ECOLOGICAL AND SOCIO-ECONOMIC FACTORS INFLUENCING LIVESTOCK PRODUCTION: A CASE STUDY OF DAIRY INDUSTRY IN THREE MAJOR AGRO-ECOLOGICAL ZONES OF KISII DISTRICT, WEST KENYA.

BY

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

Mr. David Abel Magiya Osebe (Candidate).

This thesis has been submitted for examination with my approval as University supervisor.

Prof. Dunstan A. Obara (University Supervisor).

DEDICATION

To my Wife Evelyne, Mother Jerusa Moraa, and Father Osebe Mogaka.

C O N T E N T S

List of Tables

List of Plates

List of figures

ABSTRACT

This research examines the role played by ecological and socio-economic dimensions in influencing livestock production efficiency.Its main objectives were as follows:

(1) to assess the effect of ecological factors on livestock production,

(2) to find out statistically significant socio-economic variables that influence livestock production, and

(3) to obtain some estimation of the relative significance of socio-economic factors affecting livestock production efficiency.

The study focused on the dairying enterprise which is the most important sub-sector of livestock industry in Kisii Distict. The research was conducted in Three major Agro-ecological zones of Kisii District. In order to cover the three Agro-ecological zones, systematic random sampling was employed.

The study area, Kisii District has the highest rural population density and lies within the High Agricultural potential Areas of Kenya. Thus, the research would not only benefit Kisii District but also other High Agricultural potential Areas of Kenya with similar problems of high rural population densities.

Using various techniques to analyze the impact of ecological and socio-economic factors on livestock production, it was

possible to construct a profile of major and statistically significant dimensions (variables) that influence the livestock industry. Among the ecological variables, deficiency of important mineral nutrients (Phosphates and nitrates) in the soil is a major limitation to forage production which provides the bulk of livestock feeds in the study area. Further, uneven surface water distribution and failure of the farmers to understand the economics of providing water to the animals in all grazing fields accentuates the problem of inadequate water supplies; thus affecting the production of livestock industry.

It was also evident that the stock is subjected to harsh climatic conditions especially during the day. A small percentage(only less than 2.0 per cent) of the farms provide shed to the animals to ameliorate the climatic stress, for instance high temperatures. Pests and diseases of tick-borne nature that are endemic in High Agricultural potential Areas of Kenya were also found to be a threat to livestock industry. This was particularly true to exotic and improved dairy breeds of cattle.

Analysis of Socio-economic variables using multiple linear regression analysis indicated that the number of total livestock units and size of the farm are statistically significant in influencing livestock production. They explained 33.04 per cent of the total variation in milk production; the former and the latter accounting for 4.74 and 28.29 per cent respectively.

Further, it was found that labour, education and managerial ability are positively related to livestock production; whereas age, family size and religion variables have a negative influence on milk production efficiency. Use of principal component analysis technique to rank the factors according to their relative significance confirmed that economic variables isolated as a factor has the greatest influence on livestock production efficiency. By and large family size-extension contact, land fragmentation-cosmopoliteness, concentrate-additives, age and marital status-religion in that order are major dimensions influencing livestock industry. Besides economic factor, management and education have greater impact on livestock production efficiency.

It was observed that although there is not enough feed for livestock, if farmers engage in pasture farming by application of fertilisers and removing bushes from pasture it will improve the carrying capacity. They should also fence and paddock the pasture fields in order to enhance proper husbandry.

Secondly, it was evident that dipping facilities are poorly maintained and irregularly used. Farmers with improved breeds of cattle do not rely on communal dips. On the other hand those who depend on them have heavily lost their animals to tick-borne diseases.

Thirdly, water is a serious problem especially during dry seasons. Farmers should give a careful thought of the diet which the animals take during these seasons and should provide shed to give cow comfort.

Fourthly, it was appreciated that it may be practical to think in terms of livestock unit with a lower water and feed requirements in some zones, for example Agro-ecological zone 3 which has the lowest carrying capacity. However, the demand for milk allows for higher investment, thus making the dairying enterprise profitable. This calls for financial support in the form of loans to enable the farmers to develop, improve and increase the carrying capacity of these areas.But these loans should be passed and supervised by District Livestock Development officers for efficient management.

Above all, the extension staff must carefully analyze the socio-economic factors when working with the farmers for effective and greater impact on livestock production.

Finally, the study recommended further researches on suitable dairy breeds for each Agro-ecological zone, incentives to the farmers to engage in intensive livestock production and introduction of multi purpose livestock feeds.In addition more studies should be conducted to find out the relationships between various pasture nutrients,and religious denominations and milk production efficiency.

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The opinions expressed in the thesis are personal and I am responsible for any shortcomings.

CHAPTER ONE :

INTRODUCTION

1.1: Statement of the Research Problem

This study is an investigation of ecological and socio-economic factors influencing livestock production in West Kenya with special reference to Kisii District. Various studies indicate that climate, edaphic, diseases, nutritive, economic, social, management and husbandry are the main ecological and socio-economic constraints affecting livestock farming (McDowell, 1972 and Bembridge, 1976). Identification of these constraints will immensely enhance the productivity of livestock industry.

Improvement of livestock production in Kenya is a worthy policy objective given that it provides for three products important to human welfare and economic development; namely food, fibers and finance. For instance, dairying is an important livestock enterprise within small holding farms of high agricultural potential areas of Kenya. On coffee small holdings, dairying contributes about 75 percent of the family incomes.

But a well established characteristic of livestock production is the large variation in the development of the dairy industry as observed in the smallholding farms in the country. The details of livestock production differ widely in Kenya. For example, the milk yield per cow varies from about 1700 litres/lactation in Central Province to about 1000 litres/lactation in Kisii (Coffee Board of Kenya, 1986: monthly Bulletin).

Even within Kisii District, where the study was conducted shows marked variations in the development of the dairy industry.

Hurbert (1973) observed that there was a problem of local overproduction of milk in certain pockets of the district where grade cows are concentrated because of poorly developed local market infrastructure. The fact that the market infrastructure has been greatly improved, the local variations of livestock development are not expected to persist after about sixteen years.

Previous studies indicate that such local variations should not be observed in Kisii district. A study of spatial Diffusion of Agricultural innovations which included livestock found: "There was lack of innovation centres in Kisii District . . . which suggested that the control on location of original introduction is ecological rather than social" (Garst, 1972 PP.188). Thus, according to Garst, any innovation could be introduced in any part of Kisii District with an equal chance of success. For example, dairy industry was expected to be equally developed in the whole of Kisii District by the year 1976 (Garst, 1972, PP.188).

Jaetzold and Schmidt (1982) map, however, demarcates the District into 6 Agro-Ecological zones and came up with some zones which they described as the most "suitable" for dairy farming. Thus emphasizing the significance of ecology on livestock production in the district. On the contrary, there are many pockets of livestock development outside these suitable zones.

These wide variations of livestock development indicate an important reason why so many people are deficient in animal protein for human food, but they also indicate the possibility of overcoming these deficiencies. Most conventional farm management studies (Russel and Kimenye 1975, Kamau 1977, Goldson 1977, Ruigu 1978 and Stotz 1979, 1980 and 1983) intended to increasing livestock production have commonly sought reasons for these variations in terms of land-size, labour, and capital inputs, husbandry and ecological areas. Such studies have tended to exclude the important dimension of human element. This is a key factor in livestock production because of the importance in decision-making. The ecological and economic factors are significant in livestock production, but to be fully productive these resources have to be organized, operated, manipulated and developed.

Improvement of agricultural resources depends upon rational decision-making which in turn is influenced by ecological and socio-economic characteristics surrounding the farming population. It is thought that the removal or minimizing of barriers (disparities) limiting optimum livestock development in west Kenya is a function of understanding the ecological and socio-economic factors. Both factors influence the complexity of human beings and consequently dictating their development path.

From the previous studies, none has been carried out to analyze the influence of both ecological and socio-economic factors affecting livestock production in Kenya. Furthermore, the latter dimension has received very little attention. They have only tended to concentrate on either economic or ecological dimensions. Thus, ignoring the social factors at a cost and their implications when planning communication of farming information to the farming community.

It is against the above background that a geographical investigation was conducted to establish the role of ecological and socio-economic constraints on dairy production efficiency in Kisii District. Identification of these constraints is of paramount importance in the future improvement of the dairy industry in the study area and elsewhere in Kenya.

1.2: Justification of the Study

A case for this study can be made on the basis of the expressed policies of the Government of Kenya as laid out in the recent Development Plans (Republic of Kenya 1974, 1979, 1984 and 1989), Livestock Development policy (Ibid, 1980), Food Policy (Ibid, 1981) and Sessional Paper No.1 (Ibid, 1986). The Policies adopted call for increased emphasis on rural development.

The majority of Kenya's poorest population is found in the rural areas. Development of these areas will not only alleviate poverty, but also provide jobs which in turn will curtail rural - urban migrations. Improvement of livestock industry, an important component in the rural areas seems to be a worthy objective since it provides for three products important to human welfare and economic development, namely food, fibers and finance.

The Ministry of Livestock Development (Republic of Kenya, 1980) has projected the demand for major livestock products which indicate large and possibly continuing deficient over domestic supplies. In view of this, the Ministry has outlined major objectives to increase livestock production and these objectives are further elaborated in Sessional paper No.1 (Ibid, 1986) that farmers will still continue to lead the country to the year 2000 as stipulated in the paper that:

(a) Food security remains the major objective and it should provide for a population of 35 million but for Kisii District 1.6 million people (Central Bureau of Statistics, CBS 1988),

(b) to alleviate poverty by generating farm family income that grows at least 5.0 per cent per year through the creation of income generating employment (at all stages of Livestock production,

(c) to absorb new farm workers at a rate of 3.0 per cent per annum,

(d) to stimulate production off-farm activities in the rural areas so that off-farm jobs can grow at 3.5 per cent to 5.0 per cent,

(e) to produce surplus over the domestic demand for export and

(f) to conserve natural resources to ensure sustained and increased productivity in the future. The fact that livestock production is an economic activity strongly tied to the rural areas, the removal of barriers will not only enhance productivity but more important provide nutritious food to the rural majority.

Some rural areas in Kenya face considerable short fall of animals and vegetable proteins. This situation brings with hardships and social stress. Failure to take the recommended level of calories and proteins result in deficiency diseases. This affects the development capability of human resources. Without minimum nutritional requirements, people are unlikely to be motivated to develop beyond the self-sufficiency stage (Bembridge, 1976).

Many of the people whose diets are most in need of improvement have a notorious poor record of acceptance of new foods in many parts of the world (Mcdowell, 1972). But in Kenya, livestock are widely distributed and their products accepted. Thus, increased livestock production is particularly important here.

Expansion of animal products can also help to diversify exports of the country. Good quality meat and milk for which the demand is vigorous (especially the former) could be an important export for Kenya, particularly in view of the difficulties of competing with other countries manufactured goods.

With break-throughs that have already taken place in food grain production, it is logical for livestock production to serve as a complementary rather than competitive enterprise. Cattle and other livestock by utilizing surplus grains and residual crop materials effectively will act as a market stabilizer for grain and provide returns from products that would otherwise go unused.

It has also been demonstrated that small farms with livestock fare better economically over a period of years than small farms relying solely on crop production (Deans, 1969). This is because crop farmers may suffer complete loss from drought whereas farmers with livestock have some reserves for their own food needs or can generate capital for crop renewal through the sale of livestock without incurring heavy debts.

In Less Developed Countries (LDCs) where rural population densities are high, there is a tendency to concentrate on cropping at the expense of livestock production. Although lying outside the tropics, Japan's efforts to fit dairy production into its pattern of agricultural production (Leong and Morgan, 1985) represents a classic example of how a country even with the most intensive cropping system in the world can add to its animal protein supply through dairy production if it has desire to do so. Similarly, this study will highlight ways of increasing livestock products in highly populated rural areas in Kenya.

According to Leong and Morgan (1985) the "Green Revolution" greatly improved the supplies of cereals in LDCs but it failed to solve the shortage of animal proteins. The study therefore will partly contribute to a better understanding of the failure of livestock production to match cereal grain's break-through.

The study is also expected to generate information for policy-makers with respect to the modernization of livestock production in order for the country to be self-sufficient in livestock products. It will make available to the extension officer's and thus to the farmers a sound data base for the decisions so as to contribute to accelerated livestock output.

Finally, the study is significant because the development of rural areas is a current subject of considerable academic interest.

1.3: Objectives of the Study

As would already be clear from the statement of the problem, the general objective of the study is to investigate the influence of ecological and socio-economic dimensions on livestock production in Kisii District. Stated specifically in terms of research objectives the following are selected aspects of the subject that are the main focus of research, namely;

(1) to examine the influence of selected ecological variables (water availability, temperature variation, soil in relation to productivity of animal feeds, pests and disease control) on the development of livestock industry.

(2) to determine statistically significant socio-economic variables (livestock units, hectarages, labour, management, education, marital status, age, religion, extension contact, land fragmentation, cosmopoliteness, family size) influencing livestock production, and

(3) to obtain some estimation of the relative significance of socio-economic factors (economic, management, education, marital status- Religion, family size - extension contact, age and Land fragmentation - cosmopoliteness) influencing livestock production.

1.4: The Null Hypotheses

In the light of the above objectives, the following are two major null hypotheses to be tested:

(1) H_0 - Observed variations in livestock production in Kisii District are not associated with variations in the following ecological variables (availability of water,

soil properties, temperature variation and diseases and pests).

H_1 - Alternative

(2) H_o - There is no statistically significant relationsip between socio-economic variables and livestock production in district.

H_1 - Alternative

(3) H_0 - Socio-economic factors are not of equal relative significance in affecting livestock production efficiency in Kisii District.

1.5 : Operational Concepts And Definitions

The Kenya Highlands

These are geographic regions that have been defined by the altitude and the amount of rainfall they receive. They range from altitudes of 1500 to 2500 above sea level and receive about 700 to 2000 mm of rainfall by annum (Jaetzold and Schmidt 1982)

Ecological Factors

They consist of climate, soil (edaphic) properties and biological habitat. However, in the tropical Africa the most important climatic constraint is rainfall since there is sufficient solar energy that reaches the surface throughout the year. The Highlands of East Africa are exceptional in being cooler as a result of the altitude. Temperate crops such as wheat and barley may be grown, while intensive dairy farming raises fewer problems than in the hotter tropical lowlands (Upton, 1987). The ecological factors that will be examined in the study will include water source and availability, soil properties in regard to increasing feeds yield from the diminishing hectarages. Diseases and pests are also examined with respect to their contribution as a limitation to increased output of livestock industry.

Socio-Economic Factors

These involve all man's cultural contributions that affect the livestock industry. The social aspects encompass age, Family size, education, marital status, cosmopolitness, extension contact, conservation concern and managerial aptitude. While economic dimensions include farm hectarage, labour and other capital inputs.

Agricultural Potential Areas

The criterion applied for the definition of land categories is rainfall. According to which Kisii obviously ranks among the peak districts in Kenya, thus falling under high agricultural potential areas of the country.

Agro-Ecological Zones

In Kenya the Agro-ecological zones were first established by FAO (1978). The main zones are based on their probability of meeting the temperature and water requirements of main leading agricultural activities (crops and livestock). Normally, a computer is used to calculate the climatic yield potential for each agricultural activity. The zones are roughly parallel with Braun's climactic zones of the precipitation/evaporation index but there are differences according to the influence of the length and intensity of arid periods. The names of the main zones refer to the potentiality leading crops\animals there: many of them can be found in some other zones too.

Dairy Industry

The production of milk from cattle reared for the purpose which is distinct from beef industry - rearing animals primarily for their meat products.

Livestock Production Efficiency

This involves multiplication of livestock units and increasing the products produced by the animals, for instance milk, meat, skins and hides, and so on per a livestock unit. This can be done by introducing breeds that are high-yielding, controlling diseases or supply the animals with enough and nutritious feeds. But this study will specifically examine the fashion in which the farmers will produce efficiently and return a reasonable profit by understanding the ecological and socio-economic factors that limit the output of livestock industry. Milk output per a unit is used as the main criterion.

Farmholding

This is a typical farm unit of production that comprises a nuclear family of a man, his wife\wives and their unmarried children, although other relatives may be involved. Such a family may live in more than one dwelling units but all members generally "share the same pot". Given that the family is the production unit, a farm may be defined as all the agricultural activities under the control of a farm family. Used in this way the "farm" means all the plots of land cultivated by the family which of course differs from the common idea that a "farm" is a single plot. This definition also includes livestock farmers who share communal grazing land but is under their control.

1.6: Literature Review

Literature review is significant in any study because it provides a deeper insight to the investigated problem. This enables one to integrate the basic concepts into an explanatory model. The literature pertinent to this study will, therefore, include important and related previous works on livestock production.

Studies by Pratt (1984), Jahnke (1982), Pratt and Gwyne (1977) and Raikes (1981) indicate that differences in livestock production have their roots in geographic and climactic factors. The interaction between ecology and livestock introduces a distinct set of animal environments which are considered hereby reference to climatic stress, feed, water supply and disease hazard (Pratt, 1984).

Jahnke (1982) presented an analysis of livestock production systems in tropical Africa with more than half of the livestock population located in Arid zones and a further concentration occurring in the highlands. According to Pratt and Gwynne (1977) the observed distribution pattern and productivity is profoundly influenced by diseases in tropical Africa. The prime example is trypanosomiasis which excludes all except trypanotolerant breeds. The control or eradication of trypanosomiasis or of the tsetse flies (Glossina spp) which transmits the disease will open up to 10 million km 2 of land to livestock in the higher rainfall areas (ILCA, 1980).

Penning de Vries and Djitege (1982) observed that landform and soil characteristics determine the occurrence of stock watering points without which there would be no livestock production. Some of the influences affect all livestock species equally, while others such as terrain affects some species more than others (Ibid, 1982).

French (1956), Phillips (1960,) and Horrocks and Phillips (1960) show that different breeds vary considerably in their ability to withstand reduced water intake or the intake of water at different intervals. The general finding is that *Bos taurus* need more water than *Bos indicus* types under same environmental conditions (French, 1956). This result has been explained by differences in the number of sweat glands per unit area (Findlay and Yang, 1950). French (1956) working on the comparison of Afrikander and exotic beef cattle in Tanzania, found that the former lost 1.5 percent of their body weight if left 24 hours without water and suffered no loss in appetite, while exotic animals suffered 15 percent loss in liveweight and 24 percent decline in food intake. He also found that three-quarters Ayshire cross Zebu steers consumed 68.4 percent more water than Zebu cattle at 1.5 years of age and 39.2 per cent more at 3.5 years. Where a farmer has both exotic and indigenous stock and water is limiting then preference must be given to the exotic cattle. Wigg and Owen (1973) confirmed these results in later work with Borans and Angus X Boran steers on a per liveweight basis.

Phillips (1960) reported that under East Africa conditions where water is limited in amount and frequency of availability, low productivity could be the result of restricted water intake through its effect of reducing food intake. Bailey and Broster (1958) noted that water intake increased with increasing ambient temperature. Johnson, Ragsdale, Berry and Shanklin (1963) showed that at high ambient temperatures, milk yields of lactating Holstein Friesians decreased and water intake increased, suggesting an inverse relationship. The animals also ate less at high temperatures. The upper critical temperature of these animals was found to be 77°F (25°C). Consideration of the climatic data for most smallholder areas in the high areas of Kenya suggests that for part of the year at least grade dairy cattle are affected in the same way (Goldson,1973).

Castle and MacDaid (1975) established that in temperate climates positive relationships exist between climate components and water intake when relating water intake and ambient temperature and daily hours of sunshine. Woodward and McNulty (1931) and Winchester and Morris (1956) in America, and Bailey and Broster (1958) in United Kingdom, also recorded the same relationship, the latter workers quoting an increased intake of 0.14-0.27 litres per °F rise in temperature.

Hoffman and Self (1972) reported high levels of free water intake by animals in feedlots during summer months. Wilson (1961) also recorded double water intake requirements for East Africa short horned Zebu heifers in Uganda during the dry season.

As water is of vital significance in the homeothermy of animals, it is obvious that any means of controlling the climate to give better comfort to the cow in the hot dry season in the tropics will reduce water intake requirements. For example, Hoffman and Self (1972) found that the provision of shelters for feedlot cattle in summer reduced water consumption. In another work on grade and pedigree Jerseys at the Kenya coast where animals are subjected to a stressful climate for at least 6 months of the year, Goldson (1973) found that water intake in the dry season was 58.7 per cent higher than in the wet season, and the provision of shed trees and other factors, likely to provide better cow comfort could reduce water consumption of animals by 21 per cent below that of animals in "open" pastures.

Johnson, Ragsdale, Shanklin and Kibler (1960) found that the stage of lactation affected water intake. Winchester and Morris (1956) gave a correcting factor for comparing non-lactating and lactating animals, adding 87 per cent of the weight of milk produced by a lactating animal to compare it with a similar non-lactating animal.

Kelly, Bond and Ittner (1955) and Horrocks and Phillips (1961) noted that water intake was increased by the presence of salt in water. In their work Kelly, et.al (1955) showed a difference between Brahman and Hereford cattle. Only in the latter breed was intake per unit of liveweight reduced and liveweight gain significantly increased when drinking water was cooled from 31.2 to 18.3 C. Lofgreen,Givens, Morrison and Bond (1975) reported that cattle also drink less of the cooled water than those given warm water.

Castle and McDaid (1975) noted a difference in water intake between a rotational and set stocking system, the latter having higher rates of intake. This is probably related to water content of offered herbage, the former system possibly offering to the animal a more constant supply of young herbage with high water content.

French (1956) has recorded a higher intake of water by animals whose feed and water sources are widely separated. Daws and Squires (1974) noted the same fact with sheep. According to Goldson (1977), the difference could be explained by a greater requirement caused by the expenditure of energy and production of heat involved in travelling the long distances.

McDowell (1983) has shown that the resulting crossbreds between indigenous and exotic cattle have come under severe nutritional stress from feed supplies and diseases resulting in much lower performance and frequently a shorter life than expected. This agrees with Bisschop (1948) who found that the results of "grading-up" system of cattle improvement were disappointing. The half breed of first generation animals were most promising and much better than their indigenous dams and compared favorably in growth and in weight for age with the breeds of their sires in their respective home countries. The higher grades, - the second, third and higher Filial (F) generations, however failed to maintain the initial improvement and deteriorated progressively often to below the level of their original indigenous maternal ancestors (Bisschop, 1948).

Investigating into the cause of Bovine parabotulism,Bisschop (1948) showed that the soils and natural pastures of South Africa were deficient in phosphates that caused botalism, and inferior growth and reproduction in cattle in the phosphorus deficient areas.

Other studies which support the aforementioned observations are those of Trail and Gregory (1981), Meyn (1974) Meyn and Wilkins (1973) and Kimenye and Russel (1975). They noted that climatic, nutritive and disease\parasite environment characteristics of much of sub-saharan Africa have great effect on livestock production. The ecological factors favour the use of germ-plasm with varying percentages of Bos indicus cattle because of their higher level of adaptability to environmental stresses (Trail and Gregory, 1981).

It is clear from the foregoing that ecology is undoubtedly the most basic and pervasive of the many determinants of livestock production systems in the world. Thus, it means that any effort aimed at improving livestock production systems must give ecology a lot of priority. According to Pratt (1984): "ignoring or opposing ecology is one way of courting disasters".

