bull stations and AI services for milk production and control and prevention of diseases. Both ARDP and WADU have made a great impact in the dairy development of the area, and today well over 5,000 crossbred dairy cows are found in the Arsi area alone. Both projects are now under the Ministry of Agriculture. Although ARDU's and to some extent WADU's extension programs have been successful, they are found to be very expensive and impossible to replicate on a national scale. As a result, the Ministry of Agriculture set up the Minimum Package Program (MPP) approach as a cheaper method of reaching a large section of the peasant farmers. Under the MPP, integrated minimum services which include extension advice, credit and to some extent marketing facilities are carried out.

The livestock extension program of the Ministry of Agriculture is at present following the MPP approach and is selling 50% Friesian crossbred heifers in calf to farmers on credit basis with freight, feed and medication until calving (usually for two months) free. In addition, 75% to 100% exotic Friesian bulls are also sold to farmers on a credit basis with freight, feed and medication free for the first year. Farmers are advised to enclose grazing areas at a rate of 2 ha per animal for their improved animals and concentrate feed is made available to them. Development agents and regional animal husbandry experts undertake regular visits to the farmers. In addition to the farms distributed to individuals in the pre-revolutionary period, there are now 136 small-scale collective type dairy farms with a herd size ranging from 10 to 70 cows.

Large-scale Production: Large-scale milk production is not very well developed and has had its own problems in the last decade.

Commercial dairy farming was established in the late 1950s with about 40 large commercial farms in and around Addis Ababa. A milk collection scheme was established in the early 1960s with UNICEF's assistance and in 1966, the Addis Ababa Dairy Industry (AADI) was set up to control and organize the collection, processing and distribution of milk. AADI was able to install a pasteurization plant of 30,000 litres capacity per day which became operational in 1969. In 1971, the Dairy Development Agency (DDA) - now the Dairy Development Enterprise (DDE) - was established with the added responsibility of planning and implementing the national dairy development program, and also taking over taking over AADI's marketing aspects.
The major objective of DDE when it was first established was to increase milk production by setting up farms - through loans around Addis Ababa. Friesian heifers were to be imported, and crossbreeding on six private ranches and on one Government ranch was envisaged. The DDE was also to handle milk production, collection, transportation and processing of milk. But these objectives were not realized. Farm loan investments did not take place in full scale as planned after the revolution, due to the land reform program that took place in the country, the loss of private land ownership and the Government's policy of discouraging private enterprise. Private farm lending has been discontinued. Only 40 small to medium sized farms were established through DDE's loan system. DDE is now responsible for the management of the state milk farm subsector which comprises mainly its own previous farms and farms nationalized after the revolution, totalling 14 state farms, 11 of which are found in and around Addis Ababa and the rest in Jimma and Gondar. There is a total of 3,130 grade cows, mainly Friesian, in all of these farms with an average milk production of approximately 11 litres/day. Concentrate feeding is practised. Some herbage production on the farms consists predominantly of natural pastures with a few areas planted to rain-fed fodder crops and irrigated alfalfa.

Marketing Organization and Channels

The marketing situation can be classified into three different areas:

- Commercial enterprise which is mainly DDE;
- Farm to house arrangements by smallholders;
- Local trade in the form of butter or ghee;

Another aspect of DDE's function is the collection and processing of milk which is done through 40 milk collecting centres all lying not more than 135 km on the five main roads leading to Addis Ababa. There are no cooling facilities at these collection centres, and the milk is transported by DDE to the plant in 50-litre aluminium cans on medium size trucks. The suppliers include state farms (45%), large or medium size private farms (15%) and small-holders (37%). The raw milk quality is tested for adulteration and souring at the site of collection. Processing is done at two places, namely Addis Ababa and Asmara. The Addis Ababa Dairy Industry, with an original plant capacity to process 30,000 litres of milk, doubled this, after renovations, to 60,000 litres per day. Additional facilities for recombination and processing of milk powder and butter oil have also been installed. However, the plant now receives an average of 28,000 litres daily and is not working at full capacity.

DDE formerly ran its own sales shops around the city of Addis Ababa, but today milk and milk products are marketed through approved agents who are entitled to a commission of 3%. In addition, DDE delivers milk direct to hospitals and organizations. The milk is packed into 0.5-litre plastic bags. DDE also serves as a market outlet for the milk produced by about 2,700 smallholders who sell their milk to DDE through the collection centres.
The other form of milk marketing is through a farm to house contract type of arrangement whereby individual producers in and around major cities, especially Addis Ababa, deliver raw milk direct to the consumer. This type of milk is usually not clean and is diluted with water. It is also usually sold at a much higher price than DDE's pasteurized milk. An estimated 10,000 to 15,000 litres of milk per day is sold in this way.

In the rural areas, milk is sold in the form of butter or ghee. The price varies from place to place and is usually expensive during the dry seasons as compared to the wet seasons.

Economics of Milk Production

The state dairy farms are operating at a loss since their cost of production is estimated to be 67 cents* per litre and their sale of milk to the plant at 45 cents per litre. This is in part due to poor management of the farms and to a greater extent due to the fact that the milk price has been kept fixed while inputs tend to be high in the state farms.

In a financial study made by ILCA on five small to medium size private loan farmers, the cost of production per litre of milk was 26 to 38 cents per litre. This figure can be compared with the official producer price of 45 cents per litre.

In the case of smallholders, information is limited on the cost of production, but it is generally believed that the cost of production is much less than the retail price. Further, the small-scale farmers fetch a high price as they sell their products direct to consumers.

Pasteurized milk from the Addis Ababa Dairy Industry is at present sold at a loss. The cost of production is estimated to be 75.5 cents per litre while retail price per litre is 60 cents.

Factors Limiting Production

There are a number of factors limiting production, especially among the smallholders. Some of these are:

i) Milk production largely based on the indigenous zebu cattle which are genetically low producers of milk;

ii) An overall scarcity of feed resources in terms of both grazing land and improved feeding practices. The high population density of livestock has led to overgrazing, especially in the highlands. There is very little specialized fodder production and fodder conservation. The availability of concentrate feed and hay for smallholders with improved type of dairy cows is also limited;

* 2.07 birr = $1 (US); 100 cents = 1 birr
iii) Absence of an adequate market framework resulting in a lack of incentive for farmers to produce more. This is aggravated further by the subsistence attitude to livestock rearing and the farmer's reluctance to consider livestock as a potential cash earner. Lack of all-weather roads and feeder roads makes milk collection difficult, preventing the creation of a market for milk in the interior;

iv) Disease and high mortality among cattle.

Potential for Small-Scale Milk Production

- The long tradition of Ethiopians in cattle keeping and the subsistence nature of milk production provide a basis for dairy development in the country;

- The presence of a large livestock population could serve as a national asset for livestock products including milk. Approximately 36% (9.3 million) are females above three years of age, i.e. milk producers;

- A substantial increase in milk production could be attained by improving the management of the traditional system through extension services and disease control;

- Higher production can be attained by improving the genetic merit of the local animal with the aim of replacing the low-yielding local cows with a smaller number of improved animals;

- The traditional crop farming system and the climatic and soil structure of much of the highlands together make up an integrated type of livestock and crop production;

- Fodder oats, fodder beet, vetch and some trifoliums are promising fodder for the highlands, and can easily be grown during the land fallow periods which characterize the highland agriculture;

- The large quantities of crop residues available could also provide a cheap source of feed;

- Temperatures of the Ethiopian Highlands are also ideal for dairy production;

- About 90% of the country's human population lives in the highlands, thus providing a ready local market for milk and milk products;

- The land reform and the Government's policy to promote cooperatives can pave the road for the easier introduction of modern technology to the peasant farmer;
Milk Production from Other Animals

Milk production from other animals is not very common in Ethiopia. It is only in the pastoralist area where milk from other animals - sheep, goats and camels - is utilized.

The Ministry of Agriculture has a pilot program in dairy goat improvement. In areas where land holdings are small, the people are accustomed to drinking goat's milk, and where farmers cannot afford to keep cattle, the dairy goat is considered a good alternative to supply milk to the farm family. The program hopes to distribute about 20 exotic crossbred does and some 40 bucks annually. To date, a few Saanen X local goat crossbred does and bucks have been distributed to different parts of the country. The program has met with limited success partly due to lack of proper follow-up.

Research on Milk Production

The Institute of Agricultural Research (IAR) is responsible for research in agriculture on a national scale.

The Institute is at present running a long-term crossbreeding study using three indigenous breeds (Horro, Barka and Boran) and crossing them with three exotic breeds (Friesian, Jersey, Simmental) with the objective of finding out which combination of zebu and exotic breeds, what level of exotic blood and ultimately what breeding policy to follow in the different environmental and farming conditions in Ethiopia. The program started in 1974 and some preliminary results on growth and milk data are available. There are also a number of trials on calf rearing systems, such as use of by-products as animal feed, pasture and forage production and utilization trials.

Another institution conducting research on milk production is ARDP. It has been conducting research on Arsi type of cattle and its crosses with Friesian and Jersey. The results from F1 cows show that crosses between Jersey and local Arsi females during the first lactation for 120 cows was 1,165 kg of milk with 4.9% fat while Arsi X Friesian crosses yielded 1,435 kg with 4.4% fat. Calculations on the second lactation show an increase from first to second lactation by at least 30%.

Other than these two institutions, the International Livestock Centre for Africa (ILCA) and different agricultural colleges run experiments on animal production. ILCA's relevant research program with regard to milk production is its Smallholder Highland Farming Program. It deals with the development of improved farming practices both with crops and livestock.
DAIRY PRODUCTION IN BURUNDI

Venant Kakunze

Burundi, lying in the heart of Africa, belongs to two important drainage areas. One part of the water flows towards the Mediterranean Sea through the Nile, the other goes to the Atlantic Ocean via River Lukuga which flows over from Lake Tanganyika.

The area comprises:

1) a low belt (1,000 m), the Ruzizi and the Imbo plains bordering Lake Tanganyika;
2) the Mirwa foothills (1,000-1,750 m);
3) the Tablelands (1,750-2,000 m);
4) the Kumoso depression to the east and south-east (1,200-1,400 m).

The country has an area of 27,000 km² for a population of over 5,000,000 inhabitants. The temperature fluctuates between 23°C in the Ruzizi plain and 14°C on the high plateau.

At the present time, following the proclamation of agriculture and livestock as first priorities by the Government of the Second Republic, the goal has been the production of sufficient milk and meat in quality and quantity to meet people's needs, to fight malnutrition, to curb the importation of dairy produce and to improve living standards of the rural population.

The Government aims at:

- Improving the sanitation of the rural environment;
- Improving stock feeding by fodder crops;
- Up-grading stock breeds reputed best dairy types;

Reliable statistics on milk availability in the country are difficult to establish because of the direct consumption of milk produced in the countryside.

Typical Areas of Dairy Production

Three areas are suitable for dairy production, and these coincide with the large projects of stock-farming - the Mugamba, the Bututsi and the Imbo centres:

- The first two areas are situated on a high plateau, the average altitude of which is between 1,600 and 1,800, with a very moderate temperature and a maximum rainfall of 1,400 mm;

- The Imbo area lies on a plain of 800-1,000 m altitude and has a rainfall of about 1,000 mm. The temperature is very high here (28 to 30°C);

In these areas, grazing lands have a communal status.
Milk is mainly produced on small traditional farms except in the farms of Kiryama in Bututsi and of Gifurwe in Imbo flatland where Sahiwal crosses are sometimes used.

Traditional stock farming in Burundi is based on extensive exploitation of natural communal grazing lands. These grazing lands, estimated in 1972 at 900,000 ha, are becoming smaller at the rate of 30,000 ha/year. Thus, theoretically, it can be inferred that in the year 2000, at that rate, there will be only 300,000 ha available for traditional extensive stock farming.

Bovines estimated at 600,000 head, which use these grazing lands, virtually all belong to the Ankole breed whose coefficients of production are as follows:

- age at first calving 5 years
- calving rates 50 to 60%
- interval between calving 18 to 24 months
- mortality of calves of 0-1 year 40%
- weight of adult males 300 kg
- weight of adult females 250 kg
- milk production by lactation 300 to 600 kg (8 months)

In her effort to develop livestock and increase its productivity, Burundi has to face constraints of different natures:

i) The poverty and scarcity of the grazing lands, besides the very high stock density and demographic rate;

ii) The low productivity of the Ankole breed;

iii) Stock diseases, especially protozoan and intestinal parasitic diseases.

Under such conditions the strategy to increase dairy and stock outputs at the peasant farmer level must aim at more intensive use of land and integration of crops and livestock, improving of grazing lands and upgrading of Ankole with Sahiwal or Bos taurus breeds.

Collecting, Processing and Distributing of Milk and Other Dairy Produce

The Central Dairy collects milk from the Ruzizi plain and the quantities collected in the last several years are indicated in table 1. In addition, private hawkers also collect from the same areas but the quantities are unknown.
Table 1. Milk Collection by the Central Dairy (1978-1982)

|----------------------|--------|--------|--------|--------|--------|

The tangible increase in 1982 is due in part to the new price the farmers were offered for their milk, which jumped from 25FBu*/litre to 45FBu/litre in July 1982. The sudden increase in price has also been profitable to Zairean dairy farmers who contribute from 1,000 to 1,500 litres of milk supply daily. The milk is processed in the plant in Bujumbura and three products are manufactured: pasteurized milk, butter and cheese. The prices for these are shown in table 2. The margins for the factory are small.

Table 2. Summary of the Selling Prices of Different Produce (in Burundi francs)

<table>
<thead>
<tr>
<th></th>
<th>Factory Prices</th>
<th>Shop Prices</th>
<th>Retail Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurized milk</td>
<td>55</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Butter/kg</td>
<td>400</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>Cheese</td>
<td>700</td>
<td>850</td>
<td>1,000</td>
</tr>
</tbody>
</table>

* 115.50 Burundi francs = $1 (US)

The margins of hawkers are rather high in comparison with those of the milk plants. The plants' margin is defined by the Government at 18% while that of middlemen fluctuates between 27% and 42%.
The consumption of milk is currently estimated to be at least 11,000 litres per day for the town of Bujumbura with its population of about 150,000 inhabitants, or 0.07 litre per person. The market seems to be easily saturated, especially during the rainy season when estimates show that real demand is constantly increasing while the supply is compelled to follow the rainfall pattern. Imported dairy produce is significant with regard to the quantity of local produce, and it ends up competing strongly with the latter. This is especially true in the case of butter and cheese products. Important dairy products are mainly imported from Kenya and the EEC countries. Data on importations are summarized in table 3.

Table 3. The Position of Imported Dairy Produce (1977 - 1980)

<table>
<thead>
<tr>
<th>Year</th>
<th>Items</th>
<th>Quantities (kg)</th>
<th>CIF Value (FBu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Whole powder milk</td>
<td>367,332</td>
<td>59,260,155</td>
</tr>
<tr>
<td></td>
<td>Skimmed powder milk</td>
<td>15,745</td>
<td>1,737,119</td>
</tr>
<tr>
<td></td>
<td>Fresh butter</td>
<td>41,902</td>
<td>7,533,212</td>
</tr>
<tr>
<td></td>
<td>Preserved butter</td>
<td>2,507</td>
<td>349,663</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>44,356</td>
<td>18,411,397</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>87,291,546</td>
</tr>
<tr>
<td>1978</td>
<td>Whole powder milk</td>
<td>465,033</td>
<td>66,589,050</td>
</tr>
<tr>
<td></td>
<td>Skimmed powder milk</td>
<td>30,609</td>
<td>1,634,432</td>
</tr>
<tr>
<td></td>
<td>Fresh butter</td>
<td>63,300</td>
<td>7,493,876</td>
</tr>
<tr>
<td></td>
<td>Preserved butter</td>
<td>971</td>
<td>202,091</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>36,881</td>
<td>10,999,897</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>86,919,346</td>
</tr>
<tr>
<td>1979</td>
<td>Whole powder milk</td>
<td>1,187,511</td>
<td>132,427,568</td>
</tr>
<tr>
<td></td>
<td>Skimmed powder milk</td>
<td>50,840</td>
<td>4,524,514</td>
</tr>
<tr>
<td></td>
<td>Fresh butter</td>
<td>51,067</td>
<td>12,460,714</td>
</tr>
<tr>
<td></td>
<td>Preserved butter</td>
<td>5,443</td>
<td>752,299</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>349,259</td>
<td>77,095,884</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>227,260,979</td>
</tr>
<tr>
<td>1980</td>
<td>Whole powder milk</td>
<td>664,205</td>
<td>124,963,677</td>
</tr>
<tr>
<td></td>
<td>Skimmed powder milk</td>
<td>10,931</td>
<td>1,490,924</td>
</tr>
<tr>
<td></td>
<td>Fresh butter</td>
<td>38,400</td>
<td>18,125,533</td>
</tr>
<tr>
<td></td>
<td>Preserved butter</td>
<td>49,135</td>
<td>5,994,470</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>21,136</td>
<td>13,937,942</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>164,512,546</td>
</tr>
<tr>
<td></td>
<td>Grand total</td>
<td></td>
<td>565,984,417</td>
</tr>
</tbody>
</table>

Dairy Production of Goat Milk

In areas where grazing lands are scarce and population density high e.g. Ngozi and Kayanza provinces (+300 inhabitants/km²), goats play an important role. In these provinces, a project to develop goat milk was set up in 1980 with the help of the Federal Republic of Germany.

The project consists of:

i) Multiplication of goat breeds, namely, Alpine and Boer;
ii) Up-grading of the local breed through up-grading with the Alpine or Boer breeds;
iii) Popularization in rural areas of the idea of the dairy goat and its crossings;
iv) The setting up of a prophylactic programme for goats;
v) Experimenting on fodder crops and foddering techniques.

The project's experiments are interesting and the results obtained promising.
Botswana, located in southern Africa between 18° and 27° south, is 582,000 km² in area. Mean rainfall is 475 mm, ranging from 250 to 650 mm. 80% of Botswana is Kalahari desert without surface water; human and livestock populations are concentrated in wetter areas of the eastern highveld.

Although 80% of the population of about one million is rural, urbanization is increasing dramatically at 10% a year. In rural areas, population is mobile, moving between home village, arable lands, and "cattle post", with male labour migration to South Africa.

There are an estimated three million cattle in Botswana, 85% in the traditional sub-sector, 15% in commercial freehold. The national cattle off-take is 11%, 80% of total agricultural output, an indication of the importance of the livestock sector. Freehold farmers represent less than 3% of the population, but contribute half the cattle inputs to the Lobatse abattoir.

Livestock productivity in the traditional sector is low. While beef supplies are adequate, milk supplies are not, especially in the urban centres. Currently, Botswana is importing powdered and fluid milk from South Africa at a cost of 11 million BWP (Botswana pula)* per year.

Current milk production is estimated at 109 million kg per annum and consumption per capita at 109 kg. The traditional sector contributes the bulk of milk produced, but even with production from commercial ranches fails to meet the demands of urban centres.

A developed milk production industry in the traditional sector would provide increased milk supplies to rural and urban populations, stimulate employment in rural areas, increase rural income, diversify economic activities in rural areas, reduce dependence on imported milk, and save foreign exchange.

Types of Cattle

The indigenous cattle in Botswana are the Tswana, which are of the zebu type. This breed is heat resistant and hardy. Under normal circumstances a Tswana cow will produce about 1 litre of milk per day. This, however, is the case when a calf is allowed to first suckle its dam before the dam is milked.

* 1.15 Pula = $1 (US)
A 1979 research program initiated by the Botswana Animal Production Research Unit (APRU), Ministry of Agriculture, revealed that a Setswana cow, kept under ranch conditions and not being supplementary fed but receiving bonemeal and salt, produced on average 98.9 litres of milk over a 120-day lactation. The exotic breeds available in Botswana are Friesians, Guernseys, Brown Swiss, Ayrshires, Jerseys, Simmental, Dairy Shorthorn and Red Polls.

Crosses: There is a wide range of dairy cattle crosses in Botswana's dairy research which only started in 1980. The results so far obtained indicate that the mean extracted milk from the Simmental crosses is about three times greater than that from Setswana cows. These preliminary results indicate that the Simmental cross cows have some potential for milk production in a once-per-day milking while allowing the calf to suckle during the day.

Milk Production Systems

Large-scale: The eastern part of the country consists of freehold farms extending from the extreme south-east to the extreme north-east. There are the Lobatse block, the Gaborone block and the Tuli block of farms. Most of these are beef cattle farms, with only a few dairy farms or a combination of the two. Cattle graze freely in the extensive ranches and are fed concentrates and supplementary feeds during milking.

Small-scale (traditional): Milk is produced in a traditional system as a by-product of the beef industry, contrary to other countries where beef is produced mainly from dairy herds. In Botswana the calf is not removed from the cow, nor fed supplementary feeds and reared separately. The cow is milked while she suckles the calf, making it impossible to measure the yields of the cow under this system.

Potential for Small-scale Milk Production

The Setswana cow will continue to play an important role in forming the breeding stock or foundation stock for many small-scale farmers. However, other dual purpose breeds like the Simmental and Brown Swiss, and their crosses which have proved to be adaptable to local conditions, could be used.

Feeding Systems: Veld grazing will continue to play an important role for the small-scale producer. Both government and parastatal organizations are being encouraged to grow more fodder and provide a more reliable feed resource. Other feeds which are being exploited are stovers*, cereal brans, brewers waste and mineral supplements.

The possibility of setting up a milk collecting and cooling mobile unit can facilitate the flow of milk to urban centres.

* "Stover": residues
1. Historical Perspective

Kenya has a relatively well established modern dairy industry which can be traced to the early days of European settlement in the former "White Highlands". The settlers imported some of the well known European breeds of dairy cattle such as Ayrshires, Friesians, Guernseys and Jerseys and crossed them with the indigenous animals and over the years produced the present national grade dairy cattle herd. The process of upgrading is still continuing through judicious importation of breeding stock backed up by a national breeding program.

In order to provide for orderly marketing of milk and other dairy products the Government set up a commission to study the situation in 1956 and this led to the formation of the Kenya Dairy Board under the Dairy Industry Ordinance in 1958.

The main institutions that are currently responsible for the organization and general development of the dairy industry in Kenya are the Kenya Dairy Board, the Kenya Co-operative Creameries (KCC), the Ministry of Agriculture and Livestock Development, the Ministry of Co-operative Development and the dairy farmer himself either individually or collectively through the Dairy Co-operative Societies.

