POTENTIAL FOR CONTINUED LIVESTOCK PRODUCTION IN THE FACE OF POPULATION PRESSURE IN UKWALA AND BONDO DIVISIONS, SIAYA DISTRICT, KENYA

BY

LUKE OUMA AWANGE

THESIS

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DECLARATION

I, Luke Ouma Awange, do hereby declare to the Senate of the University of Dar-es-salaam that this thesis is my own original work and has not been submitted for a degree award in any other University.

Awange

Luke Ouma Awange

Date: 1980

ABSTRACT

The thesis is based on a sample survey of 50 farmers conducted in Siaya District, Kenya, to assess the livestock position of small farmers which has been adversely affected by high population pressure in the District. The study begins by assessing generally the role of livestock as an agricultural enterprise and the position of livestock in Africa and Kenya. Then the position of livestock in Siaya District is examined in detail in accordance with the objectives of the study.

As an agricultural enterprise, livestock is a significant contributor to gross domestic product in terms of income from internal and external markets. It is also a source of food, manure, and ox-power in places where intermediate technology is recommended. Reasons for poor performance of the cattle industry in Africa include diseases, starvation due to drought and poor grazing management, etc. Reasons for the lack of full development of the livestock industry in Kenya include inadequacy of certain basic input supplies and services and widely scattered research development efforts in animal production. Suggested solutions to the Kenya livestock problems include establishment of pasture leys, cultivation of fodder crops, and fencing to reduce communal grazing.

Siaya District is occupied mainly by subsistence small-scale farmers. High population pressure building up in the District has caused competition for scarce arable land

between cattle and crops. The competition is eliminating cattle, and as such, mixed farming and its numerous benefits.

This study has two objectives: (1) to examine whether to integrate the livestock enterprise more closely with a cropping system or accept the trend and ensure an efficient use of arable land without a livestock component. If (1) indicates a place for livestock, the (2) examines whether emphasis should be placed on milk production, draught animals, or a combination of both, thus essentially involving a choice between grade milk animals and Zebu animals, since only Zebu cattle are used for ox-cultivation.

The analysis uses gross margins to determine three alternative feasible farming systems, namely: (1) two dairy cows and crops; (2) one dairy cow, a team of two oxen and crops; (3) crops alone (no livestock). The dairy enterprise is based on a grade milk animal. Alternatives (1) and (2) are based on family labour only, but alternative (3) is based on (a) family labour only and (b) family labour plus a maximum of one casual labourer as required.

Conclusions and recommendations of the study are: (1) if family labour only is employed, livestock should be kept regardless of whether major emphasis is on dairying (2 cows) or oxen (1 pair + 1 cow mainly for subsistence), because cash income is about the same with 2

grade cows or with one grade cow and a pair of oxen, both with crops, and this is all that can be kept on a typical farm under a rotational grass ley system if food needs are met totally from the farm. (2) if a moderate amount of casual labour is hired (total of 61 man-days per year), then it would be equally profitable to grow crops alone within a framework of uncertainty about how best to value milk to family, provided continuous cropping is compatible with Siaya soils.

A C K N O W L E G M E N T S

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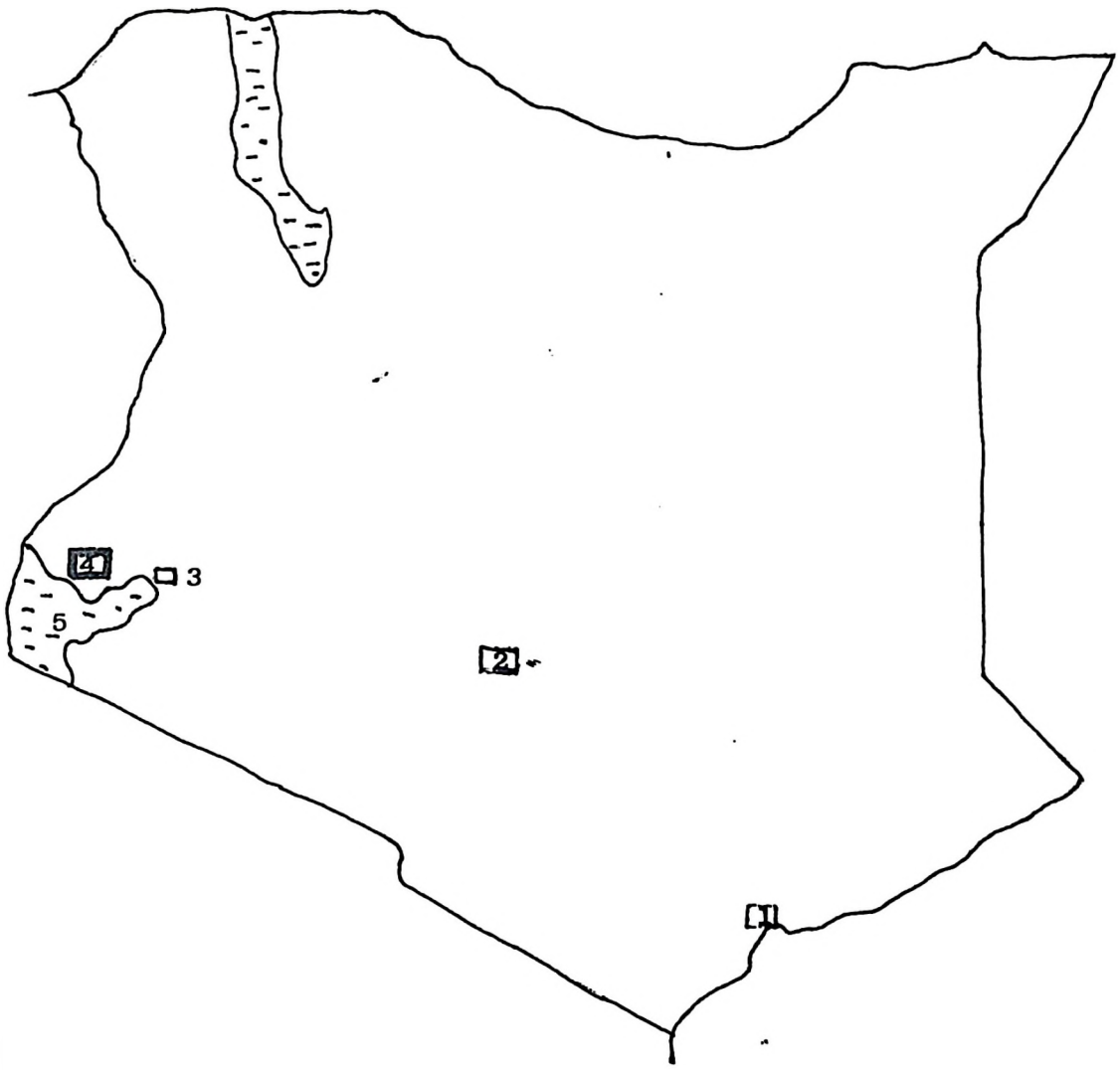
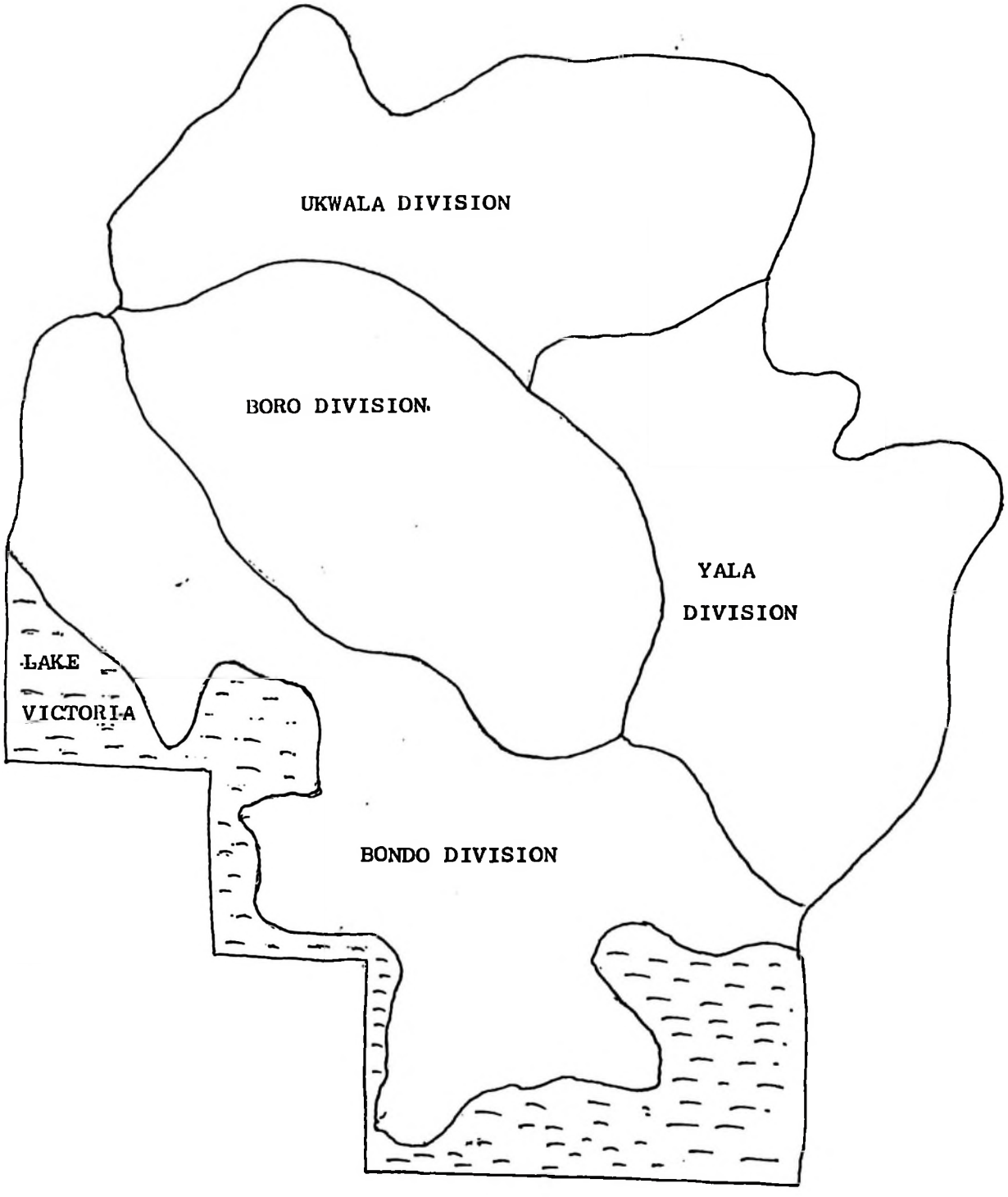


KEY

1 Mombasa
2 Nairobi
3 Kisumu
4 Siaya District
5 Lake Victoria

A ROUGH SKETCH OF SIAYA DISTRICT



CHAPTER 1. INTRODUCTION AND OBJECTIVES

1.1. Livestock As An Agricultural Enterprise

Livestock plays a major role in many developing economies where agriculture makes a significant contribution to the gross domestic product. In monetary terms, meat and meat products, dairy products, wool, and hides and skins fetch substantial income in both internal and external markets. In subsistence economies, livestock supplies milk, meat and blood for food and hides and skins for home use. For example, a report by the International Bank of Reconstruction and Development (IBRD, 1973) points out that in Kenya, in 1970, 75 percent of the milk and 80 percent of the beef were consumed within the farmstead. Besides the above, the role of animal manures in maintaing soil fertility cannot be over emphasised. Lastly, ox-cultivation is the most highly recommended intermediate technology package in developing countries. It eases labour constraints and therefore allows timely cultivation especially in areas where the reliable rainfall season is short. Hever, Maitha and Senga (1976, p.190) add that "most small farmers throughout Kenya have some cattle and in nearly all areas it is regarded as a sign of poverty to be entirely without cattle". The same is true for most parts of Africa.