Apart from ecology there are other determinants which are equally important in livestock production. Gregory, Trial, Koch and Qundiff (1982) noted that many breeds of introduced Bos taurus cattle have the additive generic merit to respond for both milk and meat production characters when environment stresses are minimal. In sub-saharan Africa, however, economic and technological factors generally do not permit sufficient modification of natural environments to realize as high percentage of the genetic potential as can be exploited in temperate zones (Simpson, 1984).

The Kenya Development plan (Republic of Kenya,1979-1983) points out that with increasingly continuous reduction of grazing lands in the high and medium potential areas large animals may become uneconomic. Nylholm (1975) and Kenya farmer (1986) however observed that dairy farming is not only labour intensive but also does not require much capital or land. As small farmers are under-employed and have little of the other two factors it is thus argued that dairy farming is eminently suited for small farmers (Stotz, 1983). Increasing livestock production will be particularly important in West Kenya where rural population density is highest in the country (CBS, 1979).

Stotz (1979, 1983) points out that labour and capital are the major constraints in livestock production for smallholder dairy farmer. On small farms there is lack of capital and on large farms labour is lacking. Stotz's study had one major weakness in that he picked his sample from literati and only those who were willing to cooperate. So at the best the sample was only representative of the particular farmers who shared some characteristics.

Krishna (1967) observed that pricing policies in developed countries (DCS) which successfully stabilize incomes often have opposite effect in LDCS. Pricing policies for livestock meat can have distributed benefits which accrue to the urban and growing industrial sectors. Furthermore, producers who would invest to commercialize livestock production have less incentive to do so (Sullivan, Farris, Yetley and Njukia 1978).

Dovan, Low and Kemp (1979) have noted that the government's efforts to establish effective pricing policies have not been successful because they do not account for the environment in which producers make their marketing decisions. Livestock are held for various reasons by the producers such as a convenient repository of wealth. This value is greater in many respects than the commercial market value, one that in most cases is an administered price by the government (Sullivan et, al 1978). According to Evangelou (1984) increasing marketing efficiency provides additional incentives for expanded livestock production. However, saturation of milk in the local market can be a disincentive to the livestock farmers (Garst, 1972).

Meyn (1974) noted that availability of dairy heifers for smallholder was a constraint in achieving milk production goals. Later work by Ruigu (1976) conformed to and further observed that prevalent high mortality rates of improved grade animals under "average" smallholder conditions were serious problems.

Pratt and Tweeten (1982) have observed that lack of an effective extension service mechanism can lead to low adoption rates of known technology. Unfortunately most extension staffs deal with water-tight compartments of livestock production instead of synthesizing all the complementary elements (Bembridge, 1976).

Adoption of new packages of farming technology and farming efficiency are significantly related to extension contact, age and level of education (Sewankambo, 1986). Early findings of Bembridge and Burger (1977) however show that well educated farmers and less experience farmers are more efficient in beef production.

Relationships between farming operations and religious practices have been shown to be remarkably close in the simpler agricultural societies (Gregor, 1970). From the writing of Malinowski (1935), Deffontaines (1948) and Conklin (1957) one can gather that religious practices irrespective of what changes take place in the physical, institutional, cultural and infrastructural environments (Singh and Dhillon, 1987) have a negative contribution to agricultural production.

Burger (1967) concluded that farming progressiveness was a personality trait and was denoted by a farmer's quality of management. Farming as a tool in the hands of the manager and managerial aptitude of the farmer has been shown to be the most important ingredient for farming efficiency (Bembridge, 1976).

The dairy enterprise makes heavy demands on labour. In the United Kingdom estimates show that a quarter of the hours devoted to farming are spent in and around dairy buildings (Banard, Halley and Scott, 1970). In addition there is the time spent growing and harvesting fodder crops.

Generally, there is a range of many factors that affect the efficieny of livestock industry. Many of the studies that have been carried out tried to look at individual variables on the efficieny of livestock production. This study is examining a wider range of ecological and socio-economic factors influencing livestock production.

1.7 : <u>Conceptual Framework For Livestock Production</u>:

In order to design a strategy for increasing livestock production in West Kenya, the situation must be analyzed so as to provide a comprehensive understanding of the system in which the change is intended. The interacting variables that govern livestock

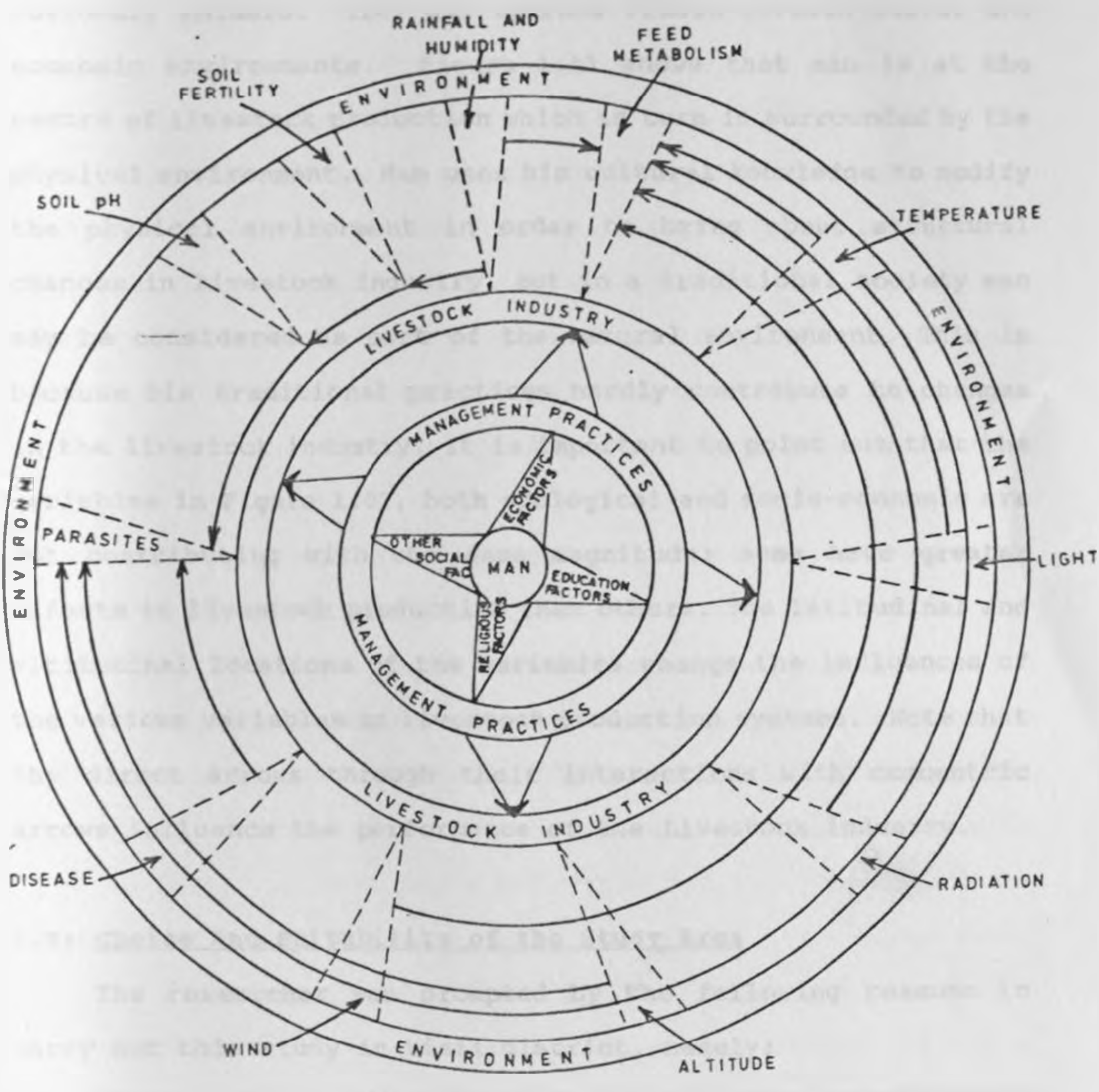


Fig.1·01: Elements of physical, cultural, and economic environment bringing about structural changes in Livestock Industry.

production should be understood in order to manipulate the variables in the most efficient manner.

Livestock production is a complex system which has many interrelated components such as climate, soils, plants and obviously animals. They all operate within certain social and economic environments. Figure 1.01 shows that man is at the centre of livestock production which in turn is surrounded by the physical environment. Man uses his cultural knowledge to modify the physical environment in order to bring about structural changes in livestock industry. But in a traditional society man may be considered as part of the natural environment. This is because his traditional practices hardly contribute to changes in the livestock industry. It is important to point out that the variables in Figure 1.01, both ecological and socio-economic are not contributing with the same magnitude; some have greater effects to livestock production than others. The latitudinal and altitudinal locations of the variables change the influences of the various variables on livestock production systems. Note that the direct arrows through their interactions with concentric arrows influence the performance of the Livestock industry.

1.8: Choice and Suitability of the Study Area

The researcher was prompted by the following reasons to carry out this study in Kisii district, namely;

(1) Kisii is the leading district in population density after Nairobi and Mombasa respectively (CBS, 1979). Since the latter two districts mainly consist of urban population who are not engaged in agriculture; the former qualifies to be the leading

district in rural population density in Kenya. It is against this background that everything should be done to provide adequate nutritious foods to the rapidly increasing population. It is therefore, important to point out that any successful research will not only benefit Kisii but also other districts that are likely to be faced with similar problems of higher rural population densities.

(2) Considering the animals slaughtered during the period between 1984 and 1988 there were a steady increase of about 33 per cent (cattle) till 1986. Thereafter animals slaughtered declined with almost same percentage as the previous increases (Animal production Division, Kisii Annual Reports, 1984-1988). The difference could be explained by the rise in livestock prices following the decontrolling of meat products' prices by the Government in 1986. Thus making it difficult for a common man to secure this essential food.

Seemingly, milk remains the most important livestock product affordable by many people. However, the increase of milk in the district has been too slow, only less than 14 per cent over the period between 1984-1988. This could not meet the demand which is more than 3 percent per annum (Ibid, PP.6). This calls for a concerted effort to increase milk production in the district so that it can cope with the rapidly increasing population.

(3) Kisii district in west kenya was chosen because is one of the most progressive and dynamic regions which is self-sufficient in most of the other agricultural produce. However, the efficieny of livestock industry is far below optimum although the government of kenya has been supporting livestock development

programmes since independence.

(4) The district has an environment and climate similar to that of Scotland (Garst, 1972) and therefore favourable to modern dairy development. However, the district has varied degree of livestock development (stotz, 1983), thus forming a good representative of west Kenya. In addition the study area traverses through major agro-ecological zones (Jaetzold and Schmidt, 1982) which are important for a systematic approach to stratified random sampling (Pratt, 1974).

(5) The district is occupied by homogeneous ethnic group, the Gusii tribe where the researcher comes from. This enabled him to enjoy the confidence of the farmers unlike when he had to go outside his home district.

1.9: Organization of Chapters

The thesis is divided into six chapters. The first chapter is the introduction which covers the statement of the research problem, justification, objectives,literature review and conceptual framework. Towards the end of the chapter it has been explained why the study areal matrix, Kisii District was chosen.

Kisii District is extensively dealt with in chapter two. The bio-physical and socio-economic characteristics of the study areal matrix are discussed.

The third chapter examines the methodology. It entails procedures of data collection, analysis, presentation and limitations to the study.

Chapters Four and Five deal with the main issues raised in the thesis. The former mainly examines the ecological variables in respect to livestock production efficiency; whilst the latter assesses the role and relative significance of socio-economic dimensions in livestock production efficiency.

Finally, chapter six focuses on the conclusions and gives various recommendations that are meant to enhance productivity on the dairy industry in the most densely populated rural area in Kenya.

CHAPTER TWO:

BIOPHYSICAL AND SOCIO-ECONOMIC BACKGROUND OF THE STUDY AREA

2.1: Location and size of the study Area

The study was conducted in three major Agro-Ecological zones of Kisii District. It was important to do the study in the area because of the reasons that are discussed at the end of chapter One. This Chapter will therefore elaborate the points that have already been raised in the previous Chapter. It will give a detailed description of the location, biological, physical, social and economic characteristics in which the livestock industry has thrived for many years.

In order to find out the factors responsible for inefficient production of livestock products (milk), a research was conducted in an area leading in rural population density in Kenya (Central Bureau of Statistics, 1979). The location of the study area , Kisii is one of the seven districts of West Kenya (Fig.2.00) which share many other characteristics of High Agricultural potential Areas of the Country. Thus, this research has potential for broader application.

Kisii District is situated about 25km South-east of Lake Victoria and about 50Km South of Equator. The District stretches about 50km from North to south and about 45km from East to West. The distance from North-east to South-west is about 70km.

The District borders the Rift Valley province in the East and South (Kericho and Narok Districts respectively), and on the West and North is bordered by South Nyanza District.

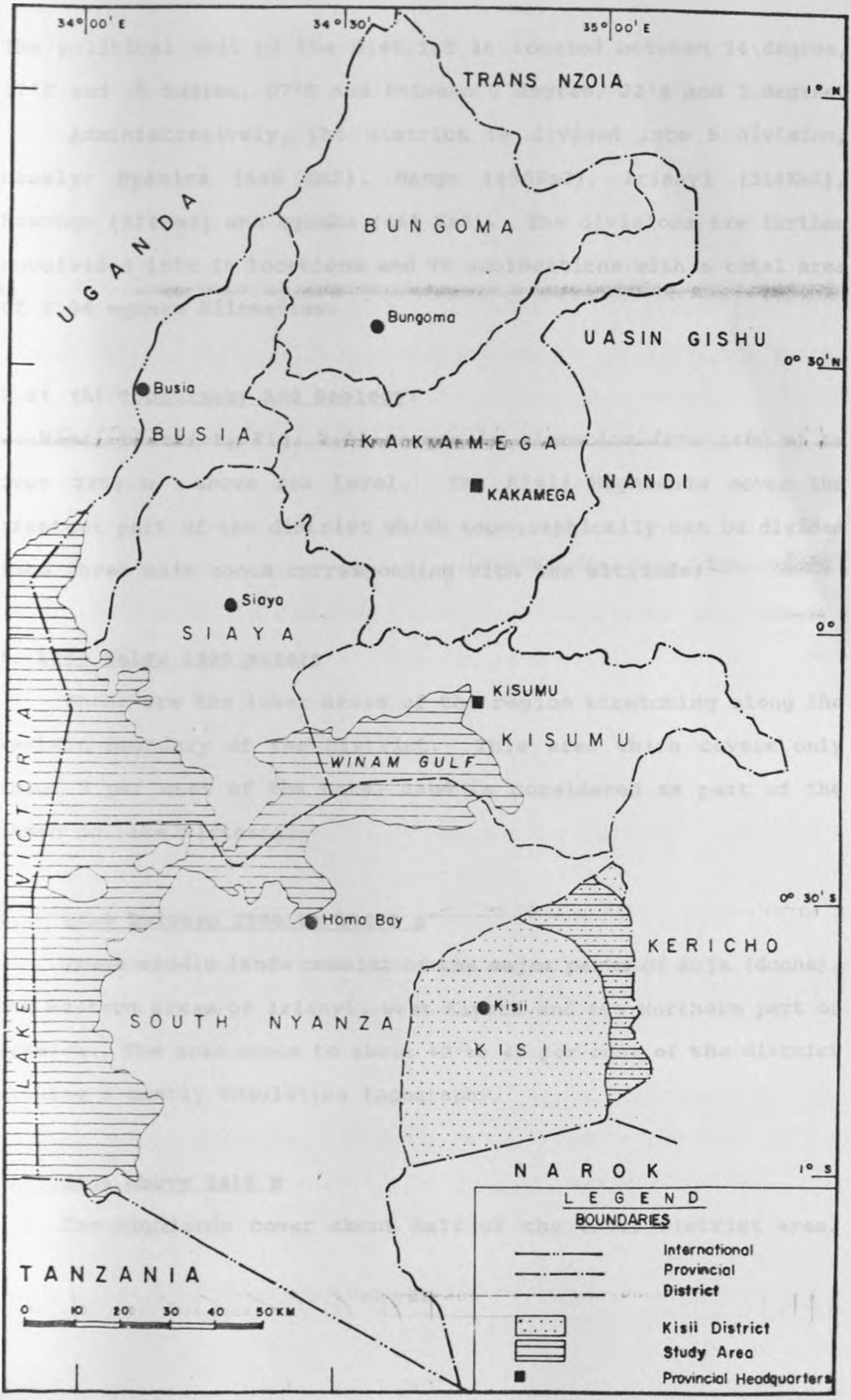


Fig. 2.00 : THE LOCATION OF STUDY AREA IN WEST KENYA.

The political unit of the district is located between 34 degree, 37'E and 35 degree, 07'E and between 0 degree, 32's and 1 degree.

Administratively, the district is divided into 5 division, namely; Nyamira (640 Km2), Manga (455Km2), Irianyi (314Km2), Bosongo (324Km2) and Ogembo (461 Km2). The divisions are further subdivided into 18 locations and 79 sublocations with a total area of 2196 square kilometres.

2.2: (A) <u>Topography And Geology</u>:

Kisii District, Fig. 2.01 ranges in elevation from 1400 m) to over 2200 m above sea level. The Kisii Highlands cover the greatest part of the district which topographically can be divided into three main zones corresponding with the altitude;

1. <u>Zone Below 1500 meters</u>

These are the lower areas of the region stretching along the Western boundary of the District. This area which covers only about 5 per cent of the total land is considered as part of the basin on lake victoria.

2. <u>Zone Between 1500 to 18000 m</u>

These middle lands consist of the major parts of Kuja (Gucha), the Western areas of Irianyi, west Kitutu and the Northern part of Nyamira. The area comes to about 40 to 45 per cent of the district showing a gently undulating topography.

3. <u>Zone Above 1800 m</u>

The Highlands cover about half of the total District area.

They include the southern parts of Nyamira, Central and East Kitutu and Eastern parts of Irianyi and small pockets in the South of Gucha. In the Eastern and South-eastern parts of the district, the highest hill reach 2200m. The Highlands show a rigid and gently undulating topography. The area is described as a deeply dissected cretaceous peneplain with steep ridges with a westward slopping. The ridges probably represent the remnants of the tilted peneplain (Garst, 1972). Most of the slopes are steep and cultivation induces ecological problems such as soil erosion and water economy (Uchendu and Anthony, 1975).

The prevailing geological formation in Kisii District is the "Kisii series" precambrium of the Bukoban system. The Kisii series consist of a three-tier formation of upper and lower divisions of lavas and the middle division is composed largely of quartzite:

1. Upper group - rhyolite and rhylitic tuffs
   - andesite and dacites
   - porphyritic and non-porphyritic fesites.
2. Middle group - Ferrugineous siltstone
   - quartzite .
3. Lower group - Kisii soapstone
   - non-porphyritic basalt
   - porphyritic basalt .

The island characteristic of the Kisii series is revealed by its virtual envelopment in the North, West and East by the precambrian kavirondian or nyanzian system and in the south by the Bukoban system. A variation of the Bukoban system found in Uganda and Tanzania consists of almost flat lying quartzite lavas

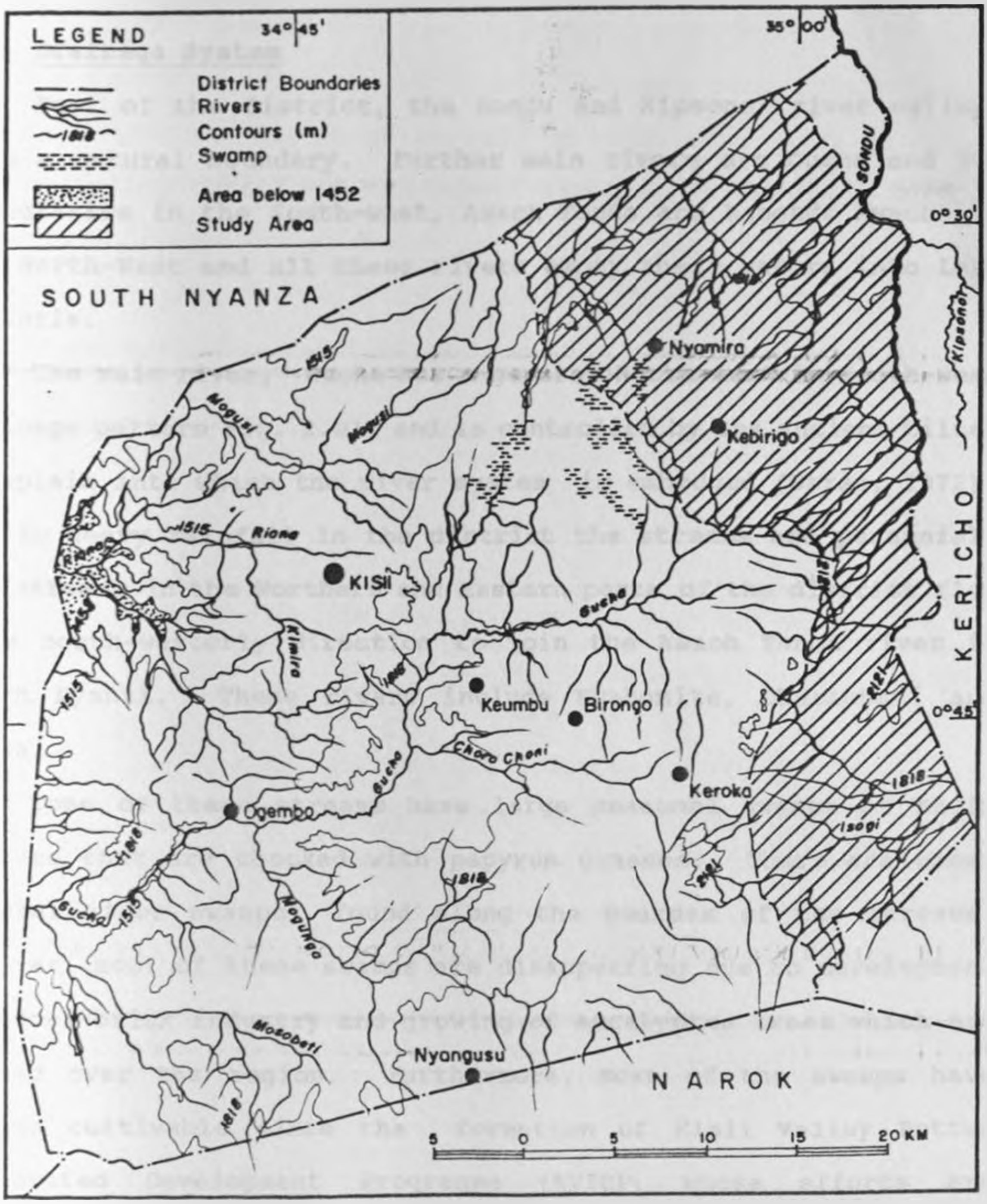


Fig. 2.01 : TOPOGRAPHY AND DRAINAGE OF KISII DISTRICT

and basalts. Pleistocene deposits are all of a superficial nature and nowhere do they attain any great thickness (Hutchinson,1951).