The smallholders began keeping grade dairy cattle in the early 1950s, mainly in the areas adjoining the former European settled areas, especially in Central and Rift Valley provinces.

During that period there was deliberate government policy to introduce and encourage commercial dairy farming in the smallholder agricultural system. The dairy animals were therefore acquired mainly out of the individual farmers' initiatives arising from their experience as farm workers or as enlightened businessmen who had seen and realized the value of the dairy cattle as better milk producers than the indigenous zebu stock. The bulk of the smallholder milk was therefore either consumed within the farm or sold locally unprocessed in the neighbourhood.

By 1960 the total national grade dairy cattle population was estimated at 420,000 head, almost completely in the hands of European large-scale farmers. After independence (1963), however, changes in ownership began to take place. The Government adopted a deliberate policy to assist and encourage smallholders to acquire and keep dairy animals. Artificial Insemination was extended to the smallholder areas and, where this was not practicable, bull centres were established.

One major development which took place during this period was land consolidation and registration. Traditionally the indigenous communities had communal systems of land ownership. But with land consolidation and registration, each individual assumed ownership of a particular piece of land with full rights to its use. This made it possible for the smallholdings to rear grade dairy cattle without being subjected to too much communal pressures.
Also at the time of independence in 1963 the Government bought out some of the large-scale European farms to settle the indigenous population. Dairy farming was in most cases included in the mixed farming package for such schemes. A large number of such settlers received assistance through special credit arrangements to buy and keep dairy cattle.

The combined effect of all these measures was a considerable change in the ownership of grade dairy cattle population. By 1970, an estimated 418,000 grade dairy cattle or 60% of the national herd were in the hands of smallholders and settlement farmers and only 284,400 head remained in the large-scale farms.

The smallholdings and settlement scheme between then and now the account for about 75% of the dairy herd.

When the smallholders first joined the modern dairy economy the bulk of their milk was either consumed in the home or sold direct to consumers within the neighbourhood. As production increased the local market became saturated and it therefore became necessary to find alternative outlets for the surplus milk. They consequently formed themselves into Dairy Co-operative Societies to facilitate collection, transportation and marketing of their milk (see table 1).

It was in 1954 that a quota system was introduced to control the supply of milk to the Kenya Co-operative Creameries. Under the quota system farmers were given definite quantities of milk to deliver with appropriate penalties for delivering more or less than the quantity allowed. This made it very difficult for outsiders or new producers to get into big urban markets.

In 1963 the Rural Dairy Development Scheme was set up within the Kenya Dairy Board with the assistance of UNICEF to help rural dairy co-operatives establish themselves. UNICEF contributed US$110,000 for setting up 24 rural milk centres, 13 of which had milk cooling facilities and all facilities for separation of cream. By June 1964 some 68 dairies had been established through this assistance in various parts of the country and the smallholder dairy farmer began actively participating in the modern dairy economy.

In 1970 the Ministry of Agriculture set up a Dairy Working Party composed of representatives from all sectors of the dairy industry to carry out a review and "to formulate a pricing and marketing policy for the dairy industry which will encourage its growth during the 1970s in the national interest". One of the working party's major recommendations was the abolition of the quota system effective July 1970 and also the establishment of a national price based on net realization. The quota system was subsequently abolished and the Kenya Co-operative Creameries became obliged to accept milk delivered to it by any farmer and pay for it at a fixed price at the factory gate. This encouraged the smallholders to continue to deliver an increasing quantity of milk to KCC.
Table 1. Estimated Quantity of Milk Sold Privately on Farms and to Co-operative Societies

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of Farm</th>
<th>Breed</th>
<th>Quantity Available for Human Consumption</th>
<th>Milk Marketed '000 litres</th>
<th>Quantity of Milk Sold to Society '000 litres</th>
<th>Milk Sold to Society (%)</th>
<th>Quantity of Milk Sold to Society '000 litres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed farm areas</td>
<td>Smallholder</td>
<td>Zebu</td>
<td>343,231</td>
<td>20</td>
<td>68,646</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Large-scale</td>
<td>Grade</td>
<td>152,672</td>
<td>90</td>
<td>1,377,405</td>
<td>95</td>
<td>130,525</td>
</tr>
<tr>
<td></td>
<td>Smallholder</td>
<td>Grade</td>
<td>283,354</td>
<td>68</td>
<td>162,668</td>
<td>69</td>
<td>132,524</td>
</tr>
<tr>
<td>Ranching</td>
<td>Commercial</td>
<td>Zebu cross</td>
<td>1,966</td>
<td>10</td>
<td>197</td>
<td>9</td>
<td>177</td>
</tr>
<tr>
<td>Pastoralists</td>
<td>Zebu</td>
<td></td>
<td>1,199,894</td>
<td>10</td>
<td>11,989</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>901,117</td>
<td>42</td>
<td>380,905</td>
<td>69</td>
<td>263,236</td>
</tr>
</tbody>
</table>


Note: Only about 42% of the total milk available for human consumption is sold and the remaining 58% is retained in the farms for feeding calves and home consumption.

The number of registered societies increased from 235 in 1975 to 290 in 1978, out of which only 185 dairy co-operative societies were active, and handled a total of 94,930,000 litres of milk, of which 80,440,000 litres (85%) were sold to the KCC. The share of milk sold directly to KCC by smallholders without involving co-operative societies has of late been increasing, owing to a number of factors, including management problems within the societies.
2. Farming Zones

The farming areas closely follow the pattern of ecological zones. There are six distinct ecological zones classified according to climate and vegetation (Pratt, Greenway and Gwynne, 1966) as follows:

- **Zone I** consists of Afro-Alpine moorland and grassland at high altitude;
- **Zone II** is humid to dry sub-humid climate consisting of forests and dried grassland and bushland with or without glades;
- **Zone III** is dry sub-humid to semi-arid land carrying a variable vegetation cover of moist woodland, bushland or savanna with characteristically broadleaved and the larger shrubs, mostly evergreen;
- **Zone IV** is semi-arid with land of marginal agricultural potential carrying natural vegetation, dry forms of woodland and savanna or equivalent bushland;
- **Zone V** is arid land with perennial grasses such as *Cenchrus ciliaris* and woody vegetation being dominated by *Commiphora*, *Acacia* and allied genera often of shrubby nature;
- **Zone VI** is very arid with dwarf shrub grassland or a very dry form of bushed grassland in which *Acacia* is a characteristic species;

Zones V and VI are inhabited mainly by pastoralists who are forced by the environmental conditions to live a nomadic mode of existence. Zone IV is occupied by either large-scale commercial ranchers who specialize in beef production or pastoralists. Zones I, II and III contain mixed farming with dairying as one of the major farming enterprises. The three zones also carry a very high population density with about 80% of the total human population of 15 million inhabitants.

A typical holding in this region has a major cash crop of either coffee, tea, pyrethrum or a combination of them. An area is reserved for food crop production, especially maize, with a smaller plot for vegetables, including potatoes. The remaining portion of the farm is left for grazing by dairy animals with a small portion planted to fodder crops, particularly Napier grass and some paddocks for improved pasture.

As the human population pressure on land increases and the level of animal husbandry and management improves commercial dairy production is marginally being extended into the areas bordering on Zone IV, with cotton as the major cash crop.
It has been observed that in this type of mixed farming system dairying is often relied upon to provide regular income throughout the year, especially during the periods when the major cash crop is out of production. Sheep, goats, poultry and in some cases pigs are also raised. The financial contributions of sheep and goats in such farming systems in most cases are minimal and they are kept more for subsistence and traditional purposes. However, poultry and pigs - depending on the individual farm and its proximity to the market - can play a significant role as commercial farming enterprises within the system.

According to the Integrated Rural Survey (1979) Central Bureau of Statistics, about 60% of smallholders on mixed farms have one or more milk cows. On the average each farmer possesses 2.27 cows in milk, a figure which does not change according to ecological zone or farm size within the mixed farm areas. The milk production per cow, however, varies widely according to ecological zones and ranges from about 200 litres per annum per cow in the cotton zone (unimproved cows) up to 2,000 litres per annum per cow in the high altitude grass zone (high grade dairy cows).

Even though the exotic dairy animals continue to play a crucial role in commercial milk production, the indigenous zebu cows contribute by far the largest percentage of milk available for non-commercial consumption. The data in table 2 show the estimated quantity of milk available for human consumption in farming areas and that sold privately on farms and to co-operative societies.

3. Prevailing Production Systems

Production systems used by smallholders in Kenya can be broadly classified into five groups based on the degree to which modern or intensive forms of production are practised. Systems as defined below are differentiated by breeds and feeding systems employed.

System I - the most extensive system mainly based on local zebu cows which are grazed on communal land;

System II - a low intensive system mainly based on cross cows grazed on natural, extensively managed pasture owned by individual farmers;
Table 2. Estimated Quantity of Milk Available for Human Consumption by Farming Areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of Farm</th>
<th>Breed</th>
<th>No of Cows</th>
<th>Milk Available for Human Consumption per Cow/Year</th>
<th>Total ('000 litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>Smallholder</td>
<td>zebu</td>
<td>2,288,210</td>
<td>150</td>
<td>343,231</td>
</tr>
<tr>
<td>farming</td>
<td>Large-scale</td>
<td>Grade</td>
<td>169,635</td>
<td>900</td>
<td>152,672</td>
</tr>
<tr>
<td>areas</td>
<td>Smallholder</td>
<td>Grade</td>
<td>314,838</td>
<td>900</td>
<td>283,354</td>
</tr>
<tr>
<td>Ranching</td>
<td>Commercial</td>
<td>zebu/cross</td>
<td>393,190</td>
<td>50</td>
<td>1,966</td>
</tr>
<tr>
<td>Pastoralists</td>
<td>zebu</td>
<td>1,598,590</td>
<td>75</td>
<td></td>
<td>119,894</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>4,764,463</td>
<td>189</td>
<td>901,117</td>
</tr>
</tbody>
</table>


Note:
Out of the total of 901,117,000 litres of milk available for consumption, smallholders produced 69%, large-scale farmers 17% pastoralists and commercialized ranchers the remaining 14%.

System III - a moderately intensive system using higher grade cows (F3) which are grazed on well managed or cultivated pasture land;

System IV - a high intensive system identified by pure exotic or highly up-graded dairy cows which are partly grazed on natural or cultivated pasture, and which are supplementary fed with arable fodder crops and concentrates. This system is also termed semi-zero grazing;

System V - a zero grazing system which is the most intensive milk yielding using pure exotic dairy cows which are kept in a stall or confined area where they are mainly supplied by fodder crops which are cut and carried to the animals; concentrates are also fed;

In addition to typical cow breed and feeding methods for each of the five production systems, other production factors are specific to each system. As the type of production passes from the extensive through the more intensive forms, major management changes occur in breeding method, calf rearing, forage production and feeding system, cattle feeding and housing and disease control practices.

Smallholder Dairy Development Programmes in Kenya

The most important dairy development programs currently implemented in Kenya are the following:
a) **The National Tick Control Program.** The objective of this project is to effectively control tick-borne diseases; this involves the Veterinary Department:

i) taking over the management of existing dips;
ii) rehabilitation of old dips; and
iii) building of new dips where required.

b) **The National Artificial Insemination Scheme** which covers three quarters of all high potential smallholder areas. The aim of this project is to supply dairy farmers with better quality breeding stock through AI.

c) **The Commercial Farming Credit Scheme.** The objective of this scheme is to supply farmers adequately with short, medium and long term credit. The scheme covers all areas where farmers have land title deeds.

d) **Rural Milk Collection and Cooling Project.** This project aims at assisting dairy co-operative societies in establishing improved milk collection and cooling facilities.

e) **The National Dairy Cattle Improvement Program and the Integrated Agricultural Development Program** are extension and training programs which aim at the improvement of the standard of dairy farming through demonstrations and training of farmers.

These projects are financially and technically supported by various donors such as World Bank, EEC, Holland, Denmark, Finland and West Germany.

**Important Elements in Smallholder Dairy Development**

In Kenya the main factors that have contributed to the growth and development of the smallholder dairy sector are:

i) Land consolidation and registration which were given great impetus by the Swynnerton Plan in 1954;
ii) Well organized credit facilities which enabled impoverished farmers to purchase and keep dairy animals;
iii) Veterinary services and disease control, particularly East Coast fever, through dipping to control the population of ticks and allied parasites;
iv) Effective extension services;
v) Development of the necessary infrastructure such as roads for easy communication and watering facilities for the animals;
vi) Effective and organized marketing facilities which begin with collection of milk from the farm, transportation processing and finally sale of the product to the consumer.

The present objective is to increase efficiency of production and productivity of both the animals and the land, particularly in the light of the high rate of increase in human population (3.9%), one of the highest in the world.
Nutrition Factors

Fodder Production: The continually diminishing grazing area has led to great interest in fodder crops so as to get the maximum dry matter yield from the land. This has in turn given rise to the adoption of zero grazing systems where the animal is totally confined within an enclosure and all feed is brought to it.

Among fodder crops, Napier grass is the most widely used, especially in agro-ecological zones 2, 3 and 4. In zones 3 and 4 fodder maize is also grown because temperatures are too low for Napier grass. Sweet potatoes are also commonly grown for both human consumption and as fodder in all the zones where climatic conditions are suitable. In general, however, fodder crops are only widely grown in smallholder areas where human pressure on the land is relatively high.

The area under fodder crops, mainly Napier grass and Bana grass, in smallholder areas expanded significantly by 13% between 1977 and 1978. The conversion of natural pasture land into arable crop land has been particularly intensive in Central and Eastern provinces (Embu, Meru and Machakos districts) (table 3).

<table>
<thead>
<tr>
<th>Province</th>
<th>1976</th>
<th>1977</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>36,930</td>
<td>41,866</td>
<td>46,200</td>
</tr>
<tr>
<td>Rift Valley</td>
<td>3,700</td>
<td>3,800</td>
<td>4,000</td>
</tr>
<tr>
<td>Eastern</td>
<td>3,906</td>
<td>8,171</td>
<td>10,213</td>
</tr>
<tr>
<td>Coast</td>
<td>370</td>
<td>410</td>
<td>550</td>
</tr>
<tr>
<td>Nyanza</td>
<td>710</td>
<td>800</td>
<td>1,030</td>
</tr>
<tr>
<td>Western</td>
<td>671</td>
<td>750</td>
<td>1,210</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46,287</strong></td>
<td><strong>55,797</strong></td>
<td><strong>63,203</strong></td>
</tr>
</tbody>
</table>


This was certainly a result of the fodder crop growing campaign launched by the Ministry of Agriculture in 1976. During the course of 1978 roughly 100 hectares of Napier grass bulking units were set up and maintained which produced planting material enough for about 1,000 hectares. Besides Napier grass and Bana grass bulking units, numerous Napier grass demonstration plots were set up on individual farmers' holdings.

"The area" under temporary arable fodder crops decreased markedly from 1974 to 1977. The area under improved pasture leys on large-scale farms decreased until 1976 then started increasing.
Concentrate Feeding

The vast majority of cattle and other ruminants, especially sheep and goats, are found in the subsistence and informal sectors and depend on grazing only. The animals in the commercial farming sector are also fed almost entirely on pastures and to a lesser extent on hay and other feed produced in the farm such as grain and silage.

Large-scale dairy farmers often mix their own feeds from brought-in materials such as seed cakes and concentrate mixtures containing vitamin and mineral supplements. The market for manufactured feedstuffs therefore represents only a small portion of the total. As purchased feedstuffs are more expensive than grazing and other on-farm feeds, their market is mainly dependent on the demand and price for meat and dairy products and the extent to which their production is undertaken on an intensive scale. For instance high yielding dairy herds are fed a portion of manufactured feeds and the milk yield and feed consumed is recorded and correlated to give optimum results. Manufactured feedstuffs are also used during dry seasons to augment shortages of farm feeds.

The first animal feed manufacturing factory was established in 1956 in Nairobi by Lea Bros and Blackman Ltd. There are now 12 such factories operating in the main commercial centres of the country. They use maize as the major raw material but also utilize the by-products from grain-milling industries such as maize germ meal, wheat and maize bran and pollard. In a flour milling operation it is estimated that grain-mill products represent about 20% of the maize mill output and 33% of the wheat milling output.

The firms manufacturing animal feeds within the country often have close connections with specialist firms in Europe who provide them with feedstuff formulation expertise. The specialist firms also supply the local firms with concentrate supplements containing vitamins, pharmaceuticals, antibodies and trace elements.

The manufactured feedstuffs like grass and legume seeds mentioned earlier are distributed through a network of retail shops throughout the main farming areas of the country. The Kenya Farmers Association and the co-operative societies again play a major role in this regard. The manufacturers themselves also employ salesmen who contact the farming community trying to establish markets for their products. In all, every farmer is within reach of some shop or store where he can buy manufactured feed to meet the farm's requirements.

Factors in Genetic Improvement

Local Breeds: The indigenous zebu cattle still form the basis of the national cattle herd. Their estimated milk production at 120 litres per cow per year is, however, very low in comparison to that of the grade dairy cows;
Cross Breeding: The importation of exotic breeds of cattle is still carried out and the source is no longer confined to Europe but has been extended to include the United States of America and Canada. The data in table 4 give the total number of animals imported into Kenya by breeds between 1925 and 1975. Among the high-grade types, Ayrshire is predominant, followed closely by Friesian and then Guernsey and Jersey (see table 4).

Table 4. Dairy Cattle Imported into Kenya upto 1975

<table>
<thead>
<tr>
<th>Breed</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire</td>
<td>423</td>
<td>372</td>
</tr>
<tr>
<td>Friesian</td>
<td>406</td>
<td>311</td>
</tr>
<tr>
<td>Jersey</td>
<td>254</td>
<td>259</td>
</tr>
<tr>
<td>Guernsey</td>
<td>277</td>
<td>255</td>
</tr>
<tr>
<td>Jersey</td>
<td>229</td>
<td>112</td>
</tr>
<tr>
<td>Short Horn</td>
<td>276</td>
<td>135</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,865</strong></td>
<td><strong>4,244</strong></td>
</tr>
</tbody>
</table>

Source: Kenya Stud Book Annual Reports, Nakuru 1925-75

Through crossbreeding and up-grading the total number of grade dairy cattle of different breeds has increased to 1,126,682 head consisting of different breeds as shown in table 5.

Table 5. Estimated Population of Grade Dairy Breeds

<table>
<thead>
<tr>
<th>Breeds</th>
<th>Number of Animals</th>
<th>Total Grade Cattle Population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire</td>
<td>306,858</td>
<td>27</td>
</tr>
<tr>
<td>Friesian</td>
<td>263,005</td>
<td>23</td>
</tr>
<tr>
<td>Guernsey</td>
<td>184,105</td>
<td>16</td>
</tr>
<tr>
<td>Jersey</td>
<td>87,668</td>
<td>8</td>
</tr>
<tr>
<td>Zebu crosses</td>
<td>2,865,086</td>
<td>26</td>
</tr>
<tr>
<td>(F₁ or F₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>generations only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,126,682</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

In most cases the dairy farmers tend to rear only female calves to maturity. The bull calves are either slaughtered soon after birth or reared on minimum amounts of milk and pasture and then sold to other farmers who are prepared to rear them for meat. This general practice has been encouraged by the fact that the producer price for milk has been much more attractive than the producer price for beef. The farmer therefore gets higher returns by selling milk direct rather than feeding it to bull calves. The price for heifers however is directly related to their milk production potential. Farmers with zebu cattle on the other hand rear all the bull calves which are later used as bulls, steers and working oxen.

Artificial Insemination with cattle is not a new phenomenon in Kenya and was first introduced in 1935, mainly due to the prevalence of breeding diseases. By 1937 approximately 6,000 cows in 10 farms were artificially inseminated and by 1941 this number had increased to 15,000 covering 36 farms which at the time was probably more than any country in the world outside Russia. At that time AI was confined to large-scale European owned farms only. The Government took active steps to encourage the development of AI and in 1946 a Central Insemination Board was formed.

In 1956 preliminary AI trials were started for cattle owned by peasant farmers in Central and Nyanza provinces. Guernsey semen was used in Central Province and Sahiwal semen in Nyanza Province.

The Government, with technical assistance from Sweden, formed the National Artificial Insemination Service on 1 July 1966. Its main functions was to carry out the AI field services while the Central Artificial Insemination Services (CAIS) remained as the semen production and distribution unit. The assistance from Sweden was renewed for a further five years between 1971 and 1976.

In 1971 the AI services were heavily subsidized. Even today a farmer pays only one Kenya shilling (approximately US 8 cents) for 4 inseminations in cases where an animal fails to hold in the first insemination.

The AI scheme in the smallholder dairy farming areas is based on roadside "crashes". According to this system when an animal is identified on heat the animal is taken to the nearest crash.

The inseminator calls at each crash at a definite time each day and inseminates any animals presented at the crash. The large-scale farmers normally organize their own services within the farm.

On the whole, Government's policy is to offer AI services to every smallholder dairy farmer, except those living in inaccessible areas. Bulls are recommended for use only in areas which cannot be adequately covered by AI.
Economic Factors Affecting Smallholder Dairying

Price relationships: Dairying has proved to be fully competitive with other farming enterprises. According to studies by Stotz (1979) in Farming Zone 1 dairying achieved higher returns per hour and per hectare than the two main cash crops of maize and pyrethrum. In Zone 2 dairying achieved higher returns than maize and higher returns per labour unit than tea but lower returns than tea per unit of land. In Zone 3 dairying received higher returns than maize and the competitive position of dairying improved in comparison to tea with the shift to semi-zero and zero grazing systems, but dairying could not compete with coffee. At the time of this survey the world coffee prices were generally high and had in fact hit a peak. In Zone 4 milk production under zero grazing conditions was competitive with maize and bananas.

Dairying shows some advantages over coffee, tea and other cash crops which are not revealed in the gross margin calculations. For one thing the prices of tea and coffee tend to fluctuate much more than the price of milk. Dairying also does not entail such sharp peaks in labour demand as many cash crops. These advantages explain why farmers tend to keep dairy cows even in areas where dairy production cannot compete with coffee, tea and other cash crops in terms of gross margin.

Marketing: KCC still dominates the formal dairy marketing system. KCC was incorporated as a public limited company in 1925 and registered as the first co-operative society in 1932 under the Co-operative Societies (Registration) Ordinance 1931. It now operates eight milk processing plants and sells liquid milk, milk powder, butter, cheese, ghee, condensed milk and evaporated milk.