1.1.1. Livestock in Africa

Makings (1967) indicate that no aspect of potential

agricultural production has so far been more neglected than has the cattle industry in those areas of Africa suitable for cattle. He noted several reasons for this, namely: (1) at the subsistence stage, the productive energy of the people is almost wholly devoted to food crop supply, and cattle are kept merely as a sign of wealth and only used occasionally. This may partly explain tribal attitudes towards cattle, in which they are regarded as a store of wealth and a source of prestige; (2) moreover, during the subsistence era, drought conditions, diseases, and depredation by carnivores and raiders subjected cattle to heavy losses; (3) in the early stages of colonial administration, the efforts to combat famine and to improve food supplies generally were focused on cropping, and when attention turned to cattle production, intractable problems were encountered. Any general improvement in condition was likely to be offset by overpopulation and overstocking of the improved areas. Progress was therefore slow and difficult. The situation has improved somewhat in recent years, with important studies of livestock underway in some developing countries and some international centres for research on livestock now being established. But, generally, research and development work on livestock has lagged behind that on crops and has not yet reached a level comparable to the potential contribution of livestock to farm and national incomes.

Makings (1967) argued that African farmers entered

and progressed in the market economy largely through crop sales, not merely because advance was more readily stimulated on the basis of annual cropping, but because of the formidable barriers to cattle improvement. To reduce these barriers, large-scale and long-term research programmes are required. Chudleigh and Goldson (1974, p.1) gave similar views by stating that "preliminary discussions with senior officials of the Ministry of Agriculture, Kenya, have indicated that few people disagree with the need for more research work aimed at identifying and investigating problems associated with the small scale dairy farmer in the high and medium potential areas of Kenya".

Makings (1967) further argued that apart from the deeply rooted African attitude to cattle, the main difficulties stem from the communal system of tenure in grazing areas. Improvement in cattle production cannot make headway without the introduction of cattle management and management of grazing areas and both are retarded by the communal tenure system. For example, the individual owner has no control over his cattle while they run in the common herd. He cannot practice simple breeding management functions: breeding is haphazard and protection from pests and diseases is not possible without collaboration. Ruthenberg (1968) mentioned institutional bottlenecks in animal husbandry. He argued that dipping is only useful if all the cattle are dipped.

He added that proper grazing procedures are rewarding only if smallholders consent to them. Makings (1967) emphasised that natural grazings deteriorate unchecked when no one is responsible for their conservation and individual action to improve the position, even if contemplated, would be impracticable. In connection with this factor of tenure, Amann (1973, p.135) concurs, saying "of all the factors that may affect the development of the livestock industry, none is more important than the form of land tenure prevailing in a particular area. While a sound form of land tenure is of great importance for crop production, it is of greater importance for improved livestock production. Livestock improvement depends upon the adoption of improved methods of animal husbandry by the majority of stock owners. These methods necessitate enclosure to control stock movement. This, in turn, facilitates the control of diseases and the development of permanent water supplies".

Makings (1967) added that against this background of communal grazing, there is scarcely any foothold for extension, and in competition with the great need and scope in crop production for scarce services, the cattle industry has suffered as a result. The consequences, according to him, are important and far-reaching. Where cattle ought to be a valuable component of crop production in favourable area, that position has generally failed to materialise. Vast areas where cropping is difficult but conditions are suited for cattle have

remained largely undeveloped. In countries where malnutrition is common, and protein deficiency in the diet is a matter of great concern, a large potential of the meat and milk supply is only partially exploited. Large areas of grazing are poorly used and huge quantities of grain exported from Africa as a continent which might profitably have gone into beef or poultry production. It is in the face of these problems that the cattle industry is gainingwider recognition in development programme all over the world.

1.1.2. Livestock in Kenya

Kenya's agricultural development has been geared much more towards crops than livestock and yet vast areas of the country are more suited to livestock (Heyer, et al, 1976). The IBRD report (1973) points out that only 4 percent of Kenya's land area is used for crop farming and expansion possibilities are extremely limited. Much of the remaining 96 percent of the land area is suitable for grazing livestock and wildlife. It is therefore important to improve livestock resource use as rapidly as possible.

An indicative land breakdown according to rainfall into high, medium, and low livestock - potential areas

is as follows:

Table 1.1. Kenya: Proportion of land areas and of livestock units within rainfall zones

Zone		Land area	Livestock units
Agricultural Potential	Rainfall		
	mm	percent	
High	Over 850	14	56
Medium	600 - 850	10	10
Low	Under 600	76	34

Source: IBRD (1973, p.1. annex 5).

Livestock products contributed, on average, 27 percent of gross market production in Kenya during 1964 - 74. The smallness of this contribution relative to the amount of land available for grazing can therefore be comprehended (Heyer, et al, 1976).

The IBRD report (1973) showed that in areas where animal production is developed, some areas of grazing land are overstocked, with consequent animal malnutrition. This is more pronounced in the medium than in the high or low potential areas. Overstocking has led to steady destruction of land. Heyer, et al. (1976) emphasised that livestock tend to be poorly integrated into the farming system in small-holder areas and yet they are widely kept and they represent an important source of subsistence and cash income even in areas in which crops play a major role.

Recent estimates have put Kenyas cattle herd at about 10 million head, made up of grade dairy cattle, improved commercial beef cattle, and indigenous Zebus. The latter account for about 80 percent of the total herd. The breakdown is shown in table 1.2.

Table 1.2. Kenya: Numbers of cattle of different types on large and small-scale farms

Province	Large-scale farms	Small-scale farms[1]		pastoral areas (Zebu)	Total
	Beef and dairy	Beef and dairy	Zebu		
		1,000 head			
Coast	8	7	275	148	438
North-Eastern	0	0	0	516	516
Central	94	259	185	0	538
Western	1	45	660	0	706
Nyanza	2	22	1,187	0	1,211
Eastern	63	43	1,559	409	2,074
Rift-Valley	605	156	1,371	2,197	4,329

Source: Chudleigh (1974).

1) Includes both settlement farms and small-holder farms

In addition, there are between 9.5 and 10.5 million sheep and goats, 0.5 million camels, and 0.2 million donkeys. The indigenous Zebu are commonly found on most of the pastoral rangelands and have a very low productivity. Dairy cattle, which were mostly owned by large-scale farmers before independence, are now commonly found with small-holders and settlement farmers in the high potential areas of Kenya. (Heyer, et al. 1976) reported that, in general, animal production in the

high potential areas is well developed and significantly commercialised. Further improvements are still possible in these areas but the greatest development potential is in the medium potential area. Overstocking, once considered the "major problem" is nevertheless still a problem in the pastoral areas and in the medium potential areas occupied by cultivators, especially in Baringo, the Kerio Valley, the Kano Plains, Machakos, Kitui, and lower parts of Meru. Establishment of pasture leys, cultivation of fodder crops, fencing, and other improved cultural practices will be needed to increase the carrying capacity of these areas. The IBRD report (1973) points out that until 1963, the grade dairy herd was owned almost entirely by large-scale farmers, but the majority are now owned by small-holders and settlement farms. Two-thirds of these grade dairy herd are in the Central Province, but recently a rapid build up has occurred in the high potential areas of Western Kenya. The report continues to mention that a considerable number of work oxen are kept in Western and Nyanza Provinces.

As a result of the above situation, Kenya produces, according to Heyer, et al. (1976), a wide variety of livestock products. Dairy products, hides and skins, wool, and eggs all contribute significantly to cash incomes. In terms of food supply, beef and dairy produce are the most important livestock products.

Much of the meat trade in the main urban areas is handled by the Kenya Meat Commission (KMC). This is a statutory board, appointed by the Minister for Agriculture, with powers to purchase, process, and supply the urban areas with meat or meat products.

About three-quarters of the country's beef never reaches the market but is consumed in the rural areas. The rest is delivered to the KMC. Deliveries of cattle and calves to KMC for 1969 - 76 are shown in table 1.3.

Table 1.3. Kenya: Deliveries of cattle and calves to KMC, 1969 to date

Year	Deliveries
	1,000 head
1969	185
70	196
71	210
72	199
73	155
74	159
75	134
76	228
77	

Source: Heyer, et al. (1976). Blank indicates that information is not available

The rise in delivery to the KMC in 1976 was stimulated by the increase in price to the producers in June, 1976 and again in October, 1976. The drop during 1973 and 1974 was due to drought conditions and quarantines to combat diseases and probably also a prevailing black

market which offered higher prices than KMC. Accurate data are not readily available on beef passing through the hands of private butchers but this is known to be significant.

There are many reasons for the lack of full development of livestock in Kenya. Heyer, et al. (1976) point out that development and modernisation will depend importantly on the availability of certain basic input supplies and services. A common complaint, even in the high potential areas, is the shortage of high-grade dairy cattle. However, full development of livestock in these areas cannot be undertaken on the basis of currently available high-grade dairy cattle alone. In any case, their prices are prohibitively high for many farmers. A more meaningful compromise in some areas is the upgrading of the existing stock through artificial insemination (AI) and improved husbandry and disease control, and some of this is already taking place.

Heyer, et al. (1976) again point out that marketing difficulties, too, have hampered the development of the livestock industry. Marketing organisations like the KMC and the Kenya Cooperative Creameries (KCC) enjoy monopoly powers in at least some aspects of their respective industries. A number of the marketing problems are a consequence of these monopoly powers and the vulnerability of these organisations to beaurocratic and political intervention.

Heyer, et al. (1976) further argue that since research and development efforts in animal production are widely scattered, some amount of reorganisation appears necessary in order to speed up progress. Current efforts do not seem to pay enough attention to the development of livestock other than cattle. For example, almost all the goat population in Kenya is of the local unimproved type and yet little is being done to improve it despite a sizeable domestic market for goat meat. Development of the goat industry is likely to complement the beef industry which currently supplies beef for the local and export markets. Goat meat is, in addition, highly demanded in the Middle East. Maro (1977) has advanced similar views in relation to Tanzania.

The Kenya government is, however, currently engaged in several programmes aimed at improving the position of the livestock industry in the country. There is a UNDP - FAO Beef industry development Project with beef research station in Nakuru, whose emphasis is on intensive feeding of cattle in feedlots for the export market. Farmers are also advised on how to plan and operate their own feedlots on a commercial basis. This project is also involved in developing management techniques needed by the industry. Other programmes include the UNDP - FAO Range Management Project, the Range Water Development Project for the Northern-eastern Province, the Kenya National Artificial Insemination Service and the Kenya National Animal Husbandry Research at Naivasha.