(B) **Drainage System**

East of the District, the Sondu and Kipsonoi river valleys form a natural boundary. Further main rivers are Gucha and its tributaries in the South-west, Awach Tende and Kabondo Awachi in the North-West and all these rivers empty their waters into Lake victoria.

The main river, Gucha has a general North-east to South-west drainage pattern Fig. 2.01, and is controlled by the ancient tilted peneplain into which the river system is embedded (Garst, 1972). Due to heavy rainfall in the district the streams are perennial. The streams in the Northern and Eastern parts of the district flow in a north-westerly direction to join the Awach Tende river in South Nyanza. These rivers include Nyabomite, Charachani and Eyaka.

Some of these streams have large seasonal swamps on their courses that are chocked with papyrus grasses. There are other several minor swamps found along the courses of the streams. However, most of these swamps are disappearing due to development of local brick industry and growing of eucalyptus trees which are spread over the region. Furthermore, most of the swamps have become cultivable since the formation of Kisii Valley Bottom Integrated Development Programme (KVIDP) whose efforts are converted to reclaiming the swamps.

2.3: Climate, Vegetation And Soils

(A) Climate

Kisii has an agreeable climate. Owing to its comparatively high altitude, temperatures are not excessive despite its proximity to the Equator. The resultant cool temperatures plus abundant rainfall give the region an appearance of verdant green landscape of vegetation throughout the year (Garst, 1972; Hurbert, 1973).

Some figures on two of the main climate determining variables; temperatures and rainfall have been compiled in table 2.01 for a meteorological station in Kisii town.

Table 2.01: 1976-1988 averages of temperatures and rainfall in Kisii town at altitude 1766M.

ITEM MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total[a]
Mean temp. °C	19.2	19.6	19.6	19.0	19.4	18.8	18.5	18.6	18.6	19.3	18.4	19.7	19.0
Min. temp. °C	10.5	12.1	12.4	12.5	12.7	11.7	11.4	11.4	10.6	11.7	11.1	11.5	11.6
Max. temp. °C	27.9	27.0	26.9	25.7	28.2	26.0	25.4	25.8	26.6	26.9	25.7	26.8	26.4
Rainfall (mm)	46	183	178	324	205	205	109	99	155	166	174	194	1979
% of total p.a	2.3	9.2	9.0	11.3	10.4	5.5	5.0	7.8	8.4	8.8	9.8	7.4	100
Rain days	7.6	12.6	18.8	23.4	18.0	14.4	10.2	14.8	14.4	19.4	19.8	15.0	18

Source: Compiled From Data supplied by Meteorological Department, Dagoretti Corner (Nairobi)
[a]) = sums or averages respectively.

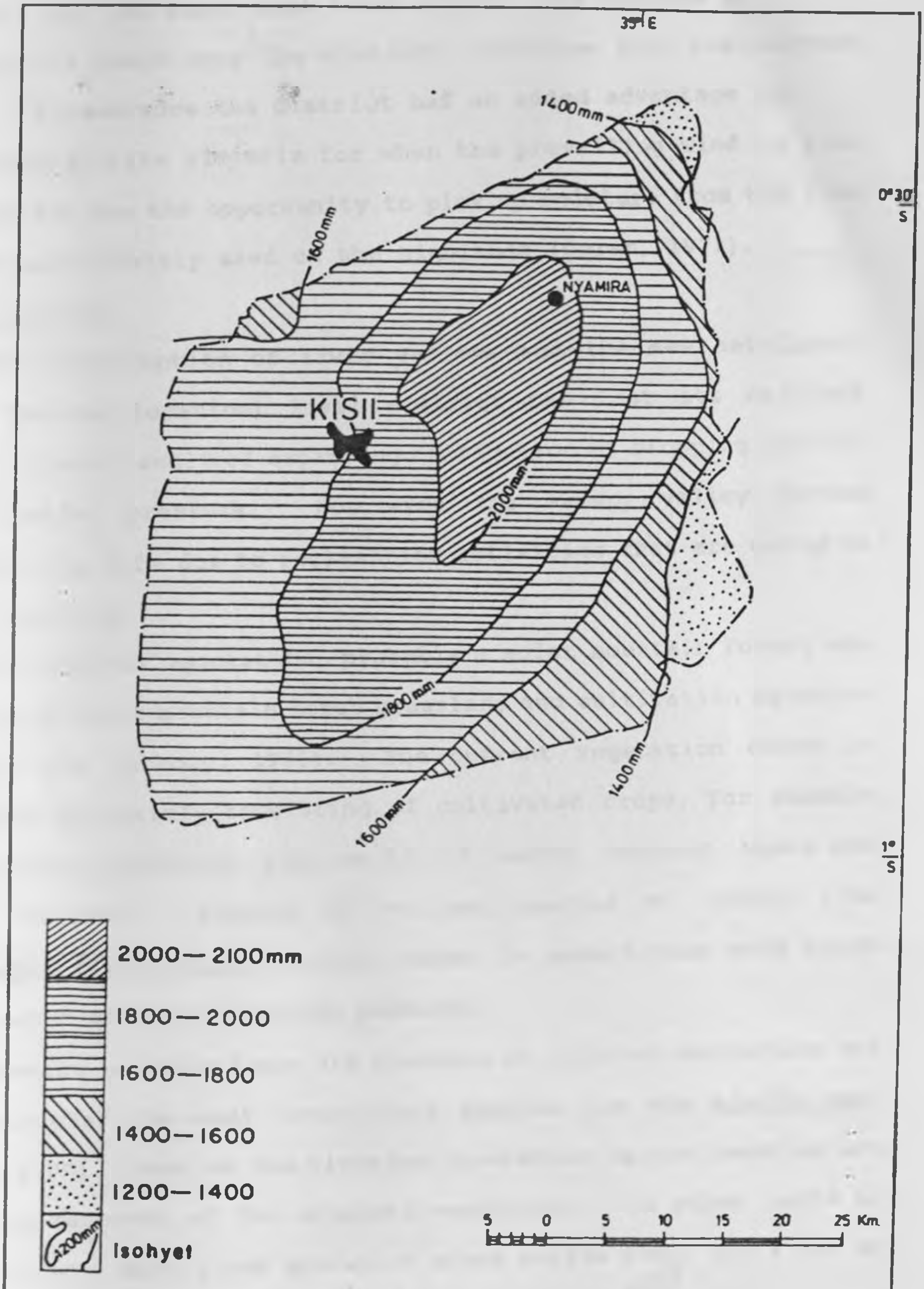
The figures indicate that the monthly temperatures deviate only slightly from the respective averages, i.e. the fluctuations of temperature are comparatively low. Except for the months with particularly heavy rain (from February to May) the maximum and minimum temperatures are highly correlated with mean temperatures. That is, the variations of the temperature within the different months are nearly the same during most parts of the year. On the whole, no extreme temperatures are likely to occur in the course of the year.

The seasonal distribution of rainfall can also be seen on table 2.01. Except for January and April (46mm minimum 325mm maximum respectively) the average monthly rainfall is between 100 to 200mm (about 20 to 40 inches).

Definite rainy or dry seasons do not exist. The number of rainy days per month corresponds to the course of rainfall within the year. As is typical for tropical climates the intensity of precipitation, that is precipitation per a unit time is usually high. With regard to the friable clay soils and the topography (Fig. 2.01) prevailing in the study area means that the danger of soil erosion is very high unless care is taken to protect the environment with conservation techniques of farming. Usually, the precipitation fall in the afternoon, sometimes as hailstones or/and accompanied by heavy thunderstorms.

The amount and regional distribution of rainfall depends largely on the altitude (compare figures 2.01 and 2.02) of the respective parts of the district. On the western slopes of the Highlands (section 2.01, zone 1) in the middle of the district, the precipitation are higher in the other parts of the district due to cooler air and the elevation. In the South-eastern and North-eastern parts of the district (Fig. 2.02) receive the least amount of rainfall and longer dry periods may occur from time to time.

Fig: 2·02. Regional distribution of Rainfall in Kisii District.



Source: Ministry of Agriculture, German Agr. Team. Jaetzold Sch. KSS.

The predominant influence on the seasonal distribution of rainfall in Kisii district are the two main wind systems, the North-east and the South-east trade winds. The passage of intertropical front over the district coincides with the wettest seasons. Furthermore the district has an added advantage in being close to lake victoria for when the prevailing wind is from the Southwest has the opportunity to pick up moisture from the lake which is subsequently shed on the highlands (Garst, 1972).

(B) Vegetation

With an exception of river valleys and the new settlement scheme (Borabu location) Kisii district has lost its original vegetation as a result of expanding cultivation of cropping induced by population pressure. Not even the swampy valley bottom vegetation is safe due to reclamation activities that are going on in the district.

The original vegetation, probably a moist mountain forest was replaced by moist mountain scrub grassland and cultivation savannah (Uchendu and Anthony, 1975). The current vegetation cover is secondary and mainly consisting of cultivated crops, for example tea, coffee, pyrethrum, passion fruits, maize, bananas, beans and finger millets. Patches of various species of grass, like Pennisetum clandestinum (Kikuyu grass) in association with couch grass occur mainly in grazing paddocks.

In Borabu location there are remnants of original vegetation and in particular the most conspicuous species are the Acacia ssp. (plate 2.00). Most of the riverine vegetation in the location are also the remnants of the original vegetation. In other parts of the district, dark green groves of black wattle trees and a lot of eucalyptus at the hill-tops and foot-hills respectively and cypress and Matata thorny trees occasionally interrupt the gently sloping green hills and ridges providing boundary markers for individual farms as well as acting as windbreaks.

Generally there are no natural forests in Kisii district and the vast majority of farmlands have natural grasslands. This latter distinction is of great significance because it can be generally stated that under the present condition, pasture is much less intensely farmed than the hectarages under crops.

Plate 2.00 : Scattered original Acacia vegetation in the new settlement scheme in Borabu location. At the foreground is the cultivated Rhodes grass at Nyansiongo.

Ecologically, most of the area lies within the Kikuyu (Pennisetum clandestinum) and star grass zones, both of which are zones of high agricultural potential. Both Kikuyu and star grasses are indicative of good soils, adequate rainfall and moderate temperatures of greater potential; not because of grass but due to the coincidence with the better soils and generally heavier rainfall. The star grass zone due to its lower elevation is marginal for pyrethrum and tea, but completely adequate for coffee, maize and bananas. The two zones are suitable for rearing grade cows, although Kikuyu grass zone has a greater potential (Uchendu and Anthony, 1975).

The two ecological types provide for the people of Kisii with favorable opportunities for developing a diversified agricultural economy.

There are no waters of significant extension in the district; the total area coincides with the land area. The whole district is classified as high potential agricultural land. However, the only criterion applied for the definition and categories is climate (rainfall and temperature) according to which Kisii obviously ranks among the peak districts in Kenya.

No allowance is made either for topographical or geological factors (rock outcrops, steep slopes, seasonally water-logged areas and swamps) or for the setting aside of land for market places, roads, townships, (except for Kisii town for which 2 sq. km are taken into account). If one allows for such areas the arable land should be reduced by about 10 per cent of the total land (Hurbert, 1973). Since 1973, the high agricultural potential land should have been reduced by more than 10 per cent. However, this may not be true because of current reclamation of swampy areas that cancels the effect of urban development in the district.

(c) Soils

Latitude, topography and other weathering factors such as temperature and rainfall and time resulted in two main types of soil association in Kisii district:

I. Middle Lands (1500 to 1800m)

(i) On the hills there are mainly red friable clays, the Kisii savannah loams (similar to the dark friable clays in the Highlands - See below)

(ii) Downward the hills, the soils are more considerably determined by the influence of the weathering factors, leaching and swilling away soluble and solid soil particles. The soils have changed into dark-red friable clays with laterite horizon and slight seasonally impeded drainage.

(iii) On the lower slopes there is a brown to yellow-red sandy clay loam with laterite horizon. Down the slopes, soils are less humid and the pH-value has increased through the accumulation of cations from the upper part of the hills.

II. Highlands (Above 1800m)

(i) On the top of the ridges of higher hills sometimes shallow stony soils with rock out-crops as a result of accelerated erosion can be found.

(ii) In the flatter areas, an accumulation of the leached soluble products from the upper areas, highly saturated dark colored, neutral or alkaline, poorly drained and massive structured soils can be found. In contrast to the soils derived from the upper areas the sticky clay originally found in the lower areas, is of montmorillonite type. The soils of the highlands are sometimes designated as "humic ferrisoils".

In the flatter areas which as mentioned above cover only a marginal part of the district area, typically an accumulation of leached soluble and solid soil particles can be found. The soils are either of light gray or white. Loam sands with laterite horizons (ground water horizon) which are seasonally waterlogged or of greenish-brown mottled clays which is a poorly drained soil.

The chemical composition of the typical soils in the district with respect to plant production is relatively poor. This is due to the intensity of high rainfall resulting into excessive leaching and intensive utilization of soils by farming activities. The contents of phosphorus, potassium and sometimes calcium is too little; whereas the contents of magnesium and manganese can be considered as sufficient (Hurbert, 1973).

Finally, it should be pointed out that there is no relationship between the land-use and land ownership patterns among the different soil types.

2.4: Demographic Characteristics

Kisii district is occupied by a homogeneous group, that is the same ethic tribe, the Gusii. The Gusii are Bantu-speaking people surrounded by the Non-Bantu Luos, Maasai and Kipsigis. They are related to the linguistically similar Kuria to the South-west and the Maragoli group of the Abaluyia from western province.

In 1931 their number was estimated at about 125,000 people, that is, nearly 11 per cent of the African population of the Nyanza province. Administrative, technical, economic and not the least medical improvement especially in the period between 1930 and 1948 contributed to the upward trend in the population. The influences were reflected in the population figures estimated at about 140,000 for 1938 and 225,000 people for 1948 with a growth rate of about 3.8 per cent.

Whatever the exact rate of population growth might have been in this period, the availability of unused land resources made an unsponsored settlement in the Kisii highlands possible. The growth in population in that period even contributed a great deal to agricultural output and helped to promote "enclosure" movement in the highlands (Hurbert, 1973).

In the 1960s, the district faced a new reality, an expanding population on an already occupied land base. The number of people increased from 519,000 in 1962 to 675,000 in 1969. In 1972 it was estimated to be 755,000 and reached 869,572 in 1979. The population of the district is currently standing at about 1.3 million and it is increasing at an average rate of 3.4 per cent. It is expected to reach 1.55 million people in the year 1993 (CBS, 1989).

Table 2.02 (a) gives the population figures for the locations/divisions of the study area for the 1979 census. It is closely correlated with figures 2.01 and 2.02 i.e., the population density of the district increases as one moves into higher areas. In other words, it can be correctly stated that the density is related to rainfall amounts which in turn is determined by the altitude. It is also not surprising to note that areas with higher densities practice most intensive form of agricultural production.

Table 2.02(a): Population per location and Kisii District

Division/Location	Total population	Sq. kms	Density
Nyamira Division	198,303	640	309
Borabu	31,587	238	132
West Mugirango	91,706	183	501
North Mugirango	75,015	218	342
Manga Division	214,707	455	471
Central Kitutu	33,545	43	764
Eronge	43,485	87	495
West Kitutu	52,274	121	431
North Kitutu	45,889	110	415
East Kitutu	39,515	92	427
Irianyi Division	147,419	314	464
Nyaribari Chache	50,777	116	437
Nyaribari Masaba	66,981	163	409
Kisii town	29,661	35	844
Ogembo Division	190,919	461	414
Wanjare	49,176	123	398
S.Mugirango Chache	36,166	114	315
S.Mugirango Borabu	32,816	86	379
Bosongo Division	118,158	324	364
Majoge Chache	44,767	105	422
Majoge Borabu	50,314	112	446
Bassi Chache	51,116	127	400
Bassi Borabu	44,722	114	390
Kisii District	869,512	2,196	395

Source: CBS (1979): Population Census

Population Age-Sex Structure

A notable feature of the age-sex structure in table 2.02(b) is the high proportion of children. In the study area the number of persons under 15 years old is more than 53 per cent. If one adds the persons over 60 years old into this group it means that nearly 60 per cent of the population consists of the dependents for which only slightly over 40 per cent have to care.

Table 2.02(b): An overview over the percentage of male and female persons in certain Age-groups

Age groups (years)	Male	Female	Total
0 - 4	10.30	10.40	20.70
5 - 9	8.70	8.80	17.50
10 - 14	7.70	7. 50	15.20
15 - 19	6.30	6.90	13.20
20 - 24	3.90	4.60	8.20
25 - 29	2.70	3.20	5.90
30 - 34	1.90	2.20	4.10
35 - 39	1.40	1.80	3.20
40 - 44	1.30	1.50	2.80
45 - 49	1.20	1.30	2.50
50 - 54	0.85	0.88	1.73
55 - 59	0.70	0.67	1.37
60 - 64	0.51	0.52	1.03
65 - 69	0.45	0.36	0.81
70 - 74	0.25	0.25	0.50
75 - tve	0.40	0.38	0.78
AGE NS	0.09	0.09	0.176

Source: CBS (1979): Population Census

Considering the density of population and the population pressure on the relatively scarce land one may assume that Kisii is an area with a high net outflow of persons. The data for the 1979 census can allow us to make indirect conclusions if out-migrations are taking place. According to table 2.02(b) the active age group population (15 - 59) the female are more than the male persons in the district. This agrees with the primary survey data that show that the ratio of women to men in the family farms was higher and the majority workforce in the farms are women. Furthermore researches carried out elsewhere in Kenya indicate that males aged between 15 - 59 years of age tend to migrate in search of better jobs and employment opportunities. This difference in ratio leads one to conclude that there has been outmigration from the district to other areas where there might be job opportunities.

2.5: Land Tenure And Land-Use

The traditional land tenure system in Kisii was based on the principle that an individual has heritable rights over his arable land mainly cultivated by his wife/wives Whilst Sharing with his kinsmen other resources such as grazing lands and forests claimed by the community. This principle could only be maintained as long as there was enough land for everybody. There was no class of landlords in the Gusii society. Kinship remained the only source of legitimate access to land. The Gusii land law can be summarized as based on the principle of individual sons having a legal claim over "fields cultivated by their mothers but owned by their fathers" (Uchendu and Anthony, 1975).

Currently, rapid population growth has led to increasing land scarcity constituting a great challenge for the district's agriculture. Agricultural production virtually takes place in smallholder farms. The average farm sizes is less than 2 Ha. The smallest farms on the average is less than 0.7 Ha in Manga division, the largest of more than 4 Ha is found in Nyamira division (Jaetzold and Schmidt, 1982). Ownership of land is secured and all farms (except Esise location) are registered though not all title deeds have been handed out yet. The average farm family comprises of 7 to 8 persons of which 2 to 3 are in the working age group. Due to the fact that most of the persons from Kisii origin who are employed outside the district are males there are more women than men working on the farms.

A typical farm, plate 2.01 is along strip of land running from top of the ridge to the valley bottom. It includes the homestead which in order to protect the family from the mosquitoes' bites is usually located in the middle of the strip.

Plate 2.01: Long strips of farms at Kebirigo in West Mugirango location, Kisii District.

Traditionally the Gusii were lacustrine lowland pastoral people: because of intertribal wars they kept on moving until they settled on the plateau. In the process of moving from open plains to the highlands the Gusii relegated cattle herding to a secondary position. More efforts were converted to cultivation of millet, sorghum, pulses, sweet potatoes, bananas and sugar cane. The deep volcanic loams in combination with ample rainfall supported an agricultural system which by early twentieth century had become permanent. Eleusine and sorghum formed their main staple: their failure during bad weather meant hunger and their excesses during good weather meant prosperity and colorful initiation rituals (Uchendu and Anthony, 1975).

Eleusine Spp. became by far the most important crop, though was the most demanding in terms of labour inputs. It could be stored well for many years and was widely used in beer brewing and commanded premium prices in exchange with Dholuo pots and baskets.

The establishment of British colonial rule in Kisii in 1907 encouraged the inhabitants to produce foodstuffs for the market. The Gusii responded enthusiastically and started producing crops for sale. As the encouragement from the Government slackened the efforts of the Gusii people to participate in market outside the district faded and by 1930s little was being produced for export (Uchendu and Anthony,1975). However, one should mention that the colonial policies toward the peasant agriculture were dominated by the development of agriculture with the so-called "Scheduled" areas, exclusively for European settlers. Africans were forbidden from growing cash crops like tea, pyrethrum and coffee in fear of competing with the settlers' agriculture in production demand for labour or access to land. Consequently, between 1907-1930 agriculture in the study area was basically subsistence, except Borabu location (the scheduled areas).

Between 1931-1945, white maize was introduced in the district and it became a very important cash crop which rivalled eleusine and sorghum as a staple. The demand for grains (millet, sorghum and maize) in food deficit areas of Kenya increased demand with the extension of the railway to Kisumu and opening of gold mines and Kericho tea estates in 1930s stimulated grain output especially maize. This was a good and brave attempt towards diversification of the economy for the Gusii people.

After the fall of the Value of Kenya's exports which came with the world's economic recession in the 1930s the colonial administration was forced to consider how export production could be extended to peasant agriculture. In 1930 the Government proposed that coffee be grown in Kisii, Embu and Meru; but this was accompanied with some restrictions.

A major policy change came out in 1950s when cash crops were recommended to be grown by peasants in the "Swynnerton Plan" published in 1954. The Swynnerton plan laid down the foundations of the role of the Government was to play in agriculture - i.e., the concentration of commercial agriculture in the "small-farm" sector - agricultural units outside the large farm sector. As per the plan, all peasant holdings were supposed to be consolidated and legally register the property of individual peasants. Once the peasant had the security of a title deed he could then adopt from a wide range of cash crops available to him and became a "modernized" agricultural entrepreneur . In other words it was commercialization of African Peasant agriculture. It was after the above plan that cash crops started expanding to Kisii highlands.

Although the formulation of Swynnerton plan achieved a lot in cash and food cropping not much was done to enhance livestock production. It was after seven years that an attempt was made to introduce the first grade cattle in the District. This is when 6 grade cows were placed on the two African farms in Kisii district (Kisii, Annual Report 1961, PP.17). By the end of 1962 there were 68 farmers registered who kept 89 cows. Regarding the adoption of grade cows were the Gusii county council By-laws stipulating the requirement for registration they were:-

(1) A stock-proof perimeter fence surrounding two acres of paddocked grazing land planted to either Kikuyu or star grass,

(2) One-quarter acre of fodder crops,

(3) an adequate watering point ,

(4) a milking shed ,

(5) a calf pen,

(6) a spray pump,

(7) regular spraying of local cattle for six months prior to adoption and the removal of all ticks, and

(8) attendance at a farmer's training centre course (Kisii, Annual Report 1963,).

The number of grade cows in Kisii expanded from 89 in 1962 to 10,207 in 1967, but over half of these were in the former "scheduled" area of Kisii, (Annual Reports 1963 PP.16 and 1967 PP.3 and 7). That is to say, most of the owners were located in the northern part of the district (Nyamira division). Whereas to the south there existed only isolated cases.