The bulk of the smallholder milk is delivered to the KCC factories through a network of collection and cooling centres (see table 6).

Table 6. Projected Milk Production, Consumption and KCC's Intake and Liquid Milk Sales in 1975 - 2000 (in million litres)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>1,024</td>
<td>1,194</td>
<td>1,479</td>
<td>2,136</td>
<td>3,645</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>878</td>
<td>1,067</td>
<td>1,297</td>
<td>1,825</td>
<td>2,973</td>
</tr>
<tr>
<td>Urban</td>
<td>102</td>
<td>127</td>
<td>182</td>
<td>311</td>
<td>672</td>
</tr>
<tr>
<td>Consumption</td>
<td>146</td>
<td>181</td>
<td>212</td>
<td>277</td>
<td>369</td>
</tr>
<tr>
<td>KCC milk sales</td>
<td>146</td>
<td>181</td>
<td>212</td>
<td>277</td>
<td>369</td>
</tr>
<tr>
<td>School milk program</td>
<td>---</td>
<td>35</td>
<td>152</td>
<td>244</td>
<td>480</td>
</tr>
</tbody>
</table>

Future Plans

Until this year most of the planning and direction of rural developments have been centrally planned. From July 1983, a decision was made to have planning and execution of development plans decentralized to the 41 districts into which Kenya is divided. A major thrust in future will be to have each district develop to the maximum potential it may have. As Kenya is basically a farming country, further development of the agricultural sector will have to feature prominently in the decentralized strategy.

Within the rural dairy development sector the following factors will need to be addressed:

i) In areas where there is already a sizeable dairy herd, improvement of milk collection and cooling will be emphasized. Collection of evening milk which at present is inadequately catered for will be an important factor;

ii) In areas where the potential exists, the major effort will be to find ways of removing the constraints which are currently under dairy development; These may be:

- Competition with other agricultural enterprises in which case research to develop viable integrated and complementary farming systems will be needed. Zero grazing and optimization of the use of crop by-products would feature in this;

- Lack of animal health facilities, especially to control tick-borne diseases. Such facilities are prerequisite to the introduction of improved dairy animals either directly through acquisition from other areas of Kenya or by AI. Improvement of tick control will be needed. In the tsetse belts of the coast and western Kenya, fly control strategies will need to be strengthened;

- Market development to ensure that farmers will be able to market their produce once it is produced. Arrangement for collection, cooling and processing will need to be made;

- Cases where dairy goats are a viable alternative, especially for home consumption for rural families;

- Smallholder fodder conservation strategy for dry season feeding, which will need further development and refining;
References

Integrated Rural Survey (1979), Central Bureau of Statistics

Pratt, Greenway and Gwynne (1966)

Stotz (1979)
Malawi, in Central Africa, has an area of 11.8 million ha. All parts of the country receive adequate rainfall for agriculture during the November - April period. In some areas total annual rainfall ranges from about 1,000 mm to 1,500 mm, but from May to October there is very little or no rainfall. In this dry spell, there is considerable decline in the nutritive value of grasses.

Smallholder cattle are a major livestock enterprise in Malawi with a population of one million (Guide to Agricultural Production in Malawi, 1980/81). Of this figure, only a small part are dairy cattle. In Malawi, as in most developing countries, traditional smallholder producers supply the bulk of the national agricultural output. If self-sufficiency in food production is to be achieved, then productivity gains must be made by these smallholders. In most areas of Malawi, smallholder farming is dominated by mixed crop and livestock production.

Crop and livestock enterprise interactions in the smallholder mixed farm setting include the following:

i) Use of animal power for transport and crop production, where crops produce straws, stubbles and residues which in turn are fed to or utilized by livestock;

ii) Use of animal manure to improve soil fertility;

iii) Reduction in overall production risk by combining crop and livestock enterprises;

iv) Improvement of crop productivity through the use of improved legume-based pastures or forage crops in the crop rotation;

v) Consumption of milk and meat by smallholders adding significantly to human nutrition;

vi) The sale of livestock products such as milk which dramatically improves the cash flow and stabilizes farm income;

vii) Livestock as a "near cash" capital stock, important in areas where no institutionalized credit facilities exist; i.e. livestock can be sold at any time of the year, thereby supporting subsistence cropping where seeds, fertilizer, etc., often must be purchased at planting time long after the harvest.

Most African countries are trying to meet the growing demand for milk and for dairy products such as butter, cheese and ghee. Malawi is no exception. In meeting this demand Malawi has to develop its own strategy.
The goal for development of the dairy industry is to produce enough liquid milk to supply the demand of urban areas, with the long-range objective of making the country self-sufficient in milk and milk products. It is the Malawi Government's policy therefore to seek self-sufficiency in dairy products based upon a successful start in smallholder dairying. Dairying is becoming increasingly popular as a smallholder enterprise since it provides an opportunity for the farmer to obtain a regular cash income throughout the year.

Development efforts to promote the dairy industry in Malawi began only in the early 1960s.

**Milk Production Systems**

Cattle ownership in Malawi is traditionally geared to meat production and animal traction. There are three main cattle production systems:

i) Smallholder subsistence dairying with indigenous cattle (Malawi zebu);

ii) Smallholder commercialized subsistence dairying with exotic or crossbred cattle (high grade Friesian or Friesian x Malawi zebu);

iii) Entirely commercialized medium-or large-scale dairying with exotic or crossbred cattle.

The production of milk, primarily oriented towards supplying the urban centres, has for many years depended on these three systems.

There are basically two management systems which are being followed:

i) Summer grazing and winter stall-feeding;

ii) Zero grazing system (cut and carry).

i) **Grazing System:** Under this system, there are two types of pasture - natural and improved:

**Natural Pasture:** Natural grasses, legumes and browse are the main roughage and are plentiful during the rainy season (November - May). During November/December, when the rains start, the lush pasture is nutritious but low in dry matter. However, in the wet season around January, February and March, farmers are advised to make hay or silage. However, the following problems are experienced:

a) The weather conditions at this period are wet and do not favour hay making.

b) At this time family labour is involved in attending to field crops and little labour is spared for hay or silage making.

c) Hay storage is a problem. Hay is normally heaped on tripod stands subject to various weather conditions.
d) Improper ensiling conditions favour spoilage of silage.

In the dry season, farmers continue feeding or grazing their animals on the "standing hay". However, many farmers also graze their animals along streams where grass remains green and succulent. But such places are limited. Farmers who make hay and silage as supplement feed do not conserve sufficient hay or silage to supplement throughout the entire dry season. Other roughage supplements include maize stover, banana stems, groundnut tops, etc. The general trend is that pasture becomes so limited in the dry season that liveweight gains and milk production are curtailed. The situation is aggravated by bush fires which wipe out all grasses in the vicinity of a farmstead, even the little that remains along streams and dambos;

Improved Pasture: Improved pasture establishment has been mainly achieved through an extension effort throughout the dairy development in Malawi. All farmers are persuaded to establish improved grasses and legumes, particularly Rhodes grass, Napier grass and Stylosanthes or Silverleaf Desmodium. Establishment of mixed swards of grasses and legumes has been achieved by some smallholders. A strong pasture research program is undertaken by the Department of Agricultural Research of the Ministry of Agriculture. The Agricultural Research Department is also collaborating with agricultural development divisions (ADDs) to introduce improved pastures in all the milkshed areas. This is being done by establishing plots at training centres for demonstration to farmers. Efforts are also being made to encourage farmers to undersow Rhodes grass and Silverleaf with maize;

There are several reasons why improved pasture is not adopted more widely by farmers.

The prices of seed and other planting materials are high. For example, Rhodes grass seed costs K6.00* per kilogram and a farmer would require at least K48 for seed to establish only one hectare of pure stand of Rhodes grass. The other factor is fertilizer. Farmers prefer to purchase fertilizer for their maize rather than for their pasture. Farmers who have established improved pastures have rarely maintained their swards by annual application of fertilizers and in many cases have been obliged to overgraze such pastures during the dry season.

Fencing is another factor. It is necessary to fence off improved established pastures for better grazing management. Few smallholders can afford fencing because of wire prices.

* 1.31 (Malawian) kwachas = $1 (US)
1 kwacha (K) = 100 tambala (t)
In addition to pastures (natural and improved), concentrates are generally fed to calves and milking cows as supplements. Local feeds as sources of protein commonly used by smallholders are maize bran and dried Leucaena leaf. Only a few farmers can afford to buy commercial feeds such as dairy concentrate (cost K10.37 per 70 kg per bag) and cottonseed cake (cost K9.20 per 70 kg per bag). Research on dairy production is under way to investigate alternative sources of protein to be fed with maize bran for enhanced milk production.

ii) Cut and Carry (Zero Grazing System): This is the system in which the animals never leave the pen and grass or crop residues are taken to them throughout the year;

Recommendations for Zero Grazing System

In Malawi, the following are recommendations for the zero grazing system:

- The use of Gold Coast Napier grass which gives the highest yields in most areas. It is readily available at little or no cost;

  Recommended spacing is 90 cm x 30 cm for higher rainfall areas and 90 cm x 90 cm for low rainfall areas;

  Grass is planted as near the khola (kraal or homestead) as possible to reduce labour for carrying;

- A legume combined with Napier grass is a definite advantage for silage making where the higher protein content will be most useful in the dry season;

- Napier growth is controlled to a height of not more than 1.5 m before harvesting. At harvest, it is cut back to a height of 15 cm;

- The khola manure is put on the Napier grass (4.5 kg per stool) and this supplements inorganic fertilizer. The aim is for high production;

- Napier grass gives twice as much dry matter yield per hectare as Rhodes grass. Thus the recommendations on area to be planted per cow is halved from 0.6 ha to 0.3 ha;

Smallholder Dairy Schemes in Malawi

In Malawi, dairy production on smallholder farms began in the early 1970s by setting up small pilot farms, raising improved animals and using more intensive production methods. In 1979 nearly 350 crossbred cows (Friesian X zebu) were sold to participating farmers as against fewer than 100 in 1975.
Criteria for Dairy Farmer Selection

Since dairying is a year-round occupation its demands on the dairy farmer are more taxing than those of a crop farmer. Thus before receiving his cows a farmer must satisfy the following conditions:

i) **Khola Construction**: a farmer must prove his interest by building a thatched khola with an exercise yard and crush, and also a milking shed with a cement floor;

ii) **Land Availability**: Dairying makes a relatively heavy demand on land; therefore for efficient production a farmer should have a minimum of four hectares;

iii) **Rainfall Pattern**: Areas of good rainfall pattern - within 750 - 1000 mm (30" - 40") range or more - are given priority. These areas will normally have abundant good quality grazing;

iv) **Location of the Farm**: The farm should ideally be within 8 km (5 miles) radius of a milk collection centre or point for easy transportation of raw liquid milk from the farmer's homestead to the milk collection centre. The other points to bear in mind are proximity to the artificial insemination centre and dip tank and a reliable source of water supply both for watering the animals and for washing utensils;

v) **Labour Availability**: Dairying is an enterprise which needs the daily attention of the farmer and an ample supply of either hired or family labour is necessary.

vi) **Social Consideration**: Age of the farmer forms another important aspect of farmer selection. Since dairying needs daily attention the farmer needs to have good temperament and circumstances fitted to long hours of hard work. Old farmers without capital and family labour are not selected;

vii) **Credit Worthiness**: With the provision of credit facilities by government to support the smallholder dairy scheme, it is only those farmers who are credit worthy who can receive items on loan.

The Role of Credit in Smallholder Dairying

It would have been difficult to implement a smallholder dairy scheme without the assistance of a credit facility. The main reason for this is the degree of control that can be exercised under such a scheme, particularly in making sure the prospective dairy farmer has planted adequate pasturage. Another reason is that those who can offer ready cash are most often businessmen who may not have the necessary time to devote to a dairy enterprise.

**Non-Credit Items**: Before receiving a loan for their cows farmers are required to build from their own resources, suitable pole and thatched housing for the cattle and a separate hard-floor milking pen and crush. They also have to prepare and plant a suitable area of grass for grazing or cut and carry. Once these criteria are met they are eligible for a loan.
Credit Items: The standard package obtainable on credit is as follows:

- 2 dairy cows
- 1 sprayer
- 5 litres toxaphene
- Insurance for 2 cows at 20% pa

Option: Wire, seed and fertilizer.

Loan Repayment: This is carried out by monthly deductions from the farmer's milk sales.

Artificial Insemination Organization

In 1963 the Government asked for FAO assistance in planning an artificial insemination service in Malawi. It was launched in 1965 mainly to improve the quality of traditionally owned cattle for beef and milk production.

Malawian Government policy is to use the zebu/Friesian crossbreed in dairy development schemes and the zebu/Brahman crossbreed in beef production schemes.

The scheme is now fully established and gaining in popularity with smaller farmers and large estate owners. During the introductory phase inseminators were trained in Kenya and South Africa, but since 1971 all training has been carried out in Malawi.

There are 29 AI centres (1983) and each centre is provided with a motorcycle and AI equipment. There are 12 AI centres in the Southern Region, 14 in the Central Region and three in the Northern Region.

The figures in table 1 represent insemination carried out by Government staff only. Some Estates carry out their own inseminations.

<table>
<thead>
<tr>
<th>Year</th>
<th>Inseminations</th>
<th>Live Birth Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>52</td>
<td>-</td>
</tr>
<tr>
<td>1966</td>
<td>50</td>
<td>23</td>
</tr>
<tr>
<td>1967</td>
<td>240</td>
<td>135</td>
</tr>
<tr>
<td>1968</td>
<td>749</td>
<td>478</td>
</tr>
<tr>
<td>1969</td>
<td>649</td>
<td>500</td>
</tr>
<tr>
<td>1970</td>
<td>1,500</td>
<td>1,000</td>
</tr>
<tr>
<td>1971</td>
<td>1,100</td>
<td>605</td>
</tr>
<tr>
<td>1972</td>
<td>1,039</td>
<td>444</td>
</tr>
<tr>
<td>1973</td>
<td>1,987</td>
<td>920</td>
</tr>
<tr>
<td>1974</td>
<td>1,978</td>
<td>717</td>
</tr>
<tr>
<td>1975</td>
<td>2,459</td>
<td>1,057</td>
</tr>
<tr>
<td>1976</td>
<td>3,328</td>
<td>992</td>
</tr>
<tr>
<td>1977</td>
<td>2,934</td>
<td>1,036</td>
</tr>
<tr>
<td>1978</td>
<td>2,605</td>
<td>1,060</td>
</tr>
<tr>
<td>1979</td>
<td>2,877</td>
<td>1,091</td>
</tr>
<tr>
<td>1980</td>
<td>3,458</td>
<td>1,136</td>
</tr>
</tbody>
</table>

Source: Jumbe (1983) Personal Communication
Future Development of the Scheme: In the immediate years ahead it is not proposed to extend the service other than to clearly define dairy development areas within the dairy plant milkshed areas. Efforts will be made to maintain the existing service by providing more staff as the number of dairy cattle increases. Priority will be to increase the extension effort through farmer training programs, in order to improve animal survival rate, up-grade present low levels of nutrition, and teach good management practices.

Milk Production Records: In a dairy farming business for the farming system to work efficiently and profitably, records must be kept of all transactions and sale of products.

In Malawi, the smallholder dairy farmer keeps records for the following purposes:

i) Primarily as an extension aid to increase efficiency of milk production through devising and implementing proper dairy management practices;

ii) To monitor farming progress;

iii) To provide information on the performance of the individual cow as well as on the entire herd for day-to-day decision making;

iv) To provide data used to isolate areas or fields requiring concentration or more attention for expansion of the dairy industry.

All hand-kept records include data on milk yield, date of birth and reproductive performance. Loose-leaf papers have been issued to farmers free of charge. This system has the disadvantage of loose papers being misplaced, and becoming soiled. However, data in Table 4 indicates a summary of data from farmers.

With the possible ILCA involvement efforts are now being made to have smallholder dairy records analysed and plans are underway to initiate a computerized recording system.

Marketing Organization and Channels

Malawi is divided into three milkshed areas (basically, a milkshed covers an area surrounding each processing factory where smallholder dairy farmers are located). Within these, there are several milk collection routes and one processing factory per area. The milkshed areas are as follows:

1) Blantyre milkshed situated in the southern part of the country with a dairy plant in the city of Blantyre;

2) Lilongwe milkshed situated in the central part of the country with the New Capital Dairy plant in Lilongwe;
iii) Mzuzu milkshed situated in the northern part of the country with the dairy plant in the Mzuzu Municipality. The quantities of milk handled by each plant is shown in table 2.

Producer Payments: Malawi Milk Marketing collects raw milk from cooling/collecting centres designated by Regional Dairy Advisory Committees. Farmers, both registered and non-registered, deliver their product to these centres where a raw milk buyer or resident buyer tests it, weighs and notes the quantities in his books and the farmers' books. Payment to the farmers is computed at the end of their accounting period which is normally 28 days. Non-registered farmers have a fixed price whilst registered farmers have a range based on quantities delivered.

Consumer Milk Pricing: The last revision of milk products prices was done in March 1983. See table 3 for current prices of milk and milk products. An evaluation of the costs and revenue indicates that smallholder dairying is profitable (see Appendix 1)

Types of Bonus Given to Producers:

Quality Bonus - 3t per litre is offered for milk with 4% fat and above. If 5% fat and above an additional 2t per litre is given.

Bulk Group Bonus - 2t per litre.

Seasonal Production Bonus - up to 3.5t per litre is offered from July to October, at the direction of Malawi Milk Marketing.

The bulk of the milk produced in Malawi comes from large-scale production. This paper is solely concerned with smallholder production and facts and figures given are for that. As a matter of comparison, in 1979 the total recorded production from large-scale producers was 2.3 million kg, of which 56% went through the Malawi Milk Marketing, whereas for smallholders total production recorded was 1.1 million kg (see table 2).

Table 2. Milk Handled by the Three Plants

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(l)</td>
<td>l000</td>
<td>l000</td>
<td>l000</td>
<td>l000</td>
<td>l000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New Capital Dairy</td>
<td>992</td>
<td>1,284</td>
<td>849</td>
<td>909</td>
<td>1,000</td>
</tr>
<tr>
<td>Blantyre Dairy</td>
<td>1,455</td>
<td>1,933</td>
<td>2,021</td>
<td>2,091</td>
<td>2,182</td>
</tr>
<tr>
<td>Mzuzu Pilot Dairy</td>
<td>--</td>
<td>--</td>
<td>107</td>
<td>250</td>
<td>272</td>
</tr>
<tr>
<td>Total</td>
<td>2,447</td>
<td>3,217</td>
<td>2,977</td>
<td>3,250</td>
<td>3,454</td>
</tr>
</tbody>
</table>

Source: Nzima (1983) personal communication
Most of the dairy cows kept by smallholders are half-breed Friesian. Most farmers depend on maize bran as a sole concentrate and make use of locally available crop residues as much as possible. With improved feeding and management standards a few farmers manage to keep three to four Friesian cows whose production levels are shown in Table 4. Smallholder dairy production is also developing in the Mzuzu milkshed area.

Table 4. Number of Participating Farmers, Number of Cows Involved and Mean Yields of Grade-Friesians in Blantyre Milkshed Area

<table>
<thead>
<tr>
<th>Year</th>
<th>Farmers (No.)</th>
<th>Cows (No.)</th>
<th>Milk Yield* (kg)</th>
<th>Lactation length (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979/80</td>
<td>326</td>
<td>767</td>
<td>1,625</td>
<td>322</td>
</tr>
<tr>
<td>1980/81</td>
<td>363</td>
<td>843</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981/82</td>
<td>372</td>
<td>878</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In 305 days.

Summary

In summary, it can be reported that there is potential for high milk production in Malawi to meet the local demand. This can only be achieved through improved pastures as nutritious forage is the key to increased milk production. Extension efforts are being made to encourage more farmers to start dairying as this is a highly profitable enterprise. Farmers are encouraged to have good feeding and management standards so that they can maintain high grade Friesian cows which produce large amounts of milk.

The current high selling price of milk acts as an incentive for farmers in the milkshed areas to start dairying.

In short, increasing milk production can only be a question of putting in practice the three key words: adopt, adapt and improve. That is adopting exotic dairy breeds, adapting them to the conditions of Malawi and then improving feeding and management standards.
References

Guide to Agricultural Production in Malawi, 1980/81 (Extension Aids)
Table 3

Current Consumer Prices for Milk and Milk Products

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Quantities</th>
<th>Wholesale</th>
<th>Retail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole milk</td>
<td>1 litre</td>
<td>52t</td>
<td>58t</td>
</tr>
<tr>
<td>Whole milk</td>
<td>1/2 litre</td>
<td>26t</td>
<td>29t</td>
</tr>
<tr>
<td>Whole milk</td>
<td>1/4 litre</td>
<td>14t</td>
<td>15t</td>
</tr>
<tr>
<td>Skim milk</td>
<td>--</td>
<td>25t</td>
<td>--</td>
</tr>
<tr>
<td>Low fat</td>
<td>1/2 litre</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Low fat</td>
<td>1/4 litre</td>
<td>6.5t</td>
<td>7t</td>
</tr>
<tr>
<td>Chocolate</td>
<td>1/2 litre</td>
<td>15t</td>
<td>17t</td>
</tr>
<tr>
<td>Cream</td>
<td>300 ml</td>
<td>K1.25</td>
<td>K1.40</td>
</tr>
<tr>
<td>Cream</td>
<td>150 ml</td>
<td>65t</td>
<td>75t</td>
</tr>
<tr>
<td>Natural yoghurt</td>
<td>500 ml</td>
<td>88t</td>
<td>98t</td>
</tr>
<tr>
<td>Natural yoghurt</td>
<td>150 ml</td>
<td>40t</td>
<td>40t</td>
</tr>
<tr>
<td>Flavoured yoghurts</td>
<td>500 ml</td>
<td>K1.00</td>
<td>K1.50</td>
</tr>
<tr>
<td>Flavoured yoghurts</td>
<td>150 ml</td>
<td>40t</td>
<td>45t</td>
</tr>
<tr>
<td>Cottage cheese</td>
<td>500 g</td>
<td>K2.10</td>
<td>K2.40</td>
</tr>
<tr>
<td>Semi soft bwemba/mudi</td>
<td>1 kg</td>
<td>K6.00</td>
<td>K7.50</td>
</tr>
<tr>
<td>Ghee refined</td>
<td>1 kg</td>
<td>--</td>
<td>K8.60</td>
</tr>
<tr>
<td>Unrefined ghee</td>
<td>1 kg</td>
<td>--</td>
<td>K7.00</td>
</tr>
<tr>
<td>Ice cream mix</td>
<td>1 litre</td>
<td>K6.00</td>
<td>K6.60</td>
</tr>
<tr>
<td>Raw filtered and tested milk</td>
<td>1/2 litre</td>
<td>--</td>
<td>25t</td>
</tr>
</tbody>
</table>
Appendix I

Profitability of the Dairy Scheme to Farmers for a 2-Cow Unit on the Two Systems

<table>
<thead>
<tr>
<th>Capital requirements</th>
<th>Pasture K</th>
<th>Cut and carry K</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cows</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Wire for pasture (1.2 ha)</td>
<td>244</td>
<td>--</td>
</tr>
<tr>
<td>Buildings</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Equipment</td>
<td>122</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td>748</td>
<td>404</td>
</tr>
</tbody>
</table>

**Depreciation**
- Wire (10 years): 24
- Buildings (7 years): 8
- Equipment (5 years): 24

**Direct Costs**
- Fertilizer: 26
- Rhodes seed: 27
- Maize bran 2800 kg at 2t/kg: 56
- Salt 4 bags at K4.90: 20
- Veterinary costs at K20/cow: 40
- Insurance for cows at 20% pa: 60

**Returns**
- Milk sales 1875 l/cow at 25t/l*: 469
- Value of calves: 30

**Less direct costs**: 299
**Margin income**: 270

**Less depreciation**: 56
**Net income**: 214

*Current price
Source: Proverbs (1982)
The Kingdom of Swaziland is one of the smallest countries in Africa (17,364 sq km). Although it is landlocked, it has good access to seaports via Maputo in Mozambique and Durban in the Republic of South Africa.

