ECONOMIC ANALYSIS OF BEEF RANCHING:

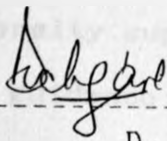THE CASE OF LAIKIPIA DISTRICT, KENYA

BY

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A thesis submitted to the Department of Agricultural
Economics, University of Nairobi, in part fulfilment
of the requirements for the Degree of MASTER OF SCIENCE
in Agricultural Economics

JANUARY 1990

DECLARATION

I, Dickson Mong'are Nyariki, declare that this thesis is my original work and has not been presented for a degree in any other university

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This thesis has been submitted for examination with our approval as university supervisors.

DR. O.L.E. MBATIA

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ACKNOWLEDGMENT

ABSTRACT

ECONOMIC ANALYSIS OF BEEF RANCHING: THE CASE OF LAIKIPIA DISTRICT, KENYA

The principal objectives of this study were to evaluate beef ranch income by comparing gross returns from sale of livestock with costs of production. Using net income as an indicator of ranch profitability, the study determined factors that influence this level of profitability from beef ranching in Laikipia.

Data used in this study were collected through a survey of a sample of ranches. Two types of data were used. These were cross-section and time-series data from the sample. Single year cross-section data were used to determine beef ranch profitability while cross-section and time-series data were pooled for the analysis of factors that determine the profitability and offtake rates. Two distributed lag models were fitted to the pooled data and regressions were run to determine the factors. Explanatory variables included beef price, offtake, income, rainfall, range condition, stocking rates, and time.

The results of the analysis show that net income from beef ranching is about Kshs.60/= per hectare per year. Statistically, this figure is low and is not

significantly different from zero. The net returns on investment are approximately one per cent per annum and are also statistically insignificant. The analysis of factors that influence net income from beef ranching indicates that the most important factors are beef price, offtake, and stocking rates. Offtake was itself shown to be determined by price, income, stocking rate, rainfall total, and rainfall distribution. These are the factors that can be manipulated to increase beef ranch income and offtake. It is expected that with high income, ranchers will have an incentive to produco more beef. This would then alleviate the problem of beef insufficiency in the country.

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ABBREVIATIONS AND DEFINITIONS