In January 1969 the smallholder credit scheme operated by German Agricultural Team was established in Kisii. The team was responsible for giving loans to the African farmers for the purpose of increasing their output. To qualify for the loan a farmer was required to demonstrate to the satisfaction of the team that he would be able to pay off the loan in five years. This meant that only the rich and "progressive" farmers benefitted from the scheme. A breakdown of the loan was seen as follows (table 2.03):

Table 2.03: Smallholder credit Scheme

	% of loans granted in each category
Grade Cows	58%
Water development	11%
Tea development	12%
Pyrethrum development	11%
Passion Fruit Dev.	5%
Miscellaneous	3%
Total	100%

Source: Garst, 1972.

By 1972 areas with more grade cows had been saturated with milk in the local market and this was due to lack of transport availability. To remedy this, the Government with the cooperation of the German Agricultural Team installed a milk cooler at Kisii town (Masaba) to store evening milk and distribute it in the next morning; and during this time no milk was exported outside the district (Garst, 1972).

Kisii district had started showing signs of contributing to the national economy through livestock production by 1975 though it was to a small scale. There were over 350,000 head of Zebu cattle kept by smallholder and three large farms had over 26,000 grade cows. They produced about 2 million kilograms of milk worth over 2.2 million shillings. About 0.75 millon kg. The marketed milk went through Sotik K.C.C. factory and the rest through the societies in the District (Kisii, Annual Report. 1975).

As of 1984 there were more than half a million dairy cows of which about 120,000 were grade cows. In 1988 there were 583,000 dairy cows which produced 84,402,000 litres of milk. Much of the milk, 81,402,000 litres was sold through 22 cooperative societies. The remaining 3,000,000 litres was for local and home consumption

(Kisii, Annual Reports 1984 and 1988).

About 90 per cent of the milk produced in the District comes from small farms. These farmers have formed cooperative societies through which milk is marketed to K.C.C. factory at Sotik. The district has 3 milk coolers - i.e. Masaba in Kisii town, Tombe and Borabu where evening milk is stored to await transport to K.C.C. factory at Sotik the next morning (Kisii, Annual Report, 1988).

Finally, it should again be pointed out that Kisii district was chosen because of its importance in having a climate suitable for livestock development. In addition, livestock development programme have been supported by the Government for many years but have not been successful. Finally, the study area has the highest rural population density in Kenya. Thus, improving livestock production efficiency in Kisii District will not only create job opportunities but also increases family farm incomes.

CHAPTER THREE:

RESEARCH METHODOLOGY

The success of any comprehensive research work largely depends upon the methods employed to collect, analyze and present data. This chapter deals with these methods. First an explanation of sampling design is presented and is followed by an account of the data collection procedures. This is followed by the methods used to analyze and present the information. Finally a discussion of limitations to the research study follows.

3.1: Sampling Design

It was considered appropriate to have all farmholders as the universe from which the sample was drawn for interviews. Past studies (Stotz 1980, 1983, Ruigu 1978 and Goldson 1977) can be criticized on the grounds that they concentrated on "progressive" livestock farmers and neglected the "non-progressive" farmers.

Stratified random sampling technique was used to pick the sub-samples from the three major Agro-ecological zones (Fig.3.00) of the district. Stratified random sampling was used because it involves ecological zones that give a holistic approach which goes with ecology, hence leading to adoption of a systematic approach to research. According to Pratt (1984):
"Ignoring ecological constraints when planning a research is one step towards irrelevant research". It should be pointed out that the application of an ecological perspective does not, however, greatly influence research design, except perhaps in the choice of sites or number of replicates".

The reasons why samples are drawn is because the total population is too large to allow all its members to be covered within a reasonable period of time. The sample, therefore allows one to make statements about the population when it is too expensive or unpractical to collect information from the entire population. The easiest way to meet this condition is by using random sampling where everyone has an equal chance of being selected (Prewitt, 1975).

The stratified sampling is one in which the researcher first grouped the population according to the three major Agro-ecological zones (Fig. 3.00) of the District and then sampled separately from each zone. The purpose also was to ensure that enough cases of each stratum fall into the sample to make analysis possible. This was accomplished by using proportional stratified sampling which was determined by approximating the areas covered by each Agro-Ecological zones.

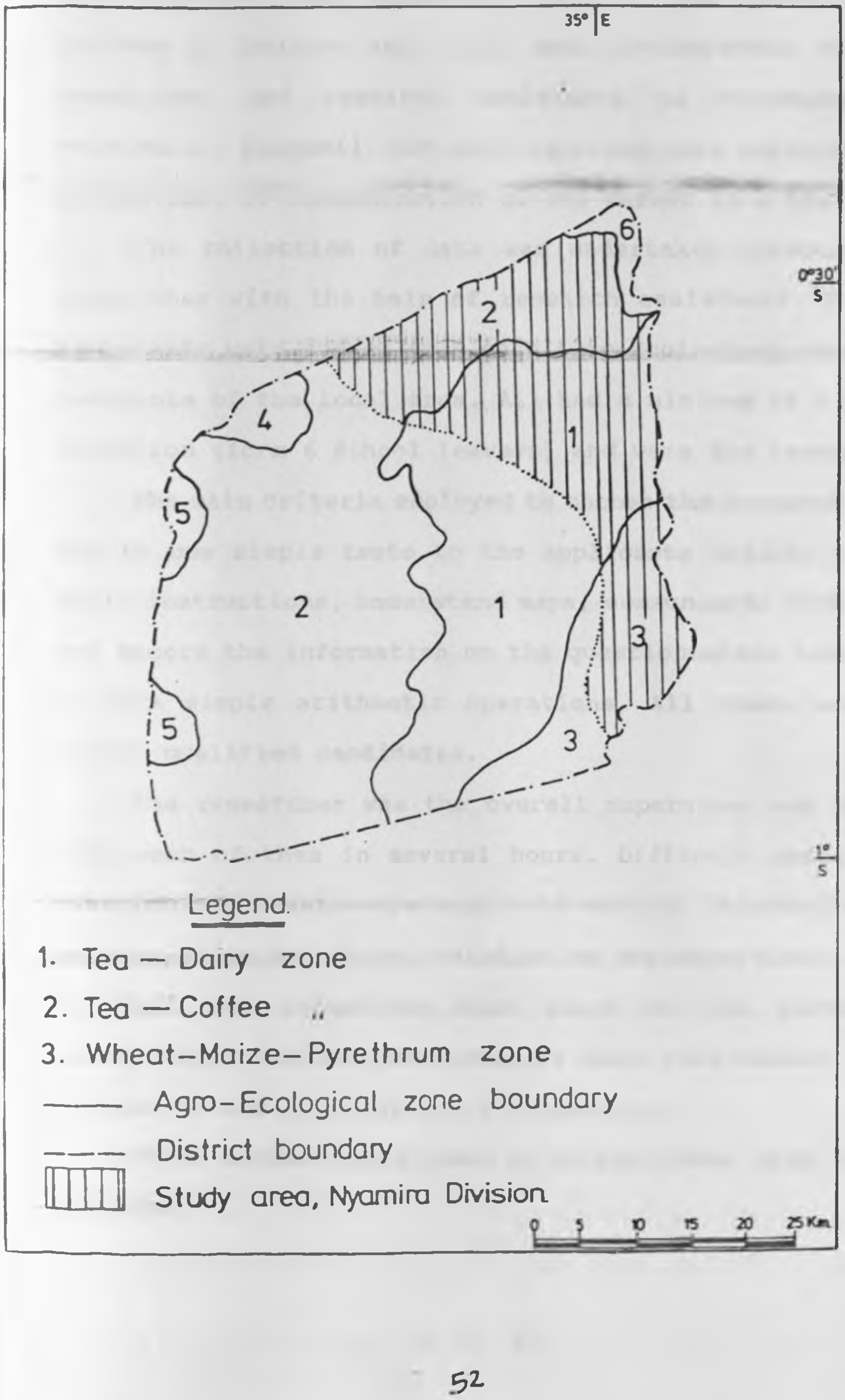
Most cases were taken from Agro-Ecological zones 1 and 2 that are of almost equal sizes and the remaining cases were picked from zone 3 which is the smallest in size.

3.2: Methods Of Data Collection

(A) Sources of primary data

The researcher used District land Register for the sampling frame. However, there was one location, Esise in Agro-Ecological zone 3 where part of the farmers' land is communally owned. Of each farm family holdings selected, the researcher interviewed the head of the family - the person designated as the putative owner of the farm and therefore most directly concerned with its

Fig. 3·00 Location of major Agro-Ecological zones of the study area, Kisii District.



day-to-day administration. The procedure that was employed in interviewing was carried out by employing an open ended questionnaire (see Appendix - A_1.). The questionnaire was written in English and later used interpreters who were the researcher and research assistants to translate it into vernacular, Ekegusii. But both versions were employed depending on the ease of communication of the farmer in either language.

The collection of data was undertaken personally by the researcher with the help of research assistants. The research assistants were chosen from each Agro-Ecological zone and hence residents of the local area. All had a minimum of high school education (form 6 School leavers) and were the farmers' sons.

The main criteria employed to choose the research assistants was to use simple tests to the applicants ability to read and apply instructions, understand maps, communicate with the people and record the information on the questionnaires accurately and perform simple arithmetic operations. All these were used to select qualified candidates.

The researcher was the overall supervisor and had to work with each of them in several hours. Difficult cases where the research assistants were unable to extract information from the farmers, they had to be revisited by the supervisor.

All the interviews took place on the farms and the administration of the questionnaire could take between forty-five minutes to one hour for every respondent.

Three methods were used to collect data from family farm holdings:

(1) **Records kept by respondents**

These were mainly found in zones 1 and 3. However in zone 2 the researcher relied on recorded information, averages that were given by the farmers. In zones 1 and 3 there were formal records for milk sales on daily basis. This applied only to those farmers who delivered milk to Kenya cooperative creameries (KCC) factory at Sotik. Those who sell to hotels and local markets do not keep records. On such cases, the researcher relied upon estimates that the farmers could recall.

(2) **Interviewing respondents**

This was the method mostly used to procure much of the data. In fact this was the best because it required less frequent visiting and less costly than direct observation and measurements. The farmers' estimates of resource used and yields may be influenced by his judgement of what is average rather than by what has occurred in the current season (Upton, 1987, pp. 107). That is why the researcher was asking for averages (for instance, milk yields) because this is what the farmers were expected to recall.

(3) **Direct Observations**

Direct estimations of variables (hectarage) was used in conjunction with the interviews to collecting data on farms (those who do not have title-deeds). However, even those that have, plots for various farm activities, for example, grazing grounds, cash crop and food crop hectarage was to be estimated. Photographs were also taken for some feature that appeared interesting for the study.

Interviews were also held with District livestock development officer, District dairy officer, Divisional veterinary officers,Agricultural extension officers and Farm manager and Dairy technician of Symbaut farm in Borabu location.

Apart from the interviews, 20 soil samples were collected using soil auger, labelled polythene bags and strong tying cords. Stratified simple random sampling was used to pick farms from where soil samples were taken. The researcher wrote on small pieces of paper a "yes" and a "no". Out of 110 pieces of paper 20 had a "yes" and the remaining 90, a "no". They were mixed thoroughly before the farmers interviewed were asked to pick from the boxes. Those who picked a "yes" had soil samples taken from their farms. However, to ensure that every agro-ecological zone had enough soil samples taken from it, in boxes 1 and 2 for agro-ecological zones 1 and 2 respectively had 7 "yes" pieces of paper and 6 "yes" pieces of paper for zone 3. Later the soil samples were transported from the study area to National Agricultural Laboratories Kabete, Nairobi for analysis and the results are presented in chapter 4. These were the main sources of primary data.

(B) <u>Sources Of Secondary Data</u>

They included the ministry of livestock development, Ministry of Agriculture, Ministry of Lands and housing, Central bureau of statistics (CBS), Meteorological station (Dagoretti Corner), District farm guidelines, National and District development plans, District animal production annual reports and the rest was collected from relevant literature in the universities libraries.

On the whole it should be pointed out that the nature of data collected involve the normal practice that require the researcher to include all those variables (attributes) that have been indicated as significant in previous studies and have some theoretical support. In addition, any other variables considered relevant to the livestock industry being studied were also included. However, in the final selection practical considerations such as the availability of data was to be taken into account.

3.3 : Methods Of Data Analysis And Presentation

(A) Coding and processing Data

These were done using punched cards for both nominal and numerical data. The information was fed into a micro-computer in the University of Nairobi at the Department of Geography which enabled the researcher to compute basic statistics. Later, advanced calculations were done at the Institute of Computer Science, specifically using Statistical package For Social Sciences (SPSS) Software developed at the Vogelback Computing Center, North Western University. The package is suitable for the analysis of farm and other data surveys.

(B) Techniques of Data Analysis

The techniques that are employed in data analysis are determined by the available data collected during the field surveys. They range from qualitative involving detailed descriptions, use of maps and graphs for illustrations to quantitative inferential statistical techniques , t- and F-tests. The latter techniques are employed to test the already mentioned hypotheses (Section 1.04).

1. Factor Analysis

The variables that influence livestock production are numerous and in most cases interrelated. To reduce them into a small number of factors that can easily be explained and remove the interrelationships among them, the researcher employed factor analysis technique.

Factor analysis is a statistical technique used to reduce a large number of raw variables to a more manageable number of conceptual factors. The assumption upon which factor analysis is based is that many variables are interrelated with one another and therefore a new conceptual variable (usually referred to as a factor or sometimes a dimension) can be constructed that will be highly intercorrelated with one or a cluster of raw variables. Some measure of the relationship the variables have to each other can be obtained by examining the simple intercorrelation matrix.

In a factor analytic problem each raw variable will relate to each conceptual factor in a different manner. The closeness of fit between a variable and the factor is referred to as the loading and measured in the same manner as the coefficient correlation; that is the values range from 1.00 to -1.00. A loading approaching 0.00 indicates no relationship. The numerical value of the loading indicates the closeness of fit between the raw variable and the factor, but when two variables have opposite signs it indicates how they relate to each other. A positive loading indicates a direct relationship with the factor and a negative loading an inverse relationship. This can be referred to as loading in opposition. Thus, if two variables load in opposition, one will approach its maximum numeric value, whereas the other approaches its minimum numeric value in those observational units. Another way of stating it is that the factor has dichotomised between the two variables. The fact that a given variable has a positive or negative loading on a factor is meaningless in and of itself, it only becomes important when both high positive and high negative loadings occur on the same factor.

The naming of factors sometimes present problems. If all the variables loading highly on a factor are simply measures of the same underlying characteristic the problem is easy for it is only necessary to identify that characteristic. Complications arise when the raw variables seem to be unrelated but load on the same factor. In such cases it becomes necessary to use some rather long and unwieldy titles (Garst, 1972, pp.117).

An important characteristic of factor analysis is that the factors derived are unrelated to each other. Also the first factor explains more than any other factor, and it may be located between independent clusters of interrelated raw variables which will result in numerous moderate loadings and perhaps none that are really high. In order to reduce the number of variables loading moderately on a factor, the matrix is frequently rotated to increase the relationship between the clusters of interrelated variables and the factors. The use of orthogonal rotation does not change the uncorrelated nature of the factors, but it does clarify the variables related to each other.

The next step in factor analysis is the construction of a factor score matrix. This explains the relationship between the observational unit and the factor. The more involved a raw variable is with the factor the higher its weight. Scores are given in standard deviation units, thus if an observational unit contributes little to the factor its scores will be very low, approaching 0.000, or the mean for the contribution of all observational units to the factor. Observational units will have high positive or low negative factor scores in the same manner as their raw variables related to the factor (Blalock,1960).

At this point it is important to mention the two variants of factor analysis that have received widest application: The common factor analysis and principal component analysis techniques. Their major differences lie in the treatment of the variance components of the variables. The latter assumes that all variations in a variable can be explained by the M - 1 variables of the observation matrix. Hence the components are supposed to summarize the total variation of the data. In the former, the assumption is that only part of the variation in a variable can be explained by M - 1 variables.

Regarding the common factor analysis (CFA) model the part of variation that can be explained is called the common variance (C). That which cannot be explained is the unique variance (U). The factors summarize the common sources of variation in the data. In the principal component model, each variable, can be expressed as a function of the number of components as shown below:

$$Z_1 = {}^{o}ij\ C_1 + {}^{o}ij\ C_2 + \ldots + {}^{o}mCp$$

$$Z_2 = {}^{o}ij\ C1 + {}^{o}ij\ C_2 + \ldots + {}^{o}mCp$$

.

.

.

$$Z_m = {}^{o}ij\ C_1 + {}^{o}ij\ C_2 + \ldots + {}^{o}mCp$$

Where Zi = the standard scores of the ith variable,

Cj = the jth component,

${}^{o}ij$ = the loading of Cj to the total variance of Zi.

In the common factor model, each variable is a function of the number of factors plus its unique variance as shown below:

$$Z_1 = {}^{o}ij\ F_2 + {}^{o}ij\ F_2 + \ldots + {}^{o}ij\ F_p + U_1$$

$$Z_2 = {}^{o}ij\ F_2 + {}^{o}ij\ F_2 + \ldots + {}^{o}ij\ F_p + U_2$$

.

.

.

$$Zm = {}^{o}ij\ Fm + {}^{o}ij\ F_2 + \ldots + {}^{o}ij\ Fp + Um$$

Where Zi = the standard scores for the ith variable

Fi = the ith factor

${}^{o}ij$ = the loading of Fj to the common variance of Zi

Ui = the unique variance of the ith variable.

The exclusion of the unique variance in principal component analysis (PCA) is a major source of criticism. It is argued that the dimensions should reflect the interrelationships existing in a group of variables (Common Variance) and not the uniqueness of

the variables. However, the assumptions within the two techniques make them ideally suited for two main roles "the PCA is essentially a data transforming technique while CFA is a model for hypothesis testing" (Johnson 1978 pp.158).
Note that the components C_1, C_2..... C_p are the orthogonal dimensions of patterned variation exhibited by the data matrix. As the first few components usually account for most of the common variance, the maximum number of dimensions that can be extracted is usually less than the number of variables. The dimensions are extracted in order of their decreasing magnitude of contribution to the total variance. The last dimensions are usually the trivial components (Rummel, 1970).

In most of the studies on factorial analysis interest is in the major factors. The cut-off point for the number of factors to be interpreted is usually based on a number of criteria which takes into consideration the amount of contribution to the common variance each of the dimensions makes.

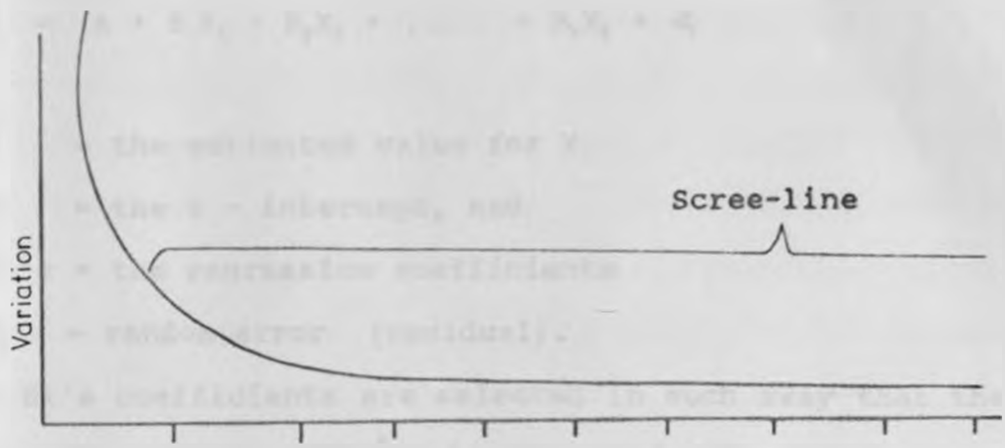
One factor cut-off criterion proposed by Kaizer (1960) is to limit the dimensions to those with eigenvalues greater than unity and to exclude the dimensions that do not account for at least the total variance of one variable. By eigenvalue, we mean the total amount of variance as the sum of the column of squared loadings for each factor (dimension).

Whilst the proportion of the variance in the variable accounted for by all the factors is known as communality (h_2). Communality sometimes can be defined as the sum of the squared loadings for each variable. A small communality value indicates that the value contributes little in the patterns of variation in the data. In other words it has a large unique variance. The unique variance can be determined by subtracting the community from the total variance of the variable which is unity.

Another criterion suggested by King (1969) has been of 5 Percent of the total variance lower bound. A third criterion is the scree-test formulated by Cattel (1966). The number of extracted factors is plotted against the proportion of the variance it accounts for. The curve fitted to the plot of the dimensions has a negative slope and tends to level-off when we get to the trivial factors. At the point of levelling-off there is a relatively sharp drop in the eigenvalues (Fig. 3.01). The proportion of the curve consisting of the trivial eigenvalues is called a scree-line.

On the whole factor analysis techniques can be employed to test or evaluate hypothesis deduced from a theory (Bell, 1955). It can also be employed to explore the underlying structure into a data matrix (Goddard, 1970) and to achieve parsimony in data description (Moser and Scott, 1961). Finally it can be used to transform a set of variables to a new set of orthogonal dimensions for input into a regression model (Kirby and Taylor, 1976).

In chapter 5, livestock production will be related to the conceptual dimensions (obtained by the factor analysis technique) through the use of multiple linear regression which will be examined in the next section of this chapter.



Dimensions (Eigenvalues)

Fig 3.01: Scree-test Curve ·

2. <u>Multiple Linear Regression Analysis</u>

This is a general statistical technique through which one can analyze the relationship between a dependant or a criterion variable and a set of independent or predictor variables. It may be viewed either as a descriptive tool by which the linear dependence of one variable on others is summarized and decomposed or as an inferential tool by which the relationships in the population are evaluated from the examination of sample data.

Multiple linear regression requires that variables are measured on interval or ratio scale and the relationships among the variables are linear and additive. However, the technique readily allows one to investigate variables measured on, continues scales and specifically investigates the interaction between categorical variables and continuous variables (Moveil, et. al. 1975).

In multiple linear regression analysis, values of dependent variable (Y) are predicted from a linear function of the form:

$$\hat{Y} = A + B_1X_1 + B_2X_2 + \ldots\ldots + B_kX_k + e_i$$

Where

$\hat{Y}$ = the estimated value for Y

A = the Y - intercept, and

Bi's = the regression coefficients

e_i = random error (residual).

The A and Bi's coefficients are selected in such away that the sum of squared residuals, $\Sigma(Y-\hat{Y})^2$ is minimized. The least square criterion implies that any other values for A and Bi's would yield a larger value of $\Sigma(Y-\hat{Y})^2$. Selection of optimum A and Bi's coefficients using the least squares criterion implies that the correlation between the actual Y-Values and the $\hat{Y}$-estimated values is maximized while the correlation between the independent variables and the residual values $(Y-\hat{Y})$ is reduced to zero.

The actual computation of A and Bi's require a set of simultaneous equations derived by differentiating $\Sigma(y-\hat{y})^2$ and equating the partial derivatives to zero. This involves long calculations but the use of computer software, SPSS permits the handling of a large number of independent variables and the dependent variable in a fast and accurate manner.

One of the main objectives of this study was to ascertain the major socio-economic factors influencing livestock production in Kisii district and rank them according to their significance. Both techniques, multiple linear regression analysis and factor analytic techniques enabled the researcher to isolate statistically significant variables by the former technique and ranked the factors by the latter. In a case where there was multicollinearity factor scores were used as independent variables because they are by definition unrelated.