About 70% of the rural population live in scattered homesteads on Swazi Nation Land* still closely bound by traditional ways of life. The rest of the rural population live on freehold title deed land, most of it owned and farmed by expatriate companies or farmers. The average population density is about 28 persons per square kilometre.

The agricultural sector holds a very important position in the country's development programme since it currently generates about 31% of gross domestic product and contributes more than 70% to the nation's export earnings.

Ecological Zones: Swaziland's diversified agriculture is, in part, the product of geography for there are four distinct topographic regions each extending from north to south (figure 1). These regions (highveld, middleveld, lowveld, Lubombo Plateau) differ in climatic conditions and agricultural potential.

Highveld (5,029.5 sq km) in the west is a mountainous region of pine forests and steep valleys with 10% of the land suitable for farming. Rainfall ranges between 1,000 and 2,300 mm per year and the temperature ranges between 10.8°C and 22.6°C. The average altitude is 1,200 metres.

Middleveld (4,597.5 sq km) with fertile soils and rolling grasslands, is the main area of arable farming in the country. Mean annual rainfall varies between 650 and 1150 mm with a temperature range of 11.8°C and 26.2°C and an average altitude of 700 metres. There is a greater variety of natural vegetation in the middleveld including the upland tall grassland, moist tall grassveld, dry tall grassland and upper broadleaved tree savanna.

Lowveld (6,416 sq km) is a low-lying region in the east with erratic rainfall ranging between 500 and 900 mm in an average year, and with temperature ranges between 14.9°C and 29.6°C. Average altitude is about 240 metres. Irrigated estates and ranches are found in this region and drought is a constant threat.

* See page 61 for explanation
Lumbombo Plateau (1,321 sq km) in the extreme east has fertile soils. Rainfall ranges between 650 and 1150 mm and temperature ranges between 14°C and 25°C per year. Average altitude is about 600 metres. The natural vegetation is mainly mixed bush and savanna. (Most of the rainfall in Swaziland, 75-80%, falls in the summer months of October to March.)

Generally the country is well watered having a number of rivers running from west to east with a significant potential for irrigation. The road network gives ready access to most areas of the country. Tarred roads are dominant in urban centres although some do pass through the rural areas. Adequate electricity is available in most parts of the country and automatic telephone exchanges have replaced many of the manual exchanges within rural communities.

Land Tenure System: The pattern of land tenure in Swaziland has a profound influence on the distribution of population, economic activity and the pattern of land utilization. There are two land tenure systems, Swazi Nation Land and Freehold Title Land. Swazi Nation Land is owned communally but vested in the King; local chiefs allocate land to individuals for family occupancy and also grant communal grazing rights. There is private ownership of Freehold Title Land. (See figure 2 for Land Base Ownership, Utilization and Distribution.)

In these two tenure systems agricultural production takes place in two distinctly contrasting patterns. There are a large number of small subsistence farms, mostly on Swazi Nation Land, which are generally operated with traditional methods resulting in low productivity. Each subsistence farm averages less than three hectares in size. Traditional agriculture consists of a combination of cattle rearing and crop cultivation. On the other hand privately owned and operated freehold farms produce cash crops and livestock on a commercial basis (see table 1).

Table 1. Agricultural Land Use and Tenure

<table>
<thead>
<tr>
<th></th>
<th>Individual Tenure farms</th>
<th>Swazi Nation Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (‘000 ha)</td>
<td>691</td>
<td>114</td>
</tr>
<tr>
<td>Per cent of total agricultural output</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Production growth rate per cent</td>
<td>5</td>
<td>2.8</td>
</tr>
<tr>
<td>Resident population (‘000)</td>
<td>148</td>
<td>345</td>
</tr>
<tr>
<td>Average holding (ha)</td>
<td>800</td>
<td>2.75</td>
</tr>
<tr>
<td>Ownership/tenure (‘000 ha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swazis</td>
<td>259</td>
<td>114</td>
</tr>
<tr>
<td>Major companies</td>
<td>173</td>
<td>--</td>
</tr>
<tr>
<td>Non-Swazis</td>
<td>259</td>
<td>--</td>
</tr>
</tbody>
</table>

Fig. 1. Veld regions of Swaziland.
Fig. 2. Swaziland: Land base ownership and utilization distribution, 1978.
Crops: On Swazi Nation Land maize is the predominant crop although groundnuts, sorghum, beans, vegetables, cotton and tobacco are also important. On private freehold farms cotton and maize are the main annual crops but pineapples, sugarcane, rice, citrus and other orchard crops are also important.

Livestock Population and Distribution

Cattle play a vital role in Swazi society. Cattle ownership, by tradition, confers prestige, represents a measure of wealth and serves a banking function for subsistence farmers. There are 636,036 head of cattle, 320,398 goats, 31,870 sheep, 8,268 trek sheep, 1,635 horses, 506 mules, 14,819 donkeys, 16,456 pigs and 905,925 fowls. Out of 636,036 head of cattle, 502,257 were on Swazi Nation Land and 133,779 on Freehold Title Land.*

On Swazi Nation Land, 171,120 were cows, 18,515 were bulls, and the rest other classes of cattle. On Freehold Title Land, 49,761 were cows and 3,719 were bulls, the rest being other classes of cattle.

The distribution of cattle population according to veld regions was as follows:

<table>
<thead>
<tr>
<th>Veld Region</th>
<th>Head of Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highveld</td>
<td>122,755</td>
</tr>
<tr>
<td>Middleveld</td>
<td>277,948</td>
</tr>
<tr>
<td>Lowveld</td>
<td>209,892</td>
</tr>
<tr>
<td>Lubombo</td>
<td>25,441</td>
</tr>
</tbody>
</table>

These totals include dairy animals since the cattle population census was not categorized into beef and dairy animals.

Development Objectives: The overall policy of Government in the agricultural sector is to improve the quality of rural life and to assist rural farmers to make the transition from subsistence to semi-commercial and commercial farming. The primary mechanism for accomplishing this goal is the Rural Development Area (RDA) programme. According to the Third National Development Plan the RDA programme has the following objectives:

i) To protect and enhance the quality of the natural environment;

ii) To promote self-reliance by means of increased crop and livestock production and diversification;

iii) To promote non-formal education for rural living and to enhance the quality and quantity of extension services;

iv) To make farm inputs and services, including credit and marketing, more accessible to farmers and cattle owners;

v) To increase levels of animal fertility, reduce the incidence of disease and make animal husbandry more profitable.

* 1982 Livestock Census, Ministry of Agriculture and Co-operatives
The Dairy Industry

The objectives in milk production are:

- To increase milk production in Swaziland in order to achieve self-sufficiency in domestic liquid milk supply and other milk products and possibly later to export surplus dairy products;

- To involve small-scale farmers in rural areas in milk production so as to improve their nutrition, increase their cash income and raise their standard of living;

These objectives are aimed at bringing to an end the dependence on imports of liquid milk and milk products. This goal has been achieved in part since no liquid milk has been imported from the Republic of South Africa since 1981. Imported liquid milk was at its peak in 1979 (2,747,839 litres) and thereafter declined dramatically. The last consignment was 50,778 litres in 1981 as a result of the increase in locally produced liquid milk which was at its peak in 1982 (2,674,579 litres) (see table 2).

Milk in Swaziland is a traditional part of the diet, particularly in its soured form called emasi. Other forms in which milk is consumed are fresh whole milk, cheeses of many different types, ice cream, yoghurt, dried and tinned milk. The farming community involved in milk production is faced with the challenge of meeting the nation's milk requirements with a regular supply of fresh high quality milk throughout the year.

The highveld and middleveld are the most ecologically suited regions for dairy farming, due to the favourable climatic conditions ideal for the recommended dairy breeds and the production of fodder crops. Most producers are found in these two regions and they contributed significantly to the national target of 2.3 million litres of locally produced liquid milk in 1982. This target was exceeded by 0.4 million litres. The severe drought which lasted from October 1982 through March 1983 makes it difficult to predict 1983 production.

Socio-economic Factors

Promotion of dairy farming in the country helps to narrow the gap between the living standards of urban and rural people, and to discourage the growing rural-to-urban migration by providing job opportunities and improving the quality of life in rural areas. The use of improved dairy breeds by small-scale farmers will help in meeting the overall government objective of self-sufficiency in basic foodstuff and in raising the nation's nutritional status by making more milk available to more people at reasonable prices both in urban and rural areas.

The development of small-scale farm units will undoubtedly contribute to more efficient and productive use of the land since the present system of communal grazing is unsuitable for high-producing dairy cows and thus the plans for the establishment of small-scale farm units are based on intensive production of forage from arable land.
Milk Demands in Relation to Supply

Milk is consumed in the form of fresh milk and *emasi* (sour milk). Locally produced liquid milk representing 40% of the milk being produced for consumption at the moment and the remainder is met through reconstituted milk powder. Fresh milk accounted for 54% and *emasi* 46% of total sales in 1982 (see table 2).

Table 2: Production (Litres) and Consumption (Sales) 1982

<table>
<thead>
<tr>
<th>Month</th>
<th>Local Production</th>
<th>Reconstituted</th>
<th>Total Produced</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>216,885</td>
<td>332,204</td>
<td>549,089</td>
<td>529,779</td>
</tr>
<tr>
<td>February</td>
<td>194,395</td>
<td>350,188</td>
<td>544,583</td>
<td>536,060</td>
</tr>
<tr>
<td>March</td>
<td>203,829</td>
<td>418,303</td>
<td>622,132</td>
<td>617,416</td>
</tr>
<tr>
<td>April</td>
<td>193,468</td>
<td>385,802</td>
<td>579,270</td>
<td>557,157</td>
</tr>
<tr>
<td>May</td>
<td>219,606</td>
<td>366,708</td>
<td>586,314</td>
<td>583,388</td>
</tr>
<tr>
<td>June</td>
<td>227,738</td>
<td>369,671</td>
<td>597,409</td>
<td>588,759</td>
</tr>
<tr>
<td>July</td>
<td>242,081</td>
<td>365,629</td>
<td>607,710</td>
<td>598,651</td>
</tr>
<tr>
<td>August</td>
<td>243,532</td>
<td>378,322</td>
<td>621,854</td>
<td>607,335</td>
</tr>
<tr>
<td>September</td>
<td>225,443</td>
<td>407,468</td>
<td>632,911</td>
<td>620,622</td>
</tr>
<tr>
<td>October</td>
<td>239,356</td>
<td>421,139</td>
<td>660,495</td>
<td>659,730</td>
</tr>
<tr>
<td>November</td>
<td>234,716</td>
<td>374,328</td>
<td>609,044</td>
<td>619,958</td>
</tr>
<tr>
<td>December</td>
<td>233,530</td>
<td>391,921</td>
<td>625,451</td>
<td>641,191</td>
</tr>
<tr>
<td>Total</td>
<td>2,674,579</td>
<td>4,561,683</td>
<td>7,236,262</td>
<td>7,160,046</td>
</tr>
</tbody>
</table>

N.B. It should be noted that local milk production figures exclude a quantity of milk which did not reach the Swaziland Dairy Board because it was either consumed on the farm or sold locally which is a common practice on small-scale dairy farms.

Based on a population of 525,000 with a projected annual growth of 3.2%, the present demand for milk is 25,000 litres per day while total local production is 10,000 litres per day of which 3,000 litres is produced by small-scale farmers. Table 2 shows that there is room for increased local milk production in order to reduce the quantity of reconstituted milk, as well as to produce sufficient liquid milk to be processed into other milk products such as yoghurt, ice cream, cheese, etc.

Types of Cattle

**Indigenous:** The most common breed is the local Nguni which is a Sanga type. The Nguni has proved to be highly adaptable to the varying climatic conditions and is more resistant than European cattle to many cattle diseases. The traditional Nguni cow generally provides household milk. Under natural conditions it is a seasonal breeder, the majority of calves being born between September and December. A Nguni cow produces 400 to 500 litres of milk per lactation, just sufficient to raise her calf. Under proper management, with plenty of good feed, the Nguni is capable of producing an extra 250 litres of milk which is consumed at home or sold.
Exotic: The predominant dairy breeds are Friesian and Canadian Holstein which have been imported from the Republic of South Africa and Canada respectively. These breeds are mostly found in the highveld and middleveld where the climate is favourable for them. Presently there is a Holstein cow at Malkerns Dairy farm which has produced 8,546 litres of milk in 305 days in its third lactation and a Friesian cow which has produced 7,645 litres of milk in 305 days at Tibiyo Dairy Project.

The Jersey breed is also found mainly in title deed farms. One of these farms has 62 cows, 42 heifers and 12 female calves. This farm specializes in this type of breed and the production presently ranges from 8 to 20 litres per cow per day.

Crosses: The commonest are Jersey-Friesian crosses. The milk production level for these crosses is better than the pure Nguni. The Government plans to produce Friesian-Nguni crosses on one of its farms, but this will take 2-3 years for the first crossbred heifers to come into milk. Friesian-Nguni crosses are more suitable for beginners in terms of management, adaptation and feeding.

Milk Production Systems and Their Relative Importance

There are three kinds of farmers involved in milk production: (i) large (ii) small and (iii) seasonal.

i) Large-scale (Graded Animals) - Generally large-scale milk producers own 50 or more dairy cows plus young stock for replacement and one or two bulls. The large-scale producers operate on freehold title land, produce milk on commercial lines and sell this milk to the Swaziland Dairy Board. Most of them own cooling facilities on their farms to protect their milk from spoilage before it is sent to the Swaziland Dairy Board. Their contribution to the national objective is indicated in table 2 for 1982 and 1983 respectively. Most of these farmers are found in the highveld and the middleveld. Some sell dairy animals in excess of their requirements to small-scale dairy farmers. Private freehold farmers produce approximately 450,000 kg of milk per year and this accounts for about 20% of the milk delivered to the Swaziland Dairy Board. Government and parastatal organizations produce about 2 million litres annually and therefore supplies 90% of the milk delivered to the Milk Board. This indicates the extent of Swaziland Government involvement in milk production;

ii) Small-scale (Graded) - These are concentrated in the Rural Development Areas and own one to ten dairy cows, mainly Holsteins and Friesians, depending on the availability of the land resource. The milk produced is consumed at home and the surplus is sold to neighbours, the community or to the Swaziland Dairy Board. Cooling facilities are provided by the Swaziland Dairy Board in the Rural Development Areas so that the farmer's milk remains fresh until collected. Presently there are two centres with cooling facilities and the third one will be operational before the end of 1983.
The contribution to the marketable milk is approximately 150,000 kg per year but this is increasing and is likely to predominate in the future;

iii) Small-scale (Ungraded Animals) - These farmers are mainly in the lowveld region and are seasonal producers of milk, mostly from the Nguni cow when it has freshly calved in summer when the grass is green and palatable. The Nguni cows produce more milk during this period than their calves require; the surplus is consumed at home and the remainder is sold to Swaziland Dairy Board through 14 milk collection depots in the lowveld. The contribution by these farmers to the Milk Board is about 80,000 kg annually.

Milk Production Patterns

Although many farmers are successful in getting a calf per cow per year some still have their cows calve at 15-month intervals. This practice is common among small-scale farmers. This is due to failure to observe heat periods in time, especially where artificial insemination is used, and, to a large extent, due to poor grazing condition and therefore nutrition. It is for this reason that improved pastures are encouraged.

Concentrates are fed according to the cow's level of milk production and the quality of roughage (usually 1 kg of grain mixture for every 3 kg of milk produced daily). The standard meal mixture used in Swaziland is 14% to 18% total protein (depending on the quality of forage), 72% to 77% total digestible nutrients, 10% to 12% total fibre and 3% or more fat.

Commercial mineral mixture is provided in amounts recommended by manufacturers.

Under this feeding system good milk yields have been obtained ranging from 2,250 to 5,000 kg per lactation on small-scale farms and 2,250 to 8,000 kg on large-scale farms depending on the dairy cattle breed used and their potential for milk production. Heifers are fed in such a manner that they should be bred at 15 to 18 months so that they first calve at 24 to 27 months. This is still a problem on small-scale dairy farms but progressive farmers have their heifers calving at 24 to 27 months.

Some farmers feed maize stover sprinkled with molasses in addition to hay and silage after harvesting maize fields.

Marketing Organization and Channels

Marketing and processing of milk is done by the Swaziland Dairy Board, a statutory board which controls the dairy industry. The Dairy Board was established under the provision of the Dairy Act in 1971. It falls under the direction of the Minister of Agriculture who appoints the members of the Board which should be represented by authorities, producers, manufacturers, distributors and consumers. At present the representative of the Ministry of Agriculture is the Director of Veterinary Services.
According to the Dairy Act the general duties of the Dairy Board are to:

i) Organize the efficient, orderly and stable production of dairy products and regulate and develop their distribution and market­ing;

ii) Ensure that the quality of dairy products is of an acceptable standard for public health;

iii) Advise the Minister on the prices of dairy products and any other matters relating to the dairy industry;

iv) Perscribe the types, grades and quantities of dairy products to be either produced or sold in Swaziland or to be exported;

v) Communicate with and consult relevant authorities and others for the purpose of facilitating the orderly and stable production and marketing of dairy products;

vi) Institute and run an information service and advise producers on the production and marketing of their dairy products.

The Boards lays down standards for the production of safe healthy milk. High quality is encouraged by means of bonuses and poor quality discouraged by deductions.

Economics of Milk Production (Small-Scale Dairy Farm)

An illustration of the economics of milk production is given below. In this budget two levels of milk production are considered since most farmers fall in this category. These levels are 2,250 kg and 3,500 kg yield per lactation. It should be noted that the 3,500 kg yield per lactation is quite modest since some farmers now possess good quality cows which produce more than 3,500 kg per lactation. Under good management these good quality cows are capable of producing up to 5,000 kg per lactation.

A 5,000 kg per lactation is included to indicate the returns to farmers with good quality cows.

Profits increase with increasing milk production and further rises could be obtained if the calving interval of 14 months could be reduced to 12 months.

Calculations of Costs and Returns

Assumptions

14 months (425 days) calving interval

- 305 day lactation period;
- 16% dairy ration for 2,250 - 3,500 kg per lactation;
- 17% ration for 5,000 kg per lactation;
Level of milk production (kg/lactation) | 2,250 | 3,500 | 5,000
Concentrates required (kg in 305 days) | 293 | 709 | 1,209
Pre-calving ration (kg) | 120 | 240 | 360
Total concentrate req/14 months (kg) | 413 | 949 | 1,569
Concentrate requirements/cow/year (kg) | 12/14 x 413 | 354 | --- | ---
| 14/14 x 949 | --- | 813 | ---
| 12/14 x 1,569 | --- | --- | 1,345

Cost of Roughage Production

a) Pasture establishment costs per hectare
   Seed | E 40.00*
   Tractor hires, etc. | E 60.00
   Fertilizer | E100.00
   Total | E200.00

Replacement cost over 5 years = E40.00 per year

b) Silage Preparation
   Seed | E 7.20
   Tractor hire | E 37.00
   Fertilizer | E 27.33
   Total | E 71.53

This is done on a yearly basis.

Concentrate Costs

2,250 kg/lactation = 354 x 12.80/50 = E 90.62
3,500 kg/lactation = 813 x 12.80/50 = E208.13
5,000 kg/lactation = 1,345 x 13.40/50 = E360.46
16% dairy ration = E12.80/50 kg
17% dairy ration = E13.40/50 kg

Total Annual Feed Costs in E

<table>
<thead>
<tr>
<th></th>
<th>2,250</th>
<th>3,500</th>
<th>5,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>(lact)</td>
<td>(lact)</td>
<td>(lact)</td>
<td></td>
</tr>
<tr>
<td>Roughage</td>
<td>271.53</td>
<td>271.53</td>
<td>271.53</td>
</tr>
<tr>
<td>Cost of concentrates/cow</td>
<td>90.62</td>
<td>208.13</td>
<td>360.46</td>
</tr>
<tr>
<td>Total feed cost</td>
<td>362.15</td>
<td>479.66</td>
<td>631.99</td>
</tr>
</tbody>
</table>

Cost of Dairy Shed

Assumption - Family labour is used for the construction of the shed so that only building material requires cash expenditure.