1.1.3. Livestock in Siaya District

Siaya District is in Nyanza Province near Lake Victoria and is composed of four Divisions - Ukwala, Bondo, Boro and Yala, all in the medium to high-potential areas.

Over three-quarters of the farmers in the District are small-scale and they operate at a subsistence level. Priorities are focused on food production for their families. The poorest farmers are risk averse and slow at adopting new innovations. The better-off farmers seem more progressive, possibly because risks for them are less critical.

The Research Division, Ministry of Agriculture, and the Department of Economics, Egerton College, cooperated with the International Maize and Wheat Improvement Centre (CIMMYT) in the demonstration of an interdisciplinary farming system in parts of Siaya District. CIMMYT (1977) reported the findings of this study which indicated, amongst other things, that the present system of mixed-farming in Siaya zone is under heavy pressure from increasing population density. This system, involving draught and milk animals and the use of manure and the feeding of maize and sorghum stalks to livestock, has been in operation for many years.

Population pressure has had two major consequences, namely, there is no longer the possibility of maintaining the soil fertility by allowing land under fallow,

and secondly, the arable area has grown at the expense of grazing, reducing the livestock carrying-capacity of the remaining land. This has had the effect of reducing cattle numbers on Siaya farms. Falling numbers of cattle in general and draught animals in particular have two disturbing effects on future development of the farming system, Firstly, the use of manure and grass as a rotation crop as alternatives to shifting cultivation for maintaining the soil fertility is jeopardised. Secondly, there are labour constraints especially in the areas where rainfall is short lived so that timeliness of cultivation and planting are critical. Milk as a source of protein for the family is also eliminated. In summary, many of the benefits acruing from mixed-farming are lost. Ruthenberg (1976) observes that in situations where short fallow systems replace long fallow systems, there is a tendency for farmers to reduce numbers of animals kept.

1.2. Objectives Of The Study

The increasing population density has adverse effects on livestock production. In their report, CIMMYT (1977) particularly emphasized that the productive investments into which surpluses are channelled in the Siaya zone

are cattle and an ox-plough as assets, the hire of labour or machinery, and the purchase of improved seeds and fertilizers. Evidence from their survey strongly suggests that a run down in assets is taking place. Cattle numbers and the number of farmers owning ox-ploughs are falling. This is most probably caused by pressures on grazing land, arising due to increasing arable requirements and the contingency demand for cash for major household expenditures met by the sale of animals. Cattle number on their surveyed farms have fallen from an estimated 862 five years ago to 688 head in August, 1976, a 20 percent reduction. The average herd size has dropped from 11.3 to 8.4 head per owner[1)].

From this background, two principle questions need to be answered and are shown below as the objectives of the study.

1.2.1. The first objective

This is to examine whether the scarce land in the District should continue to be used for livestock enterprises. The major question to be answered is whether

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1) The survey for this thesis one year later indicates an average of 7.6 head per owner, suggesting that the drop still continues

to preserve the livestock by integrating it more closely with the cropping system or to accept the trend and ensure an efficient use of arable land without a livestock component.

1.2.2. The second objective

If it is accepted that the scarce land in the District should continue to be used for livestock enterprises, then the second objective is to examine whether emphasis should be placed on milk production, draught animals, or a combination of both. This will essentially require the farmers to make a choice between grade milk animals and the Zebu animals, since the Zebu are the only ones used for ox-power.

1.3. Description Of The Study Area

1.3.1. Location

The two Divisions of Siaya District where field-work for this study was undertaken are Ukwala and Bondo. Both are adjacent to Lake Victoria and are 60 km West of Kisumu. The latter is a port on Lake Victoria, and nearly 350 km North-West of Nairobi (See the Kenya map attached).

1.3.2. Rainfall

Rainfall declines from 2000 mm per annum in the

North and North-east to 1500 mm per annum in the South of the District. The number of humid months also drops from 11 to 10 months respectively. As the number of humid months drops to 10 or lower, two clear seasons - the long rains and short rains - can be distinguished. This bimodality continues in the South and West up to a point where the short rains becomes so short as to be useless in terms of crop production.

CIMMYT (1977) reported that there are no East African Meteorological Grade I Stations in Siaya District. They, therefore, made use of the records held at the Siaya District Divisional level in the Ministry of Agriculture to construct table 1.4 which shows the monthly averages of pooled data for sites and years for Bondo (939 mm annually), Boro (1225 mm annually), and Ukwala (1472 mm annually)

Table 1.4. Siaya District. Monthly average rainfall over many years for specified Divisions

Division	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
						mm						
Bondo	42	54	89	195	139	44	55	75	68	62	88	36
Boro	47	51	150	180	107	102	89	81	100	122	100	30
Ukwala	53	30	111	262	203	113	113	80	139	132	179	33

Source: CIMMYT (1977, p.4).

The table demonstrates a marked similarity in rainfall patterns of the three Divisions but a marked disparity in levels. Of particular interest are the differences in amount and distribution in the periods February to June and August to November, the long and short rainy seasons respectiverly. Reliability of rain during the cropping season, closely correlated with the reliability of production levels, is of vital importance to small farmers dependent on the farm for staple food supplies.

1.3.3. Soils

Little information is available on the soils of Siaya District. CIMMYT (1977) observed that soils within the District are generally more fertile in the North and East, becoming a more variable mixture of sands with blacker, heavier soils in the bottom lands in the South and West. Hard pan areas and the low-lying black soil areas are left uncultivated. Soils do not vary enough over the District to influence crop potential. Hence the slight differences in cropping patterns across the District cannot be attributed to soil variations.

1.3.4. Crops

Maize is the major staple food and is a locally-important cash crop. Other important crops are sorghum, cassava, beans, finger-millet, cotton, sweet potatoes,

cowpeas, and groundnuts. Minor crops include green-gram and simsim. A high proportion of farmers grow bananas, cabbages, and other vegetables.

1.3.5. Communication system

The District is bounded along the east and north side by the main bitumenised road from Kisumu to Busia. A good network of all-weather murram roads run over the District, joining the many minor settlements and markets. The network of roads is correlated with the density of the population and frequency of markets. It is less developed south of Bondo in the less densely-populated area of the District.

1.3.6. Markets

The District has a network of local markets which are well patronised by farmers. The majority of transactions are between farmers. Each minor settlement has its own market and market days. Beyond these transactions, the main marketing channel for crops above local needs is the Siaya District Cooperative Union. Originally a cotton-buying organisation, it now buys a range of products, acting as purchasing agent for the Maize and Produce Board. The Cooperative has Produce Buying Stores at 19 of the local markets throughout the District. Maize and beans are the most dominant

food crops handled by the Cooperative. There are 22 dairy producer groups in the District. Most of their sales are made locally, and none of the milk is sold to KCC. Meat is marketed in the minor settlements and is slaughtered locally. Animals sold by local farmers are supplemented by the import of animals from other Districts.

1.3.7. Population

The District had a population of 383,000 based on the 1969 Census in an area of 2,535 Km^2, giving an average density of 151 persons per km^2. The population density varies from 27 to 500 persons per km^2. CIMMYT (1977) reported however that 60 percent of the sub-locations in the District had population densities between 130 and 260 persons per km^2. It is estimated that 90 percent of the population depend on farming as their major source of livelihood. Assuming population growth of the order of 3 percent per annum since 1969, and using the CIMMYT data with an average of 7.4 persons per household, an estimate of some 57,000 farm families in the District is obtained with an average land area of 4.2 to 4.6 ha each and supporting over 420,000 people. Average population density in 1978 is approaching 185 persons per km^2. The area is mainly populated by

the Luo, other tribes being employees in towns and minor settlements of the District. Origins and social traditions are homogeneous throughout the District.

CHAPTER 2. REVIEW OF LITERATURE

Scoville (1976) described the role of livestock, and identified the physical, biological, economic, and other limitations on improvement of livestock enterprises, especially for smallholders. He observed that livestock are a crucial component to improve smallholder agriculture and essential to improving nutrition in future. He recommended, among other things, that for any livestock improvement project to succeed the following aspects must be taken into account: people to be served by livestock projects must be involved in planning and implementation; Market development must be part of project development; Adequate feed supplies must be ensured; Much useful technology is already available, but simple, easy-to-use packages of workeable technologies must be devised; Access to capital must be improved; Programmes should be location specific, that is, geared to the problems at the site of action; Appropriate training at all levels must be devised and applied to ensure project success; Communication within projects and among project leaders must be improved; More well-planned pilot programmes and more analysis of existing projects are needed; Smallholder development programmes cannot succeed without adequate government committment and supporting policies.

Smith (1977) critically viewed the future of livestock in developing countries and warned that development of livestock production in these countries should

not necessarily follow developments in the West. In particular, capital and energy-intensive systems of production should be avoided. Attempts to change traditional systems should proceed with caution and lessons should be learnt from past mistakes. He noted with concern that the developing world is littered with livestock production improvement schemes, that have either been only partially successful, or positively harmful, resulting in disruption of traditional ways of life, and in some cases, the destruction of environment by overgrazing. Finally, he added that systems should be developed such that they are fully integrated with crop production and should increase rather than decrease the total amount of food for human consumption. This was, in effect, a recommendation of mixed-farming systems.

Zalla (1974) investigated economic and nutritional aspects of smallholder milk production in a coffee-banana zone in northern Tanzania. He observed that cattle numbers were falling in this area as a result of population pressure on the land and continued expansion of coffee production at the expense of grazing lands. The situation led to nutritional problems of both cattle and humans, reduction in per capita milk production, increase in calving intervals, and a decline in meat consumption. As a result, the government reacted by providing intensive medium grade-dairy animals and semen both for maintaining the genetic quality of grade cattle already owned as well as upgrading Zebu cattle.

Zalla concluded that the general downtrend in milk production in this area was due to land, labour, capital, and political constraints.

Merinar (1973) examined an intensive smallholder dairy farming system in Uganda. The study, based on a smallholder dairy farming came to the following conclusions: (1) to maximise output and profits, each cow must be fed by one individual; (2) good pastures are the key to economic feeding; (3) successful calf rearing programme is vital for development of a high-yielding herd and; (4) the best returns can be obtained only if, among other things, high quality pastures, accurate concentrate feeding, proper disease control, good quality animals, and proper management aspects are taken into account.

Chudleigh (1976) classified and described small-scale dairy production systems in the high potential areas of Kenya. The study was designed to link such classifications and descriptions to the formation of priorities for improvement, more particularly by way of research in pasture and fodder production. He stated strongly that before animal production systems can be improved, existing systems of production must be fully defined and understood.

Bassel and Daplyn (1976) examined dairying in Zambia. The study observed that this enterprise had been in steady decline since 1964 due to low level of

technical efficiency, which was caused by unfavourable economic circumstances, for example, the long gaps between producer price rises in 1968, 1969, and 1976. Competition from other agricultural enterprises for management time and skills was a further factor contributing to dairy production inefficiency. The study recommended that in order to restore the dairy industry to an acceptable average standard of technical efficiency, stress should be laid on economic incentives and extension advice.