The next two chapters presents the results and discussion of ecological and socio-economic factors that influence livestock production efficiency in the study area. Chapter 4 will solely examine the ecological factors and chapter 5 critically look at the socio-economic factors on the efficiency of livestock production.

3.4: Limitations to The Study

1. In one location, Esise in Agro-ecological zone 3 there is communal grazing land which is shared by some families. Special problems arose in assigning the communal land per family. In fact in this case, the collection of data may not be considered accurate. To overcome the problem, the researcher used a method suggested by Upton (1987) where the total land is first estimated and then divided by the number of families using the communal land. The portion was then added to the other private grazing land for the family farm.

2. In some few cases, the researcher found that the owners of the randomly sampled farms were absent and the family farms were under some people who were not informed of the farm situations. In other cases, they could not answer the questions about the farms because of fear that the head (husband) will beat them (incase of a wife) for having divulged information which is supposed to come from the head of the family. This was particularly true in zone 2 among the young farm population and monogamous families.

In such cases the researcher tried to solve the problem by interviewing neighbours who have same or almost same hectarages of the farms.

3. Some farmers were suspicious of the intention of the exercise and simply refused to be interviewed. Particularly, this happened to the research assistants who could not explicitly tell the significance of the study and hence failing to convince the reluctant farmers. In such cases it required the researcher himself to visit the suspicious farmers.

4. Generally, there was lack of secondary data on the family farms, locations and on each of the agro-ecological zones that were important as areal units of the study. This led to generalizations in this research.

5. Originally, the study intended to cover the whole of west Kenya. Unfortunately there were no enough funds, time and other relevant resources to cover this area. However, the problem was circumvented by choosing a representative areal matrix (see Section 3.02, Fig. 3.00) of Kisii district. All population characters were covered by employing stratified random sampling technique which eliminates any biasness.

6. There is the problem of applying multiple linear regression analysis to farm survey from the fact that it is impossible for the researcher to control any of the variable inputs. At least he could restrict the study to farms of certain size range or type, but he could not set any inputs of selected levels or arrange that the inputs were independently of each other. This still did not create serious problems if it could be assumed that the quantities of inputs used on different farms varied at random.

Unfortunately, this is not the case since the quantities of resources used are largely the result of conscious human decisions. The levels of variable inputs are closely related between themselves which leads to "multicollinearity". Its presence means that it is difficult if not impossible to disentangle the influences of the variables and obtain a reasonable precise estimate of their separate effects. However, as long as there is some independent variation between variables there is not "exact multicollinearity" and it may be possible to estimate separate marginal products for all variables (Upton, 1987).

7. Sometimes the problem of multicollinearity can be eliminated using a technique that groups together related variables. This was done using factor analytic techniques. However, several criticism have been levelled at the techniques that they are arbitrary, i.e different investigators can arrive at different answers - (they interpret the same results differently) using the same data and techniques. But as Rummel (1970) points out, this is not essentially so. On the contrary, a complete factor analysis of a data matrix is mathematically unique. The idea of arbitrariness has arisen in part from the problems associated with rotating factors once a factor analysis has been completed.

CHAPTER FOUR:

RESULTS AND DISCUSSIONS OF ECOLOGICAL FACTORS INFLUENCING LIVESTOCK PRODUCTION

4.0: Introduction

Ecological factors are undoubtedly the most basic and pervasive of the many determinants of livestock production systems. In any one locality it is the totality of all the ecological factors which characterizes the site, but it is useful to look at the range and impact of each individual factors. This chapter, therefore, will examine the relationships between some ecological variables and livestock production efficieny in Kisii District. The ecological factors considered include source and supply of water and provision of sheds to ameliorate stressful climatic conditions to the animals. Soil fertility in respect to production of livestock feeds and livestock pests and diseases are also considered. In essence this chapter will mainly deal with objective one (section 1.3).

4.1: Climate and Water Availability

Rainfall, temperature and day-length are all influential features of the climate of tropical systems. However, day length is rather uniform and temperature is a dominant influence only if it is extremely hot or where elevation or latitude produces a cooling effect, especially in those few areas where frost occurs (Pratt, 1984).

Rainfall has an overall dominant influence. Although there is a close relationship between mean annual rainfall and land use and potential, the correlation is even closer when water availability is substituted for rainfall (Pratt, 1984). Water availability depends partly on the absorptive capacity, and retentivity of the soil in relation to evaporation but it is determined primarily by the seasonality of rainfall.

Kisii District is considered a high agricultural potential zone in which rainfall amount is used as the main criterion. The relationship between livestock and rainfall is more complex than in crops. It will, therefore, be appropriate in this study to consider water availability and livestock production relationship which is closer as already been shown.

Survey results on water availability for livestock indicate that there is a problem. Animals are driven for long distances to watering points. Of the 110 farms visited, only 11.84 per cent (table 4.01) drive animals to watering points in a distance of less than 0.5 Km. Among these only 1.84 per cent had watering points on the grazing fields. The mean distance from watering points is 2.89 Km and the mode is 2.1 - 4.0Km (table 4.01). More than 25.45 percent drive their animals at least a distance of more than 4.0km to watering points.

Table 4.01: Distance from watering points and number of farmers in each Category

Distance(Km)	Number of farmers	Percentage	Cumulative Percentage
None	2.0	1.82	1.82
< 0.5	13.0	11.82	13.66
0.6 - 2.0	33.0	30.00	43.66
2.1 - 4.0	34.0	30.91	74.57
4.1 - 5.0	11.0	10.00	84.57
> 5.0	17.0	15.45	100.00

Source: Compiled by the Author, 1988.

As one would expect the magnitude of the problem is different from one Agro-Ecological zone to another and from one season to another. Agro-Ecological zone 3 is the worst hit. The average distance from the watering points is more than the mean of the study area (Table 4.02). The problem is compounded by the fact that most farmers in the zone have improved breeds of cattle whose water requirements is much higher than the local breeds. The problem is worse in some months of the year when average monthly rainfall is at the minimum. This is particularly true from the month of June to August and from November to February when monthly rainfall amounts are at the minimum. This is the time when seasonal rivers become dry (Plate 4:01) and thus requiring the animals to be driven longer distances for watering.

Computed correlation coefficient between distances from watering points and average milk yield is presented in table 4.03. It is negatively correlated (r = - 0.346). One important revelation from this result is that as the distance from watering points increases the milk yield declines.

Table 4.02: Agro-Ecological Zones in Relation to Average Distance from Watering Points

Zone	Distance (Km) from Watering Points
1	2.01
2	2.80
3	3.20
Average	2.98

Source: Compiled by the Author, 1988.

Williamson and Payne (1959) have stated that cows should always have access to water in the grazing paddocks and in the yards. This is a standard text book recommendation and should be regarded as the optimum and anything less than that will almost

Plate 4.01: cattle drinking polluted water in a pool of a seasonal river, a tributary of Esise in December 1988, one of the driest months in the study area.

Table 4.03: Relationship between the dependent variable (average milk yield) and distance from watering points - correlation output

ITEM	VALUE
Correlation coefficient (r)	- 0.346
Coefficient of Determination (r2)	0.1199
Degrees of freedom	108
X coefficient	- 3.743
Standard error of coefficient	0. 9802

Source: Author's Survey, 1988.

certainly have some effect on milk production. If this is regarded as the optimum, then 98.16 percent of the farms surveyed can be regarded as having some deficiencies in their water supply. Only 1.84 percent of the farms had unlimited supply of water which was distributed to all fields but even those had to spend a lot of resources to carry water to the fields.

It should be pointed out that although a farmer may have a river running through his farm, the watering point for his animals may not be located there. Most of them prefer driving their animals to communal watering points even when it is far from the farm. This is probably due to farmers' failure in understanding the economics of driving animals for long distances.

Although in all cases water supply is free, most farmers, especially in zone 3 where farms and number of livestock units are large have to spend money in the form of time, labour and other resources in getting water to the animals or vice-versa. In the majority of cases the provision of funds for this work was limited and a constraint to the supply of water which is a constraint to increased livestock production. This is because most farms rely on family labour which is also limited because of the other work in the farm that may have higher demand.

On the whole, water is a limiting factor not only to increased production but also to the economics of actual milk production in Kisii District.

4.2 (a): Temperature variation

Temperature data for this study was collected at a station in Kisii town which is situated in Agro-Ecological zone 2. Beside this station there were not other temperature records available. Thus, at the best the temperature data will be considered as a representative, because Agro-Ecological zone 2 occupies the largest area of the District.

The mean monthly temperature of the study area, table 4.04 is relatively low and can be considered suitable for the development of dairy industry. The relatively low temperature is due to high altitude (Fig: 2.01) which ameliorates the effect of tropical climate.

Johnson et.al (1963) have shown that at high temperature, milk yield of lactating Holstein Friesians decreased and water intake increased suggesting an inverse relationship. The animals were also shown to be eating less at high temperatures. The upper critical temperature of these animals was found to be

Table 4.04: Mean Monthly Temperature Variations in the study area, station at Kisii town (alt. 1766m).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Min. air temp. °C	10.5	12.1	12.4	12.5	12.7	11.7	11.4	11.4	10.6	11.7	11.1	11.5	11.6
Max. air temp. °C	27.9	27.0	26.0	24.7	24.2	24.6	24.4	25.6	26.6	26.9	25.1	26.8	25.6
Mean air temp. °C	19.2	19.6	19.2	18.6	18.5	18.2	17.9	18.6	18.6	19.3	18.1	19.2	18.7

Source: Compiled by the Author from Dagoretti Meteorological Station Nairobi, 1988.

(25°C) and this is the upper limit. Musangi (1978) gives 21° C as the critical temperature for exotic and improved dairy cows in East Africa. Considering the maximum mean monthly temperatures, table 4.04 indicates that from the month of August to March, temperatures are slightly higher than the upper critical temperature given by Johnson and others for optimum milk yield. But looking at Musangi's critical value,it leaves no doubt that the maximum air temperature is too high for optimum milk production in the study area.The maximum temperature occurs during the day when the animals are exposed to grazing resources which in turn results in the animal drinking less. It is now apparent as can be shown in the next section, (b) that the improved breeds of dairy cattle are highly affected by high temperatures during the day.

(b): <u>Provision of Shed</u>

Goldson (1977) has shown that provision of shed in the grazing paddocks gives the cow comfort when temperature are high. For example, <u>Bos taurus</u> milking cows increase water intake at comfort temperature. This increase has been attributed to an increase in feed intake and hence productivity (Winchester, 1964).

The significance of shed for cow comfort can be appreciated in plate 4.01 (a). High-grade, <u>Bos taurus</u>, cattle especially Friesians' grazing length of the daylight is radically curtailed and confined almost entirely to early morning and late afternoon periods. The importance of shed for cow comfort cannot be overemphasized. The friesians are large-bodied animals which make them more vulnerable to increasing temperature due to relatively small evaporating surface to the size of the animal.

Even if all cattle possess sweat glands, some type sweat more freely than others; cattle in general are poor sweaters as compared with some other mammalian species such as buffaloes, sheep, goats and pigs (Findlay and Yang 1950).

Plate 4.01 (a): High-grade Bos taurus Friesians under shed at Symbaut cooperative farm (Nyansiongo) at 10.00am.

As farmers gear towards the improvement of their stock, need for provision of shed increases. However, characteristic of most farms in the study area, is lack of sheds to provide cow comfort during the day (Plate 4.01(b). There is no shed for the animals although much of the farm holding is under bushes and trees (background). The implication here is that the importance of shed for cow comfort is unknown to most farmers.

Of the 110 farms surveyed only 20 (18.2 per cent) provided sheds in the grazing fields. The remaining 78.2 per cent exposed their livestock to harsh environmental factors, for instance high temperature without realizing that it affects the productivity of the animals.

Plate 4.01(b): Cattle placed in an enclosure where there is no single tree shed for the animals to take shelter when temperature was at the maximum (at 2.00pm).

4.3: Production of livestock feeds and soil fertility

About one third of Kisii district is covered with natural grassland (Fig. 5.01). The dominant ones are Kikuyu (Pennisetum clandistenum) and Star (Cynodon dactylon) grasses which spread easily by means of stolons (creeping stems which root at the nodes). The former is mainly confined in the higher altitude, while the latter is found in the lower areas of the district.

Although the portion of farms occupied by grassland is reasonably big, pasture farming is virtually unknown to most farmers. Except elephant grass known as napier grass (Pennisetum purpureum) whose contribution to animal forage is insignificant in the majority of the farms. The Pennisetum purpureum is of two types:

(a) Ugandan Hairless - This species is soft and succulent on maturation, and the stem can be eaten by cattle. The only disadvantage with the species is that it takes too long to mature.

(b) Cameroonian type - It establishes faster than the Ugandan. Its main disadvantage is that it hardens and very little is available to the cattle on maturation. Thus to be used effectively it must be eaten when it is young.

Other species of grass that are not common but have been found to do well on trial stations and large scale Dairy farms (Symbaut) are, Bana grass developed by crossing Pennisetum purpureum and Pennisetum typhoides, Giant sectaria. Guatemala grass, Panicum maximum and the Rhodes (Chloris gayana). There are also lurcene, sunflower, sweet potato leaves and maize. The latter two are dominantly fed to the animals during some seasons of the year.

Comparison with other agricultural enterprises it can be stated without undue generalization that pasture management is usually very poor, hardly any proper pasture husbandry techniques are applied. Failure to control grazing, none clearance of bushes (plate 4.02) and neglect of proper fencing are common features in the study area.

During the survey it was found that only 1.84 per cent had introduced cultivated grass on the farms. This means that the majority of farmers rely on natural grasses which in most cases are overgrazed. Evidence of overstocking is shown on plate 4.02 which was taken in Borabu Location in the New Settlement Scheme where farmholdings are reasonably large (4.62 Ha. per Household). The presence of Eleusine jaegeri to the left foreground of the plate is an indication of repeated overstocking. This is a hard grass which adapts well in such environment.

Currently, forage provided by natural grasses is inadequate to support the livestock industry in the study area. There is need to increase the productivity of livestock feeds in this most densely populated district in Kenya in order to maintain milk production for home consumption and sale. Studies conducted by Jaetzold and Schmidt (1982) indicated pasture farming will increase livestock feeds. Table 4.05 shows that if the natural grasses are replaced by planted pasture (without application of fertilizers) production of forage will be increased by 2.0 to 3.0 times. This will release some land which at present is under grass or increase the carrying capacity of the farms. Some species like Bana grass produces more than 3 times the quantity of tones of Dry matter (DM) and Total Digestive Nutrients (TDN) as Kikuyu grass.

Results of chemical soil analysis of the samples that were collected from the three major Agro-ecological zones indicate that the soils are deficient of important mineral nutrients that would have otherwise enhanced productivity of pasture. Table 4.06 presents the results of soil analysis. The sample shows moderately acid soil reaction with generally adequate supplies of magnesium and potassium and low levels of phosphorus.

The spatial deficiency of certain mineral nutrients is well marked in the study area. Phosphorus, an important ingredient of a fertile soil is deficient in the 3 Agro-Ecological zones. Soils in Agro-Ecological zones 2 and 3 are not only deficient of phosphorus but also calcium and magnesium. The deficiency of the latter is particularly pronounced in zone 2. Agro-Ecological zone 3 is the worst hit with the spatial deficiency of the important mineral nutrients and it also receives the least amount of rainfall in the whole of Kisii district (Fig. 2.02).

Table 4.05: The Productivity of Pasture in Kisii District (tones\hectare) (a)

Kinds of Pasture Production Per Year		I	II	III	Total
(a) Planted Pasture		Jan - Mar	Apr-Sep	Oct-Dec	
1. French Cameroon	DM	2.0	6.8	2.2	11.0
	TDN				7.2
2. Bana Grass	DM	3.1	10.7	4.4	18.2
	TDN				1.8
3. Giant Setaria	DM	1.9	7.4	3.6	12.9
	TDN				8.4
4. Guatemala	DM	1.2	4.7	2.2	8.1
	TDN				5.3
5. Boma Rhodes	DM	1.1	5.0	2.5	8.6
	TDN				5.6
6. Masaba Rhodes	DM	0.9	4.2	2.3	7.4
	TDN				4.8

7. Nandi Setaria	DM	1.2	4.7	2.4	8.3
	TDN				5.4
(b) Natural Pasture					
8. Star Grass	DM	0.4	2.7	1.3	4.4
	TDN				2.8
9. Kikuyu Grass	DM	0.7	3.0	2.0	5.7
	TDN				

Note (a): is yield at zero fertilizer input.
Source: Jaetsold and Schmidt (1982).

Plate 4.02: Taken at Esise location showing Eleusine jaegeri which survives in an overstocked environment.

The impression here is that although zone 3 has the largest population of livestock, it has the least carrying capacity per hectare amongst the zones of the district. One thing comes out clearly about the potentiality of an area: A marginal area to

Table 4.06: Results of soil Analysis from the 3 Major Agro-Ecological zones of Kisii District

CHEMICAL TEST RESULTS

Zone One

FIELD DESIGNATION	1	2	3	4	5	6	7	*
pH	5.20	5.60	5.70	5.30	5.10	5.60	5.30	(-)
Na.m.e.%	0.08	0.08	0.32	0.18	0.18	0.28	0.28	(-)
K.m.e.%	0.25	0.54	1.18	0.81	0.43	0.94	1.02	(0.2)
Ca.m.e.%	2.80	2.80	6.80	3.60	2.00	2.00	1.60	(2.0)
Mg.m.e%	1.80	1.40	2.60	1.90	1.40	2.00	2.30	(1.0)
Mn.m.e%	1.17	0.92	1.00	1.20	1.34	1.09	1.42	(0.11)
P.p.p.m	4.00	6.00	18.0	6.00	4.00	9.00	4.00	(20.0)
C%	0.28	0.29	0.34	0.32	0.29	0.30	0.20	(-)
N-%	2.21	2.49	2.57	2.41	2.25	2.71	1.72	(0.2)
Hpm.e%	0.50	-	-	0.60	0.40	-	0.60	(-)

Zone Two

FIELD DESIGNATION	8	9	10	11	12	13	
pH	5.0	6.5	5.00	6.00	4.90	5.00	(-)
Na.m.e.%	0.25	1.62	0.18	0.60	0.04	0.08	(-)
K.m.e%	0.11	1.96	0.69	1.56	0.11	0.11	(0.2)
Ca.m.e.%	0.80	13.60	1.60	8.00	0.80	0.80	(2.0)
Mg.m.e%	0.50	6.00	1.40	3.60	0.30	0.10	(1.0)
Mn.m.e%	0.98	1.00	0.75	0.78	1.12	0.45	(0.11)
P.p.p.m	9.00	52.00	18.00	9.00	6.00	12.0	(20.0)
N%	0.35	0.42	0.49	0.39	0.31	0.29	(-)
C%	2.86	3.32	2.58	3.01	2.49	2.57	(0.2)
Hp.m.e%	0.70	-	1.00	-	1.60	2.20	(-)

Zone Three

FIELD DESIGNATION	14	15	16	17	18	19	20	
PH	5.90	5.70	5.60	5.20	5.4	5.10	5.00	(-)
Na.m.e%	0.68	0.54	0.41	0.54	0.36	0.54	0.22	(-)
K.m.e.%	1.96	0.65	0.63	0.46	0.77	0.77	0.25	(0.2)
Ca.m.e.%	2.00	1.20	1.20	1.20	1.40	3.20	3.20	(2.0)
Mg.m.e%	1.60	2.20	1.20	1.80	1.60	1.90	1.40	(1.0)
Mn.m.e%	1.28	0.87	1.17	1.28	1.17	1.17	1.57	(0.11)
P.P.P m	4.00	4.00	6.00	2.00	4.00	4.00	8.00	(20.0)
N%	0.20	0.27	0.11	0.12	0.20	0.43	0.38	(-)
C%	1.61	2.90	0.88	0.80	2.04	3.04	2.65	(0.2)
HP.m.e.%	-	-	-	0.60	0.20	0.40	0.60	(-)

(Deficiencies underlined)

*(Critical levels bracketted)

Source: National Agricultural Laboratories Kabete, Nairobi.

agricultural enterprises can best be utilized by turning it to grazing field. But Kisii District with a leading rural population density in Kenya may not take longer for livestock to depend on natural grasses. At present the farmers should turn to cultivated pastures whose production will enhance the carrying capacity of livestock in the district. Application of fertilizers particularly nitrogenous and phosphatic have shown to greatly increasing the yield of pastures. The productivity is increased by more than twice. For example, addition of Nitrogen, Phosphorus and Potassium (NPK) fertilizer to Pennisetum purpurerum/Bana grass increased total digestive nutrients (TDN) from 4,500 to 10,000 and from 4,100 to 8,700 in Agro-ecological zones 1 and 3 respectively (Jaetzold and Schmidt, 1982).

It should be pointed out that use of fertilizers to promote productivity of pasture must be accompanied with highly productive stock in the study area. Furthermore, the fertilizer is effective and its use will lead to surplus pasture at certain times of the year. Farmers should be prepared to conserve the surplus as **hay** or **silage**: otherwise the use of fertilizer is likely to be a waste of money.

4.4: Diseases and Pests

Livestock units that die every year seem to be pointing that diseases and pest are serious problems in the study area. Farmers interviewed indicated that each loses an average of 1.2 livestock units per annum. However, this loss is highest in zone 3 and the least affected is zone 2. This is expected because zone 2 has the least improved and largest number of local breeds and Agro-Ecological zone 3 has the largest and highly improved breeds respectively. Table 4.06 shows the spatial deaths in the three Agro-Ecological Zones.

Table 4.06: The average spatial deaths of livestock units in the 3 Agro-Ecological zones.

Zone	Dead Livestock units per year
1	0.97
2	0.43
3	2.92

Source: Author's Survey, 1988

Table 4.07 also presents the endemic diseases that are mainly tick-borne. The study area has a hot and humid climate that favours the ticks to multiply rapidly, especially when the stocking rate is high creating a disease hazard through the transmission of a number of livestock diseases (for example, East Coast fever, heartwater, anaplasmosis).

It should be pointed out that many of the diseases of livestock are avoidable when there is good farm management. Although the climate of the study area favours the occurrence of the diseases, evidence from well managed farms (Symbaut) reveals that the diseases are not a serious threat to livestock industry. They are easily controlled by regular dipping or spraying or hand dressing the animals.

However, there is one major problem in terms of provision of dipping facilities. In particular, farmers who rely on communal dips lose more animals to tick-borne related diseases (ECF, foot and mouth) by infected animals when they are driven to the dips. Secondly, in most cases there is lack of acaricide solutions in the dips for long periods. During the interview most farmers indicated that they had missed the acaricide solutions for a period ranging from 3 months to one year. This means that the farmers who rely on dips have to wait for long periods for the acaricide solutions to be replenished by the Government.

Table 4.07: Tick-borne diseases found in High Agricultural potential Areas of Kenya.

Tick species	Animal affected	Diseases caused
Brown Tick	Cattle Cattle Cattle Sheep/goats	East coast fever Mild anaplasmosis Corridor disease Nairobi sheep disease
Red-legged tick	Cattle " " Cattle/Goats/sheep	Red Water East Coast Fever Mild Anaplasmosis Spirochaetosis
Blue Tick	Cattle " Cattle/Goats/Sheep	Red water Anaplasmosis Spirochaetosis
Bont Tick	Sheep Cattle/Sheep/goats	Nairobi sheep disease Heartwater
Bont-legged tick	Cattle/goats/sheep/ pigs	Sweating sickness

Source: Barber and Wood (1977).