Cost of Shelter

Total cost of building material = E150
Replacement cost over 10 years = E15 per year

* (E):1.22 emalangeni = 1$ (US)
Other Costs

Cost of dairy equipment = E60
Replacement cost over 5 years = E12 per year
Cost of 1 cow = E600
Salvage value after 5 years = E200
Replacement cost = 600 - 200 = 400 = E80 per year

Summary of Costs (Annual) (in E)

<table>
<thead>
<tr>
<th>Capital costs</th>
<th>Total cost</th>
<th>Annual replacement cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building materials</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Equipment</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Cow purchase</td>
<td>600</td>
<td>80</td>
</tr>
<tr>
<td>Pasture establishment (1 ha)</td>
<td>200</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>1,010</td>
<td>147</td>
</tr>
</tbody>
</table>

Recurrent Costs

Annual Cost (E)

<table>
<thead>
<tr>
<th></th>
<th>2,250 kg lact</th>
<th>3,500 kg lact</th>
<th>5,000 kg lact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Dairy concentrate</td>
<td>91</td>
<td>208</td>
<td>360</td>
</tr>
<tr>
<td>Calf rearing</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total silage</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Preparation</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Veterinary</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Dairy supplies</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>343</td>
<td>460</td>
<td>612</td>
</tr>
</tbody>
</table>

Annual replacement cost on capital

|                        | 147           | 147           | 147           |
|                        | 343           | 460           | 612           |
| Total                  | 490           | 607           | 759           |

Calculation of Returns

Assumption - 14 months (425 days) calving interval

Annual Return (E)

<table>
<thead>
<tr>
<th></th>
<th>2,250 kg lact</th>
<th>3,500 kg lact</th>
<th>5,000 kg lact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale of milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/14x2250x38</td>
<td>733</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>12/14x3500x38</td>
<td>--</td>
<td>1,140</td>
<td>--</td>
</tr>
<tr>
<td>12/14x5000x38</td>
<td>--</td>
<td>--</td>
<td>1,629</td>
</tr>
<tr>
<td>Sale of calf</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>808</td>
<td>1,215</td>
<td>1,704</td>
</tr>
</tbody>
</table>

NB: 1 litre of milk is 38° (Swaziland Dairy Board Price) on average as per appendix I.
Calculation of Net Return Per Cow

<table>
<thead>
<tr>
<th></th>
<th>2,250 kg lact</th>
<th>3,500 kg lact</th>
<th>5,000 kg lact.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total returns</td>
<td>808</td>
<td>1,215</td>
<td>1,704</td>
</tr>
<tr>
<td>Less: Total costs</td>
<td>490</td>
<td>607</td>
<td>759</td>
</tr>
<tr>
<td>Return:</td>
<td>318</td>
<td>608</td>
<td>945</td>
</tr>
<tr>
<td>Less: repayment on investment</td>
<td>278</td>
<td>278</td>
<td>278</td>
</tr>
<tr>
<td>Net return</td>
<td>40</td>
<td>330</td>
<td>667</td>
</tr>
</tbody>
</table>

NB: The repayment on investment is based on the assumption that the farmer received a loan for E1,000 for investment at a rate of 13% per year payable in 5 years and he pays E278 per year. Furthermore it should be mentioned that small-scale dairy farming is still concentrated in Rural Development Areas and cost of fencing material to farmers is still free, hence cost is not included in the budget.

Milk Powder

The Swaziland Dairy Board receives milk powder from the FAO/World Food Program. This powder is reconstituted by the Swaziland Dairy Board and distributed throughout the country to meet local demand for liquid milk to supplement insufficient supplies of locally produced liquid milk.

The availability of milk powder helps to keep the consumers' price low so that many people are able to buy and consume milk and/or emasi while the producer price is satisfactory. It is hoped that as more milk is produced locally, there will be a decline in the use of reconstituted milk as well as a decrease in the importation of milk powder. Already the Swaziland Dairy Board is pressurized by some consumers to increase the proportion of fresh milk so as to improve the taste and acceptability of the processed product.

The FAO/World Food Program has agreed to supply the Swaziland Dairy Board with milk powder for a specified period until, it is hoped, liquid milk produced locally is able to meet consumers' demand. In order to achieve this, the Swaziland Dairy Board's original tasks of milk procurement, processing and distribution have been greatly increased by adding the responsibility of milk production.

Technical Services and Extension

The Ministry of Agriculture has set up a dairy extension service to advise farmers on how to keep healthy, productive and profitable milk cows. Presently there are ten Dairy Extension Officers mainly in Rural Development Areas, and two Animal Husbandry Officers (Dairy). The Range Management and Soil Testing Officers occasionally help farmers in pasture establishment of improved grass species. Farmers are also advised on preparation of silage and hay for winter feed. Equipment to do this is available in Rural Development Areas project centres. Technical advice is also extended to freehold title deed farms. The health of dairy cattle is the concern of Veterinary Service staff who may also visit individual farmers to attend sick animals.
An artificial insemination service is still in the pilot stage. It has three qualified technicians to carry out artificial insemination, and other areas use natural service (bulls of approved dairy breed). In some areas, District Veterinary Officers carry out artificial insemination. The semen used is from Holstein and Jersey bulls. Title deed farmers conduct their own artificial insemination or acquire the services of the qualified technicians.

Factors Limiting Production (Small-scale Farmers)

Dairy farming is not a traditional enterprise for the Swazi farmer. It will therefore take sometime for him to acquire a high degree of management to be successful in milk production. Another serious obstacle is failure to understand the importance of conserving feed for winter so that production is not affected by lack of feed in the dry winter season. A common problem among farmers is their failure to observe dairy cows on heat and this results in over-long calving intervals, which in turn affects milk production.

Small-scale farmers fail to give priority to and distribute time equally among their various agricultural enterprises, resulting in little attention given to the dairy enterprise and a decline in milk production. With the available technical and extension service the farmer should be able to improve his management skill. Scarcity of dairy heifers is also a notable bottleneck.

Potentials for Small-scale Milk Production

In the long term the small-scale farmers will become the mainstay of the country's milk production industry. It is government policy to involve small-scale farmers in milk production to improve their nutrition as well as increase their cash income to enhance the quality of life in rural areas.

The number of small-scale dairy farmers has increased from 32 to 80 between 1980 and 1983 and their milk production has been as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Quality Produced (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>162,807</td>
</tr>
<tr>
<td>1981</td>
<td>252,107</td>
</tr>
<tr>
<td>1982</td>
<td>317,944</td>
</tr>
<tr>
<td>1983 (January to June)</td>
<td>186,705</td>
</tr>
</tbody>
</table>

These 80 small-scale farmers own about 210 dairy cows which are already producing milk and about 28 more are making preparations to start on dairying. There is generally a big demand for dairy cows in the rural areas.

These farmers are located in the milk producing areas, i.e. the high-veld and middleveld where climatic conditions are suitable for milk production. The Lubombo Plateau has a few farmers who already own dairy cows and these are included in the total of small-scale farmers. Climatic conditions in this region are similar to the middleveld and the demand for dairy cows is also increasing.
The Swaziland Dairy Board is responsible for supplying these farmers with dairy cows and the breed is presently the Canadian Holstein. The farmers buy these cows at E600 per cow and in most cases the cow is milking and in calf.

The use of milk powder which is reconstituted and distributed throughout the country to meet the demand for liquid milk shows that there is a deficit in the supply of locally produced milk. Small-scale farmers have no problem in selling their milk because there is an existing market with an increasing demand for liquid milk. In future the demand will still be there for small-scale farmers to satisfy, as is shown clearly in table 3.

Table 3: Milk Production Projections 1982-1992

<table>
<thead>
<tr>
<th>Year</th>
<th>Total consumption (litres/day)</th>
<th>Total Local Production (litres/day)</th>
<th>Small-scale Farmers (litres/day)</th>
<th>Large-scale Farmers (litres/day)</th>
<th>Local Production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>25,000</td>
<td>10,000</td>
<td>3,000</td>
<td>7,000</td>
<td>40</td>
</tr>
<tr>
<td>1984</td>
<td>26,500</td>
<td>14,000</td>
<td>4,000</td>
<td>10,000</td>
<td>53</td>
</tr>
<tr>
<td>1986</td>
<td>28,000</td>
<td>18,000</td>
<td>5,000</td>
<td>13,000</td>
<td>64</td>
</tr>
<tr>
<td>1989</td>
<td>30,800</td>
<td>22,000</td>
<td>6,000</td>
<td>16,000</td>
<td>71</td>
</tr>
<tr>
<td>1992</td>
<td>33,880</td>
<td>26,400</td>
<td>7,400</td>
<td>19,000</td>
<td>79</td>
</tr>
</tbody>
</table>

It is clear from table 3 that small-scale farmers should increase the quantity of locally produced milk in order to cope with the increasing demand from consumers. This therefore calls for better management skills, feed preparation and improved husbandry of the dairy cows in order to increase the production per cow.
References

Currently Tanzania imports milk byproducts worth US$10 million annually, but plans to encourage milk production to meet local demand - for rural and urban centres - and cease importation of milk products. Tanzania has areas potentially capable of producing sufficient milk to meet that demand.

The National Diary Development Plan is designed to formulate a strategy for dairy development for the current Fourth Five-Year Development Plan (1981 - 1986) and to identify specific project proposals for funding. Some of these projects, however, will have implementation periods which extend beyond the five-year plan. Consumption and production levels have been forecast through to 1990 when the bulk of the development undertaken during the five-year plan will be in full production.

Tanzania's action plan aims to increase dairy production at the most rapid rate possible, with the least cost and on a long-term basis. Development is aimed at eventual self-sufficiency in dairy production and a consumption pattern which ensures that minimum nutrition levels are attained by all sectors of the community. The national milk consumption target is 25 litres per head per annum by 1986, increasing to 28 litres per head per annum by 1990. The urban consumption target is 39 litres per head in 1986 and 48.5 litres per head in 1990. The respective target for rural consumption is 22.5 litres per head. To meet these targeted levels milk product imports for recombining purposes will be required. The projections are illustrated in figure 1.

The plan concentrates on the provision of liquid milk rather than manufactured products (cheese, butter, skim milk powder, etc.) as it is considered that with certain exceptions, milk should be provided as a basic food rather than as speciality products.

Subsequently, when there is a surplus of liquid milk consideration will be given to the manufacture of higher value products. The degree of self-sufficiency to be achieved by 1990 is only 41%. The aim is to increase the milk supply over this period in urban areas to meet ever-rising demands.

Although the rate of development proposed in the plan is ambitious, an accelerated rate of development is essential if tangible progress is to be made in meeting Tanzania's animal protein requirements in the longer term.

A major obstacle in establishing a thriving dairy industry in Tanzania is the shortage of experienced farm managers. Practical on-farm experience in Tanzania coupled with formal training and overseas experience are desirable adjuncts.

This calls for the need to establish additional farms which could provide opportunities to develop a large pool of competent farm managers.
The short-term implication of this will be that, while experience is being gained, many of the farms will operate with lower than normal production coefficients. This must be regarded as an unavoidable short-term training cost if an environment for sustained growth in the longer term is to be realized.

In most areas increased production from smallholders and villages is expected to be consumed by the rural population. As a consequence much of the increased local milk supply to urban areas is planned to come from large-scale farms.
Fig. 1. Milk production and consumption and population growth.
Large-Scale Milk Production Policy

The Tanzania Dairy Farming Company (DAFCO) was established in 1976 as a parastatal in charge of large-scale dairy production to supply the major urban centres with milk. In the new plan, DAFCO will continue to have prime responsibility for establishing and operating new large-scale state dairy farms and will continue to be the most important supplier of milk to the urban sector.

Large-scale farms are to be based on a model size of 360 milking cows, with three management units of approximately 120 cows each. These units will be managed autonomously, having a specifically defined land area and with animals being allocated to a specific unit on a permanent basis.

Major items of equipment will be shared among units. Procurement and administration, including accounting procedures, will be handled on a farm rather than unit basis. The objective of this structure is to make herd size sufficiently small to place one competent herd manager in effective control of all aspects of farm management, so enabling greater accountability for good and poor performances and the early identification of problem areas. Other bodies may establish new large-scale dairy farms only with the approval of the Ministry of Livestock Development.

Milk Processing Policy

In the short to medium term, milk products will remain in very short supply in Tanzania and the free market price for milk will remain well above the cost of production incurred by large-scale farms and smallholders. In this situation the Tanzania Dairies Limited (TDL) will remain primarily a processor of recombined milk. However with the increase in milk supplies relative to demand the free market price for milk will decline in real terms. This will lead to an increase in the production of total milk being supplied to TDL as producers seek to take advantage of the lower unit costs associated with higher volume collection, processing and marketing.

Processing facilities must be geared to the production of pasteurized milk manufactured and long-life products being produced only when genuine milk surpluses exist. Milk will be standardized to 2% milk fat, with the surplus fat being used for butter production. The long-term objective of TDL must be to supply adequate quantities of treated milk and other dairy products to urban centres. As far as possible this objective should be achieved as a result of consumer preference for TDL products, this preference being based on either a price or a quality advantage. TDL's eventual domination of the milk product market should be based on both the economies of scale and the ability of a national organization to effectively transport milk products from surplus to deficit areas.

The objective of TDL in the next 10-year period will be to establish, expand or up-grade milk plants in those areas where recombining facilities are required and where liquid milk volumes are sufficient to enable economic throughput levels. (Generally throughput levels of 25,000 litres per day are required, if reasonable unit costs are to be achieved.) Initial milk collection and market development should be undertaken by collecting and selling untreated chilled milk.
TDL will be responsible for the quality of its products in accordance with the standards laid down by the Tanzania Bureau of Standards (TBS) and the regulations established by the Ministry of Health. TDL will apply quality control tests to all milk entering its plants. A differential payment system will be applied to graded local milk.

Milk Production and Consumption in Rural Areas

Consumption is strongly linked to cattle ownership. Difficulties exist which limit the redistribution of milk from one region to another and will persist in the foreseeable future. The divergence between regions in cattle ownership and in each region's suitability for dairy development means that large differences in per capita consumption will continue well into the future.

The rural population is expected to continue increasing at 2% per annum and cattle numbers at 2.3% into the foreseeable future. Increased milk production will be limited by the rate at which cattle owners adopt new management practices, and at which animals with dairying potential can be generated.

Improving the milk supply to rural people generally will depend on a longer-term plan to improve production from indigenous cattle. Here, traditional attitudes towards livestock production will limit the rate of change and even with intensive extension campaigns and incentive schemes the response rate is expected to be slow.

Development is planned in the areas of disease control and breeding.

Disease Control: Intensive disease control programs will be necessary to support dairy development. The increased susceptibility to disease of up-graded dairy cattle is recognized and improvements to the dipping service, the supply and use of veterinary drugs for the control, and the treatment of diseases will be undertaken.

Breeding: The shortage of dairy type animals is a constraint to development. Crossbreeding between exotic bulls and indigenous cows has been in progress for years.

It is intended to lessen this constraint through:

Heifer Breeding. The production of F₁ heifers on ministry and parastatal farms is planned to increase from 650 in 1978 to 5,455 in 1990. These will be for the purpose of increasing both smallholder and large-scale dairy farm production.

Bull Centres. It is planned to rear bulls bred on parastatal dairy farms establish 100 new bull centres and 6 breeding stations, and distribute 1,500 bulls over the 10-year period. The purpose is to establish crossbreeding programs in villages interested in undertaking dairying. The approach is the most effective means of generating F₁ crossbreds over a short period of time.
**Artificial Insemination.** Artificial insemination, based on a centrally controlled and well organized field service, is planned for the main dairying regions to service smallholder F1 owned cattle.

**Supply of Inputs:** Inputs required by farmers, e.g. building materials, water pumps, containers, feedstuffs, are difficult to obtain at village level and it is planned to establish, through the Regional Livestock Development Service, a system of village livestock commodity stores. Closer liaison between the Ministry as a planning and co-ordinating body and the organizations responsible for the inputs is planned to ensure regular supply.

**Extension:** To assist farmers improve their dairy husbandry, and to initiate dairying in new areas, extension workers are seen to be a key input. Plans include the selection of suitably motivated field staff from the main dairying regions for in-service training. Farmer training in addition to the extension program will also receive attention but will be short term, localized, and integrated with extension and supply (heifers and farm inputs) programs.

Extension workers will also have the responsibility of assisting with better distribution of milk in rural areas. It is recognized that villages may be able to arrange their own milk collection schemes in order to:

- make butter or ghee;
- redirect milk to needy groups, e.g. school children;
- sell to neighbouring villages;

**Rural Milk Production/Consumption Policy:** Milk produced by smallholders and villagers will only be transferred to the urban market when the nutritional requirements of the rural sector have been adequately met. Milk production for the rural sector will only be encouraged by continued distribution of F1 heifers from breeding units, the establishment of bull and breeding centres and the establishment of retail outlets for dairy farm inputs. The milk price in the rural sector will operate either as free market prices or be controlled by village authorities.

**Breed Type:** Dairy breeds for general use will be restricted to Jersey, Friesian, Ayrshire, Sahiwal, and Mpwapwa. Friesian cattle will be used predominantly in the Southern Highlands on the large-scale farms while Jersey and Ayrshire will be the main breeds in smallholder herds. In those areas which experience greater problems with heat stress or high disease challenge the zebu dairy breeds of Sahiwal and Mpwapwa and crosses of these will be the predominant breeds.

**The Role of Research in Dairy Development Strategy**

The foregoing strategy for dairy development has been designed to encourage production while research continues to find new information that will eventually make the objectives a reality. Very little is known about small-scale dairy production in rural areas.

Two studies are currently in progress to find out the answers that only careful research can provide:
Study I: Breeding for Optimum Dairy Production in the Humid Coastal Belt

Background: A major constraint to production plans at present is the lack of specific knowledge as to the ideal breed for commercial dairy production under humid tropical conditions. Numerous studies and reports (Getz and Kyomo 1974; Mahadevan 1965; McDowell 1971; Rendel 1968) all indicate that, in general, one cannot base viable commercial dairy enterprises on the indigenous cattle of the tropics. On the whole, production and dairy temperament are absent. Gene frequency appears to be extremely low for those characteristics associated with dairy merit.

These reports show that milk yield and dairy temperament can be greatly improved and at the same time the maturing process can be speeded up to lower the age at first calving. Crossing with a temperate breed will in many cases give as much increase in milk in one generation as selection within local cattle could do in 50 years or more.

Little is known about the relative adaptability of various temperate breeds either as pure breeds or in crosses with indigenous cattle in the tropics.

As Rendel (1973) has pointed out, numerous reports are available in which comparisons have been made of the productivity in tropical environments between European breeds, indigenous cattle and European X indigenous crosses.

Objectives

1. To study and document parameters connected with total dairy merit and their association with various breeds and/or levels.

2. To test several breeding systems for maintaining what appears to be the optimum level of Bos taurus breeding.

3. To study the occurrence of genotype X environment interactions which may be associated with the use of semen from male progeny tested in the temperate zones of the world.

4. To investigate associations between genotype, climate and management systems, Study of dairy systems based on various genotype, management, feeding and housing combinations.

5. To demonstrate breeding and production techniques useful in improving milk production and breeding efficiency.

Material Method and Design

All investigations will embrace the use of Sahiwal cattle as a straightbred control and as a Bos indicus base for crossing with Bos taurus specialized dairy breeds: Jersey, Ayrshire and Friesian. These three represent small, intermediate and large body sizes. In addition they embrace those breeds most often recommended or favoured by policy makers and/or production specialists in Tanzania.
Breeding plans will essentially follow a stepwise procedure with the results of step one guiding step two and so on. First generation plans simply call for the production of F₁ stock from each of the three specialized dairy breeds and Sahiwal. Second generation breeding can involve several further alternatives using the F₁ females as a base. The alternatives to be examined include any or all of the following:

i) Backcrossing to the same breed as sire;
ii) Backcrossing to exotic but different from sire;
iii) Mate F₁ inter se to produce F₂;
iv) Mate F₁ females to F₁ males of different exotic breed composition.

Care should be taken not to mate halfsibs or sire and daughter combinations.

Third generation matings will be determined largely by what options were investigated in the second generation and the results thereof.

No crossbreeds of less than 50% Bos taurus will be intentionally produced. Most evidence indicates half-bred Bos taurus dairy stock can live and produce quite well in tropical regions these days with the minimum level of management required for a viable commercial dairy enterprise. It would, in this instance, be a waste of experimental animals to go less than half.

**Duration:** The study began in 1975 and will continue under this initial outline for 15 years. Duration depends to some extent on how fast generations are turned.

**Location:** Livestock Research Centre (LRC) - Tanga

Altitude : 66 metres
Longitude : 39° east
Latitude : 5° south
Rainfall : 1,200 mm
Mean max temp : 29°C

As the results compiled up to 1982 are the subject of an MSc thesis, University of Dar es Salaam, it is still too early to draw conclusions. Overall, no definite pattern has emerged as far as the halfbreds are concerned. The F₁ Jersey is way ahead of the others (Ayrshire and Friesian) in mean age at first calving (973 days vs 1,025 and 1,049 days for Friesian and Ayrshire halfbreds, respectively).

In terms of lactation performance, the F₁ Friesian appears to be ahead of the other two breeds. As for lactation length, the Friesian cross has the longest and Jersey the shortest, with the Ayrshire coming in between. The wide variation observed is probably largely a reflection of the variability in management.

It is expected that information gained from this study will guide future small and large-scale dairy development along the hot and humid coastal belt of Tanzania which already has a relatively high concentration of dairy farms.
Due to the shortage of improved breeds of dairy cattle, the tendency has been for smallholders to accept anything available on the market. It is not unusual to find beef crosses in dairy herds.

In one sense this study can be looked upon as a breed comparison of exotic animals to find out the "best" and/or ideal level of exotic blood for a given area. At present there is insufficient evidence to recommend any of the breeds being studied for any given ecological zone.

Study II: Dairy Recording on Small-Scale Farms in Rungwe District

Background: This experiment was initiated with the broad aim of increasing the technical level of the extension service to small-scale dairy farms. The location of the experiment is Rungwe District in the southern highlands of Tanzania where a considerable proportion of farmers have owned improved dairy cattle for more than 10 years. It is intended that results from this experiment, if successful, will be used to launch a durable, large-scale dairy recording scheme in smallholder farms in the district and elsewhere in Tanzania where intensive small-scale dairying is practised.

The idea of introducing recording on small farms sprang from the findings of a farm survey carried out by a team of research workers from the Uyole Agricultural Centre (UAC) in August/September 1980. It was noted that, among other things, there was almost a total lack of production or management data on the farms (Mchau 1980). In this situation, it was obvious that no objective assessment could be made of the impact of cross-breeding, improved feeding and health care on small-scale dairy production. At the same time, it was observed that many farmers could read and write, and were even willing to participate in a recording scheme, if this could be shown to be of practical value.