Lutke-Entrup (1971) examined the limitations and possibilities of increasing market production of peasant cattle owners in Western Province, Zambia. This was an area of traditional cattle husbandry from both the natural and socio-economic points of view. The study described the peasant cattle husbandry of the Province, analysed the obstacles which hinder a market-oriented cattle industry, and pointed out the possibilities of increasing production for the market. The study observed that: (1) the average age of cattle owners in the province was 60 years; (2) cattle play an important role in the subsistence agriculture of the Province; (3) in addition to their function as suppliers of manure and milk, the socio-economic function of the cattle, for instance, saving purposes and old age security, limit their market availability; (4) the state of production techniques was also a limiting factor; (5) finally, on the average,

the cash income out of cattle sales by all interviewed cattle owners amounted to only 16 percent of total cash income.

Wagner (1968) conducted a comprehensive survey of dairy farming in Ethiopia. He observed that this industry was largely operating at a subsistence level. The study concluded that milk was usually obtained from low-yielding native cattle, and the need for improvement was emphasised in order to meet domestic needs as well as raising the farmers income.

Girod (1977) discussed the concepts of Gross Margin as a tool in farm management. The study investigated the problems involved in investing in large herds without adequate preparation. He observed that although income per labour unit increases with herd size, there can be wide variations in income for the same herd size depending on whether the farm is established on a sound technical and financial basis. He concluded that annual milk production per ha is a decisive technical criterion which in turn affects the economic criterion - gross margin per ha.

Broster and Gibbons (1970) discussed systems of feeding of dairy cow. They criticized the rule of thumb system of assessing a cow's feed requirement mainly on the basis of current milk yield and suggested an alternative approach which considers long-term nutrient requirements and utilization over the total lactation

period and prevailing milk and feed prices. They concluded that, regardless of the system of feeding, there are four vital profit factors: (1) bringing the cow to the maximum potential yield in early lactation; (2) economizing judiciously on concentrates in mid-lactations; (3) ensuring recovery of body condition by the next lactation and (4) use of good roughages.

Armero, et al. (1975) studied the economic and administrative situation of a group of milk producers in Mexico. The study observed that resources were inefficiently managed, costs were generally high owing to fodder production problems and poor management, and depreciation was not often taken into account. It concluded that producers should employ simple accounting methods to assess their situation.

Kitsopanidis (1970) investigated the economics of milk production in Greece. In his analysis, using statistics, production functions, and linear programming, he showed that milk yield was related to source of feed. He found that the dairy farm business may become a profitable and competitive one when it depends on dairy cows of high milk yield and home-grown feed.

Silva, et al. (1976) compared natural cattle breeding and artificial insemination in Argentina. They concluded that at the present price of bulls, and with some conception rates, it is more profitable to use artificial insemination.

CHAPTER 3. METHODOLOGY

3.1. Pilot Survey

A pilot survey preceeded the full-scale field-work. A tentative questionnaire was drawn up and pretested on 8 selected farmers in the District. After adjusting certain questions, a final questionnaire was drawn up for the field-work. The latter contained both open-ended and closed-type questions. Most of these questions related to the problems and strategies for farming under conditions of increasing land scarcity.

3.2. Sampling Procedure

A sampling frame could not be obtained from Siaya District Agricultural Office as early as required. The District Agricultural Officer (DAO) instead advised that the land register be used. A weakness was however discovered in the land registry system in that some farmers registered their land for loan requisition purposes only and were less interested in farming. Other farmers had been away from their farms for the last five years or so (probably employed in urban areas). A fresh sampling frame had therefore to be compiled. In the process, the Assistant Agricultural Officers (AAO's) heading the two Divisions in question, that is, Ukwala and Bondo, were consulted and requested to do a quick census[2] of farmers in their respective Divisions.

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2) Conducted in November, 1977

They did this by relaying the information to their Junior Agricultural Assistants (JAA's). The latter are normally the agricultural officers who are in close contact with farmers at the village level. With their help, a list of 850 farmers was compiled in two weeks and this was considered adequate. To avoid any bias in selection of the farmers during the census, the JAA's were to pick the farmers at random. The JAA's were then contacted to assist in locating the farmers in the sample.

3.3. Field-work

During the interviews, every effort was made to convince the farmers of the value and nature of the survey. They were asked a wide variety of questions, and memory recall was the basis for most of the information collected. In those cases where a farmer could not recall specific details of operation which were relevant to the study, for example, labour inputs, incomes and expenditures, and consumption, the averages over a period of time (based mainly on the farmers guess) were used. In situations where it was found that a farmer had a clear picture of the location and boundaries of his plots under cultivation and fallow during the year (1977), but could not convert them to acres or hectares, an estimate of the farm size was obtained from a casual walk around the farm. This was later cross checked with the land register.

Secondly data were collected from various departments in the District.

CHAPTER 4. SURVEY RESULTS AND ANALYSIS OF DATA

4.1. Siaya As a Typical Mixed - Farming District

4.1.1. Production resources

Production resources are discussed under land, labour, capital, and management. Both the quality and quantity of these resources vary from place to place within the District and may therefore form different constraints on the types of change in the farming technique that can be adopted. Different farmers may therefore make different decisions based on these aspects of their resources. In general, averages for all sample farms are discussed here.

4.1.1.1. Land - The land covered by the survey lies in the medium to high-potential zone of Nyanza Province. This classification is based largely on the quantities of rainfall per annum (IBRD, 1973, p.1, annex 5). Pooled annual rainfall in the District is 1200 mm (CIMMYT, 1977). Within the District, rainfall varies from 2000 mm to 900 mm.

Land adjudication has been completed in most parts of the District. The sample survey (1977/78) indicated that 98 percent of the farms had been adjudicated (consolidated). The average arable farm size was 4.5 ha per family.[3] The combined effect of land adjudication

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3) Excludes homestead and paths.

and high population densities has been a reduction in sizes of farms. This has serious repercussions on shifting cultivation as a fertility-maintenance technique in Siaya District. The arable area has also grown at the expense of grazing, reducing the total livestock carrying-capacity of the remaining grazing land. This situation is threatening the position of the "Mixed Farming" system which has been established for many years in the District. The system involved draught animals, the use of animal manure and milk, and the feeding of sorghum and maize stalks to livestock. Traditionally, the cattle that have been involved in the system are Zebu type. The latter have evolved with extensive management methods involving large areas of communal grazing, where grazing land and drinking points were free to all communities. Communal grazing, however, raises its own special problems since under this system it is difficult to improve livestock or grassland. In the first place it is hard to keep cattle from straying too far and even from trampling on adjacent cultivated land, so many people spend their days herding livestock and trying to keep them where they belong, seldom with complete success. Secondly, many common lands, particularly those near watering points, are overgrazed. Eventually the grass cover may be destroyed and erosion results. Because the land is free to all, no one has an individual incentive to limit the number of animals he turns on to it, to attempt to maintain

or improve the grazing, or to provide more watering facilities. Finally progressive farmers who want to improve their own animals cannot do so as long as their stock graze together in a common herd. They cannot control diseases, nor can they control breeding so as to improve their herds. As population increases and land adjudication progresses, people fence their lands as they acquire a sense of security. This reduces common grazing land and people with large herds are forced to dispose of them.

4.1.1.2. Labour - Farm labour is supplied mainly by the family, supplemented with hired labour, the latter composed of casual and permanent types. Casual labour is employed at periods when the workload is heavy. These periods occur mainly from March to May and from August to October. Many farmers hire labour for planting and weeding in areas with low population density, especially where most farmers own and operate ox-ploughs and cultivate larger areas. The same applies during harvesting periods. The sample survey (1977/78) showed that 92 percent of the sampled farmers were employing casual labour. The remaining 8 percent reported that they had no money for hiring. In addition, 40 percent of the farmers employed permanent labour. It is interesting to note that the farmers who had a lower active family population in relation to total family population employed a higher number of permanent workers as shown in table 4.1.

Table 4.1. Sample farms: Active family population as a percent of total family population as it affects hiring of permanent labour[1].

Item	Unit	Active family population in relation to total family population (percent)			
		10-30	31-50	51-70	71-100
Households:					
Total	percent	18	48	18	16
Hiring permanent labour	"	14	16	6	2
Permanent labour	No	15	20	4	1

Source: Sample survey (1977/78).

1) Active family members are those who contribute to family income by labour in some way.

About two-thirds of the households (18 + 48 percent) have a ratio of active to total family population below 50 percent. They hire a total of 35 permanent workers compared to those who are above 50 percent and employ only 5 permanent workers.

4.1.1.3. Capital - Capital is related to income levels. Higher income groups have higher cash surpluses for re-investment. CIMMYT (1977) investigated the different sources of income as shown in table 4.2.

Table 4.2. Siaya Zone: Farmers reporting specific sources of family income

Source of income	Farmers
	No
Sales:	
Crops	98
Livestock	27
Milk	19
From relatives:	
Occasionally	45
Regularly	14
Hire out ox-ploughs	19
Temporary off-farm work	14

Source: CIMMYT (1977).

Out of their 120 farms sampled, 80 percent reported a dependence on crop sales, mainly of food crops in the local markets.

4.1.1.4. Management - Management is a coordinating resource provided, in most cases, by the farmer himself. He works within the natural and economic circumstances of the area and within the constraints of the other resources to satisfy his family's needs and priorities. Evaluation of the management strategies of the farmer therefore depends on identification of his objectives and priorities.

4.1.2. Farm enterprises

4.1.2.1. Crops - The District Annual Report (1976) lists the following as the notable crops in the District:

Food crops include maize, sorghum, beans, groundnuts, cassava, finger-millet, green-grams, simsim, rice, sweet potatoes, and horticultural crops, that is, fruits and vegetables. The fruits are oranges, lemons, guava, bananas, mangoes, and pawpaw. The vegetables are kales, cabbages, cowpeas, carrots, onions, and tomatoes. Mulberry trees are also available in some places. Commercial crops include cotton, sugarcane, coffee, sunflower, and sisal, the latter mainly hedge planted at farm boundaries.

The cropping pattern in the District is fairly homogeneous, although there are localised specialities. Crops are grown in both the long and short rains. The difference in yields of crops in areas with similar climatic circumstances therefore depend on the farmer's managerial ability and other production factors such as local variations in rainfall, diseases, and insect attacks.

4.1.2.2. Livestock - Types of livestock in the area include Zebu and grade dairy cattle, sheep, goats, poultry, and rabbits. Bees are also kept to some extent. Estimated numbers of these livestock are shown in table 4.3.

Table 4.3. Siaya District: Quantity and types of livestock

Livestock type	Year	
	1976	1977
	No	
Zebu cattle	180,000	
Grade dairy cattle	850	930
Goats	67,600	
Sheep	64,400	
Pigs		650
Poultry	5,800	10,240
Rabbits		242
Bees (no. of hives)	350	450

Source: District Annual Report (1977).
Blanks indicate that information is not available.

4.2. Decision-Making Circumstances In Siaya District

Farm Management factors that face the farmer as a decision-maker are: (1) the high variability of rainfall and relatively short crop-growing seasons; (2) population growth, which is breaking down the effectiveness of shifting cultivation, and creating competition for land between use for arable and for grazing; (3) adjudication, a practice which is reinforcing the effects of population growth and also creating individual responsibilities for grazing management; (4) wide seasonal fluctuations in selling and buying prices for foodstuffs, particularly starch staples in the local markets; (5) falling soil fertility; (6) capital scarcity and a running down of numbers of oxen and ploughs as capital assets; and (7) labour shortage in peak periods.