At most dips also farmers complained that the acaricide solutions were too weak to kill the ticks, hence developing resistance. Farmers who regularly sprayed their animals with same acaricide solution, however, did not experience the same problem. From the foregoing it therefore, becomes obvious that the main reason for resistant is due to too dilute acaricide solution used in the dips.

4.5: Summary

Although it has been indicated that the study area is suitable for the development of livestock industry, improvement makes the stock vulnerable to ecological hazards. For instance when both exotic and improved indigenous dairy cattle are not regularly dipped/Sprayed they easily die due to tick-borne diseases that are endemic in the Kenya Highlands. It was also observed that the majority of farmers have to drive their stock long distances to watering points. This affects milk production because a lot of energy is expended in walking the animals.

Thirdly, it has been shown that the majority of farmers do not provide shed for cow comfort during the day. Again the improved stock is greatly affected thereby reducing their productivity because lack of sheds curtails and restricts grazing lengths to early in the morning and late in the evening.

Finally, there is also spatial deficiencies of important soil mineral nutrients in the grazing fields. This has led to low output of forage production which presently is not enough to support the livestock industry. However, there is hope because farmers have not started using fertilizers in enhancing the productivity of pasture.

On the whole, it can be concluded that the ecological variables examined above are influencing the production of livestock efficieny. It is therefore important to reject the null hypothesis (on page 8): " Observed variations in the production of livestock in Kisii District are not associated with variations in the ecological variables".

CHAPTER FIVE:

RESULTS AND DISCUSSIONS OF SOCIO-ECONOMIC FACTORS INFLUENCING LIVESTOCK PRODUCTION

5.1: Introduction:

This chapter analyses data at two levels. The first approach deals with objective two (section 1.3) by investigating the effects of individual variables on livestock production with consideration of the presence of other variables' effects. This multivariate analysis was attempted by means of Partial linear regression analysis according to Least Square procedure to explore the variance in the dependent variable (average milk yield) of livestock production.

The second level of analysis was done by factor analytic technique, specifically using principal component analysis (PCA). The technique is not only important in eliminating multi-collinearity but also important in ranking the components according to their relative significance. This analysis responds to hypothesis 3 (Page 8).

Firstly, the findings of Partial linear regression analysis are presented. These considered the effects of individual socio-economic variables on livestock production. Equation and table 5.01 present the results of the variables that were found to be statistically significant ($P < 0.01$ and $P < 0.05$) computed using average milk yields as the dependent variable.

$Y = A + B_1 X_1 + B_2X_2 + --- + B_9X_9$ -------- EQ 5.01

Where Y = Average Milk Yield

X_1 = Number of Livestock Units

X_2 = Grazing Hectarages

X_3 = Food Crop Hectarages

X_4 = Cash Crop Hectarages

X_5 = Farmers' Education

X_6 = Farmers' Age

X_7 = Labour

X_8 = Farmers Managerial ability

X_9 = Religion

Table 5.01:Regression Coefficients and standard Errors of Coefficients of average milk yields on Nine statistically significant socio-economic variables.

Independent variables	Standard Errors (S.E.)	Regression coefficient (R)	Cumulative R^2 (%)
X_1	5.280	0.218**	4.75
X_2	4.290	-0.509**	30.66
X_3	4.360	0.11*	31.89
X_4	4.280	0.107*	33.04
X_5	0.596	0.176*	36.14
X_6	0.105	-0.104*	37.22
X_7	0.044	0.189**	56.12
X_8	0.420	0.106*	57.24
X_9	0.026	-0.146*	59.37

* significant at $P < 0.05$
** significant at $P < 0.01$
Source: Author's Survey 1988

5.2: X_1 - **Livestock Components**

The main premise of this thesis lies on the improvement of livestock components and hence increasing yields per unit. In the study area, livestock represents an important component of small farms: some type of livestock commonly seen on the farms are ruminants and poultry.

In the multiple linear regression analysis, the number of livestock units were found to be statistically significant at $P < 0.01$ (table 5.01). They explained 4.75 Per cent of the total variation in milk production, and the relationship between number of livestock units and the dependent variable was positive ($r = 0.218$).Table 5.02 shows the frequency of family farms with various numbers of livestock units and dairy cows respectively. The total livestock units were calculated from the following:

Grade dairy cows	= 1.00;	Zebu heifer	= 0.4
Crossbred dairy cows	= 0.8;	Calves	= 0.2
Zebu " "	= 0.6;	Sheep/goats	= 0.2
Bulls\Oxen, 2 years or older	= 1.00;		
Dairy grade heifer	= 0.8;		
Crossbred heifer	= 0.6;		

Source: Barber and Wood (1977) pp -21.

Computation of correlation coefficient between total livestock units and dairy cows was found to be very strong, $r = 0.80$ (Appendix B). This points out that dairy cows (both improved and unimproved) are the most popular type of livestock amongst the farmers.

During the Survey only less than 5.0 per cent did not have dairy cows and more than 3.0 per cent of this, either had dairy heifers or the farmer had lost his dairy cow few months ago due to diseases and was in the process of acquiring one. The remaining less than 2.0 per cent were not staying at the farm or had just settled.

Table 5.02 : Distribution of total Livestock Units (TLUS) and Dairy Cows among the family farms.

No. of TLUs Dairy cows	No. of farms with each category of TLUs	%	No. of farms with each category Dairy Cows	%
None	2.0	1.80	5.0	4.5
<2.00	29.0	26.40	64.0	58.2

2.01-4.00	37.0	33.60	24.0	21.8
4.01-6.00	12.0	10.90	4.0	3.6
6.01-8.00	15.0	13.65	6.0	5.5
>8.01	15.0	13.65	7.0	6.4

Source: Author's Survey, 1988.

The positive relationship between number of livestock units and milk production does not only mean the popularity of dairy cows, but also implies that they are the most economic type of livestock in an area where land shortage is a problem. The correlation coefficient between land hectarage and total livestock units rated highly $r = 0.70$ (Appendix B).

The implication here is that larger farms keep more animals than small farms. These animals are of all sorts; that is bulls, dairy, beef, goats and sheep. But as the size of the farm becomes smaller, the farmers tend to specialiaze in dairy cows. Thus making them important components of total livestock units in the diminishing hectarages.

5.3 :X_2 - **Grazing Hectarages**

Figure 5.01 summarizes the land use pattern in the study area. The largest proportion of land is allocated to food crops. This is followed by hectarage under pasture and cash crops respectively. The average hectarage for cash crops are expected to be of equal size with food crops and pastures if it were not for zone 3, where average farm hectarages are larger and most farmers have not planted cash crops.

In the study area, much of the feeds come from the farms, particularly for dairy cows whose diet normally consists of bulky forage. The mean hectarage under grazing is 0.504 Ha. and more than 61.0 per cent of the family farms have been allocated less than 0.809 Ha to grazing (table 5.03). The remaining less than 39.0 per cent have more than 0.809 Ha.

Table 5.03 Distribution of farm sizes under grazing (Ha.)

Hectarages Range	Number of family farms	Percentage	Cumulative percentage
<0.808	68.0	61.8	61.8
0.809-1.616	10.0	9.1	70.9
1.617-2.424	7.0	6.4	77.3
2.425-3.232	7.0	6.4	83.6
3.233-4.040	5.0	4.6	88.2
>4.04	11.0	10.0	98.2
None	2.0	1.8	100.0

Source: Author's Survey, 1988.

The geographic distribution of various grazing hectarage sizes is somewhat uneven in the study area. Much of the grazing hectarages that exceed the average (0.504) are found in zone 3 and a small portion of zone 1. In zone 2, the grazing hectarages are smaller than the average of Kisii district. The former zones, 1 and 3 are located in Borabu location (Settlement Scheme) where farm sizes are larger than the average farms in the district.

During the survey it was found that 98.2 per cent of the respondents had allocated some portion of the family farms to grazing. The remaining percentage, less than 2.0 per cent were either having some other land elsewhere or they were not staying at the farm and had rented it to a neighbor.

In the multiple linear regression analysis between grazing hectarages and milk production, the regression coefficient was found to be negative, r = -.509. An important revelation from this finding is that large grazing hectarages are under utilized.

Whilst small grazing hectarages are used to the maximum, sometimes experiencing over-carrying capacity. it was also observed that as the farms become larger, the farmers prefer introducing other livestock units which do not contribute to milk production. Hence giving a negative relationship between grazing hectarages and milk yield.

It was evident that there is shortage of land for grazing. This is illustrated by a large percentage of farmers who graze their animals on communal grounds, for instance road reserves.

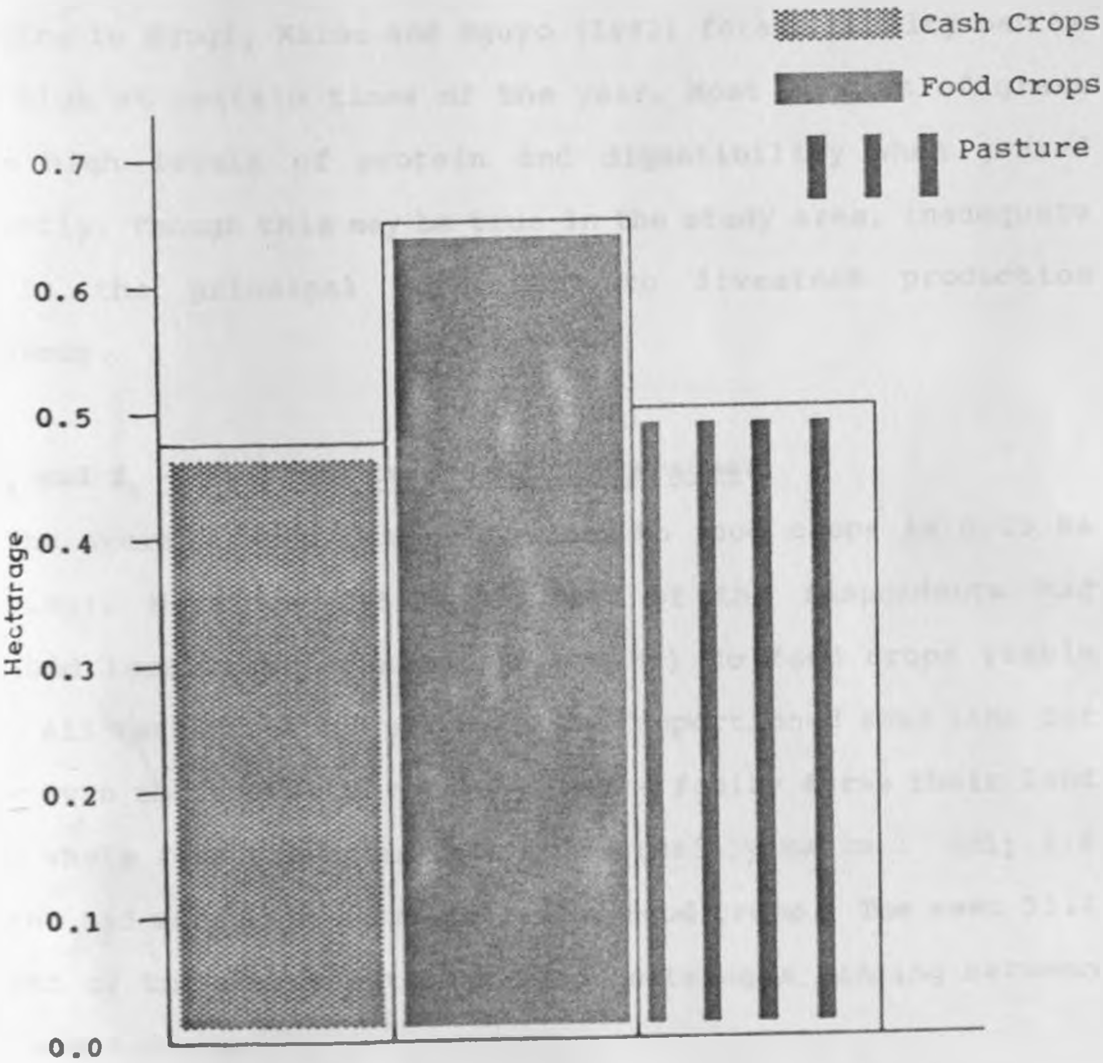


Fig 5.01: Average land use pattern in the study area
Source: Author's Survey, 1988.

Among the farmers interviewed, more than 50.0 per cent graze their animals on communal land. Though some of them denied grazing their animals on communal land, it was observed that when the animals are driven to watering points are allowed to graze along road reserves (plate 5.01). This means that the percentage is much higher, except few whose farms are large enough to provide adequate forage and those who practice zero-grazing. Off-farm grazing along roadside and other communal land is used extensively to supplement the private grazing fields. According to Ngugi, Karau and Nguyo (1982) forage quality can be quite high at certain times of the year. Most species of grass retain high levels of protein and digestibility when grazed frequently. Though this may be true in the study area, inadequate feed is the principal constraint to livestock production efficiency.

5.4: X_3 and X_4 - **Food and Cash Crop Hectarages:**

The average farm sizes allocated to food crops is 0.65 Ha (fig.5.01). More than 65.0 per cent of the respondents had allocated less than 2.0 acres (0.808 Ha) to food crops (table 5.04). All farms (i.e 100 per cent) had apportioned some land for crops. Even those who did not stay on the family farms their land or the whole farm was under food crops (mainly maize). Only 1.8 per cent had more than 4.041 Ha. under food crops. The rest 31.7 per cent of the respondents had food hectarages ranging between 0.809 and 4.04 Ha.

The relationship between food crop hectarages and livestock production is positive, r = 0.111 (table 5.01), and was found to be statistically significant at $P < 0.05$. This implies that the more food crop hectarages, the more milk produced from the family farms.

Table 5.04 : Distribution of farm hectarages under food crops

Hectarages Range	Frequency	Percentage	Cumulative Percentage
<0.808	72.0	65.5	65.5
0.809-1.616	19.0	17.3	82.7
1.617-2.424	7.0	6.4	89.1
2.425-3.232	9.0	8.2	97.3
3.233-4.040	1.0	0.9	98.2
>4.014	2.0	1.8	100.0

Source: Author's Survey,1988.

Plate 5.01 : Animals grazing along the road reserves.
This was one of the many farmers in zones 1 and 2 whose on-farm feed resources are inadequate. Thus the farmers supplement by grazing the animals on the roadside.

From the findings it can be correctly said that the interaction between food crops and animals components is not quite strong. Food crops explain only 1.23 per cent of the total variation in livestock production (table 5.01). The most important direct interaction is feeding crop residues to livestock. Maize stoker and thinning are sometimes available for livestock consumption. Banana leaves are also fed to the animals, especially in zone 2. Occasionally spoiled maize grains are particularly fed to dairy cattle.

The only time of the year when there is adequate feed for livestock is immediately post-harvest period of food crops (maize). This is normally between the months of June to October. This is especially true in zone 3 and a small part of zone 1 where family farms are relatively large. In other parts of the study area, in particular zone 2, where growing of cereal grains (maize and millet) are grown twice a year the livestock industry does not enjoy surplus feed in any season of the year. Livestock in Zone 2 should be benefitting more from post-harvest residues than Zones 1 and 2 since the growing of maize is throughout the year. However, as already indicated above, this is not the case. This is because farmers in this Zone use the residues as compost manure instead of feeding them to the animals.

Among the three land uses in the study area, the average hectarage under cash crops is the smallest (fig: 5.01). The most important cash crops in the district are tea and coffee and most of them are found in zone 1 and 2 respectively. In zone 3, maize is the main food-cum-cash crop, with tea found in isolated farms.

The average farm sizes under cash crops is 0.47 Ha. The majority of the respondents had less than 0.809 Ha. under cash crops and this constituted more than 62 Per cent of the sampled population. The distribution of various hectarages is shown in table 5.05:

Table 5.05 : Distribution of various hectarages under cash crops

Hectarage Range	Frequency	Percentage	Cumulative Percentage
None	28	25.5	25.5
<0.808	69	62.7	88.2
0.809-1.616	9	8.2	96.4
1.617-2.424	4	3.6	100.0

Source: Authors's Survey, 1988

From 110 cases, 25.5 Per cent did not have cash crops (tea and coffee) on the farms. Their sources of income mainly come from the sale of livestock products (milk) and\or sale of cereal grains (maize) and this is especially true in the whole of zone 3.

The relationship between cash crops and livestock production (average milk yield) was found to be positive ($r = 0.0107$) and was significant at $P < 0.05$. The implication here is that cash crops are playing a supportive role to the livestock industry. This is particularly true with tea whose sale proceeds enable the farmers to buy the concentrates and additives such as salts and other inputs. The correlation coefficient between cash crops and the above mentioned inputs is $r = 0.23$ (Appendix B). It was evident in zones 1 and 3 that farmers who produced a lot of milk also had put much of their farms under cash crops (tea). In addition, they had improved milking cows (pure and crossbred cows).

It should be noted that the price of pure grade cows depending on the size and breed ranged from Kshs 5,000 to Kshs 12,000. The indication is that the proceeds from the sale of tea is not only important for farmers to procure additives and concentrates, but also to adopt dearly improved grade cows.

5.5: Total Farm Hectarages:

The average farm sizes are 1.75 Ha. and the majority, more than 56.0 per cent of the respondents had less than 1.617 Ha. Those who had more than 4.04 hectares were 28.1 per cent and most of them are found in Borabu location. In other parts of the District where family farms are more than the mean sizes (1.75 Ha) are those whose head is at an advanced age and family sizes are large. This is particularly true because the coefficient of correlations between farm size and age, and family size were quite high, r = 0.62 and r = 0.43 respectively (Appendix B). Suggesting that older farmers had relatively large farm sizes. It is also true that these farmers have old sons who would have inherited pieces of land from their fathers. Thus if family farms are subdivided amongst the sons their sizes would be much smaller.

Computations done on milk productivity on various ranges of family farm sizes (table 5.06) revealed that productivity increases with hectarage and it is at optimum when the size of the farm is between 0.809 - 1.616 Ha. Above and below this range the

productivity drops. This suggests that there is an optimum range (0.809 - 1.616 Ha.) of farm size that can support livestock production most effectively. Farm sizes below this range are too small to provide adequate feed which may be a principal constraint to livestock productivity.

Table 5.06:Relationship between farm sizes and Livestock productivity

No. of Respondents	Hectarages range	Total hectarage	Milk in litres	Litres of milk/Ha
25	<0.808	17.17	117.2	6.83
27	0.809-1.616	29.94	226.7	7.57
16	1.617-4.04	43.20	290.2	6.72
32	>4.05	254.22	1221.5	4.82
100(a)		344.53(a)	1855.6(a)	5.39(b)

Source: Author's Survey, 1988

Note: (a) and (b) indicate sum and mean respectively.

From the above finding it can be concluded that livestock production (milk) is not a viable option in farms that are Less than 0.809 Ha. However, it was evident that all farmers (98.2 per cent), except those who are not staying on the farms (table 5.03) had allocated some portion of the land to grazing although economic returns per hectare of most other on-farm activities are higher than livestock production. Table 5.07 which shows the national average values of different commodities rank milk production/Ha. as the second last commodity according to its economic contribution.

Looking at livestock production in economic terms alone is misleading. There are other important issues that should be examined in terms of social satisfaction. But in an area where land shortage is a problem, we should expect the farmers to specialize on on-farm activities that bring maximum economic returns. This is a clear indication that farm size is not the only factor influencing livestock production. It is therefore important to examine other factors although the size of the farm under grazing, food and cash crops were found to be statistically significant in influencing livestock production (Table 5.01).

Table 5.07: Estimated value per Hectarage for selected commodities

Commodity	Value per Ha (Kf/Ha)	Rank
Coffee	1489	1
Tea	1325	2
Vegetables	913	3
Pyrethrum	419	4
Fruits	295	5
Root crops (potatoes)	205	6
Maize and beans(a)	153	7
Milk	70	8
Millet and sorghum	48	9

Source: Sessional Paper No.1/1986: Republic of Kenya pp.64

Note: Because beans are typically inter-planted with maize the two crops are considered together, maize alone accounts for 13.3 per cent of the total value of (a).

5.6: X_5 - Farmers' Education

In the present study the modal level of education of the population was 4 to 7 years of school (up to primary), while 71.3 per cent had a primarily level of education of which 4.6 per cent had technical training (fig. 5.02). Those with professional training, after high school level are less than 2.0 per cent. The findings of those who cannot read or write (illiterate) were 42.6 per cent and those who could read\write only in vernacular, Ekegusii adds up to 76.4 per cent. This meant that only less than 24.0 per cent could read and write in Kiswahili and English on top of Ekegusii.

The modal category of farmers' wives education was none educational and including those who had primary education up to standard 3 formed 65.7 per cent (Fig. 5.02). In general the husbands were better educated than the wives. Those having higher level of education were married to the farmers of same or better than average education or farmers of higher socio-economic status in the community. Socio-economic status means the position or standing of an individual in a society whose profession or the like is ranked based on consensus of members of the community or society as to what they regard to be "high" or "low" characteristics. The attributes of the individual of high status is associated with those who give power or/and those who have amassed wealth (rich businessmen).

The influence of education on livestock production has a positive relationship, r= 0.176 and statistically significant at 0.05 level of significance (Table 5.01). Education and its relationship to farming progressiveness has been studied by numerous researchers most of whom support the evidence of a positive correlation between education and the adoption of improved practices and hence efficiency (Bembridge and Burger, 1977 and Sewakambo (1985).

The present study show that clear cut relationships between increased livestock production efficiency is hard to establish. This is because the number of years of schooling is related to other factors likely to influence farming efficiency. However, there is one thing clear with these findings.
They imply the need for mass media such as bulletin and leaflets to be written for different educational levels.