On the basis of this knowledge, it was decided to introduce recording on a limited number of farms on a trial basis. The objectives of this trial were to:

i) Provide reliable production data for critical assessment of breeding, feeding and management practices;

ii) Foster a closer relationship between research workers and farmers;

iii) Study the problems of introducing and running a dairy recording scheme.

Actual recording commenced in September 1981 and is still going on.

Materials and methods: Selection of farms - A total of 97 smallholder farmers, located around five bull centres in Rungwe District, were selected to take part in a pilot dairy recording scheme. The following were the criteria for selection:

i) Possession of at least one female improved cow, i.e. crossbred and/or purebred exotic;

ii) Ability to read and write the national language, Kiswahili;
iii) Willingness to keep records in exchange for increased advisory visits by extension and research workers;
iv) Easy accessibility of the farms by motor vehicles and/or proximity to the bull centres.

The number of farmers selected from each bull-centre area ranged from 12 to 27.

Recording Material

Each farmer was provided with the following recording materials free of charge:

- A number of "Dairy Cow Record Cards" corresponding with the number of improved female cattle on the farm;
- Monthly return sheets;
- A plastic cup of one-litre capacity for measuring milk yield;
- A 1.5-metre long plastic measuring tape for taking body measurements;
- A paper file to hold the cards and spare return sheets. Also provided with the file were a number of blank foolscap sheets for recording additional information such as purchases and medical treatment acquisition and disposal of cattle;

Recording Procedure

When farmers were given recording material, they were also instructed briefly on how to measure milk yield and body size and where to enter the readings - both on the card and on the monthly return sheets. Each card contained the name of the owner and the registration number of the cattle (females only). This number was coded to identify the individual animal within the farm, the farm within the bull centre (registration) area and the particular bull centre among all others. Other information given include date of birth, breed, sire and dam numbers, name of the village, registration (bull) centre, district and region in which the farm is located; service dates and bull used, calving dates, sex of calf and registration number of calf (if female). Monthly milk records (in litres) of the cow are given on the 15th day of each calendar month.

Liveweight, body length, height at withers and heart girth of the animal at birth, six months, one year and two years of age are also recorded. It was not possible to record liveweight due to lack of weighing scales.

Once a measurement is made, it is entered in the appropriate place on the individual record card. All observations made in a given month are then entered on a monthly return sheet for transmission to the bull centre.

Flow of Recorded Information

Once every month the monthly return sheets from all farms in a given registration area are sent to the registration centre where information is entered on another monthly return sheet which is forwarded to the district livestock headquarters and eventually to Uyole Agricultural Centre by post. At both places the incoming return sheets are used to update a set of
individual record cards, equal in number to all cattle registered in the district. At first it was planned that the farmers should take the monthly return sheets to the bull centres when they brought their cattle there for dipping. This was later changed so that extension workers from the bull centres should visit the farms around the 15th day of the month, assist the farmers with the recording and retrieve the monthly return sheets. The recorders were provided with bicycles from UAC. At Uyole, the incoming information is summarized and the individual farms compared for production efficiency. A copy of the overall summary (listing all farms) is then sent to the district livestock headquarters while remarks on individual farms are forwarded to the farmers through the recorders. The number of registered grade cattle is shown in table 2.

Results

Farmers' Initial Response

Among the registered farmers, the response to the question as to whether they would participate in a recording scheme was always positive and enthusiastic. However, when the researchers went into the details of recording the initial enthusiasm was almost invariably replaced by apprehension and confusion.

For instance, farmers made mistakes in locating the appropriate cell in a table, probably because they were not familiar with the co-ordinate system. Another difficulty was in writing numbers less than one. Many farmers were unfamiliar with numerical representation of fractions and decimal notations. They also found it difficult to follow the fiscal year cycle (used on the cards) which starts and ends in the middle of the calendar year. All these problems, and others, convinced the researchers that assistance was needed if the farmers were to start recording at all. Thus, recorders were recruited as a temporary measure to train the farmers in recording, but there are plans now to make such training part and parcel of extension work.

Flow of Information: The weakest link in the transmission of information has been between the farms and the registration centres. Recorders have not made regular visits to the farms, in spite of being provided with bicycles.

This is a common finding in the extension service. Several reasons can be offered to explain this:

i) Vague job description of extension workers and lack of detailed programs for specific farms or group of farms;
ii) Inadequate training;
iii) Lack of motivation and confidence;
iv) Lack of transport.

So far, very little use has been made of the monthly returns. The few that were sent from the farms or from the bull centres had many mistakes and this led to de facto abandonment of the procedure. In fact, the flow of information as described above is still non-existent. Consequently Uyole has not made any feedback to the extension service based on the records from the farms.
Findings from Dairy Records

The average herd size on registered farms was 4.5 head of cattle (table 1). The table shows that there is considerable variation between herds. Part of this variation (with respect to breeds) can be explained by differences among bull centres. Crossbred cattle comprised about 50% of the average herd while purebred exotic cattle and zebus accounted for 22% and 28% respectively. Female cattle made up about 82% of the average herd (table 2).

Halfbreeds (F₁) made up about 40% of the population of improved cattle while purebred exotic contributed about 25%. About 12% of the population consisted of backcrosses but, if three-way crosses are included, then the proportion of cattle with 3/4 exotic blood becomes 20% of the total population.

Table 1. Average Herd Size and Composition of Cattle among 82 Registered Farms

<table>
<thead>
<tr>
<th>Breed Type</th>
<th>Sex</th>
<th>Average Number</th>
<th>Standard Deviation</th>
<th>Proportion of Whole Herd (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exotic</td>
<td>male</td>
<td>0.2</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>0.8</td>
<td>1.7</td>
<td>18</td>
</tr>
<tr>
<td>Crossbred</td>
<td>male</td>
<td>0.4</td>
<td>0.7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>1.8</td>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>Zebu</td>
<td>male</td>
<td>0.2</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>1.1</td>
<td>2.0</td>
<td>24</td>
</tr>
</tbody>
</table>
Table 2. Number of Various Grade Cattle (Females) Registered in Rungwe District

<table>
<thead>
<tr>
<th>Breed Type</th>
<th>Number Registered</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First crosses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friesian x zebu</td>
<td>72</td>
<td>29</td>
</tr>
<tr>
<td>Ayrshire x zebu</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Backcrosses 1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Friesian bulls</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>to Ayrshire bulls</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>to zebu bulls</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Purebreds:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friesians</td>
<td>53</td>
<td>21</td>
</tr>
<tr>
<td>Ayrshires</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Other grades</td>
<td>54</td>
<td>22</td>
</tr>
</tbody>
</table>

1. Excludes three-way crosses. These are included in the "Other grades" group and account for about 8% of the total population.

Only a small proportion (3%) of the females has resulted from "accidental" backcrossing of F<sub>1</sub> females to zebu bulls. Intermediate crosses and crosses between exotic breeds accounted for about 14% of the population.

The Friesian breed is the most common breed of sire in the crosses and also among exotic purebreds.

These results indicate considerable displacement of the zebu breed on registered farms. Table 3 shows the incidence and extent of pasture establishment and concentrate supplement in registered farms. Both activities were observed on 54% of the farms. The mean area of sown pasture was 0.4 hectare. When available, about 5 kg per cow per day of concentrate was offered. The commonest concentrate ration is a maize bran mixed with cottonseed cake.
Table 3. Occurrence and Extent of Pasture Establishment and Concentrate Supplementation

<table>
<thead>
<tr>
<th></th>
<th>Pasture Establishment</th>
<th>Concentrate Supplementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farms</td>
<td>52.0</td>
<td>52</td>
</tr>
<tr>
<td>Percentage of registered farms</td>
<td>.54.0</td>
<td>54</td>
</tr>
<tr>
<td>Mean</td>
<td>0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> - area in hectares

<sup>b</sup> - kg per cow per day (when available).
Production and Reproduction: So far, only calvings and milk yields have been recorded in considerable numbers. A definite peak in the incidence of calving has been observed towards the end of the rainy season (April and May); calving incidence is lowest towards the end of the dry season (September and October). This implies that more conceptions take place during the dry than the wet season. The monthly milk records were grouped according to stage of lactation and genotype of cow. Means were computed across lactations for the halfbred (F1) and purebred exotic cows (table 4). Mean 305-day lactation yields for F1 and exotic cows were estimated to be about 1,660 and 2,990 litres, respectively (Mchau and Mwakatumbula 1983).

Table 4. Mean Monthly Record of Milk Yield for Halfbred and Purebred Cows in Rungwe District

<table>
<thead>
<tr>
<th>Month of Lactation</th>
<th>Halfbred Cows</th>
<th></th>
<th>Purebred Cows</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n  mean (kg)</td>
<td>s.d.</td>
<td>n  mean (kg)</td>
<td>s.d.</td>
</tr>
<tr>
<td>1</td>
<td>26 7.3</td>
<td>4.4</td>
<td>24 12.6</td>
<td>6.4</td>
</tr>
<tr>
<td>2</td>
<td>29 7.2</td>
<td>2.7</td>
<td>28 12.7</td>
<td>6.1</td>
</tr>
<tr>
<td>3</td>
<td>29 6.7</td>
<td>3.4</td>
<td>27 12.5</td>
<td>5.4</td>
</tr>
<tr>
<td>4</td>
<td>31 6.0</td>
<td>3.5</td>
<td>24 11.2</td>
<td>5.2</td>
</tr>
<tr>
<td>5</td>
<td>27 5.8</td>
<td>3.8</td>
<td>25 9.9</td>
<td>5.9</td>
</tr>
<tr>
<td>6</td>
<td>27 5.4</td>
<td>3.5</td>
<td>24 9.4</td>
<td>5.9</td>
</tr>
<tr>
<td>7</td>
<td>19 5.1</td>
<td>3.8</td>
<td>20 9.2</td>
<td>4.8</td>
</tr>
<tr>
<td>8</td>
<td>20 4.4</td>
<td>3.3</td>
<td>18 7.5</td>
<td>6.1</td>
</tr>
<tr>
<td>9</td>
<td>19 3.3</td>
<td>2.1</td>
<td>15 6.6</td>
<td>3.3</td>
</tr>
<tr>
<td>10</td>
<td>21 3.2</td>
<td>2.4</td>
<td>17 6.2</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Conclusion: Experience gained from one year of this trial has brought into question many of the original ideas about the organization of recording on small-scale dairy farms in rural Tanzania. Many weaknesses have been discovered in the proposed model, the most serious of which is associated not with the farmers themselves, but rather with the extension service. With better planning and training of extension staff (recorders), these problems can be overcome. If the records are used primarily to improve management and feeding on the farms, chances are that farmers will continue to record. In the long term, analysis of such records will lead to genetic improvement of the population.

It is now proposed to:

i) Modify the recording cards and make them much simpler.

ii) Train extension workers in recording.

iii) Have extension workers regularly visit the farmers to assist them with recording and to retrieve the records for breed evaluation in order to formulate appropriate breeding plans in the long term.
This recording trial has shown that it is possible to organize a simple dairy recording scheme on smallholder farms in some districts in Tanzania. Without the use of accurate records, there is no way real improvement can be brought about in any field of animal production, especially small-scale dairy production.

Both the regional and the district livestock extension authorities have expressed their interest in the recording trial, and would like it extended to other districts. UAC has agreed to provide the necessary technical advice and recording material.

Ultimately, information obtained from this trial will be of equal value to that expected from the first study discussed above, but emphasis this time is on small-scale dairy production in a completely different locality some 1,800 metres above sea level.
References


1973. The role of breeding and genetics in animal production improvement in the developing countries. III World Genetics Congress, Berkeley, California. 20 - 27 August.
POSSIBLE STRATEGY IN ANIMAL BREEDING FOR MILK PRODUCTION
BY SMALL-SCALE PRODUCERS

M.L. Kyomo

Most countries in Africa and the Food and Agriculture Organization of the United Nations (FAO) have been addressing themselves to problems and strategies on how to feed the growing human population (Hrabovszky 1981). It is natural that they should also be addressing themselves to agriculture in order to provide sufficient employment opportunities and incomes for people who depend on agriculture for their livelihood. The strategies to increase production should look into investments, inputs, and technologies needed to bring about a change. Very often there is need also to consider institutional changes in order to increase production. This paper presents views on how to increase milk production through breeding of dairy cattle and other dairy species of livestock in the small farmer holdings.

Dairy products are sources of export earnings in countries such as Kenya and Zimbabwe. In addition, dairy cattle are very useful as draft animals and manure producers in mixed farming agricultural production systems in most countries in the eastern and southern African region. They, therefore, contribute towards increased crop production. Hrabovszky (1981) has observed that the poorest people in developing countries are in agriculture. Thus, to reduce income gaps within these countries between the poor and the rich, focus must be on small farmers for whom income from livestock keeping is often a major component of their livelihood.

Strategy for Increased Milk Production in Dairy Cattle

Several approaches have been used in producing dairy cows for the small farmers in the region. They include selective breeding of indigenous cattle, crossbreeding and use of pure exotic cattle.

Selective Breeding Within Local Cattle: Table 1 presents the means and variations of the more important production traits in some of the indigenous types of cattle raised under experimental station conditions in East Africa (Mahadevan 1965).
Table 1. Means and Variations of Production Traits of Indigenous East African Cattle

<table>
<thead>
<tr>
<th>Traits</th>
<th>Cattle Types</th>
<th>Mean</th>
<th>C.V. (%)</th>
<th>Mean</th>
<th>C.V. (%)</th>
<th>Mean</th>
<th>C.V. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small East African zebu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boran</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nganda</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at 1st calving (months)</td>
<td></td>
<td>42.0</td>
<td>13</td>
<td>43.0</td>
<td>15</td>
<td>40.0</td>
<td>12</td>
</tr>
<tr>
<td>Length of lactation (days)</td>
<td></td>
<td>267.0</td>
<td>18</td>
<td>239</td>
<td>24</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Length of dry periods (days)</td>
<td></td>
<td>153.0</td>
<td>61</td>
<td>123</td>
<td>65</td>
<td>382.0</td>
<td>23</td>
</tr>
<tr>
<td>Lactation milk yield (litres)</td>
<td></td>
<td>1,021.5</td>
<td>42</td>
<td>823.5</td>
<td>40</td>
<td>1,039.5</td>
<td>39</td>
</tr>
</tbody>
</table>

Data summarized by Mahadevan (1965) on studies done in Kenya, Tanzania and Uganda.
C.V. Coefficient of variation
N.A. Date not available
* First lactation

Mahadevan (1965) observed the following from the data in table 1: "The indigenous cattle in East Africa evolved by natural selection over many thousands of years in an environment where a premium was placed on the ability of the animals to live and reproduce; the efficiency of conversion of feed into products of economic value to the owners of the animals hardly entered into the evolutionary picture. When subsequently programs of selection for milk production cattle began to be superimposed on the prevailing natural selection for survival and reproductive ability, it was not surprising that the frequency of genes for high dairy production was found to be minimal." From data collected after 30 years in East Africa, Mahadevan (1965) was able to estimate genetic gains in milk yield due to selection (see table 2).
Table 2. Estimates of Genetic Gains in Milk Yield due to Selection

<table>
<thead>
<tr>
<th>Lactation of Herd</th>
<th>Estimated genetic superiority of dams of cows* (litres)</th>
<th>Estimated genetic superiority of dams of bulls* (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baraton Livestock Improvement Centre, Kenya</td>
<td>3.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Maseno Livestock Improvement Centre, Kenya</td>
<td>8.1</td>
<td>-1.2</td>
</tr>
<tr>
<td>Sangalo Livestock Improvement Centre, Kenya</td>
<td>-1.2</td>
<td>-0.4</td>
</tr>
<tr>
<td>Entebbe Livestock Exp. Station, Uganda</td>
<td>5.1</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

N.A. = Data not available.

Based on tests undertaken Mahadevan (1965) concluded that selective breeding for milk production within the indigenous cattle of East Africa has failed to give any worthwhile results and that there was no reason to suppose on genetic grounds that it was likely that selection among indigenous cattle would give improvement in future.

Crossbreeding: The object in crossbreeding for milk production in East Africa was to develop heat-tolerant dairy cows capable of high production in areas where it is difficult to maintain purebred exotic stock. Various studies that have been undertaken in East Africa on crossbreeding are discussed below.

i) East African Zebu X Sahiwal: The crossbreeding of the East African zebu into the Indian Sahiwal in Kenya commenced in 1939 with importation of bulls from Sahiwal studs in India and Pakistan. Table 3 shows some of the results of the crossbreeding work;

The introduction of the Sahiwal genes into East African zebu cattle has led to increase in lactation length, lactation milk yield and significant shortening of the dry period between lactations (see table 3). The calving interval showed a slight though statistically significant increase. Age at first calving, however, was relatively unaffected. Further, studies have shown that grading up to Sahiwal leads to further increases in milk yield. In Tanzania, the use of a three breed cross - Red Sindhi, and Sahiwal cattle (both from India) and the local zebu - as well as the use of other genes such as Boran and Ayrshire have resulted in the production of a dual purpose animal, the "Mpwapwa", for beef and milk. These have been extensively used by dairy farmers in medium altitude and coastal belt areas of Tanzania. Kiwawa and Kyomo (1971) reported the blood composition of the Mpwapwa as being:
Red sindh 32%
Sahiwal 30%
Tanzania Short horn zebu 19%
The remaining 19% being blood of Boran and Ayrshire.

Table 3. Means and Variations of Production Traits in East African Zebu and Sahiwal Grade Cattle

<table>
<thead>
<tr>
<th>Trait</th>
<th>East African zebu</th>
<th>Sahiwal Grade C.V. (%)</th>
<th>Differences between Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at 1st calving (months)</td>
<td>42.7 15</td>
<td>42.3 12</td>
<td>N.S.</td>
</tr>
<tr>
<td>Length of lactation (days)</td>
<td>239 24</td>
<td>283 18</td>
<td>**</td>
</tr>
<tr>
<td>Length of dry period (days)</td>
<td>123 65</td>
<td>105 70</td>
<td>**</td>
</tr>
<tr>
<td>Length of calving interval (days)</td>
<td>362 19</td>
<td>388 19</td>
<td>**</td>
</tr>
<tr>
<td>Lactation milk yield (litres)</td>
<td>823.5 40</td>
<td>1,503.0 36</td>
<td>**</td>
</tr>
</tbody>
</table>

C.V. = coefficient of variation
N.S. = not significant

ii) East African Zebu X European Dairy Breeds: The idea of using a wide gene pool in producing an animal which is well adapted to a given environment and is capable of high production was used again in Tanzania in producing a dairy type of animal for the coastal region of Tanzania. The resulting animal was called a Taurindicus as a hybrid name between Bos indicus and Bos taurus. Mahadevan and Hutchison (1964) reported on this study and their findings (see table 4) revealed that for the hot coastal region of Tanzania the half taurus was more adaptable and gave more milk than the animal with higher levels of blood of the Bos taurus animal (see table 4). The Indicus were mainly Boran and Jiddu from Kenya imported in 1946-1947. The Taurus were mainly Guernsey, Jersey, Freisian and Ayrshire used in rotation. The above study also revealed that for the hot coastal region of Tanzania the half taurus was more adaptable and gave more milk than the animal with higher levels of blood of the Bos taurus (see Table 5).
Table 4. Means and Variations of Production Traits in Indicus and Taurindicus Cattle at Tanga, Tanzania

<table>
<thead>
<tr>
<th>Trait</th>
<th>Indicus</th>
<th></th>
<th>Taurindicus</th>
<th></th>
<th>Differences between Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>C.V. (%)</td>
<td>Mean</td>
<td>C.V. (%)</td>
<td></td>
</tr>
<tr>
<td>Age at 1st calving (months)</td>
<td>39.9</td>
<td>12</td>
<td>37.4</td>
<td>14</td>
<td>N.S.</td>
</tr>
<tr>
<td>Length of calving interval (days)</td>
<td>382.0</td>
<td>23</td>
<td>432.0</td>
<td>31</td>
<td>**</td>
</tr>
<tr>
<td>First lactation milk yield (litres)</td>
<td>1,039.5</td>
<td>39</td>
<td>1,854.0</td>
<td>34</td>
<td>**</td>
</tr>
</tbody>
</table>

C.V. = coefficient of variation
N.S. = not significant

Table 5. Comparison of Average Lactation Milk Yield (Corrected to First Lactation) and Average Length of Calving Interval in Bos indicus and 1/4 Bred; 1/2 Bred and 3/4 Bred Bos taurus Cows at Tanga, Tanzania

<table>
<thead>
<tr>
<th>Breed Group</th>
<th>Yield (litres)</th>
<th>Relative yield (%)</th>
<th>Calving Interval (days)</th>
<th>Relative Interval (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bos indicus</td>
<td>1,030.5(413)</td>
<td>100</td>
<td>381(441)</td>
<td>100</td>
</tr>
<tr>
<td>1/4 bred Bos taurus</td>
<td>1,669.5(197)</td>
<td>162</td>
<td>420(185)</td>
<td>110</td>
</tr>
<tr>
<td>1/2 bred Bos taurus</td>
<td>1,890.0(399)</td>
<td>183</td>
<td>428(424)</td>
<td>112</td>
</tr>
<tr>
<td>3/4 bred Bos taurus</td>
<td>1,764.0(63)</td>
<td>171</td>
<td>486(58)</td>
<td>128</td>
</tr>
</tbody>
</table>

Numbers in parenthesis refer to numbers of lactations for milk yield and numbers of calving intervals.
Mahadevan and Hutchison (1964) also observed that, although milk yields obtained at Tanga in the crosses were low compared with Sahiwal X Jersey studies in Jamaica, the halfbred was superior to three quarter-bred cows. They further observed that the length of calving interval should be taken into account when considering the economies of dairy production. The longer the calving interval the lower the average dairy milk yield and the fewer the number of calves produced per cow for replacement and selection purposes.

Use of Pure Dairy Cattle: The introduction of pure exotic dairy cattle in the 1920s in the highlands of Kenya first met with disappointments because of lack of effective disease control and poor animal husbandry practices. But when environmental factors were controlled, dairying based on exotic cattle became very successful. Similar successes in other areas of East Africa with similar climate were slow in coming. The essential points which led to this success were:

i) An adequate stockproof circumferential fence, and if possible a double fence;

ii) Independent water supplies for each fenced farm and sufficient grazing and/or conserved forage to last through the dry period;

iii) An effective spray race or dip;

iv) An effective quarantine system to ensure that ticks were not re-introduced either by new purchases of stock or by imported feed or bedding.