Based on factors (2), (3) and (6), farmers in the sample survey (=977/78) were asked whether they would like to continue to keep cattle on their farms or would like to grow crops alone, thus essentially requiring a choice between mixed-farming and crop farming. Of the sampled farmers, 94 percent indicated that they prefer mixed-farming. The choice of type of farming in relation to total farm land is shown in table 4.4.

Table 4.4. Sample farms: Effect of size of farm on the choice of type of farming

Total land	Type of farming	
	Mixed	Crops only
Ha	Percent	
1 - 5	68	6
5.1 - 10	12	0
10.1 - 15	14	0
Total	94	6

Source: Sample survey (1977/78).

It is interesting to note that mixed-farming was chosen predominantly regardless of size of farm. The higher figure appearing in the first group only implies that a majority of the sampled farms ranged from 1-5 ha.

4.3. Factors Relating To The Future Of Livestock On Siaya Farms, Including Training and Extension

As indicated in table 4.3, almost all cattle on Siaya farms are Zebus. The sample survey (1977/78) indicated that 62 percent of the sampled farmers own Zebu cattle, 4 percent own grade dairy cattle, 6 percent own a mixture of these, and 28 percent do not own any cattle. However, the Annual Report (1977) points out that Zebu cattle are a minor enterprise in the District. This remark likely refers to their low milk-production potential.

But although the sampled farmers in the District expressed a desire to continue to keep cattle on their farms, evidence from section 1.2 (p.13) shows that the cattle are fading out. Factors relating to the future of cattle on Siaya farms are therefore examined in various sections of this chapter.

4.3.1. Land adjudication as it affects livestock preferences

In section 4.2, land adjudication was mentioned as one of the decision-making factors in the District, in as far as it affects individual farm-land sizes. Table 4.5 examines the effect of land-size changes on number of cattle.

Table 4.5. Sample farms: Effect of land-size changes on numbers of cattle

Land-size change[1]	Cattle change		Total[2]	Proportion reducing cattle numbers[3]
	Reduced	Increased		
	No of farmers			
Reduced	17	3	20	0.85
Increase	14	4	18	.78
No change	4	3	7	.57

Source: Sample survey (1977/78).

1) Change in size after land adjudication.
2) Totals do not add to 50 because for 5 farmers change could not be determined.
3) First data column divided by last data column.

The table illustrates that most farmers are reducing cattle numbers. As shown by the last column, a slightly larger proportion of the farmers with reduced land also reduced their cattle, but application of a chi-square test indicates a relation which is not statistically significant.

The choice between the Zebu and grade dairy animals heavily depends on the way the farmers perceive these animals, particularly with regard to their suitability to the local environment. While all the farmers in Siaya have a perfect knowledge of Zebu animals, the grade milk animal is a new innovation to them. Their courage to adopt this innovation will therefore be influenced by the success or failure of the early adopters. This fact was realised and, in the sample survey (1977/78), farmers were asked if any of their neighbours were keeping

grade dairy animals. Of the farmers reporting, 42 percent had neighbours with grade animals, most of which were Gurnseys, Jerseys, Ayshires, or crosses. In light of the above, the major question in the second objective, which was designed to examine whether future emphasis should be placed on grade milk animals, Zebu animals, or a combination of both, was asked. Farmers in the survey were therefore asked to clarify their choices. Of the farmers who preferred mixed-farming 70 percent indicated that they prefer to adopt the grade dairy animals. Others preferred the Zebu animals. The latter therefore constitute a category of farmers who think in terms of ox-cultivation, milk, meat, and blood as traditional foods from the Zebu cattle, and also social factors like paying bride-price. On the ox-cultivation issue, the sample survey (1977/78) indicated that 60 percent of the farmers relied on hired ox-ploughs, 26 percent had their own, and the remaining 14 percent neither owned, hired, nor used them. Table 4.6 shows the relationship between availability of ox-ploughs (hired or owned) and the percent of land cultivated by oxen.

Table 4.6. Sample farms: Relation between availability of ox-ploughs and percent of land cultivated by oxen

Availability of ox-ploughs	percent of land cultivated by oxen		Total[1]	Ratio of 1st to last column
	10-50	51-100		
	percent			
Owned	14	12	26	0.54
Hired	36	24	60	.60

Source: Sample survey (1977/78).

1) Totals do not add to 100 percent because 14 percent neither owned, hired, nor used ox-ploughs.

The table was tested by use of a chi-square test, but the relation is not statistically significant. Examination of the percentages under column (10-50) in relation to the totals for the row reveals that the values are nearly the same. Hence the proportion of land ploughed by oxen is not affected much by whether the ox-ploughs are owned or hired.

On the other side of the coin, 70 percent of the farmers preferred to adopt the innovation of owning grade cows. Table 4.7 examines the effect of land-size change on the choice of grade milk animals.

Table 4.7. Sample farms: Effect of land-size change on the choice of grade milk animals

Land-size change	Preferred type of milk animals		Totals[1)]	Proportion preferring grade animals
	Grade	Non-grade		
	No of farmers			
Reduced	17	7	27	0.71
Increased	13	2	15	.87
No change	5	2	7	.71

Source: Sample survey (1977/78).

1) Four farmers are excluded from totals because change could not be determined.

A chi-square test was applied to the table indicating a relation which is not statistically significant. Examination of the data reveals a slightly stronger preference by those with increased land for grade cattle than by the other groups.

4.3.2. Age of farmers

Most of the farmers interviewed were aged between 20 and 70 years. Due to the common belief that aged farmers are traditional in their outlook and resistant to change, the age factor was tested against the choice of a grade milk animal in table 4.8.

Examination of the data reveals that the middle aged group has the strongest preference for grade cattle but a chi-square test indicates that the difference is not statistically significant.

Table 4.8. Sample farms: Effect of age of farmers on the choice of grade milk animals

Age of Farmers	Preferred type		Totals	Proportion preferring grade milk animals
	Grade	Non-grade		
Years	Percent			
20-40	14	8	22	0.64
41-60	42	16	58	.72
61-80	12	8	20	.60

Source: Sample survey (1977/78).

4.3.3. Extension and training of farmers

Agricultural training and extension are the two major non-formal education systems used in Kenya to educate farmers. Extension particularly is designed to bring about desirable changes in farmers' behaviour which will contribute to better farming. For this reason, Clayton (1964) recommends proper training for agricultural instructors as follows: "It is recognised that planned farmers require a regular and constant follow-up with advice, guidance, and supervision. And for this, agricultural instructors must be fully trained and regularly refreshed" (p.53).

As discussed in section 4.3.1, a majority of Siaya farmers have indicated a strong preference for grade dairy animals, but this is an innovation which may demand much from a Siaya farmer, especially when one appreciates the drastic difference in milk production between the farmers and the District guidelines as indicated by the

sample survey (1977/78). Table 4.9 shows the details of enterprise management computed on the assumption that all labour will be met by the family and permanent workers if there are any.

Table 4.9. Siaya District: Comparison of dairy sample average and the District guidelines based on 1977 prices for a cow and follower

Item	Unit	Production level	
		Sample average 1)	District guidelines 2)
Output:			
Yields	litres	160	1,500
Gross output	Shs	320	3,000
Variable inputs:			
Cow depreciation less calf value 3)	Shs	50	150
Forage establishment	Shs	0	80
Concentrates	Shs	0	88
Veterinary costs, dips, and artificial insemination (AI)	Shs	76	306
Milking utensils 4)	Shs	0	20
Total variable cost	Shs	126	708
Gross margin per cow and follower 5)	Shs	194	2,292

Source: Sample survey (1977/78) and District guidelines (1977).

1) Based on 49 sampled farmers. One farmer was excluded because he had high productive grade milk animals which produced milk above the District average production level.

2) Average production level was used for comparison.

3) The guidelines assumed the price of a cow (grade milk) at Shs.1,500, culling price of Shs.500, and a calf price at Shs.50. The cow was depreciated for 5 years. In contrast, the sample average was based on a price of a Zebu at Shs.800. Other computations are the same for both groups. Livestock depreciation is treated as a variable cost (Upton, 1973, p.233).

4) The guidelines are based on a 10 year depreciation rate. Costs of this were ignored on sample farms because none used sophisticated equipment.

5) Difference of gross output and total variable costs.

The guidelines recommend the use of minerals, good forage, and concentrates. Most of these items were ignored by the sample farmers. The table demonstrates that Siaya farmers have a long way to go in milk production. Clayton (1964, p.53) however admits that "it is demanding too much of a farmer to expect him to follow through an involved rotation, tend an unknown cash crop, master the difficulties of pasture establishment relating to cows unless a proper training and extension is given to the farmers". With this in mind, attention was given to extension and training aspects in the sample survey (1977/78). This was necessary because the keeping of the grade milk animals requires good knowledge of the what records need to be kept, and how to obtain and utilise loans properly. Most of the Kenya government policies on farming are also geared in this direction.

4.3.3.1. Effect of training of farmers on choice of grade milk animals - Table 4.10 shows the relation-between trained and untrained farmers and the choice of grade milk animals.

A chi-square indicates a statistically significant relationship. Examination of the data shows that among the trained farmers, nearly 80 percent prefer grade animals while among the untrained farmers only a half do so. Hence training of farmers is a factor influencing a preference for grade milk animals in the District.

Table 4.10. Sample farm: Effect of training on choice of grade milk animals

Farmer	Preferred type of milk animals		Totals	Proportion preferring grade animals
	Grade	Non-grade		
	No of farmers			
Trained	27	7	34	0.79
Untrained	8	8	16	.50

Source: Sample survey (1977/78).

4.3.3.2. Effect of training of farmers on knowledge of livestock feeds - During the sample survey (1977/78), farmers were asked to name any other livestock feeds apart from the obvious natural grass pastures and familiar fodders like napier grass. The purpose here was to discover whether the farmers have been exposed to feeds like hay, silage, minerals etc., which are important for those who keep grade milk animals. The results obtained were related to training as shown in table 4.11.

Table 4.11. Sample farms: Effect of training on knowledge of non-traditional livestock feeds

Farmer	Know-ledge	Non know-ledge	Totals	Proportion with know-ledge
	No of farmers			
Trained	26	6	32	0.81
Untrained	9	9	18	.50

Source: Sample survey (1977/78).

The table indicates that among the trained farmers, 81 percent had knowledge, but among the untrained farmers only 50 percent did. A chi-square test indicates a statistically significant relationship. Hence training is a factor influencing knowledge of farmers of non-traditional livestock feeds.

4.3.3.3. Effect of training of farmers on record-keeping - Record-keeping, being a major issue in peasant farming, especially in developing economies where most of the peasants are not market oriented, was investigated in the study. It was tested against training as shown in table 4.12.

Table 4.12. Sample farms: Relation between training and record-keeping

Farmer	Record keeping		Totals	Proportion who kept records
	Keepers	Non-keepers		
	No of farmers			
Trained	11	22	33	0.33
Untrained	1	16	17	.06

Source: Sample survey (1977/78).