Kshs.   = Kenya shillings

KgLwt   = Kilogramme live weight

1 U.S. dollar   = Kshs. 20*

1 Sterling pound   = Kshs. 32*

1 Hectare (ha)   = 2.471 acres

1 Metre (M)   = 39.370 inches

1 Square kilometre (km^2)   = 0.386   square miles

1 Kilogramme (kg)   = 2.207 pounds

1 Litre (l)   = 0.220 gallons

1 Livestock unit   = 450 KgLwt animal(s)

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*: Approximate exchange rate (December 1988)
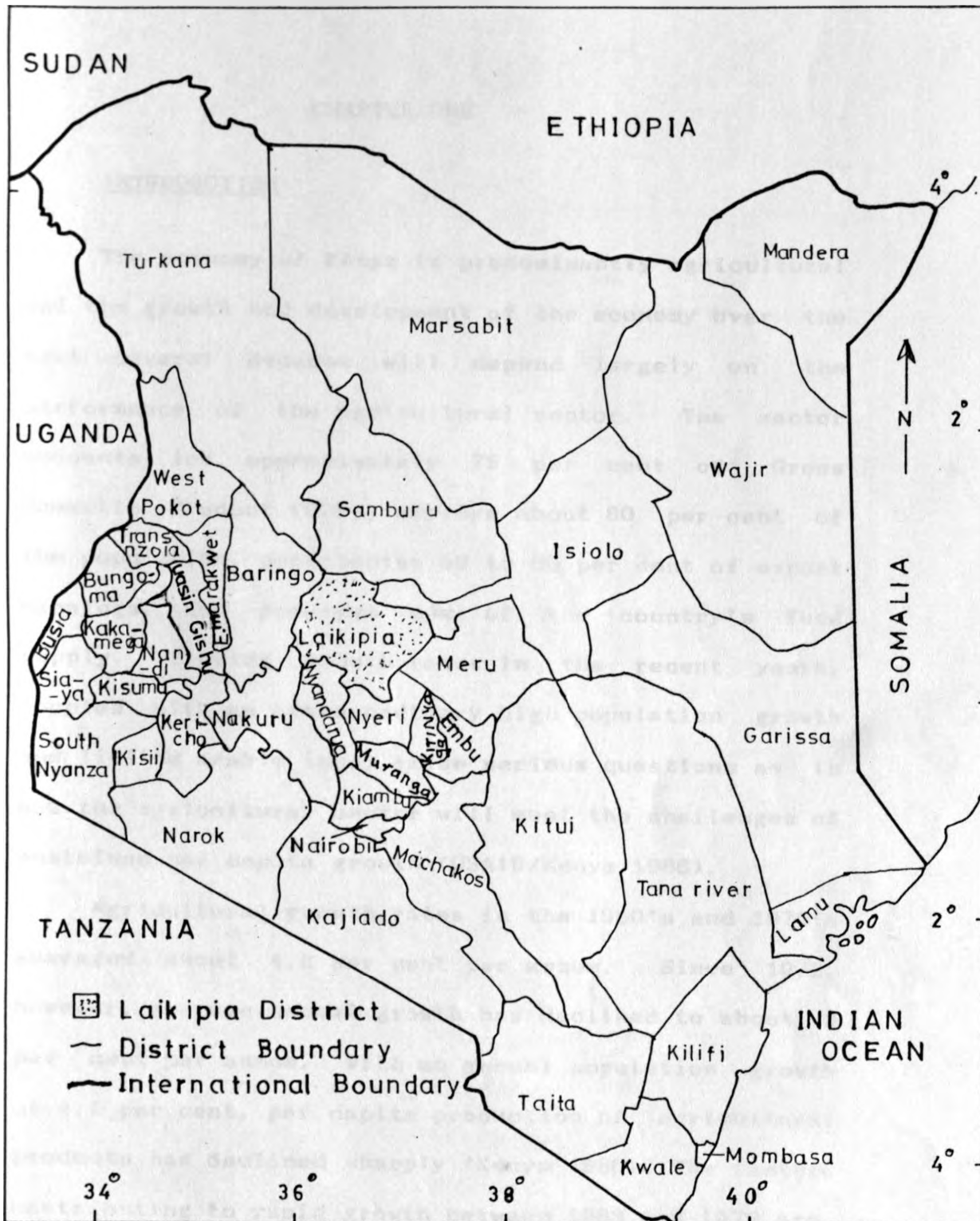
Map 1 :   The Location of Laikipia District

Source: Kenya   1984

CHAPTER ONE

1.1   <u>INTRODUCTION</u>

The economy of Kenya is predominantly agricultural and the growth and development of the economy over the next several decades will depend largely on the performance of the agricultural sector. The sector accounts for approximately 75 per cent of Gross Domestic Product (GDP), employs about 80 per cent of the population, contributes 50 to 60 per cent of export earnings, and provides most of the country's food supply. Slowing growth rates in the recent years, coupled with an extra-ordinary high population growth and limited arable land, raise serious questions as to how the agricultural sector will meet the challenges of sustained per capita growth (USAID/Kenya 1986).

Agricultural growth rates in the 1960's and 1970's averaged about 4.6 per cent per annum. Since 1972, however, average annual growth has declined to about 2 per cent per annum. With an annual population growth of 4.1 per cent, per capita production of agricultural products has declined sharply (Kenya 1986). The factors contributing to rapid growth between 1963 and 1972 are, for the most part, no longer operative. During that period there was a substantial expansion of cropped land, increase in yields resulting from introduction of improved inputs, and a shift in smallholder production

towards high valued commodities. Since at present
there are few technological innovations available,
and because of limited additional arable land, coupled
with the fast population growth and resulting pressure
on the land resource, the contribution of these factors
will be much less in the future than in the past
(USAID/Kenya 1986). For these reasons therefore, more
emphasis should be laid on the marginal lands of the
country if any substantive growth in food production
has to take place.

The dryland areas in Kenya occupy about 80 per
cent of the total land area and support about 20 per
cent of the human population, 50 per cent of the
national cattle herd and 78 per cent of sheep and goats
(Hansen *et al.* 1986). Of the total land area, which is
estimated to be about 569,000 sq. Km, 7 per cent has
adequate and reliable rainfall, soil and topography
suitable for crop production. An additional 4.5 per
cent of the land can sustain crops in years when there
is adequate rainfall. Therefore, except for limited
areas under irrigation, the rest of the country can
mainly support livestock production (Kenya 1986).