An alternative system of management for dairy cattle, especially for small intensive farms, was that of growing well-fertilized forage crops, e.g. Pennisetum purpureum, to be cut and fed to cows housed in a stall unit. The breeds of cattle that were imported then were mainly Ayrshire, Guernsey, Jersey and Friesian from Europe, Sahiwal from India used largely in Kenya, and Red Sindhi (Indian) used mainly in Tanzania. These exotic cattle were to be confined to areas with an altitude of 1,500 m and above. They could be kept at lower altitudes if greater attention was paid to stock husbandry and grasslands management.

Choice of Breeding Program

From data collected in East Africa, Mahadevan (1965) was able to observe that owing to the range of environmental conditions prevailing in the region there was no single solution to the problem of improving milk production in the whole area. The preliminary crossbreeding experiments indicate breed-environmental interaction. The higher milk yields of Friesian crosses as compared to the Channel Island crosses at Tanga cannot be interpreted as having general validity in all parts of East Africa. Where the standard of management is high and the climate is favourable the exotic cattle are likely to give higher economic returns than crossbred cattle.
The Governments in East Africa as elsewhere in the region are aware that the demand for dairy cows of all types (crossbred and purebred) is higher than the supply. They have, consequently, resorted to the more vigorous program of top crossing exotic bulls on indigenous stocks. Since opportunities for selection and genetic improvement are primarily through bulls, programs of progeny testing would need to be initiated. Artificial insemination (AI) is being widely used for crossbreeding and grading up to exotic bulls. However, it requires trained inseminators, availability of transport for inseminators and semen, efficient detection of heat in cows and good semen storage facilities. Use of natural mating could be more efficient in producing crossbred and grade cows where AI facilities are poor.

The governments should be able to set up bull centres and determine the most efficient methods of their use by small farmers. For example, one method would be to allow small farmers to take cows to the nearest bull centre for mating. The other would be to lend the bull to the farmer for a specified period after which it would be sent to another farm. The latter method is likely to lead to misuse of bulls. For example, some farmers will not have enough feed for the bull, or due to poor management the bull might contract diseases. It is recommended, therefore, that each area will have to work out the most appropriate method of using the bull.

Some Governments have, depending on the economic situation prevailing at the time, resorted to importation of in-calf purebred or crossbred heifers from overseas. Such a venture is likely to be very costly and could be limited to acquiring animals for the experiment stations or to a few individual farms. The importation of progeny-tested bulls for semen production is undertaken at Kabete in Kenya and at Arusha in Tanzania. If these AI centres are well supported with funds and staff, they will make a big contribution to the improvement of dairy cattle.

Another way to improve dairy cattle will be in the selection of females for breeding purposes. The technique of superovulation accompanied by embryo transfer is becoming more widespread. This means that outstanding females will be able to leave several progeny through the use of surrogate mothers. The indigenous cows could be useful either as dams of crossbred calves or as artificial mothers of the embryos of high producing exotic cows.

Record Keeping: A breeding program cannot be successful if there is no system of collecting accurate data. It is, therefore, important for any country wishing to improve dairy production to institute a method of identifying dairy animals individually. Most countries advise farmers to use a combination of permanent and temporary methods of identifying animals. The permanent ones include metal or plastic ear tags, fire brand on the hide, caustic-burnt brand, freeze brands, and ear tattoos, while the semi-permanent ones include neck tags of various types such as metal or plastic attached to a neck chain or nylon cord; hair dyes or bleaches, paint or spray marks or numbers, and stick-on labels.
Potential for Milk Production from Other Species of Livestock

Although milk production comes mainly from cattle, other species, especially buffaloes, goats, sheep and camels, could contribute substantially to milk production. Because of their flat hoofs, the buffaloes have mainly been used as draft animals in the wet paddy fields. Their contribution to milk production was not given great emphasis. FAO has, however, encouraged Asian and Middle Eastern countries with a tradition of keeping buffaloes to set up experiment stations where studies on improving the meat and dairy traits of buffaloes can be undertaken. Some buffaloes have been imported into Tanzania from Egypt and India for use as dairy animals and for draft. Their numbers are still very small to make an impact. Efforts will have to be made to import more of them if use in the small dairy farms is envisaged.

The animal that has a great potential in producing milk to supplement cow milk in the eastern and southern African region is the goat. Small flocks of exotic dairy goat breeds of Saanen, Toggenburg, and Anglo-Nubian have been kept by some farmers in most countries in the region in the past. Devendra and Burns (1970) and French (1970) have given reasons why the goat should be developed for many uses including milk production. They have shown data which indicate that some purebred dairy goats produce more milk per head than some indigenous cows. Because of its small size, the goat is easier to keep in densely populated districts and urban areas. These authors also present data which show that the goat is more efficient in producing milk per body weight than dairy cattle. The small farmers who are short of feeds can manage to feed a goat more easily than a cow and at the same time obtain milk for use in their homes.

In Tanzania the Government has been convinced that the goat must be developed for both meat and milk. It is planning to set up goat improvement centres where dairy production traits from exotic and crossbred goats will be studied. These centres will also act as sources of animals for sale to small-scale farmers.

Although sheep and camels are used for milk production in some northern African countries, they do not play a significant role in the region under discussion. This is mainly because there is no tradition of keeping these species of livestock for dairy production. There is also the fact that the numbers of dairy types of these species, with the exception of camels in parts of Ethiopia and Kenya, are very small. It can be recommended that in rural areas where there is a tradition of using sheep and camel milk in the diets of people, efforts be made by the relevant governments to assist farmers to improve milk production through acquisition of higher yielding strains and through improving management.
Governments in the eastern and southern African region realize the need to encourage the small dairy producers to improve milk production so that they may improve their diets and raise their incomes. The strategy for raising production lies in raising the yield per cow, controlling diseases and parasites, and producing high quality fodders which will supply nutrients required for milk production at a lower cost. The high milk-producing cows can be out of reach to small farmers because of their cost. The governments provide loans for purchase of such animals and at a subsidized price. Imported cows are expensive. The cost per animal can be reduced if they can be bred locally through crossbreeding and grading up using imported semen or semen produced locally from highly selected bulls. Studies undertaken in East Africa show that crossbred, grade and purebred exotic cattle produce more milk than indigenous cows. The management of these cattle in fenced freeholdings will enable farmers to isolate their cows and thereby control breeding, improve forage and prevent infection of diseases from neighbouring farms.

Buffaloes, goats, sheep and camels can contribute towards increasing milk production in the rural areas. Governments should encourage their use for milk production in districts where they are already being used for this purpose.
References


Milk production in Zambia has a small base both in absolute terms and in terms of consumption of milk and its products. Excluding the traditional sector, there are probably little more than 200 dairy herds in the entire country (1977), of which only 50% contribute to the growing demand for milk supplies generated by the major urban population, particularly along the "line of rail" (see page 102).

In 1976, total milk sold to marketing organizations amounted to 12.8 million litres, but sales from the same were 42 million litres. This meant that a balance of 27.2 million litres was supplied from milk reconstituted from imported skim milk powder and butter oil. These figures clearly indicate that domestic production marketed through formal channels along the "line of rail" contributed only about 30% of the total urban consumption, although it is also known that an appreciable volume of milk is sold direct to the consumers.

The bulk production off the "line of rail" is from the traditional sector. The supply and demand situation here is difficult to quantify since milk produced in these areas is consumed within the farmers' households while any surplus is sold through unrecorded informal channels. However, UNGZAMI (1976) estimated that annual milk production from the traditional sector averaged 12.5 litres per head, ranging from 6.7 litres in Eastern Province to 27.7 litres in Southern Province. The total estimated annual supply from the traditional sector is about 24 million litres - most of which is used for subsistence purposes. Most of farmers in the traditional sector milk their cattle. Milk, therefore, forms a major item in their daily food intake.

**Types of Cattle**

**Indigenous:** Based on cattle types, Zambian dairy industry can be divided into two broad groups. The first group is the traditional sector where milk production is preponderantly based on indigenous cattle and includes the Angoni (the south-eastern part of Eastern Province), the Barotse (the Western Province) and the Tonga (the southern part of the country). The Angoni cattle are short-horned zebus, with well-developed cervical humps. These cattle have great potential for beef production. The Barotse and the Tonga cattle are of the Sanga type, characterized by slightly developed thoracic humps and - especially in the Barotse, which are larger than the Tonga - by widespread horns. The Tonga have now mingled with non-indigenous types due to their close proximity to European agricultural settlements. The Barotse, too, is considered to have potential for development and is being reared for beef production. Although all these cattle are considered beef types by modern dairying standards they are milked under traditional systems of management. Not unexpectedly milk yield from these breeds is low since Zambian indigenous cattle have undergone little or no selection for dairying traits.
Exotic and Crosses: The second group is the commercial and state sector where the cattle are European dairy breeds - predominantly Friesian, with a few Channel Island and Ayrshire herds. These cattle require high capital and management inputs for feeding and health purposes. There is yet another group belonging to state-assisted farmers - where cattle are crossbred derived from crosses between the Friesian and the indigenous breeds.

Milk-Producing Areas in Zambia

Natural resources: Zambia is a land-locked country. The total land area covers 752,614 km² comprising a complex of rift valleys in the south and east and a series of plateaus over the rest of the country. The altitude ranges between 500 m in the west to 1,500 m in the north-east. Much of the country's relief is moderate to gentle with low river gradients and consisting of several extensive areas of swamp and flood plain.

The climate is Sudanian type which is warm and wet from November to April, cool and dry from May to August, and hot and dry from September to November. Annual rainfall ranges from 700 mm in the south to over 1,400 mm in the north-west. Average temperatures range from 25°C in July to 32°C in October. Temperatures fall rapidly at night during the cool dry season and many parts in the south of the country experience some frost.

The vegetation over most of the Zambia is predominantly deciduous woodland, with true forest being confined to a few areas in the north and west. Extensive grasslands exist in swamp and flood plain areas, major grasslands being the flood plains of the upper Zambezi and its tributaries in the North-Western and Western provinces, the margins of Lukanga Swamp in Central Province, the Kafue Flats in Central and Southern provinces and the Chambeshi Flats in Northern Province.

The distribution of the Zambian indigenous cattle has been greatly influenced by the interaction of these factors - climate, disease and vegetation. In broad terms, the 1,000 mm isohyet divides the "cattle" areas from "non-cattle" areas of Zambia, except for a small concentration of cattle in the tsetse-free area of Northern Province which lies partly in the higher rainfall zone. Most of the natural grasslands are in lower rainfall zone. North and west of the 1,000 mm isohyet, tree growth is heavier and consequently grazing becomes poorer at the same time as tsetse fly infestation increases.

The "Line of Rail"

The commercial/traditional dichotomy in the socio-economic set-up of Zambia is accentuated by the fact that these two sectors are geographically distinct. The commercial (modern) sector is confined to the "line of rail", a narrow zone which borders the railway line linking Livingstone in the south to the Copperbelt in the north. Coinciding with the areas of greater agricultural potential which enjoy fertile soils and are free of the tsetse fly the modern sector, which is still largely owned by Europeans, consists of large units of land ranging from a few to several hundreds of hectares. Land in this sector is held by written tenures and farms are legally demarcated by cadastral survey.
On the other hand, the traditional sector consists of small family units, land area seldom exceeding tens of hectares, and tenure is on customary basis. The traditional sector is by and large confined to the outlying areas away from the "line of rail".

**Milk Production Systems**

The Zambian dairy industry comprises a variety of enterprises whose main characteristics are summarized below under "large-scale", "small-scale-graded" and "small-scale-traditional".

**Large-scale:** Commercial herds - individual or corporate private ownership. They are generally large (an average of 88 cows to the herd) and most of them are owned or managed by Europeans. Up to 1960, these herds supplied all the formally marketed milk. Today, they still represent over 70% of dairy cattle on the "line of rail". Their number has been reduced from 120 in 1964 to about 53 in 1977.

**Informal commercial herds** - dairy herds, mostly owned privately by Europeans but smaller than commercial herds. These market their milk informally. They are estimated to have increased in number in the mid-1970s due to the low price offered for formally marketed milk and also due to the high demand for fresh as opposed to heat-treated and/or reconstituted milk.

**State and parastatal herds** - established with imported stock from late 1960s mainly to offset the decline in commercial herds and the production of high quality dairy stock. There were eight of these by 1977 with about 1,700 cows and an annual milk production over 4 million litres. Most of them are now managed by Zambians.

**Small-Scale-Graded:** State-assisted herds - Dairy tenant schemes were established in the late 1960s on the "line of rail" with the main objectives of broadening the base of dairy production and encouraging participation of indigenous farmers in dairying. Graduates from dairy husbandry courses are offered tenancies on dairy schemes established on farms previously owned by European farmers. They are assisted to acquire the necessary stock, equipment and working capital. There were 40 such farmers by 1977 with an average herd of under 20 cows. Production from these schemes in 1976/77 was about 0.8 million litres.

**State-assisted herds** - Rural milk production schemes are small-scale dairy herds established off the "line of rail" with the aim of boosting milk supply to rural centres of population. Village farmers have been assisted to acquire between two to four crossbred cows and the necessary buildings and equipment. The total number of herds so established by 1977 was over 120.

**Small-Scale-Traditional** - The Zambian cattle population managed under traditional methods is about 1.6 million cattle, 36% of which consists of mature cows. The majority of these cows are milked mainly for subsistence purposes with a small proportion of the milk sold in nearby villages and small rural centres. The estimated annual supply from these herds is about 24 million litres, or twice as much as that supplied by the commercial sector.
The milk yields in the traditional sector are about 1.5 litres per cow per day at peak of lactation, except for Mongu where yields are about 1.0 litres per day. Average annual yields per cow are estimated in the range of 200 to 300 litres (Mongu - 120 litres). These yields compare very well with yields for indigenous cattle elsewhere in Africa. There is, however, a wide variation in yields from the Zambian indigenous cattle. Maximum annual yields according to UNGZAMI survey (1976) ranged from 450 to 900 litres per cow, indicating the presence of indigenous cows with superior dairying traits.

Milk Production Parameters: While the main factors affecting milk production in commercialized herds is the presence of the calf and provision of suitable environment (e.g. good nutrition, good health, less physical stress) suitable for milking, the critical performance indicators for traditional cattle are calving rate and calf losses. This is so because the presence of the calf is essential in milking indigenous cows. In this respect, Southern Province which displayed higher supplies of milk than the other three provinces had expectedly higher calving rates of 68% compared with rate of 40% to 50% for the other provinces.

Marketing Organization and Channels

For most farmers selling milk, family nutrition is an important consideration, and milk will only be sold after family needs have been satisfied. This is particularly true of the traditional sector. The volume of milk sales is therefore related to the surpluses.

The formal selling of milk is undertaken through the Dairy Produce Board (DPB) - a parastatal monopoly marketing body. The DPB operates milk depots at main urban centres where farmers along the "line of rail" bring their milk for sale.

Most of the milk produced in the outlying areas away from the "line of rail" is marketed at farmsteads, except for state dairy farms which formally sell their produce through established retail shops. Some farmers operate delivery service ranging from hawking milk around adjacent villages to trips of several kilometres by bicycle or on foot. In Mongu, middle men buy milk (mostly sour) from cattle owners far away from markets and resell it in the settlement along the Zambezi plain. In the traditional sector, fresh milk is usually sold by the "bottle" (750 ml) and sometimes in 2.5 litre containers, while sour milk is sold by the "cup" measuring 0.25 to 0.5 litre capacity.

Economics of Milk Production

Zambia's main obstacle to milk production is the long dry seasons of seven months of the year, which drastically reduces natural grazing and raises the cost of year-round production of liquid milk. There is also the danger that if producer prices were set high enough to offset the high capital investments required, the milk produced would be priced out of reach of the lower income bracketing. Part of the demand is met by imports from countries with low production costs enabling milk to be sold at a price within reach of the lower income group.
Until the end of the 1960s the commercial sector was the sole domestic supplier of milk to the main urban centres of the "line of rail". However, since shortly after independence, production in this sector has gradually declined with the decrease in numbers of farmers and cattle. This decline is due mainly to the fact that dairy farming has generally proved less economical than other farm enterprises. This is in turn attributed to the extremely slow response of the pricing mechanism to changed cost price relationships.

The main factor affecting milk prices in the traditional sector is distance from markets such as government offices, schools, hospitals and trading stores. In Katete, for example, UNGZAMI (1977) reported that milk prices declined with increasing distance from the township.

Factors Limiting Production (Small-Scale)

There are several main factors determining the level of milk production from Zambia's traditional herds. These are:

i) Farmers' attitude to milk production

ii) Calving rates;

iii) Calf losses;

iv) Milk yield per cow.

A major constraint in milk production from the traditional sector is the farmers' attitudes to milking. UNGZAMI (1977) reports a significant number of farmers who did not milk their cattle at all, and the majority of those who milked delegated the operation to children or other unskilled persons. Most of the traditional farmers regarded milking as a peripheral activity which should not interfere with more important farming tasks. Such farmers do not perceive milking as a possible main source of income, particularly since, with uncontrolled breeding and high calf losses, the income derived from milking is variable. Other management practices of feeding, selection and disease control are also constraints to production.

Another serious constraint is that most of the cows in Zambia's traditional herds may not be milked due either to poor temperament or low yields. Since most traditional farmers milk their cattle to satisfy subsistence needs, the number of cows milked depends largely on the number of cows with high yields. This in turn affects total herd yields obtained from the traditional cattle - 1.5 litres per cow per day at the peak of lactation. The range is from 0.5 to 4 litres per day.

As already mentioned, calving rates and calf losses influence milk production since the presence of the calf is essential in milking indigenous cows. The combined effect of calving rates, calf losses and unmilkable cows is that only about 23% of the cows are milked in any one year. Obviously this lowers the total milk yields from the traditional sector.
However, the low yields are expected since the Zambian traditional herd has undergone little or no selection for milking traits. These low yields are also attributed to the level of nutrition and poor health of cattle that prevail over much of the year.

Potential for Small-Scale Milk Production

Production from the traditional sector can be increased by improving any or all of the factors cited above, though the extent of increase will vary with the factors.

The proportion of cows milked and yields per cow are by and large determined genetically and improvement can only be obtained by selection. The fact that some cows can yield 4 litres per day while others yield as low as 0.5 litres indicates there is room for improvement through selection. In Katete, for example, there is a high concentration of cows yielding moderately high yields of 3 litres per cow per day (UNGZAMI 1977).

Demand for milk is fairly high, particularly near the "line of rail", and near centres of population away from the "line of rail". With proper marketing channels such as introduction of co-operatives for tapping milk traditionally produced, the problem could be reduced.

Technical Services and Extension

The Department of Agriculture's Extension Services branch disseminates technical information to traditional farmers. The branch has officers, at the village level, as commodity demonstrators who are graduates in animal husbandry and dairy courses.
Technical help is also provided by such agricultural institutions as the National Council for Scientific Research and the Research Branch of the Department of Agriculture.

Local Experimental Results

To date it has only been possible to find very brief results of two experiments relevant to small-scale milk production. Little research has been done in this field.

Some results reported by Agricultural Research (1963) indicated annual milk yields in litres for the three indigenous cattle reared as dairy herds for eight years as 772 for Angoni, 1,045 for Barotse and 639 for the Tonga.

In another experiment conducted over a period of three lactations, Cruickshank et al. (1976) crossed the three indigenous breeds with the Friesian and found annual yields of 1,124, 1,379 and 1,199 litres for the Friesian X Angoni, Friesian X Barotse and the Friesian X Boran cattle respectively. No data for the Tonga cross were available.
References


COMMERCIAL AND COMMUNAL DAIRY FARMING IN ZIMBABWE
C.T. McCabe and S.D. MacCallum

The history of commercial dairying in Zimbabwe goes back to the earliest days of colonial settlement. Even today, commercial dairy farming is almost exclusively undertaken by white farmers, though there exists a considerable but unquantified local commerce in milk within the peasant sector.

In eastern and southern Africa, Zimbabwe is perhaps an unusual case in terms of its milk production patterns: the majority (over 98%) of centrally retailed milk emanates from about 500 large-scale dairy enterprises with a mean herd size of about 90 animals. Current milk production as assessed by deliveries to the national marketing organization, the Dairy Marketing Board, stands at 150 million litres per annum. This sector contributes 5% to the commercial agricultural output which in 1981 stood at Z$579 million.* This percentage has remained constant since 1965 (see table 1) and the value of wholesale milk sales now stands at Z$27 million.

Another 500 producer-retailers, with herds of some six to seven animals each, produce milk for local consumption and are usually situated too far from the nearest depot to allow either economic or regular deliveries with the present churn system. There are no comparable figures for milk production in the peasant sector, though the estimated total agricultural output of these areas is Z$146 million, of which some 80% is consumed within the sector itself.

The Dairying Sector

The dairy farming sector may be divided into four main groupings:

1. Commercial large-scale dairying: 500 producers in the former European farming areas. Leasehold or freehold. Predominantly in Natural Regions I, II and III. Average herd size of 90 purebred animals with a total production of 150 million litres per year. Wholesale deliveries to the Dairy Marketing Board.

2. Commercial small-scale dairying: 500 producers in the former European farming areas. Leasehold/freehold in Natural Regions II and III. Average herd size of six purebred animals. Production unknown. Local retail sales.

3. Commercial small-scale dairying: 177 producers in the former African purchase areas. Freehold in Natural Regions III and IV. Average herd size of six animals. Production unknown. Local retail sales.

4. Communal sector dairying: Possibly 700,000 households owning indigenous beef cattle predominantly in Natural Regions III, IV and V.

* 1.15 Z$ = 1$ (US)
Production and Demand

Demand for milk and milk products has increased since Independence by an estimated 56% and an increasing proportion of the milk delivered has been directed towards whole milk sales (68% of total milk production in 1981/82) (102 million litres out of a total of 151 million) (table 1).