Among the trained farmers, 33 percent kept records, but among the untrained farmers, only one farmer (6 percent) kept records. A chi-square test indicates a statistically significant relationship. Hence training is a factor influencing record-keeping.

4.3.3.4. Effect of training on reasons for fallowing - All the farmers in the sample indicated that they leave a part of their land under grass fallow during some seasons. The reasons for doing so, however, varied from farmer to farmer. But, for the purpose of this analysis, the reasons were divided into two categories, that is, "good husbandry" and "others". These reasons were related to training as shown in table 4.13.

Table 4.13. Sample farms: Effect of training on reasons for fallowing land

Farmer	Reasons for fallowing		Totals	Proportion who indicated good husbandry
	Good husbandry	Others		
	No of farmers			
Trained	23	11	34	0.68
Untrained	5	11	16	.31

Source: Sample Survey (1977/78).

Among the trained farmers, 68 percent gave their reason as "good husbandry", while among the untrained, only 31 percent gave equivalent reasons. So again training has a part of play.

4.3.3.5. Training frequency and duration - Farmers in the sample were trained for different periods of time, ranging from a few days to several months or years. Some went for training once, and others went repeatedly with breaks in between, or continuously. A number of alternatives are shown in table 4.14.

Table 4.14. Sample farms: Duration and frequency of training

None	Less than 1 week	1 week with no repeat	1 week with at least one repeat	More than 1 week continuous
		No. of farmers		
17	7	10	5	11

Source: Sample survey (1977/78).

In total, 33 farmers out of 50 went for training. Among the trained, most of them went either once for 1 week, or more than 1 week continuously. The situation presented here is that most farmers either went to the training institute and did not discontinue, or went for 1 week only and could not secure another chance after they had discontinued.

4.3.3.6. Effect of extension on loan utilization -

All the farmers in the sample said they were aware of the existence of the extension service in the District. 82 percent indicated that they had had extension contact with agricultural extension officers at one time or another. Extension officers are likely to touch on issues concerned with loans, especially where grade dairy animals are desired and the farmers cannot raise their own money to meet the buying cost of these animals. The effect of extension on loan utilization in Siaya farms is examined in table 4.15.

Table 4.15. Sample farms: Relation between extension contact and loan use

Extension Contact	Loan utilization		Totals	Proportion utilizing loans
	Utilizers	Non-Utilizers		
	No. of farmers			
Full	18	16	34	0.53
Poor	7	9	16	.44

Source: Sample survey (1977/78).

A chi-square test indicates a relationship which is not statistically significant. Thus extension contact has little effect on the use of loans.

4.3.3.7. Effect of extension on record-keeping - A grade dairy animal is likely to be affected in its production by, for instance, underfeeding. Unless daily milk production is recorded, proper feeding rates for concentrates cannot be determined. Extension officers are expected to be concerned about proper record-keeping. The two issues are tested in table 4.16.

Table 4.16. Sample farms: Relation between extension contact and record-keeping

Extension contact	Record Keeping		Totals
	Keepers	Non-keepers	
	No. of farmers		
Full	11	23	34
Poor	0	16	16

Source: Sample survey (1977/78).

A chi-square test indicates a statistically significant relationship. Hence extension contact had impact on record keeping or perhaps those who keep records are more apt to seek extension advice or extension workers may cater more to those who keep records.

4.3.3.8. Effect of extension on training of farmers - Farmers who are often visited by extension officers would be expected to be informed about training programmes. Therefore one might expect that more of this group would be trained. Observations in this area from the sample (1977/78) are shown in table 4.17.

Table 4.17. Sample farms: Relation between extension contact and training of farmers

Extension Contact	Training of farmers		Totals	Proportion trained
	Trained	Untrained		
	No. of farmers			
Full	24	9	33	0.73
Poor	9	8	17	.53

Source: Sample survey (1977/78).

A chi-square test indicates a relationship which is not statistically significant. Extension contact thus apparently has little impact on farmer training, although a larger proportion of those with full extension contacts had been trained..

4.4. Further Details About Survey Farms

Most of the sampled farmers in the District were producing milk below the "average" production level recommended for the District (table 4.9). Out of 49 farmers, 32 reported that they owned cattle. Only 13 percent of these sold some milk, in most cases to the villages near them. The remaining 87 percent had insufficient milk even for their own families. Furthermore the use of variable inputs for milk production, as the table shows, were largely ignored. Only 7 percent of the cattle owners used some minerals, 9 percent used fodders, and 48 percent used veterinary, artificial insemination, and dipping facilities.

Farmers in the survey had an average of 5 milking cows, each producing an average of 2.6 litres of milk per day[4]. Assuming the standard lactation period of 305 days was attainable, the annual milk production per cow was 160 litres. The average land area left for grazing was 3.5 ha and this carried an average total of 7.4 head, giving an average stocking density of 0.5 ha per head[5].

Capital was restricted to credit facilities available in the District and the non-farm sources of income mentioned in table 4.2. Agricultural Finance Corporation (AFC) is the major credit agent for the Siaya farmers who need loans.

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4) Most cows were the Zebu type, with a few crosses.

5) The District recommended stocking density was 0.8 ha per head based on grade milk animals and ley pastures.

4.5. Background Information in Relation To Farming Systems

4.5.1. Farm enterprises considered

4.5.1.1. Crops - Section 4.1.2.1 mentions a range of crops that can be grown in the District. Although sugarcane and tomatoes have higher gross margins per ha than most of the crops mentioned, only cotton, maize, beans, and sunflowers are covered under the farm plan to be discussed because they are the only familiar crops in Siaya which can be easily marketed. Their gross margins per ha follow each other in magnitude. Among the selected crops, maize and cotton are considered only in the long-rains, and sunflowers and beans in the short-rains. Some beans are however interplanted with long-rains maize, so this intercrop also is considered. The reasons for these choices are: (1) maize is based on a hybrid variety that cannot be grown during the short-rains due to lack of sufficient rainfall; (2) CIMMYT (1977, p.29) recommends cotton in the long-rains only saying "short-rains cotton planting in Siaya is not justified because the dry period from December to February is too long"; (3) sunflowers are recommended in the short-rains by Acland (1971, p.202) and (4) beans are considered in the short-rains because, for agronomic reasons, it is the best crop that can be rotated within years with cotton. Beans, intercropped with maize in the long-rains, raise the total gross margin per ha and, being legumes, help to maintain the soil nitrogen.

4.5.1.2. Livestock - Grade dairy cattle are considered in the plan as a source of milk both for subsistence and sale. Zebu cattle are considered as a source of ox-power for land preparation. These are the only livestock that compete significantly for the resources covered by the farm plans.

4.5.2. Monthly labour requirements by enterprises

Livestock require constant labour per animal per month throughout the year whereas crops vary in their requirements per ha per month depending on what activities take place in which month. Monthly labour requirements by enterprises considered in the plan are shown in table 4.18.

As shown in the table, the work peak for maize/beans occurs in August when maize is being harvested, for cotton in March at planting, for sunflower during weeding in September, and for beans during weeding in October, harvesting in December. It is only at the peak periods that labour becomes critical.

Table 4.18. Siaya District: Monthly labour requirements for specified enterprises

Month	Dairy [1]	per ha				Oxen [2]
		Long-rains crops		Short-rains crops		
		Maize/beans	Cotton	Sunflower	Beans	
		Man-hours				
January	40	0	0	0	0	30
February	40	0	0	0	0	30
March	40	56	360	0	0	30
April	40	90	240	0	0	30
May	40	90	240	0	0	30
June	40	90	0	0	0	30
July	40	0	0	0	0	30
August	40	150	210	72	0	30
September	40	0	0	180	90	30
October	40	0	0	0	120	30
November	40	0	0	0	0	30
December	40	0	0	120	120	30

Source: District guidelines (1977), and Ministry of Agriculture National guidelines (1974) but adapted for Siaya in terms of working hours per day.

1) Requirement for a cow/follower which require 0.8 ha of ley

2) A pair of oxen requires 1 ha for the pair.

4.5.3. Subsistence requirements for maize, beans and milk

According to the Flannel Board, Kericho (1974), persons above 16 years are each equivalent to 1 subsistence unit. A child under 16 years is considered as half a subsistence unit. A subsistence unit requires 180 kg of maize, 45 kg of beans, and 150 kg of milk per year in addition to minor foods not considered here. The total subsistence units for an average sample family are shown in table 4.19.

Table 4.19. Sample farms: Computation of subsistence Units

Family component	Persons per farm	Subsistence units
Man	1	1
Women	2	2
Children (16-20)	2	2
Children (under 16)	4	2
Total	-	7

Source: Sample survey (1977/78).

The 7 subsistence units require a total of 1260 kg of maize, 315 kg of beans, and 1050 kg of milk per year for subsistence. Low yields for crops in the District were used to assure that subsistence needs would be met in most years. In a normal year, some would be available for sale from the subsistence hectares but this would be uniform for all plans. For the cow, however, average District yields were assumed. Requirements for subsistence are as shown in table 4.20.

For the plans without a cow, the cost of obtaining milk by purchase is deducted from the gross revenue for crops. This is somewhat misleading, however, because farmers without a cow likely would replace most of the nutrients from milk from the much-cheaper crop sources.

Table 4.20. Sample farms: Subsistence food requirements

Enterprise	Unit	Nutritional requirement for 7 subsistence units	Yield per unit	Requirement to meet subsistence needs
		kg	Kg	Units
Maize	Ha	1260	1800 [1]	0.70
Beans	Ha	315	450 [1]	[2]
Milk	Cow	1050	1500 [3]	.70 [4]

Source: Sample survey (1977/78), and District guidelines (1977).

1) Low production level per ha based on District guidelines.

2) Interplanted with maize.

3) Average yields based on District guidelines.

4) Of the total production of the first cow/follower, 70 percent is for subsistence and 30 percent is available for sale. Each cow requires 0.8 ha of ley.

4.5.4. Available family labour

Most of the farm labour in Siaya is supplied by the family. Farmers who can afford to pay for hired labour (casual, seasonal, or permanent) could easily obtain it, but for the purpose of this analysis, only family labour is considered for plans 1 and 2 because most of the farmers have no reasonable income for hiring

labour. The quantities of family labour available on sample farms are computed as shown in table 4.21.

For plan 3 (crops only), lack of labour in critical periods was a severe constraint, resulting in use of only about two-thirds of the arable land. So allowance was made to hire a maximum of one casual labourer as required, at any given time in plan 3-B as contrasted with plan 3-A which used family labour only

Table 4.21. Sample farms: Available adult labour units per day

Type of worker	Persons per farm	Day unit	Work[1] equivalent	Adult labour units per day[2]
		Hours		Man-hours
Family labour:				
Man	1	6	1	6
Women	2	6	2/3	8
Children [3]	2	4	½	4

Source: Sample survey (1977/78).

1) Based on Upton (1973, p.128)

2) Product of first three columns.

3) Children are assumed to work only during school holidays and to be in the 16-20 year age-group The work equivalent applies only in those months when they are not in school.