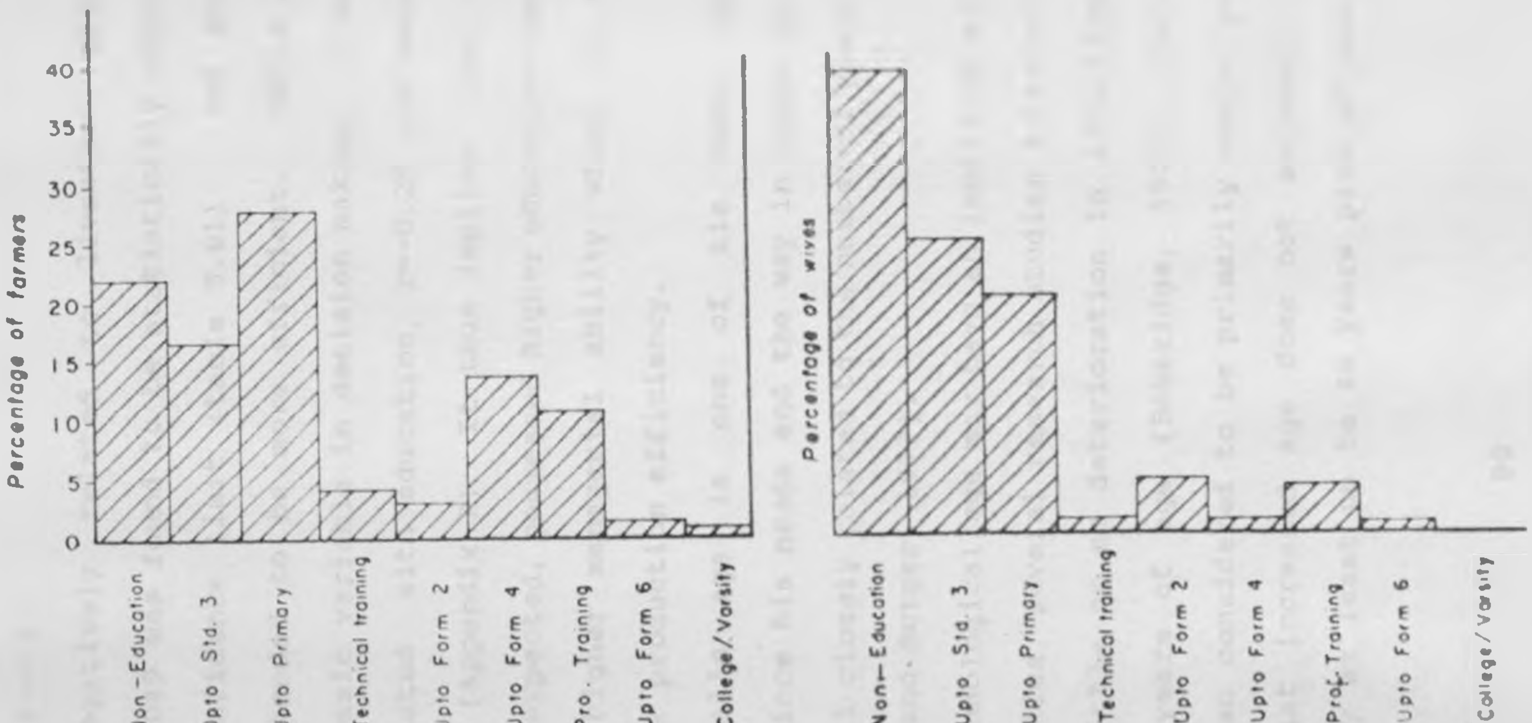


FIG 5.02 EDUCATION LEVELS OF FARMERS AND THEIR WIVES SAMPLE SURVEY, 1988

5.7: X_6 -**Farmers' Age:**

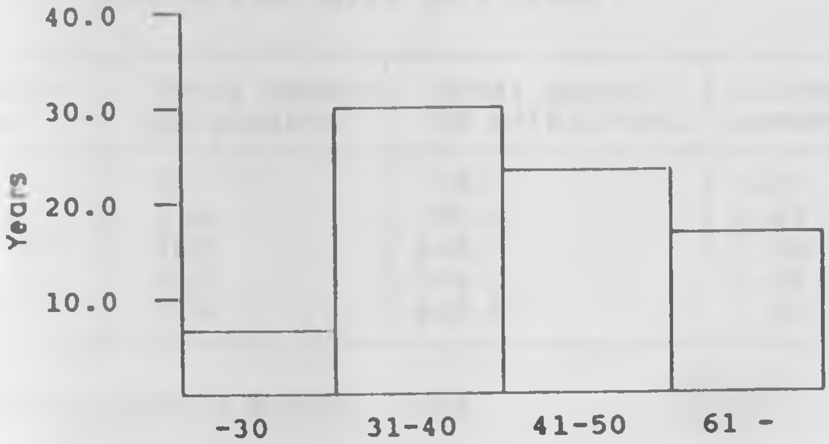
As is typical of farm populations, the age distribution was unskewed from young ages (Fig. 5.03). Only 8.3 per cent of the respondents were below 30 years of age, 58.7 per cent were in the middle age, ie between 31 and 51 years and 33.0 per cent were more that 51 years old.

Age was negatively related to livestock production efficiency, r=-.1049 was found to be statistically significant at 95 percent confidence limit (table 5.01) and therefore younger farmers tended to be more efficient. While age is theoretically a basic variable in decision making, it was also negatively correlated with education, r=-0.29 and managerial ability r=-0.23 (Appendix B) It thus implies that younger farmers, as maybe expected, possessed higher education than older farmers showing higher managerial ability which in essence enhanced livestock production efficiency.

An individual's age is one of his most important characteristics since his needs and the way in which he thinks and behaves are all closely related to the number of years he has lived (Bembridge and Burger, 1977).

Although Chronological age may have an impairing effect on Physical capabilities, several research studies in recent years have indicated little or no deterioration in intelligence at least up to 60 years of age (Bembridge, 1976). Since farm management has been considered to be primarily mental process, it is assumed that increased age does not seriously impair managerial ability at least up to 60 years plus of age (Ibid, 1977).

Fig. 5.03: Farmers' Age groups.



Source: Author's Survey, 1988.

However, age and family size are positively correlated, r = 0.48(appendix B:). This suggests that the older people have large family size. These findings point towards the added financial commitments of raising a large family which may act as constraint to livestock production efficiency. This is exemplified on table 5.08 which shows a sharp decline in milk production as family size increases.

However, the results show that there is an increase in milk production as the family size goes beyond 12.0 persons. This discrepancy arose because the head of the family farm could not exactly tell the people who were directly under him. This was especially true in zone 3 where farms are large and the owners had allowed relatives to carry out on-farm activities. During the survey, they were considered to be under him, though he did not support them directly. Furthermore, there was a positive correlation between the family size and farm size, r = 0.43 (Appendix B) which points towards the same contention. That is, in cases where the family is large, some members do not directly depend on the head of the family.

Table 5.08: Relationship between family size and livestock production (milk in litres)

Family Size	Total Number of persons	Total amount of milk(litre)	Litres of Milk/ person
<5.0	26	78.3	3.01
6 - 7	126	305.6	2.43
8 - 9	282	448.5	1.60
10 -11	246	345.3	1.40
>12.0	270	435.5	1.61

Source: Author's Survey, 1988.

5.8:X $_7$ - Labour Requirements

All labour input was provided by the family, except in zone 3 where some farmers have large stock of animals and have engaged laborers to herd them. It was found that the farmers spent an average of 2.94 hours looking after animals. The time spent on looking after animals involve the amount of milk they produce which in the study area is obtained by hand rather than machine and whether the animals are fenced, herded or stall fed. During the survey it was observed that 36.6 percent of the farmers herded and\or tethered their animals in the stall (zero-grazing). The remaining, 61.8 per cent fenced and tethered their animals in the grazing fields.

Generally, it was difficult to establish the relationship between labour requirements for unimproved and improved stock. In all cases the improved stock was fenced rather than herded and hence produced more milk. On the other hand, most of the unimproved livestock have lower labour requirements than improved. In fact, however, the labour coefficients were higher in zone 3 for unimproved stock. This is because the larger farms have many kinds of livestock which is herded by paid herdsboy or young members of the family.

Labour input coefficient was positively related to livestock production, r = 0.189 and was statistically significat at 0.01 level of significance (table 5.01). An important revelation from the finding is that the more hours spent looking after the dairy cows, which involves grazing, feeding and watering, the more milk is raised by the farmer. Improvement of livestock industry will not only provide adequate delicious and nutritious food but will also provide employment opportunity in this most populous district in Kenya.

5.8:X_8 - **Managerial Ability**

According to the scales devised by Burger (1967) and slightly modified for this study (Appendix A1) respondents managerial ability ratings and the dependent variable was found to be positive, r = 0.106 and statistically significant at 99 percent confidence limit (table 5.01). Results in table 5.09 gives the livestock industry some cause for concern in the study area. More than 39.0 per cent have very poor managerial ability and are probably unable to fully integrate modern principles and technology into farming systems. More than 63.0 per cent can at best be described as below average and about 32.0 per cent have average. Only less than 6.0 per cent have good and very good managerial ability.

The significant differences in managerial ability were explained by sound forward planning and objectives, suitable farm office facilities, adequate financial and livestock records and effective budgetary and expenditure control. All items in the scale (Appendix A1) are important elements but a large proportion of farmers tended to concentrate on one or more elements to the exclusion of others. In view of the individual and the collective importance of these factors of management, it is imperative for extension staff to direct more effort towards influencing of farmers to initiate these practices and thus facilitate an overall improvement in management and decision making.

Efficient livestock production requires the application of these scientific principles and concepts of animal husbandry and management. Management of the farming enterprises is the key to efficiency. Without this even with the most up-to-date knowledge of modern practices and techniques there is less likelihood that the enterprise will be efficient or a financial success (Van Zyl, 1965). The extension worker has a key role to play in influencing management.

Table 5.09: Respondents' Managerial ability scores by efficiency category

Managerial Ability Scores		Number and percentage respondents per efficiency category		
Scores	Efficiency	Number	Percentage	Cumulative %'ge
<7.0	V. Poor	43	39.1	39.1
8-10.0	Poor	27	24.5	63.6
11-15.0	Fair	34	31.0	94.6
16-20.0	Good	4	3.6	98.2
>21.0	V. Good	2	1.8	100.0

Source: Author's Survey, 1988 .

He can do this by providing more knowledge and understanding on livestock production process by shaping attitudes to promote better practices and by teaching new skill and techniques to production and efficiency.

5.9: X_9 - Religion

Religion was negatively related to livestock production efficiency, r = -0.146 and statistically significant at 95 percent confidence limit (table 5.01). It is also negatively correlated with many other variables (Appendix B). This is in agreement with other studies (Gregory, 1970, Deffontaines 1948, Malinowski 1953 and Conklin 1957) which indicate that irrespective of what changes take place in the physical , institutional, cultural and infrastructural environments religious practices affect agricultural production. This negative relationship can probably be explained by a lot of time devoted to religious rites and ceremonies. Thus, little time is left for on-farm activities. Generally, it can be concluded that the following variables; grazing, food and cash crop hectarages, education, managerial ability, labour, religion, family size and age were found to be statistically significant in affecting livestock production efficiency. The above first six variables indicating a positive relationship while the latter variables having a negative relationship with livestock production efficiency.

5.10: Results of Principal Component Analysis

In this second level of analysis, factor analytic technique was used to extract components (factors/dimensions/constructs) from the 29 raw variables. Using Kaiser (1960) method which limits the components to those with eigenvalues greater than unity and exclude the components that do not account for at least the total variance of one variable it was possible to extract 9 components. The method is well developed in Spss computer software and could easily extract those components whose eigenvalues are/or are more than unity.

According to factor analytic technique, the first component extracted accounts for the greatest common variance in livestock production. The second component explains much more of the remaining variance than the subsequent components and this continues until the last is reached; that is the 9th component accounts for the least variance in livestock production in Kisii District. In other words the components are extracted in order of their decreasing magnitude of contribution to the total variance in livestock production.

In addition the technique was used to extract scores of the 9 factors which were later used in regression. The 9 factor scores are unrelated by definition and this helped to eliminate the problem of multicollinearity. Furthermore, any quadratic function that could not be handled by multiple partial linear regression analysis is catered for by Principal Component Analysis (PCA).

From the results in table 5.10, it is possible to construct a profile of major socio-economic factors affecting livestock production in Kisii district. By and large, family size-extension contact, fragmentation-cosmopoliteness, agro-ecological, age, marital status-religious and concentrate-additive inputs in that order are major factors. Besides economic factor, management and education have greater impact on livestock production. The economic factor is of greatest influence on livestock production. Next in rank is management according to principal component analysis technique. This is followed by education, fragmentation-cosmopoliteness, age, marital-religious status and concentrate- additive input factor.

However, hectarage under food crops, wives education and farmers' literacy appear to be compound variables. By compound we mean those variables which appear in more than one factors. Hectarage under food crops is found in factor 1, economic and is also found in factor 9, concentrate-additive input.

The correlation co-efficient between the hectarage under food crops and the 27th variable (concentrates/fodder/salts) is relatively high r=0.44 (Appendix B). This is because most of the concentrates are prepared from maize grains as already been shown in section 5.02-(X_3). A farmer who has large hectarage under maize, stands at a high chance of harvesting large quantities of spoiled maize grains.This was particularly true in zone 3, where farms are large and maize the predominant crop-both as a cash and food crop. This means that the only economical way to dispose of it is to feed them to the animals as concentrates. The concen- trates are normally prepared by grinding the maize grains and then mixed with the salts before given to the animals.

Wives education and farmers' literacy appear in both factors 4 and 5. Wives education, farmers literacy, family size and extension contact form factor 4. The correlation coefficients

Table 5.10: Major components of socio-economic variables influencing Livestock production in Kisii district, extracted by principal component analysis technique:

FACTOR	NAME/VARIABLES	FACTOR LOADINGS
1.	Economic Factor	
	Variables:	
	V.15: Number of Livestock units	0.17931
	V.16: Number of Milking cows	0.17182
	V.17: Farm size in hectares	0.15645
	V.18: Hectarage under grazing	0.15395
	V.19: Hectarage under food crops	0.14966
	V.20: Hectarage under cash crops	0.12019
	V.30: Labour	0.15171
2.	Management Factor	
	Variables:	
	V.12: Managerial aptitude	0.19717
	V.13: Conservation concern	0.29028
	V.24: Grazing management type	-0.25493
	V.25: Use of bulls/A.I. Services	-0.25495
	V.26: Possession of dairyshed/ fence/paddock pasture	0.16895
	V.28: Dipping/Spraying Frequency	-0.24503
	V.35: Use of communal grazing resources	-0.19321
3.	Educational Factor	
	Variables:	
	V.6: Farmers' Education	0.24595
	V.7: Wives' Education	0.29048
	V.8: Farmers' Literacy	0.25739
	V.9: Wives' Literacy	0.35160
4.	Education-Family size-Extension Contact Factor	
	V.7: Wives Education	0.18058
	V.8: Farmers Literacy	0.20100
	V.10: Family size	0.31087
	V.29: No. of visits by Agr./ Vet. officers	0.26768
	V.34: No. of visits to Demonstrations plots	0.43392
5.	Fragmentation-cosmopoliteness Factor	
	V.14: Cosmopoliteness	0.39629
	V.21: Land Fragmentation	0.41668
6.	Agro-ecological Factor	
	V.2: Agro-ecological zones	0.67930
7.	Age Factor	
	V.4: Farmers age	0.41607

V.5: Respondents age 0.43281

8. Marital status-religion factor

V.3: Marital Status 0.16343
V.11: Religion 0.58593

9. Concentrates-Additive input factor

V.19: Hectarage under food crops 0.16343
V.27: Provision of fodder, concentrates and salts 0.58593

between wives education and family size and extension contact were r = 0.29 and 0.31 respectively (Appendix B). It is evident that education is negatively correlated with family size and positively related to extension contact.

According to Maunder (1962), farm women who have participated in extension activities have reacted better than men in most instances, except in cash crops where men have shown an active interest in farming. In this study, improvement of wives education has not only enabled them to reduce their family size but also make more contacts with extension workers on their own initiatives.

Marital status and religion were grouped together to form factor 7 - Marital status-religious component. Marital status was originally grouped under single, married (monogamous), married (polygamous) and widowed. However, during the field survey, there were not single cases that own farms in the study area. The groups were therefore built from married (monogamous), married (polygamous) and widowed.

It was observed that the dominant religious sect in the study area is seventh Day Adventist (SDA) which comprised of 59.6 per cent of the total respondents. Catholic was second consisting of 28.3 per cent and the remaining 12.1 per cent belonged to other religious denominations.

It is evident that the relationship between marital status and religion are fairly strong r = 0.36 (Appendix B). Considering the percentage of married (mono) and adherents of SDA sect (table 5.11) are of almost the same size. One of the main reason is due to restrictions imposed to SDA followers that require them to be monogamous.

Table 5.11: Frequency of Marital Status and Religion

Marital Status	Percentage	Religion	Percentage
Married (Mono.)	65.5	SDA	59.6
Married (Poly.)	29.0	Catholic	28.3
Widowed	5.5	Others	12.1

Source: Author's Survey, 1988.

In regressing the nine factor scores against the dependent variable (average milk yield) using F-test, seven of them were found to be statistically significant at $P<0.05$, 0.01 and 0.001 (table 5.12). The results of the nine factor scores as the independent variables indicate that economic factor has the greatest influence on livestock production in Kisii district. It explains about 67.4 per cent of the total variance in livestock production. This is followed by management, education, Land fragmentation-cosmopoliteness, marital status- religious, age and concentrate-additive input.

Factor scores of factor 4, Education-family-extension contact and factor 6, Agro-ecology were found to be statistically insignificant (table 5.12). The insignificance in factor 4, can probably be explained by the compound variables; wives education and farmers literacy which had already been regressed in factor 3.

Tables 5.12 Regression coefficients and standard errors of coefficients of average milk yield of the nine factor scores as independent variables

Factor	SE.B	Regression coefficient(R)	Cumulative R^2 %
1	0.948	0.821	67.4 ***
2	"	0.320	77.6 ***
3	"	0.145	79.7 ***
4	"	0.018	79.8
5	"	0.125	81.3 ***
6	"	-7.510E-03	81.4
7	"	-0.100	82.3 **
8	"	-0.124	83.9 ***
9	"	0.068	84.5 *

*** Significant at $P < 0.001$
** Significant at $P < 0.01$
* Significant at $P < 0.05$

Source: Author,1988.

Factor 5, consists of two variables; land fragmentation and cosmopoliteness which can be named as fragmentation-cosmopoliteness factor. Land fragmentation refers to possession of more than one family farms in different locations. Whilst cosmopoliteness refers to the degree to which individual farmers have travelled/stayed /studied outside their immediate local social system (outside the district) and consequently more likely to be influenced by wider reference groups.

Fragmentation-cosmopoliteness factor related significantly with the livestock production efficiency, $r = 0.125$ at $P < 0.001$ (table 5.12). The correlation coefficient between land fragmentation and cosmopoliteness was found to be 0.36 (Appendix B). The fact that it is a positive correlation it is evident that people who have travelled more outside their immediate environment also have other pieces of land elsewhere. This was particularly true in zone 3 and part of zone 1 which are the New Settlement Scheme. The farmers in these zones formed cooperatives (Land buying companies) which enabled them to buy land from the white settlers. This was too expensive for below an average economic person. At best, we can say that the people who occupy the settlement scheme (Borabu location) are above average of most peoples' economic status in Kisii district.

Among the 67 cases interviewed in zones 1 and 3, 59.7 per cent admitted having other pieces of land elsewhere and most of them were found in Borabu location. The other land referred to by Borabu respondents was ancestral and in most cases was farmed by their next of kin or rented.

According to most studies (Chisholm 1962, singh et.al, 1987) land fragmentation is negatively related to farming efficiency. However, this study shows that fragmentation-cosmopoliteness is positively related to livestock production efficiency. This is probably because the people who have land fragments and travelled a lot are economically stable than those who have not as already been shown above. It is a fact that people cannot travel outside their immediate environment and buy a piece of land without money. This point emphasizes the significance of economic factor in livestock production efficiency. Furthermore cosmopoliteness seems to have an overriding influence on land fragmentation. This suggests that people who travelled a lot outside their immediate social environment have higher managerial ability, thus leading to increased productivity.

5.11: Summary

Various socio-economic components analyzed have shown that they are significant in influencing livestock production. Economic dimension has the greatest influence. Although farm size as one of the major economic variables is significant in affecting the productivity of milk, provision of labour is equally important.

The positive relationship between labour and milk production efficiency indicate that improved productivity of livestock will provide more job opportunities in this most densely populated District in Kenya.

Management factor was found to be the second most important aspect of livestock production. However, managerial ability for the majority of farmers was below average. Education the third most important component has a greater impact when the wives have higher education. This is because educated women take initiatives to contact extension staff for advises on management of livestock. They are also quick to notice and take action when their stock is not doing well because they spend most of the time with the stock, especially the in-milk dairy cows.

Other dimensions that are significant include age, land fragmentation-cosmopoliteness, marital status-religion and family size-extension staff contact. Age, marital status-religion and large family size have a negative influence on livestock production. But well trained extension staff can reverse the influence of the above factors.

Finally, it is important to reject the Null hypotheses (2) on page 8 and accept the alternative. It has been shown that total livestock units, size of farms, labour, management, education, age, religion and family size have statistically significant relationships with milk production efficiency. It has also been shown that the Null hypothesis (3) should not be rejected. This is because the relative magnitude of the factors that affect livestock production efficiency were found to be different.

CHAPTER SIX:

SUMMARY, CONCLUSIONS OF THE FINDINGS AND RECOMMENDATIONS

(A) Summary and conclusions of the findings

This study set out to investigate the influence of ecological and socio-economic factors on livestock production. It was conducted in an area, Kisii District which shares most of the characteristics of High Agricultural potential Areas of Kenya. The study area was covered in terms of Agro-ecological zones (FIG. 3.00); thus emphasizing the element of ecology - significant in leading to systematic random sampling.

In the analysis chapters (Four and Five) it has been shown that both ecological and socio-economic factors have great influence on the livestock industry. In particular, among the ecological factors, provision of water to the animals offers a serious challenge to the livestock farmers. Although the study area is under High Agricultural potential zone of Kenya where rainfall amounts received per annum is used as the main criterion the temporal and spatial distribution of rainfall and surface water are quite uneven.

Some months of the year especially from November to February, rainfall amounts received in the study area are lowest. Small and seasonal streams are known to drying up during this period (Plate 4:01). This has always meant to driving the animals for long distances to permanent communal watering points. Though the distribution of surface water is not even, it was observed that livestock farmers accentuate the problem of water supply to their stock. Seemingly, the farmers do not understand the economics of driving animals for long distances to watering points. This is demonstrated by farmers whose animals are driven long distances yet a stream is traversing through his farm but opts to communal watering points. It is also clear that the state of livestock, for example whether in-calf, in-milk, dry, heifer, steers, bulls or calves are driven together without selective watering and feeding.

In addition to water shortage in the months of November to February there is also inadequate forage because of insufficient rainfall amounts to support rapid growth of pasture. Agro-ecological zone 3 is the worst hit with these spatial deficiencies. The zone does not only receive the least amount of rainfall amongst the other zones, but also the average distance the animals are driven to watering points is more than the average distance for the whole of the study area (Table 4.02). Thirdly, the zone has the largest and most improved breeds of dairy cattle amongst the zones. These animals require more water in terms of frequency and quantity intake. This means that the animals are subjected to more suffering and their productivity greatly affected.

Results of soil chemical analysis also indicate that significant mineral nutrients that are important for soil fertility are inadequate in the study area. This has led to inability to produce enough feeds for the animals because farmers hardly apply fertilizers in the pasture fields to enhance productivity. Again zone 3 is the worst hit. Coupled with inadequate rainfall amounts and irregular distribution of surface water and most improved and largest number of dairy cattle implies the zone needs greater and immediate attention to maintain and enhance productivity of the livestock industry in Kisii District.

Diseases and pests also pose a major challenge to livestock industry in the district. The most vulnerable stock are the exotic and up-graded dairy cows. The tick-borne diseases are endemic in High Agricultural potential Areas of Kenya where these grade cattle do well when the diseases are controlled by regular dipping\spraying of the stock. As observed, however, in most farms in the study area the tick borne diseases are a threat to livestock industry. Farmers are losing an average of 1.2 total livestock units per family farm to tick-borne diseases because of irregular dipping. The farmers who rely on communal dips are the worst hit because of irregular supply of dip acaricide solutions and poor management of dips. The acaricide solution in the dips are always under-concentration. This has made the ticks to develop resistance and thus rendering the acaricide ineffective.