Table 1. Milk Utilization by the Dairy Marketing Board
(millions of litres (per cent of total))

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholemilk</td>
<td>65 (44)</td>
<td>70 (49)</td>
<td>73 (52)</td>
<td>77 (51)</td>
<td>84 (58)</td>
<td>102 (68)</td>
</tr>
<tr>
<td>Indust. milk</td>
<td>19 (13)</td>
<td>16 (11)</td>
<td>13 (9)</td>
<td>15 (10)</td>
<td>19 (13)</td>
<td>23 (15)</td>
</tr>
<tr>
<td>Lacto*</td>
<td>12 (8)</td>
<td>15 (10)</td>
<td>16 (11)</td>
<td>18 (12)</td>
<td>17 (12)</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Cheese</td>
<td>18 (12)</td>
<td>20 (14)</td>
<td>19 (14)</td>
<td>17 (11)</td>
<td>12 (8)</td>
<td>10 (7)</td>
</tr>
<tr>
<td>Sterimilk</td>
<td>3 (2)</td>
<td>4 (3)</td>
<td>4 (3)</td>
<td>5 (3)</td>
<td>6 (4)</td>
<td>7 (5)</td>
</tr>
<tr>
<td>Butter/skim</td>
<td>27 (8)</td>
<td>15 (10)</td>
<td>11 (8)</td>
<td>17 (11)</td>
<td>5 (3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Misc.</td>
<td>5 (3)</td>
<td>4 (3)</td>
<td>4 (3)</td>
<td>3 (2)</td>
<td>3 (2)</td>
<td>3 (2)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>148</td>
<td>145</td>
<td>141</td>
<td>151</td>
<td>146</td>
<td>151</td>
</tr>
</tbody>
</table>

Source: Dairy Marketing Board

* Acidulated milk product

This increase is primarily the result of an improved level of disposable income in the low-income sector coupled with a substantial marketing drive and door-to-door sales in the high-density urban areas. The demand is exacerbated by a heavy subsidy on fresh milk sales, presently at a level of Z$44 million per annum, or nearly 26 cents per litre. Estimates of the shortfall for 1983 vary from 24 to 86 million litres and this deficit is made up by food aid imports of skimmed milk powder and anhydrous butter fat from the EEC (see table 2).
Table 2. Milk Demand and Twenty Year Projection
(Millions of Litres)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total utilization</th>
<th>Commercial production</th>
<th>Recombination (shortfall)</th>
<th>New sectors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>147</td>
<td>147</td>
<td>0</td>
<td>0</td>
<td>147</td>
</tr>
<tr>
<td>1981</td>
<td>159</td>
<td>151</td>
<td>9</td>
<td>0</td>
<td>159</td>
</tr>
<tr>
<td>1982</td>
<td>192</td>
<td>168</td>
<td>24</td>
<td>0</td>
<td>192</td>
</tr>
<tr>
<td>1983</td>
<td>219</td>
<td>188</td>
<td>31</td>
<td>0</td>
<td>219</td>
</tr>
<tr>
<td>1984</td>
<td>231</td>
<td>196</td>
<td>34</td>
<td>1</td>
<td>231</td>
</tr>
<tr>
<td>1985</td>
<td>246</td>
<td>204</td>
<td>40</td>
<td>2</td>
<td>246</td>
</tr>
<tr>
<td>1990</td>
<td>323</td>
<td>248</td>
<td>30</td>
<td>45</td>
<td>323</td>
</tr>
</tbody>
</table>

Source: Dairy Marketing Board.

The National Dairy Herd

The National Cattle Herd in Zimbabwe is predominantly a beef herd, divided almost equally between commercial and communal sectors with only 100,000 head of dairy cattle in the commercial sector (table 3). The predominant commercial dairy animal is of Friesian/Holstein type, though there are some herds of Jersey and Ayrshire. There are few crossbred dairy producers in any sector. In the peasant sector the principal type of animal is the Mashona, an indigenous animal of Sanga type. These animals are maintained for draught, manure and subsistence needs in the form of milk and meat.

The composition of the herd in the small-scale farms (former African Purchase Areas) is shown in Table 4. Draft oxen comprise 18% of the total herd in this sector. Estimates of the proportion of draft oxen in the communal areas are much higher (+ 30%). This demand for draft oxen may prove a serious limitation on the number of animals available for commercial milk production in the future.
Table 3. National Cattle Herd (000s)

<table>
<thead>
<tr>
<th>Year</th>
<th>Commercial Farming Areas</th>
<th>Dairy herd</th>
<th>Total</th>
<th>Commercial Herd</th>
<th>National Herd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beef herd</td>
<td>Dairy herd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>2,785</td>
<td>125</td>
<td>2,910</td>
<td>2,691</td>
<td>5,601</td>
</tr>
<tr>
<td>1973</td>
<td>2,665</td>
<td>129</td>
<td>2,795</td>
<td>2,847</td>
<td>5,642</td>
</tr>
<tr>
<td>1974</td>
<td>2,668</td>
<td>128</td>
<td>2,796</td>
<td>2,936</td>
<td>5,732</td>
</tr>
<tr>
<td>1975</td>
<td>2,882</td>
<td>127</td>
<td>3,009</td>
<td>3,123</td>
<td>6,132</td>
</tr>
<tr>
<td>1976</td>
<td>3,007</td>
<td>126</td>
<td>3,133</td>
<td>3,183</td>
<td>6,409</td>
</tr>
<tr>
<td>1977</td>
<td>3,103</td>
<td>123</td>
<td>3,226</td>
<td>3,388</td>
<td>6,614</td>
</tr>
<tr>
<td>1978</td>
<td>2,960</td>
<td>117</td>
<td>3,077</td>
<td>2,950</td>
<td>6,027</td>
</tr>
<tr>
<td>1979</td>
<td>2,600</td>
<td>109</td>
<td>2,709</td>
<td>2,860</td>
<td>5,569</td>
</tr>
<tr>
<td>1980</td>
<td>2,304</td>
<td>106</td>
<td>2,410</td>
<td>2,869</td>
<td>5,279</td>
</tr>
<tr>
<td>1981</td>
<td>2,298</td>
<td>104</td>
<td>2,119</td>
<td>2,900</td>
<td>5,019</td>
</tr>
<tr>
<td>1982</td>
<td>2,095</td>
<td>101</td>
<td>2,196</td>
<td>2,900</td>
<td>5,096</td>
</tr>
</tbody>
</table>

**Sources:**
- Agricultural Marketing Authority of Zimbabwe;
- Department of Agricultural and Technical Services.

**Milk producing areas:** The commercial milk producers are concentrated around the principal towns and cities. The urban demand for fresh milk has resulted in whole milk production being undertaken near consuming centres, even where natural conditions are strongly unfavourable for dairying. Apart from such marketing considerations and the availability of transport, it is economically and ecologically desirable that farming systems should conform to natural controls.

The majority of milk delivered to the Diary Marketing Board is produced in Natural Region II (see Appendix I with this paper), compromising some 5.7 million hectares (14 million acres) of which 1.6 million hectares (4 million acres) are arable and considered well suited to intensive dairying. Natural Region II with an altitude of greater than 1,220 m and temperatures ranging from 12°C to 29°C, is most suitable for dairying. Dairy production can be based on veld, then on planted pastures, pasture products, ensilage and farm-grown or brought-in concentrates.
Natural Region III, although considered marginal for dairying, is however partly a milk-producing area. Natural Region IV, like III, is ill-adapted to crop production and the natural veld provides adequate nutrition for only three months at the most. The practice of most dairymen in these regions is to bring in both carbohydrates and protein feedstuffs and even to import high quality roughage. Irrigation is used for both pasture and maize.

Table 4. Composition of Small-Scale Sector Cattle Herd (000s)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulls</td>
<td>7.9</td>
<td>4</td>
<td>8.1</td>
<td>4</td>
<td>8.0</td>
<td>4</td>
</tr>
<tr>
<td>Draft oxen</td>
<td>36.1</td>
<td>18</td>
<td>38.3</td>
<td>18</td>
<td>40.3</td>
<td>18</td>
</tr>
<tr>
<td>Steers</td>
<td>25.2</td>
<td>12</td>
<td>28.3</td>
<td>13</td>
<td>30.2</td>
<td>13</td>
</tr>
<tr>
<td>Cows</td>
<td>62.6</td>
<td>31</td>
<td>67.6</td>
<td>31</td>
<td>71.5</td>
<td>31</td>
</tr>
<tr>
<td>Heifers</td>
<td>32.8</td>
<td>16</td>
<td>35.3</td>
<td>16</td>
<td>34.1</td>
<td>16</td>
</tr>
<tr>
<td>Cattle 1 year</td>
<td>37.5</td>
<td>19</td>
<td>40.6</td>
<td>19</td>
<td>42.1</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>202.1</td>
<td>100</td>
<td>218.2</td>
<td>100</td>
<td>226.2</td>
<td>100</td>
</tr>
</tbody>
</table>

No. of farms 7,799 7,835 7,814
Average herd Size 26 28

Source: Central Statistical Office.
Marketing Organization and Channels

Formal Sector

In this sector the Diary Marketing Board (DMB), a quasi-autonomous non-governmental organization, is responsible for the purchase of 98% of milk production sold off farms (excluding farm consumption for human and livestock feeding). This milk is predominantly used for fresh milk sales in the urban areas through six dairy factory complexes and it is estimated that the market channels of the DMB reach some two million people or about one-third of the present population. As a result of the Board's relatively small production of long-life milk, the majority of the principal products require a network of refrigerated distribution. This limits supplies to in and around the major urban areas.

The Board operates 47 depots; in the main cities the majority of depots are primarily employed in the distribution of liquid products (pasteurized whole milk, acidulated milk and fruit juices) on a door-to-door basis in the high and low density areas. Some depots are over 200 km from their supply dairy. The marginal costs of extending refrigerated distribution into the rural areas not currently served by the DMB are rising rapidly which at this stage can only be circumvented by increasing sterimilk production.

Informal Sector

A recent survey (Diary Marketing Board 1983) in a communal area close to Harare has provided some base information on the role of milk, its production and distribution in a Natural Region II communal area. The cattle ownership pattern that emerged is that 57% of households owned cattle with a herd composition of 43% cows, 29% oxen, 24% young stock and 4% bulls (see table 5). The herds in this area suffered greatly during the years of war and immediately after and some 23% of non-owners of cattle once owned herds. A 50% calving percentage is claimed for the 1982/83 season and 37% of the households in the area owned these cows; 10% of the households owning lactating cows did not milk them this season.

Table 5. Herd Composition in the Chikwakwa Communal Area

<table>
<thead>
<tr>
<th>Type of Animal</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>43</td>
</tr>
<tr>
<td>Bulls</td>
<td>4</td>
</tr>
<tr>
<td>Oxen</td>
<td>29</td>
</tr>
<tr>
<td>Young stock</td>
<td>24</td>
</tr>
</tbody>
</table>

Source: Dairy Marketing Board Research Report.
Half of the farmers reported that they milk their cows for some seven months, the others for four to six months. Of those that milked, 48% obtained between 1.5 and 3 litres per day, while 46% claimed four litres or more. A small field trial indicated average yields nearer 2 litres and extrapolating the figures to the total communal herd would suggest a level of milk production close to 75 million litres per annum within the majority of production in the months November to April. This gives a consumption of 15 litres per capita per annum based on recent population estimates for the communal areas. By comparison the average consumption in the urban areas served by the DMB would be 52 litres/capita/annum.

Milk was sold by 17% of those milking or 9% of all those owning cows. Most milk is consumed by the families, but the survey also indicated that 77% of cattle owners and 94% of non-owners purchased periodically (see table 6).

The milk yield of an indigenous cow in this area is comparable to that found elsewhere in Africa under similar conditions and is insufficient for the establishment of a financially viable milk collection co-operative (DMB 1983).

Table 6. Local Milk Prices in Chikwakwa Communal Area

<table>
<thead>
<tr>
<th>Product</th>
<th>Price Range</th>
<th>Mode</th>
<th>c/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh or soured</td>
<td>10.5-20c/bottle*</td>
<td>20c/bottle</td>
<td>27-35c/litre</td>
</tr>
<tr>
<td>local milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMB fresh milk</td>
<td>20-24c/600ml sachet</td>
<td>22c/sachet</td>
<td>37c/litre</td>
</tr>
<tr>
<td>DMB sterimilk</td>
<td>30-40c/500ml bottle</td>
<td>38c/bottle</td>
<td>76c/litre</td>
</tr>
<tr>
<td>DMB lacto</td>
<td>22-38c/600ml sachet</td>
<td>25c/sachet</td>
<td>42c/litre</td>
</tr>
<tr>
<td>DMB fresh milk</td>
<td>Official retail price</td>
<td>16c/sachet</td>
<td>27c/litre</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Dairy Marketing Board Research Report

* Range depends on capacity of bottle.

Economics of Milk Production

In the commercial sector, the cost of milk production as calculated using a standard dairy production model is 23.10c/litre (table 7). The mean price paid by the DMB is 28.80c/litre giving a margin of 5.7c/litre.
In the small-scale and communal areas there are no figures on the costs of production of milk. A field trial in the Chikwakwa Communal Area conducted by the Dairy Marketing Board in conjunction with the extension service, "Agritex" (The Department of Agricultural, Technical and Extension Services), has clearly ruled out the use of concentrate feeding of indigenous cattle to produce milk in quantities sufficient for the establishment of a dairy co-operative.

This economic analysis suggests that to support a dairy co-operative with a central collection facility and make the scheme sufficiently attractive to the farmers, milk yield would have to be at least trebled.

Table 7. Costs of Milk Production in Zimbabwe

<table>
<thead>
<tr>
<th>Item</th>
<th>Total $</th>
<th>Per cow $</th>
<th>Per kg c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>14,709</td>
<td>112.28</td>
<td>3.06</td>
</tr>
<tr>
<td>Tractor operating</td>
<td>2,141</td>
<td>16.34</td>
<td>0.45</td>
</tr>
<tr>
<td>Feed - silage</td>
<td>21,990</td>
<td>167.86</td>
<td>4.58</td>
</tr>
<tr>
<td>Concentrates</td>
<td>50,202</td>
<td>383.22</td>
<td>10.46</td>
</tr>
<tr>
<td>Dipping</td>
<td>720</td>
<td>5.50</td>
<td>0.15</td>
</tr>
<tr>
<td>Dosing</td>
<td>172</td>
<td>1.31</td>
<td>0.04</td>
</tr>
<tr>
<td>Vets and medicines</td>
<td>4,495</td>
<td>34.31</td>
<td>0.94</td>
</tr>
<tr>
<td>Detergents</td>
<td>987</td>
<td>7.53</td>
<td>0.21</td>
</tr>
<tr>
<td>Artificial insemination</td>
<td>1,484</td>
<td>11.33</td>
<td>0.31</td>
</tr>
<tr>
<td>Levy</td>
<td>714</td>
<td>5.45</td>
<td>0.15</td>
</tr>
<tr>
<td>Transport</td>
<td>6,077</td>
<td>46.39</td>
<td>1.27</td>
</tr>
<tr>
<td>Insurance</td>
<td>408</td>
<td>3.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Electricity</td>
<td>2,695</td>
<td>20.57</td>
<td>0.56</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4,095</td>
<td>31.26</td>
<td>0.85</td>
</tr>
<tr>
<td><strong>Total variable costs</strong></td>
<td>110,888</td>
<td>846.47</td>
<td>23.10</td>
</tr>
</tbody>
</table>
Model Assumptions

The model makes certain assumptions that are listed below:

i) 100 cows in milk at any one time. Even calving spread.

ii) Average calving interval of 400 days, lactation length of 305 days, giving 120 lactations per year with 131 cows.

iii) Yield of 4,000 kg/lactation or 3,664 kg/cow/year.

iv) Calving percentage of 92%.

v) Heifers bred to calve at three years.

vi) Mortality and culling: 20% of cows culled per year
5% cow deaths
10% calf mortality in the first year.

vii) One bull for follow-up on artificial insemination.

viii) Herd composition: 1 bull
131 cows
32 heifers 2+ years
50 heifers 1+ years
54 calves and weaners

The Dairy Marketing Board research report proposes a stepwise up-grading of animal nutrition, pasture management and breed type, though maintaining a full integration with the mixed-farming systems presently practised. This is to be paralleled with the development of a milk production and marketing co-operative.

Support Services for Agriculture

Technical services and extension for agriculture are provided primarily by the Ministry of Agriculture and the Ministry of Lands, Resettlement and Rural Development.

Ministry of Agriculture is responsible for agricultural economics, marketing, conservation, extension, research and specialist services, veterinary services and certain components of agricultural education at diploma and certificate level. Within the marketing area, the Agricultural Marketing Authority is responsible for the marketing and price regulation of commodities such as grain, coffee, beef, milk and cotton, but does not control tobacco, pork and sugar.

The extension services of the Ministry are provided by Agritex, which is responsible for extension in all sectors. It has a central head office with support structures for each province which are further divided into regional areas. Each regional area has Agricultural Extension Officers with responsibility for Senior Extension Officers, Extension Supervisors and Extension Workers. The latter three categories deal directly with farmers in the communal, small-scale and resettlement areas. The Regional Extension Officers are available to advise the large-scale commercial sector.
Each province has a specialist advisory structure for animal and pasture management, farm management, training, irrigation, tobacco, crop production and planning. They assist the Provincial and Regional Officers and their staff with specialist advisory problems.

In the area of dairy production there are at present insufficient staff to service the present needs of the industry and in view of the Zimbabwe Government's desire to initiate commercial milk production from the communal, small-scale and resettlement sectors, it will be necessary to substantially increase the number of specialists in the fields of dairying, pasture management and fodder crop production.

The Department of Veterinary Services are responsible for all animal health control programs throughout the country. The organizational structure is similar to that of Agritex. The Department also has an active research component in the fields of tick and tsetse control and provides services for brucellosis monitoring and registration, mastitis bacteriology and routine pathology.

The technical progress of agriculture is entrusted to the Department of Research and Specialist Services. This Department has three divisions: the Division of Livestock and Pastures with four regional research stations, the Division of Crop Research with six research stations and specialist institutes, and the Division of Research Services.

The dairy research program at Henderson Research Station aims to consolidate the productivity of the established dairying sector by improving management services: expanding Dairy Technical Services in the fields of milk recording, quality control testing, mastitis control, milking machine testing, farm management services, and milk hormone pregnancy testing; setting up a Dairy Management Research Unit. The programme also aims to investigate the productivity of indigenous and dairy crossbred cattle under various systems of management; to investigate the productivity of legume-based pastures for milk production in both commercial dairy enterprises; to undertake co-operative investigations on milk production from goats, and on mixed-farming models with a dairy component.

Ministry of Lands, Resettlement and Rural Development

As part of its responsibilities this Ministry has a brief to expand employment in the agricultural sector through a land resettlement scheme in association with the development of irrigation resources. The three-year program began in October 1980 with the objective of purchasing 1.1 million hectares of land and the resettlement of some 18,000 families. The cost is estimated at Z$60 million, 50% of which was made available through United Kingdom Government funding. By March 1983, some 1600 families had been resettled.

Three types of settlement are envisaged:

1) intensive village settlement with individual arable land allocations in conjunction with communal grazing areas. The leased arable allocation is 5 hectares with grazing rights for eight livestock units;
ii) Intensive settlement combined with a core estate. The individual farmer is given 2 hectares of irrigated land for his own use. Provision is made for services to be supplied by the estate on a commercial basis;

iii) Intensive settlement with communal living combined with co-operative farming.

The objective of the Government is that the resettlements should rival commercial farms and reduce the dependence on the commercial sector. Many of the participants in these schemes are ex-combatants or people without land. Unfortunately, many of these people lack cattle and productivity has been low as a result of the constraints on drought and manure.

Constraints on Small-Scale Milk Production

Breed Constraints: The indigenous cattle of Zimbabwe, though providing small amounts of milk for home consumption and sale in the communal areas, are unsuited to any intensification towards milk production. Viable co-operative schemes will have to be based on crossbred animals. A five-year program will be initiated shortly in Zimbabwe to investigate the total productivity of indigenous cattle, and crossbreds derived from them, under various systems of management.

Nutritional Constraints: Obstacles to intensification of livestock production in the communal areas are the provision of fodder and the lack of private grazing areas. There is little or no tradition in Zimbabwe of fodder crop production, planting of edible browse or the careful collection and preservation of crop residues. These aspects of animal husbandry are not actively pursued by the extension services; the main thrust is in crop production.

In the small-scale farming area, the potential for dairy production of legume-based pasture is significant. Current research is directed at the potential of these pastures using crossbred animals, partnered with work on the use of browse species. However, promotion of dairying should not be considered in isolation from other areas of farming.

Marketing Constraints: The considerable, if unknown, commerce in milk is already served by the local marketing channels, but if milk is to be marketed to the Dairy Marketing Board at some time in the future, this would only be feasible through a central bulk milk collection facility. The Dairy Marketing Board has proposed a plan whereby the infrastructural requirements will be provided by them in the first instance, later to be taken over by the milk co-operative. The extensive program of construction of all-weather roads in the communal areas will facilitate this plan.

Socio-economic Constraints: The problem of the cattleless households cannot easily be solved directly, but there is undoubtedly room for such households within the framework of the co-operatives in a supportive role. Special attention will have to be given to this group to prevent further income/health disparities developing within a given communal area.
A further problem may arise in the form of the additional workload that livestock intensification will place on the women of the household. With increasing school attendance the work components undertaken by the children will have to be taken up by the women and it is not clear if this increased workload can be accommodated.

**Hygiene Constraints:** A survey undertaken jointly by the Dairy Services Branch of the Department of Research and Specialist Services and the Dairy Marketing Board has shown that hygienic quality of milk in the communal areas is poor, with high concentrations of coliform bacteria present. The provision of clean water is in many communal areas a particular constraint that may not be easily overcome. In the small-scale areas this is less of a problem.
References

Agricultural Marketing Authority of Zimbabwe. Various.


Appendix I

Zimbabwe's Five Main Agro-Ecological Regions

Region I: specialized and diversified farming areas accounting for 1.8% of the country with rainfall generally about 1,000 mm per annum and comparatively low temperatures, permitting forestry, tea, fruit and intensive livestock production;

Region II: an intensive farming region accounting for 15.4% of the country with moderately high summer (October to March) rainfall of between 750 to 1,000 mm. Intensive farming systems based on crop and/or livestock production;

Region III: a semi-intensive farming zone comprising 18.5% of the country with rainfall of 760 - 800 mm. Infrequent heavy falls and fairly severe mid-season dry spells. A marginal zone for maize, tobacco and cotton;

Region IV: a semi-extensive farming zone constituting 37.4% of the country with fairly low rainfall (450 - 500 mm) periodic seasonal droughts and severe dry spells during the rainy season. The predominant use is livestock production;

Region V: an extensive farming region constituting 26.9% of the country with rainfall too low and erratic for the reliable production of even drought-resistant fodder and grain crops. Farming is therefore based on natural grassland alone. Extensive cattle and game ranching are only recommended agricultural activities practised without irrigation.