4.5.5. Labour available for cash enterprises by months after meeting requirements for subsistence

Labour available was computed on a monthly basis. Variations in availability are expected in different months depending on the number of public holidays.

Children are assumed to work only during the school holidays, which normally occur in April, August/September, and December. Labour available by months after meeting requirement for subsistence is shown in table 4.22.

4.5.6. Gross margins for specified crops and livestock

4.5.6.1. Livestock - The gross margin per cow from milk was computed in column 2 of table 4.9 as Shs. 2,292. When manure value of Shs. 400 per cow/follower (Livestock Recording Centre, 1977) is included, the total gross margin per cow becomes Shs. 2,692.

Gross margin per owned pair of oxen is based on cost of hiring an ox-plough for land preparation per ha, as well as the value of manure contributed by the pair. The cost is based on ploughing and harrowing required land for cash crops both in the long and short-rains, and similar operations on land needed for subsistence in the long-rains. These costs per ha in Siaya are Shs.400. The 0.70 ha for subsistence would therefore cost (0.7x400) = Shs. 280. The cost of land preparation for ley is omitted on the assumption that grass seeds are broadcast with no land preparation after harvesting the last crop. In addition, manure value of Shs. 800 is contributed by the oxen team per year. The total gross margin of an owned pair of oxen is therefore the full ha-based operations (covered under cash crops as saved costs) and subsistence operations and manure value which total (280 + 800) = Shs. 1080.

Table 4.22. Sample Farms: Labour available for cash enterprises by months after meeting subsistence requirements

Month	Working days	Total family labour available [1]	Labour for subsistence [2]		Balance for cash enterprise	
			With 1 cow/ follower	With no cow/ follower	With 1 cow/ follower	With no cow/ follower
		Days			Man-hours	
January	27	378	40	0	338	378
February	24	336	40	0	296	336
March	24	336	79	39	257	297
April	26	468	103	63	365	405
May	26	364	103	63	261	301
June	25	350	103	63	247	287
July	27	378	40	0	338	378
August	27	438	145	105	293	333
September	26	412	40	0	372	412
October	26	364	40	0	324	364
November	26	364	40	0	324	364
December	27	486	40	0	446	486

Source: Sample survey (1977/78).

1) Product of total of column 4 in table 4.21 and column 1 in table 4.22 except that children are available only in April, August/September, and December.

2) Maize/beans is 0.7 of column 2, table 4.18. Cow/follower is from column 1 of table 4.18.

4.5.6.2. Crops - Gross margins per ha of crops are computed on an assumption that only family labour is used. Upton (1973, p.231) comments that "Costs such as that of family and regular labour are not so easily allocated because they are fixed or indivisible; the same applies to the cost of an ox-team". Hence, where oxen are owned, land-preparation costs for each crop considered are treated as fixed and ignored in the gross margin computation for that crop. However, where an ox-plough is hired, the land-preparation costs for a ha of each crop are treated as variable and deducted from gross output of that crop. Thus, part of the value of an owned team of oxen is represented by a higher gross margin for the cash crops. The gross margins for specified crops are shown in table 4.23.

The last four columns in table 4.23 involve rather unusual calculations. Depending on whether labour or land is the limiting factor, we will wish to consider in section 4.6 which crops give highest returns to the limiting resource. For land this is no problem. But for labour, each crop has peak demands in a different month. As a first approximation, the last section of the table shows labour requirements per ha in the peak month for each crop. Gross margin per ha is divided by this figure to give the gross margin per man-hour for that crop in the one potentially-critical month.

Table 4.23. Siaya District: Gross margins for specified cash crops with and without owned oxen

Crops	Gross margin				Labour requirement per ha in peak month	
	per ha		per man-hour [1]			
	with hired oxen	with own oxen	with hired oxen	with own oxen	Amount	Month
	Shs				Man-hours	
Long-rains:						
Maize/beans	2070	2670	13.8	17.8	150	August
Cotton	1930	2330	5.4	6.5	360	March
Short-rains:						
Beans	956	1356	10.0	11.3	120	Oct. & Dec.
Sunflowers	595	995	3.3	5.5	180	Sept.

Source: District guideliness (1977).

1) Column 1 or 2 divided by next to last column. The calculations are based on the peak months.

4.6. Alternative Feasible Farming Systems

In the following sections, solutions which maximise total cash returns for the following alternatives are discussed: (1) dairy cows and crops; (2) dairy cow, oxen, and crops and (3) crops alone (no livestock). These could have been handled by linear programming, but a direct solution is used instead because it illustrates better what is taking place and the alternatives are so few that it is a waste of time and computer facilities to run as an LP programme on the computer, or to bother with a simplex approach on desk calculators.

Average total land available for arable farming is 4.5 ha as explained in section 4.1.1.1. Crops not covered in the plan, mainly vegetables, can be grown within the homestead. Ley is expected to be grazed for at least 3 years. Assuming a 6-course rotation, 2.25 ha will be required for ley, thus leaving a maximum of 2.25 ha for total crops at any given time. In the long-rains, subsistence maize/beans occupy 0.70 ha and only 1.55 ha are available for cash crops, whereas in the short-rains all the 2.25 ha is available for short-rains cash crops.

Because of the rotational requirements for ley, livestock must be in units that utilize most of the available pasture if livestock are kept at all. If oxen are kept, then 1.25 ha of ley are available for one or more cow/followers. Since each requires 0.8 ha,

only one cow can be kept. This combination is used for Plan II. If oxen are not kept, then two cows are the maximum that can be fully carried on 2.25 ha. So this is used for Plan I. But, in fact, Plan I leaves unused 0.65 ha of pasture and Plan II does likewise on 0.45 ha. So grass or hay from this likely could be sold, or goats or sheep or perhaps a beef animal could be added at little additional cost. These potential sources of additional income from livestock are not considered in this thesis. In actual practice, most farms may be a bit smaller than the average or a bit larger so that pastures available more nearly matches these nondivisible livestock units.

4.6.1. Plan I: Two dairy cows and crops

From table 4.23, we observe that of the alternative crops, with hired oxen as required for this plan, maize/beans gives a slightly higher gross margin per ha and a much higher gross margin per man-hour for the critical months shown than does cotton, and these are both far better on gross margin per ha than are the short-rains crops. This table also indicate that maximum man-hours required for maize/beans are 150 per ha in August. We then go to table 4.22 and look at the next to last column under August. This indicates 293 man-hours available for cash enterprises in that month, after allowing for one cow/follower for which part of the milk is used for subsistence. But in this plan we have two cows,

so another 40 hours must be deducted, leaving 253 hours. Thus, the maximum maize/beans that can be grown in relation to August labour is (293 -40)/150 = 1.69 ha. Comparing tables 4.18 and 4.22, we observe that June is another potentially critical month for which a comparable computation is (247 - 40)/90 = 2.30 ha. Since only 1.55 ha of land is available, this is all that can be grown.

From table 4.23, we observe that beans are the preferred crop in the short-rains. For this crop, the critical labour month is October. So the computation is (324 - 40)/120 = 2.37 ha. But only 2.25 ha of land is available, so land is the limiting factor. As a check, we note that the maximum sunflowers that could be grown, based on September labour, is (372 - 40)/180 = 1.84 ha, which would have a much smaller gross margin than 2.25 ha of beans.

The total gross margins from cash enterprises for Plan I are summarised in table 4.24.

Table 4.24. Sample Farms, Plan I: Total net cash returns from two dairy cows and crops based on 1977 prices

Enterprise	Total net cash income
	Shs
1 cow on a commercial basis (table 4.9, column 2):	
Milk	2,292
Manure	400
2nd cow (30% of produced milk is for sale):	
Milk (0.3 x 2292)	688
Manure	400
Maize/beans for cash (1.55 x 2070)	3,208
Short-rains beans (2.25 x 956)	2,151
Total	9,139

Source: See text.

4.6.2. Plan II: One dairy cow mainly for subsistence, two oxen, and crops

The situation for long and short-rains crops remains exactly the same as in Plan I. Labour availability for cash crops however increases by 10 hours per month because oxen require less work than the second cow. The extra man-hours required to drive the ox-team occur mostly in the non-critical months and are therefore ignored in the analysis. Thus, the maximum maize/beans that can be grown in relation to August labour is (293 - 30)/150 = 1.75 ha while the corresponding computation for short-rains beans in October is (324 - 30)/120 = 2.41 ha. Arable land is therefore the scarce resource and all is used in both seasons. However, the gross-margin calculations

are now based on the second column for each pair in table 4.23 and thus are larger on a per ha basis.

The total gross margin from cash enterprises for Plan II are summarised in table 4.25.

Table 4.25. Sample farms, Plan II: Total net cash returns from a dairy cow, two oxen, and crops based on 1977 prices

Enterprise	Total net cash income
	Shs
1 cow (30% of produced milk is for sale):	
Milk	688
Manure	400
2 Oxen (direct returns)	1,080
Maize/beans (1.55 x 2670)	4,138
Short-rains beans (2.25 x 1356)	3,051
Total	9,357

Source: See text.

4.6.3. Plan III A: Crops only (no livestock)

Apart from the subsistence requirement by maize/beans in the long-rains, all land now is available for cash crops, but the subsistence value (cost) of milk which is no longer available is deducted from total gross margin contributed by crops assuming that it is bought at Shs.2 per kg. Crops in the long-rains are permitted on 3.8 ha and in the short-rains on 4.5 ha. Labour availability is shown in the last column of table 4.22 and gross margins are based on the column in table 4.23

with hired oxen.

As before, maize/beans have the highest gross margin per ha and per man-hour among the long-rains crops. The surplus labour in August permits planting (333/150) = 2.22 ha. Hence August labour is the constraining factor.

Beans have the highest gross margin per ha and per man-hour among the short-rains crops. The surplus labour available in October permits weeding (363/120) = 3.03 ha. Hence October labour is the constraining factor. Since labour for long-rains maize/beans and for short-rains beans overlap in no months (table 4.18), no further labour calculations are involved.

The gross margin for cash enterprises for Plan III A are shown in table 4.26.

Table 4.26. Sample farms, Plan III A: Total net cash returns from crops alone (no hired labour) based on 1977 prices.

Enterprise	Total net cash income
	Shs
Maize/beans for cash (2.22 x 2070)	4,595
Short-rains beans (3.03 x 956)	2,897
Total from crops	7,492
Less cost of milk for subsistence if required to be purchased (1050 x Shs.2)	-2,100
Net return from Plan III A	5,392

Source: See text.

In most low-income countries where smallholders do not keep cows, as in much of Tanzania, the families do not drink milk. Instead they obtain the needed protein and calories from vegetable sources, mostly cereals, root crops, and legumes. So questions might be raised as to whether the full cost of milk initially used for subsistence should be deducted as in table 4.26. However, some kind of allowance should be made for the nutritional value of the milk. Also allowance should be made for the rotational value of leys as a contributor to fertility of soils within the farming system. So it seems clear that returns are less under Plan III A than under Plans I and II, confirming the judgement of farmers in the area that mixed-farming is preferred over crops only (table 4.4) despite land adjudication and the increasing population at least in those cases where family labour only is used.