It should again be pointed out that this ecological menace is felt most in zone 3 where the largest number of improved breeds are found. Control and modification of the aforementioned environmental factors can greatly enhance the productivity of livestock industry in the study area. Unfortunately, the socio-economic dimensions that are meant to modify these factors for increased productivity in livestock industry have a major limitation.

Firstly, findings on socio-economic factors presented in chapter five have yielded sufficient evidence to indicate that they are important dimensions in explaining and understanding variations in livestock production efficiency. The relationship was definitely found to be a multi-variant cause-effect phenomena. This was because of the great number of intervening and related variables involved in the structural change of livestock industry.

All the socio-economic variables that correlated with livestock production efficiency were in turn related to some of the others in varying degrees (Appendix B). Economic variables isolated as a factor had the greatest impact on livestock production efficiency. Land as an economic variable has become scarce that there is steep competition from many on-farm activities. There is not enough grazing resources in some of the Agro-ecological zones of the district. Secondly, farmers compound the problem of inadequate feeds by keeping too many poor quality total livestock units instead of keeping a few of high quality.

However, it should be understood that the high yielders are too expensive and highly vulnerable to disease attack when they are poorly managed. Thus, farmers do not have to risk heaviest losses incase their stock dies. Thirdly, the animals are hardly fed on any concentrates except in zone 3 where spoiled maize grains are disposed of by feeding them to livestock. This points out that the farmers in other zones do not know the importance of concentrates to their stock. But the fact that the dairy cattle breeds in these zones, especially in Agro-ecological zone 2, are of poor quality it will be uneconomical to feed on concentrates.

The next socio-economic factor in importance is management and education in that order. Management factor that consists of the following variables; that is managerial aptitude, conservation concern, grazing management type and pattern, use of artificial insemination or bulls, possession of cow shed\fences\paddocks and frequency of spraying\dipping came out as the second most important factor in determining livestock production efficiency. It was found, however, that managerial ability for most livestock farmers was too low. Again in view of the individual and collective importance of these variables of management, it is imperative for extension workers to put more energy towards influencing of farmers to facilitate an overall improvement in management of livestock. They can do this by giving more information on livestock production processes, by shaping attitudes and teaching new skills on techniques of production efficiency. However, as can be pointed out again, the computed regression coefficient between extension contact and livestock production was found to be statistically insignificant. This is because the extension staff in the study area are mainly conversant with crops, especially cash crops and not many have been trained to teach farmers in livestock sectors.

Education was ranked third most significant factor affecting livestock production efficiency. But it was difficult to establish a direct relationship between education and livestock production because of many interrelated variables that go with education. For example, education variables are highly related with management variables. However, the fact that the relationship between education and livestock production is positive and statistically significant, one can conclude that higher education enhances livestock productivity. Even though some factors like religion, marital status and family size that are relevant in determining livestock production efficiency cannot be easily manipulated, their significance, however, in affecting structural change and progress cannot be denied. On the other hand of the most important socio-economic factors explaining efficiency such as age, land fragmentation and cosmopoliteness are easily amenable to manipulation and can be considerably influenced by extension contact.

(B) Policy implications

By way of enhancing the efficiency of livestock industry, the following are recommendations to the policy makers:

(1) Farmers should provide clean, fresh water to their stock at all times and ensure that there is balance left at the end of the day. Even more important is the fact that for various reasons, physical, economic and social; this is only practicable on very few farms. For many years to come to the majority of farms, water will be a limiting resource and perhaps the best role of this study is to indicate how the farmers can conserve, manage and utilize this resource to its maximum advantage. The following points should be noted:

(a) walking animals to the watering points and grazing on the road reserves outside the farm increases the risk of disease infection, injury, random mating and when the distance is great, increases the workload of the animal as walking expends energy to probable detriment of milk production. Where possible water should be carried to the animal, at least to a central collecting point on the farms rather than walking the animals to the water.

(b) the requirements for water are greater during certain times when the dry matter of herbage is high (during the dry season) and when animals are subjected to climatic stress -for example high temperatures. It should be remembered that management of cattle during the dry season should be designed to reduce climatic stress. This will not only help to reduce water consumption but also give the cow comfort. Well sheded paddocks with watering points under trees or artificial sheds will keep walking distances to a minimum which are good examples of how to reduce stress. In addition careful thought to the animals diet during the dry season can help to curtail water requirements. Complete reliance on parched pastures not only leads to poor nutritional levels for the animals, but also increases water intake requirements. Napier grass _(Pennisetum purpureum)_ or other fodder, root crops and in some cases silage will not only give a better productive diet but also provide a greater percentage of water in the food.

(c) Farmers should be encouraged to develop watering points on farms instead of continuous reliance on communal watering points. Where the central watering point on a farm is under the sole control of the farmer, then it is up to the farmer to maintain and protect this source. Here it can be ensured there is no contamination and good approaches is maintained by adequate fencing and adequate access is provided.

(d) Collection from roof catchment and rock outcrops can be significant; though insufficient for livestock this can supplement outside sources. On most small farms there is at least one building with suitable roofing from which water can be collected. A building 5M x 5M, in a region receiving only 760mm, annual rainfall should even allowing for a 20 per cent loss in wastage and evaporation produce 15,000 litres of water sufficient for a milk cow for 230 days (Goldson, 1977). If the farmers can afford to build storage tanks in the study area, these will ensure enough water for their stock throughout the year.

Advice, encouragement and financial help in the form of loans should be given to the individual to develop his own water resources either in the form of roof catchment, well or dams. Only by developing his own water resources will the small farmer be more independent, less reliant on the cooperation of other people, be able to cut down on the financial expenditure involved in water supplies and develop a more profitable dairying enterprise.

(2) Generally, pasture management is poor in the study area. Clearing of bushes from pasture, fencing and fertilizer application and other operations meant to enhance productivity are hardly practised in most farms. So far a great lack of awareness among the farmers about the economic potential of the well managed pasture is observed. At present the attitude is a greater problem than the lack of introduction of scientifically proven production technique in the field of pasture farming in the study area. Here there is great need to mobilise the farmers by cooperative efforts of the extension staff.

(3) Disease control which is strongly interrelated to the pasture management but also includes activities like permanent and regular dipping or spraying to check ticks are still unsatisfactory and ineffectively done. It should be made mandatory for all farmers to spray/dip their animals at least once a week.

(4) It is implicit in the findings that extension workers must carefully analyse ecological and socio-economic factors when selecting farmers with whom to work for greater impact on the livestock industry. It is noted that extension staff for livestock are virtually unknown in the study area. The farmers are not visited by animal health officers, except in times when the animals are sick. This conforms to the information gathered that those farmers who have lost many total livestock units (TLus) to diseases have also had

largest number of visits by veterinary officers. They come only on the invitation by the farmer to attend to ailing animals. It is apparent that apart from veterinary officers, there are not animal extension staff who should promote the livestock industry and if any they are not reached by the livestock farmers. This is because all the farmers interviewed know only agricultural extension officers who have helped the farmers to increase the productivity of cash crops. Here there is also need for the Government to train and post more livestock development officers who will deal with all aspects of livestock production processes.

(5) Introduction of grade cattle was aimed at increasing milk production. The promotional effects have been successful in certain pockets of the study area. On the other hand certain problems have become apparent. The high risk involved with the high investment (grade cow sell at about Kshs. 10,000) is considerable and because of required improvements in husbandry methods, for instance with respect to feeding and disease control farmers often cannot adopt. In case the animal dies or stolen, the economic losses are immense. This has made the "average" majority of farmers to continue keeping unimproved breeds of cattle. Support should be given to the farmers in the form of loans and assisted by being provided with extension staff that can advise them the best ways of managing their stock.

(6) In order to give support to genuine livestock farmers, loans should be passed and supervised by District development Livestock officers. This is because there are unscrupulous farmers who get loans from Agricultural Finance Corporation (AFC) of Kenya for different purposes instead of using it to promote their stock. So that incase there is an accident (death or theft) the officers will advise AFC to write off the debt.

(7) Finally, it should again be pointed out that though Agro-ecological zone 3 has larger grazing hectarages coupled with largest number of improved breeds of cattle, the zone is worst hit with limited water supplies to the stock and soon will be faced with the problem of inadequate feeds. This is because of low carrying capacity in comparison with other zones 1 and 2. It may be more practical to think in terms of a livestock unit with a lower feed and water requirement, that is beef and other zones 1 and 2 to specialize in dairy production. It is, however, appreciated that the demand for milk in zone 3 may allow for higher investment in pasture farming and other relevant provisions for example water and still make dairy production profitable.

(C) Lines For Further Research

The following areas require further and detailed studies to be conducted:

(1) The role played by different religious denominations on

livestock development.

(2) Suitable dairy breeds for each Agro-ecological zone: Suitable breeds in each zone will not only increase productivity but also reduce management costs.

(3) Suitable multi-purpose plants that can supply livestock feeds and other services, for example firewood.

(4) Incentives that will encourage farmers to engage in intensive livestock production (Zero-grazing).

(5) Relationship between various forage nutrients in the soil and milk production efficiency.

(6) Similar study at a regional level and map the various dimensions.

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APPENDIX A1

DAIRY FARMERS QUESTIONNAIRE

Good morning/afternoon. You have been chosen to take part in a survey of dairy farmers. You were chosen on a scientific basis from Land Register and it is important that everyone chosen takes part so that we can get a true cross-section.

Please, spare a little of your time to answer the following questions about your own opinions and experience.

1. (a) Date ....
   (b) Questionnaire No. ....
   (c) Agro-Ecological zone No. ....

2. (a) Farmer's Name ....
   (b) Farmer's Age ....
   (c) Farmer's Marital Status ....

3. (a) Farmer's Education ....
   (b) Wife's Education ....
   (c) Farmer's Literacy ....
   (d) Wife's Literacy ....

4. (a) Who is responsible for running this farm from day-to-day?

   (b) Is the land (1) Inherited
   (2) Bought
   (3) Rented
   (4) Others?

   (c) Is the land (1) Adjudicated
   (2) Surveyed
   (3) Registered
   (4) Titled?

5. (a) Name the type of land use on this farm and give its size.

Land use Type	Size in Hectares
(i) Food crops (maize, millet potatoes, beans, etc.)	....
(ii) Cash crops (tea, coffee etc.)	....
(iii) Grazing grounds	....
(iv) Other land users (specify)	....

   (b) (i) Do you own other pieces of land separate from this farm?

(ii) If yes, specify (a) Where? ....
(b) Size? ....

6. (a) Do you keep livestock in your farm? ....
(b) If yes, specify the number of animals presently kept according to the following categories and give reasons for keeping them:

Category	Reasons for keeping them
Cows	....
Bulls	....
Oxen/steers	....
Heifers	....
Calves	....
Sheep	....
Goats	....

(c) Can you tell me the number and the amount of milk for the following types of breed?

Breed	Number	Amount of milk in Litres
(a) Friesian	......	....
(b) Aryshire	......	....
(c) Gurnsey	......	....
(d) Jersey	......	....
(e) Zebu	......	....
(f) Cross-breed	......	....
Total	......	

(d) Why don't you keep only grade cattle?

(e) What kind of management do you have for each of the following types of breeds?

Type of Management Breed Grazing	Extensive Grazing	Semi-zero Grazing	Zero Grazing
Friesian			
Aryshire			
Gurnsey			
Jersey			
Zebu			
Sahiwals			
Cross-breeds			

7. About grade or local cattle kept.

(a) Do you have (i) Dairy shed?
(ii) Pasture?
(b) Is the pasture (iii) Fenced?
(iv) Paddocked?
(c) Do you provide your cows with
(v) Fodder?
(vi) Salts and concentrates?

8. (a) Do you dip or spray your animals? ....
(b) How often do you dip/spray your animals? ....

(c) How far is the dip from your farm? ....

(d) Do you graze your animals on communal grounds, e.g. road reserves?

9. (a) If you want to buy a cow, how much would you pay for:

(i) a grade in-calf cow Kshs. ....
(ii) indigenous in-calf cow Kshs. ....
(iii) a cross-breed in-calf cow Kshs. ....

(b) In your opinion, how do you compare the cost of keeping either type of cattle in 9 (a) above?

(i) They have some maintenance costs
(ii) Indigenous are much cheaper to keep
(iii) Grade cattle are much cheaper to keep

(c) Of the three breeds (9 (b) above), which one is more/less resistant to the diseases?..................

10. (a) Have you done any pasture improvement in your farm recently? Yes/No?

(b) If not, why? ....

11. What problems do you encounter in getting livestock inputs, (acaricide, drugs, pasture, seeds and other supplements)?

....

12. (a) Do you use paid regular labourers to look after your animals?

(i) If yes, how many hours on a daily basis do they take in looking after your animals? ....

(ii) If family labour is also used, how may hours are spent in looking after the animals?

....

13. (a) Which is your major source of water for livestock?
(a) Well (b) Raintank (c) River (d) Others (Specify)

(b) Is any of these sources, (1) individually (2) communally developed?

(c) How far is this source from your farm?

14 (a) (i) Which of the following officials have visited this farm?
(a) Livestock officers
(b) Dairy officers
(c) Veterinary officers
(d) Agricultural officers
(e) Others (specify?

(ii) How many times have they visited you for the last

3 years?
Which of the following meetings did anyone from this farm attend?

(a) Baraza (b) Crop demonstration (c) Animal demonstration (d) Agricultural show
How many times have they attended for the last two years?
How many times have you attended FTC courses?

15. (i) Have you ever lived/worked/studied outside Kisii District?
(ii) If yes, how long did you stay outside? ....

16. (i) What is your main occupation? ....
Others..
(ii) What about your spouse's main occupation?.............

17. (i) Do your animals die due to diseases? ....
(ii) If yes, how many have you lost for the last two years? ....

18. <u>Managerial Ability Scales</u>
Burger's (1967) scale of managerial aptitude which has also been used by several other research workers (Bembridge and Burger, 1977) was slightly modified for use with dairy farmers in the study area.

(1) <u>Forward Planning and Objectives</u>
State briefly what plans, if any, you have to improve on your present system of dairy farming over the next few years?

<u>Interpretation</u>	<u>Score</u>
(a) Have definite plans which indicate rational planning and self-confidence	5
(b) Have plans and ideas, but exhibits lack of confidence	4
(c) Have possible plans but find it difficult to come to decisions or take action	3
(d) Haven't really any plans. Find it more expedient to be guided by what the season indicates. Then there is less risk	2
(e) Can't perceive the direction of the question, thus cannot comment "Lives from day to day"	1

(ii) <u>Financial and Livestock Records</u>
Do you keep any records of production and costs, (breeding and selection, pasture management, income and expenditure)?

Interpretation	Score
(a) Have complete range of meticulously kept financial and livestock records make good use of these	5
(b) Keeps good livestock and/or financial records but not complete or vice versa and makes use of these	4
(c) Poor and incomplete records and has to refer other returns to a third party	3
(d) Keeps no records other than receipts and papers for sales	2
(e) Does not concern himself with records, therefore keeps none	1

(iii) Office

Do you have an office or place from which you can manage your farming?

Interpretation	Score
(a) Has a separate, neat, well-kept office	5
(b) Has an administrative "nook" in some or other room which appears well-kept	4
(c) Has a separate room, untidy and disorganized which passes for the "office"	3
(d) No office, but keeps receipts and papers in a drawer, in a box or in a file	2
(e) No administrative centre or system whatsoever	1

(iv) Budgeting and Expenditure Control

Please tell me what your farming is going to cost in the coming year (total farming expenditure), and may ask how you arrived at this estimate?

Interpretation	Score
(a) Draws up a complete and rational budget in which for instance accurate estimates are made for labour, dips and medicines, feeds, repairs, overheads, etc.	5
(b) Draws up a rational budget for a few of the expense items	4
(c) No budget. Relies on reasonable estimates	3
(d) No budget. RElies on incomplete and uncertain educated guesses	2
(e) Has no idea of what will happen. Takes as it comes	1

(v) Organization and Control of Labour

What is the position with regard to labour? Do you experience more or fewer problems than your neighbours? Do you have a special compound? (Inspect its conditions). What are your mealtime arrangements and what rations do you supply? What wages do you offer? Are the labourers contented and do you have a good foreman?

	Interpretation	Score
(a)	Outstanding organization excellent, labour relations and very good living conditions and other amenities	5
(b)	Very good in certain respects but lacking in others	4
(c)	Reasonable organization and facilities	3
(d)	In most respects not very satisfactory	2
(e)	Poor organization, relations and facilities	1

19. Scale of Conservation Concern

This scale was modified from a similar scale used by research workers (Slabber, 1969 and Bembridge and Burger, 1977).
Is soil erosion a problem in your farm/this area? What are you doing to prevent erosion and conserve soil and water in your farm/location/Division/District?

	Interpretation	Score
(a)	Has a high level of understanding of soil and water conservation, not only concerned with erosion on his own farm, but also concerned with situation in the District. Practices sound conservation farming on a whole-farm basis and keeps up to date on soil and water conservation information.	5
(b)	Has a good understanding of solid and water conservation. Concerned with erosion on his own property and in the district. Practices conservation farming, but not entirely on a whole-farm basis, and is interested in new information about soil and water conservation.	4
(c)	Has an understanding of soil and water conservation. Shows some concern at erosion on his own farm and the district, but does little to practice conservation farming and obtain new information on soil and water conservation.	3
(d)	Has very little understanding of soil and water conservation. Shows little concern at the erosion situation and takes no steps to practice conservation farming or obtain information about conservation.	2
(e)	No apparent understanding of soil conservation. More concerned with his own financial position and the condition of cattle than with soil and water conservation.	1

INTER-CORRELATION MATRIX: (APPENDIX - B)

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	24	26	27	28	29	30	34	35
2	1.00																											
3	0.24	1.00																										
4	0.08	0.31	1.00																									
5	0.12	0.37	0.92	1.00																								
6	0.10	-0.40	-0.29	-0.42	1.00																							
7	-0.01	-0.03	-0.27	0.27	0.40	1.00																						
8	0.17	-0.25	-0.14	0.23	0.19	0.37	1.00																					
9	0.05	-0.02	-0.15	0.21	0.56	0.77	0.55	1.00																				
10	0.03	0.19	0.48	0.41	-0.15	-0.39	0.01	0.05	1.00																			
11	0.00	0.36	-0.10	-0.18	-0.20	0.09	-0.25	-0.11	-0.17	1.00																		
12	0.60	0.07	-0.23	0.17	0.21	0.08	0.34	0.28	0.43	-0.11	1.00																	
13	0.02	0.26	0.30	0.40	-0.20	-0.07	0.02	0.02	0.27	0.00	0.50	1.00																
14	0.38	-0.07	0.17	0.20	0.07	-0.03	0.14	0.31	0.24	-0.35	0.07	0.08	1.00															
15	-0.20	0.14	0.41	0.38	0.03	-0.08	-0.02	-0.02	0.10	-0.17	-0.02	-0.07	0.11	1.00														
16	-0.40	0.13	0.28	0.33	0.21	0.04	0.18	0.21	0.07	-0.19	0.13	0.00	0.11	0.80	1.00													
17	-0.07	0.14	0.02	0.00	0.11	-0.06	0.23	0.30	0.43	-0.50	0.25	0.06	0.33	0.69	0.62	1.00												
18	-0.19	0.20	0.01	0.00	0.01	-0.13	0.14	0.13	0.44	-0.41	0.25	0.12	0.32	0.72	0.60	0.90	1.00											
19	-0.03	0.22	0.58	0.57	0.11	0.02	0.24	0.15	0.32	-0.49	0.31	0.08	0.20	0.58	0.63	0.81	0.83	1.00										
20	-0.05	-0.04	0.48	0.38	0.04	-0.04	0.23	0.18	0.42	-0.32	0.50	0.22	0.30	0.20	0.32	0.87	0.65	0.15	1.00									
21	0.09	-0.04	-0.01	-0.08	0.21	0.05	0.17	0.05	0.13	-0.16	0.14	-0.12	0.36	-0.08	-0.14	0.00	-0.14	0.06	-0.02	1.00								
24	0.02	-0.03	-0.11	-0.11	0.03	0.01	0.00	0.02	0.03	0.24	0.04	0.03	0.00	0.26	0.31	-0.17	0.20	0.05	0.13	-0.03	1.00							
26	0.32	-0.01	0.25	0.09	0.17	-0.15	0.20	-0.11	0.32	-0.10	0.38	0.18	0.14	0.14	-0.02	0.18	0.08	0.26	0.23	0.41	0.09	1.00						
27	-0.08	-0.08	0.14	0.07	0.20	0.21	0.00	0.18	-0.16	0.00	0.10	-0.21	-0.08	0.18	0.20	-0.19	0.18	0.44	0.22	0.04	0.09	-0.22	1.00					
28	-0.11	0.04	-0.24	-0.22	0.08	0.22	-0.07	0.08	-0.43	0.21	0.01	0.57	-0.30	0.00	-0.07	0.42	-0.17	-0.17	0.53	-0.24	0.37	-0.34	0.22	1.00				
29	0.10	0.06	0.29	0.30	-0.09	0.31	0.23	0.11	0.40	-0.21	0.24	0.23	0.22	0.14	0.24	-0.42	0.40	0.34	0.20	-0.14	-0.06	0.10	-0.07	-0.19	1.00			
30	-0.12	0.21	0.30	0.36	-0.25	0.13	0.14	-0.07	0.21	-0.11	-0.06	0.05	0.13	0.73	0.63	0.48	0.52	0.44	0.06	-0.10	0.06	-0.03	0.11	0.08	0.34	1.00		
34	0.44	-0.04	0.31	0.36	-0.06	0.27	0.30	-0.09	0.48	-0.20	0.34	0.34	0.28	-0.09	-0.13	-0.28	0.27	0.23	0.27	-0.14	0.01	0.23	-0.18	-0.23	0.53	0.66	1.00	
35	0.06	-0.07	-0.14	-0.14	0.03	0.02	0.01	-0.39	0.20	0.38	-0.34	0.08	-0.02	-0.09	0.69	0.04	0.05	0.04	0.13	-0.04	0.39	0.06	0.06	0.07	0.10	0.41	0.08	1.00

LEGEND

2 : Agro-Ecological Zone
3 : Marital Status
4 : Farmers' Age
5 : Respondents' Age
6 : Farmers' Education
7 : Wives' Education
8 : Farmers' Literacy
9 : Wives' Literacy
10 : Family Size
11 : Religion
12 : Farmers' Managerial Aptitude
13 : Farmers' Conservation Concern
14 : Cosnopoliteness
15 : No. of Livestock Unit
16 : No. of In-milk cows
17 : Farm Size in Ha.
18 : Grazing Hectares
19 : Food Crop Ha.
20 : Cash crop Ha.
21 : Land Fragmentation
24 : Grazing Management Types
26 : Possession of dairyshed/Fence/Paddock
27 : Provision of Conc-Additives
28 : Spraying/Dipping
29 : No. of visits by Agri./Vet. Officer
30 : Labour
34 : No. of visits to Demo./Plots/FTC
35 : Presence/Absence of Communal Grazing Resource