4.6.4. Plan III B = Plan III A with some hired casual labour

Since labour is hired by many farmers in the area and Government policy encourages labour-intensive agriculture, it is of interest to consider how Plan III A would change if a maximum of one man-equivalent was hired in the two critical labour periods, with upto this much casual labour in other months as required. Cost of such labour would normally be deducted before computing the gross margins but, to make the new table comparable with others in this broad section, cost of hired labour

is shown as a separate item.

From table 4.21 and 4.22, we find that adults work 6 hours per day and there are 27 working days in August and 26 in October. Thus, the additional man-hours in these months are 162 and 156, respectively. So in the critical months for maize/beans we have (333 + 162)/150 = 3.30 ha and for short-rains beans, (364 + 156)/120 = 4.33 ha. So labour remains as the limiting factor but much more land and family labour is utilized.

We now use tables 4.18 and 4.22 to determine casual labour requirements in remaining months. Calculations are shown in table 4.27. Only certain months are needed for these calculations.

Casual labour is required in only two additonal months and, for these, only for a few days. Since labour likely would need to be hired for full days, these are shown in the last column in table 4.27. So a total of 61 days of casual labour is required and, at Shs. 5 per day, the cost is Shs. 305.

The total gross margins for each enterprises for Plan III B are shown in table 4.28.

Table 4.27. Sample farms, Plan III B: Computation of casual labour requirements

Month	Total labour for cash crops			Family labour available (table 4.22)	Required casual labour	
	Maize/beans (3.30 ha)	Short-rains beans (4.33 ha)	Total		Hours	Days
			Man-hours			
March	185	0	185	297	0	0
April	297	0	297	405	0	0
May	297	0	297	301	0	0
June	297	0	297	287	10	2
August	495	0	495	333	162	27
September	0	390	390	412	0	0
October	0	520	520	364	156	26
December	0	520	520	486	34	6
Total	-	-	-	-	362	61

Source: Computed from tables 4.18 and 4.22.

Table 4.28. Sample farms, Plan III B: Total net cash returns from crops alone (with some hired labour) based on 1977 prices

Enterprise	Total net cash income
	Shs
Maize/beans for cash (3.30 x 2070)	6,831
Short-rains beans (4.33 x 956)	4,139
Less cost of hired casual labour	- 305
Total from crops	10,665
Less value of milk for subsistence and leys for fertility	?(-2,000
Net return from Plan III B	?(8,665

Source: See text.

Question marks are shown in the last two rows because of comments in section 4.63 about the value of the non-produced subsistence milk and of grass leys as a contributor to farm fertility. If a figure of roughly Shs.2,000 is accepted, crop farming becomes a viable enterprise with no more than one person hired as a casual worker when required. If deduction of Shs.1,000 to cover the value to the family of the nutrients in milk and of grass leys in the rotation is considered sufficient, then plan III B is the most profitable of those considered here.

The total net cash income for the 4 plans discussed above are shown in table 4.29.

Table 4.29. Sample farms: Total net cash income from alternative farming systems

Plan	Total net cash income
	Shs
I (2 cows and crops)	9,139
II (1 cow, pair of oxen, and crops)	9,357
III (Crop only) A(No hired labour)	5,392
B(Some hired labour)	8,665 - 9,665[1)]

Source: Compiled from tables 4.24, 4.25, 4.26, and 4.28.

1) Depending on the value placed on nutrients to the family from milk and of grass leys as part of the crop rotation.

CHAPTER 5. SUMMARY, DISCUSSION, AND CONCLUSIONS

Population pressures in Siaya District have created a competition between cattle and crops for the scarce arable land. There has been a gradual reduction over time of cattle on Siaya farms, but the recent sample survey (1977/78) revealed that mixed-farming is preferred by farmers regardless of size of farms (table 4.4). Among the alternative feasible farming systems summarised in table 4.29, mixed-farming has higher total net cash income than crop farming when based on the assumption that only family labour is used. Mixed-farming benefits for example, milk, manure, grass as a rotation crop, and ox-power, are mentioned in section 4.1.1.1., and a value for all except the grass ley was incorporated in the plans. The benefits are particularly desirable in most developing countries where peasants may lack capital for buying cash inputs like fertilizers. To the extent that it remains feasible, mixed farming should therefore be encouraged in Siaya District especially in cases where for some reason, the farmer(s) cannot hire casual labour.

On the other hand, hiring of a modest amount of casual labour under "crops-only" plan results in total net returns that are slightly below to slightly above those achieved with the alternative mixed-farming systems depending on the value placed on nutrients from milk to the family and the soil-conserving aspects of the grass ley. If the family purchases all the milk otherwise

consumed from a family cow, mixed-farming is better. However, if these nutrients are replaced instead from vegetable sources, then crops alone likely are more profitable. So it seems likely that pressures toward crop-farming will continue in the area despite farmer's relactance to move in this direction. Research may be required however, to determine how best to maintain soil fertility under all-crop farming and whether this can be done at all.

Of the sampled farmers, 62 percent owned Zebu cattle, 4 percent owned grade dairy cattle, 6 percent owned a mixture of these, and 28 percent did not own any cattle (section 4.3). Hence milk production is mainly from Zebus (District Annual Report, 1977, p. 4). But the Zebus are a poor breed for milk production as implied in section 4.3. If therefore the conditions only warrant the emphasis on mixed farming and the choice is on dairying, Siaya farmers should be encouraged to adopt high milk-yielding cows.

Reasons for the reduction of cattle on these farms despite the fact that mixed-farming was preferred by farmers are investigated. It was found that of the farmers who preferred mixed-farming, 70 percent preferred to adopt the grade milk animals. Also of the sampled farmers, 42 percent had neighbours with grade milk animals. The early adopters apparently had given courage to the rest of the farmers to adopt the innovation of owning these improved animals for milk production.

Training is an important aspect of farming. As table 4.10 indicates, the relationship between trained farmers and preference for grade milk animals was statistically significant. A training institution is also a good source of knowledge for farmers on non-traditional livestock feeds, farm-record-keeping, and aspects of good husbandry. Table 4.17 indicates however that the relationship between extension service and training of farmers is not statistically significant. Since extension officers are the best source of information for farmers about training programmes, they should encourage as many farmers as possible to go for training. Table 4.14 implies that there was lack of space at the Farmers Training Centre (FTC) because it apparently was difficult for the farmers to secure another chance once they discontinued, a situation resulting because only one FTC catered for two Districts, namely, Siaya and Kisumu, and it could accommodate only 60 farmers at a time. Currently the government is constructing a Siaya FTC, consistent with the promise as stated by Heyer et al., (1971, p. 89) that "The government aims eventually to establish an FTC in every district".

Extension contact had a statistically significant relationship with farm-record-keeping but not with loan utilization. However, since credit is the most important instrument in improving farm productivity, especially to smallholders, whose lack of capital seems to be a crucial factor limiting farm development, agricultural credit to smallholders should be combined with the provision of

agricultural extension service so that it can be assessed whether loan applicants have satified adequate agricultural standards in farming their land. The District Annual Report (1977, p.5) states that "Quickening of land adjudication and issue of title-deeds (land certificate) is urgently required so that more farmers can come forward for loans to buy grade milk animals". This statement indicates that extension officers cannot be wholly blamed for failing to ask farmers to come for loans until the title-deeds are processed and released. But, during the survey (1977/78), even those farmers who had secured their title-deeds complained that loan processing involved so much time that credit obtained was not worth the effort. Moreover the loans issued in kind, such as fertilizers and seeds, seldom reach the farmers on time and this causes delays in planting which later results in low yields. The quickening of title-deed processing and the removal of much beaurocracy involved in loan processing therefore are the two key aspects which should concern the government at the moment if agricultural productivity in Siaya is to be improved.

Of the sampled farmers who preferred mixed-farming, 30 percent preferred Zebu cattle. This likely reflects the fact that Zebu oxen are the only ones used for ox-cultivation. The proportion of land ploughed by oxen is not affected much by whether the plough is owned or hired, thus implying that hired ox-plough are available in the

District as and when required. The sample survey (1977/78) revealed that 86 percent of the farmers used ox-ploughs. Table 4.2 indicates that hired out ox-ploughs are a good source of family income. The farmers who preferred Zebu cattle were therefore justified in terms of ox-cultivation.

The major conclusions arising from the analysis of the alternative feasible farming systems mentioned in section 4.6 are the following: (1) if family labour only is employed, livestock should be kept regardless of whether major emphasis is on dairying (2 cows) or oxen (1 pair + 1 cow mainly for subsistence), because cash income is about the same with 2 grade cows or with one grade cow and a pair of oxen, both with crops, and this is all that can be kept on a typical farm under a rotational grass ley system if food needs are met totally from the farm. (2) if a moderate amount of casual labour is hired (total of 61 man-days per year), then it would be equally profitable to grow crops alone within a frame work of uncertainity about how best to value milk to the family, provided continuous cropping is compatible with Siaya soils, a situation which is likely to be true because a fair part of the sampled farmers kept no livestock.

If family labour only is employed to warrant the keeping of livestock, and major emphasis is laid on dairying then feeding, veterinary and dipping aspects must be considered seriously. As shown in table 4.9, the use of good forage, concentrates and minerals were ignored by most of Siaya farmers in the sample. In addition, the costs of

veterinary services and dipping were very low. Hence apart from the poor breeds, other factors affecting milk production in Siaya District are poor forage and inadequate veterinary care. The District Annual Report (1977, p. 5) mentions that "Siaya District has four main ways of approach to dairy developments: (1) importation of grade stock from other Districts; (2) use of AI services; (3) use of exotic bulls to upgrade Zebu cows and (4) establishment of pasture and fodder crops". Then it mentions that most of the District suffers from lack of improved pastures and fodder. It added that a few farmers who had gone for loans had introduced exotic pastures, mainly "Nandi Seteria" and "Rhodes grass", but these species died after a few years. Hence the report conluded that there is scope for pasture research in the area, and that more research in animal husbandry will in future be placed on pasture and fodder improvement. Bauer (1977) however comments that research is in progress to enable him to make comprehensive recommendations on varieties to be used as well as their management and the use for all areas of the country. Siaya extension officers should therefore be in touch with the National Agricultural Research Station, Kitale to make use of the research recommendations as soon as they are out. The government is also called upon to improve the communication system between agricultural stations and research stations so that research findings are disseminated as soon as required.

On the side of veterinary care and dipping, the Annual Report (1977, p.2) said "Tick-borne diseases are a great menace to our grade cattle because most of the dips are not working due to lack of acaricides and also farmers who do their own spraying do not conform with advice given". The report adds that the few dips which are functioning are chiefly understrength and are not tested regularly. From these evidences, it is clear that exotic milk animals and bulls for up-grading the Zebu cows cannot survive unless steps are taken. The annual report again mentions that the District Development Committee Project which bought exotic bulls for up-grading local Zebus for both milk and quality beef was hit by high deaths. The dip situation became so critical that the District' Animal Production Officers, directed that those farmers introducing grade milk-animals and are near the functioning dips should also have tick-control facilities. Also in his radio announcement on February 1st, 1978, the animal production officer stressed that if the situation cannot improve then only cross rather than pure exotic animals should be kept in the District because they are more resistent to diseases. Hence the government is again called upon to take dip management seriously.

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