Livestock production is an important agricultural
activity, with nearly 60 per cent of smallholders
owning one or more head of cattle. Ranching is a major
activity in the semi-arid areas, which are ill-suited

for many other productive activities, and livestock provide the means of subsistence for Kenya's pastoral groups. In the past decade, however, the performance of livestock sector has been weak. Beef production showed a 4.1 per cent average annual growth rate in value in the period 1972 to 1982, but a decline in volume marketed production of -10.7 per cent per annum. Dairy production also registered a declining growth rate for both value and volume of marketed production over the same period. It has also been estimated that Kenya's milk production is in the range of 1600 million litres per year, and production appears to be levelling off (Kenya 1986).

There are four major types of land-use in the marginal areas where meat production is largely centred. The first is commercial ranching which supports about 25 per cent of all dryland cattle, the second is pastoral ranching with 50 per cent of the cattle, and the third and fourth are agro-pastoral and free-ranging types (Hansen *et al*. 1986). Marketed beef is produced mainly by ranches, which take a variety of forms of ownership: group ranches, company ranches and privately owned ranches.

Commercial ranching began in Kenya about 70 years ago (Pratt and Gwynne 1977). These ranches are owned by individuals or groups of persons who have formed companies, partnerships or co-operatives, and are a

distinctly land-oriented, market dependent management system that is organized primarily to satisfy outside consumers living mainly in urban centres (Child *et al.* 1984). They may have a freehold or leasehold land tenure. The ranchers indicated that most of the ranches in Laikipia District have a leasehold of up to 999 years, starting from around 1919 (author's survey). These ranches were mainly concerned with fattening immatures brought from North Eastern Province of Kenya for sale and subsequent slaughter. However, they now carry out their own breeding for fatstock production, commonly referred to as cow/calf operation.

Although the rangelands of Kenya are vast and contribute significantly toward the country's livestock products, the present and projected demand for beef and milk indicates large and possibly continuing deficits over domestic supplies. This can be seen in Table 1-1. The figures show that the level of production of beef In 1988 was about 172,000 tonnes, and there will be a likely deficit of 42,000 tonnes by 1993.

One of the major handicaps facing beef production is limited rainfall and water supply in the ranching areas. Private initiatives by group and company ranches to develop water have been limited, In part because of their financial constraints. While private ranches are on balance more efficient, group and

company ranches have faced serious financial problems and cash flow shortages (USAID/Kenya 1986). These are some of the problems that need to be addressed if production has to be enhanced.

Table 1-1: Present and Projected Production of and Demand for

Basic Foodstuffs ('000 Tonnes).

production & Demand Item	Per Capita consumption Kg/person /Year	Production 1987	Demand 1988	Production 1988	Demand 1993	Production 1993
Beef	8.1	171	183	172	223	181
Milk	9.0	1,503	2,060	1,534	2,500	1,693
Maize	100	N.A*	2,250	2,540	2,670	3,090
Wheat	19.4	N.A	440	231	535	255
Sorghum &						
Millet	7.7	N.A	175	181	213	255
Rice	3.0	N.A	69	28	84	41
Beans	13.2	N.A	300	309	366	394
Potatoes	33.5	N.A	760	821	925	1,048
Sugar	17.6	N.A	399	426	523	525

Source: Kenya 1989

*: N.A means "not available"

The Kenya National Livestock Development Policy (1980) has stressed the need for a detailed livestock development policy with several objectives. The policy states that shortfalls in livestock production would either be expensive to satisfy from imports or else the welfare of the people would be seriously compromised. It indicates that the national aims of livestock development are:

> "Alleviation of poverty through the creation of income-generating employment at all stages of livestock production ...., production of surplus over domestic demand for exports ...., production of sufficient animal proteins to ensure adequate nutrition for the people ......, and full development of the extensive drylands".

It is, however, doubtful that most of these objectives have been met to any extent if the demand/production projections are accurate and if the downward trend of livestock production, as is evident in Laikipia, is taking place in other regions of the country. The hope of ever meeting most of these objectives is further dwindled by handicaps facing efforts towards these goals. These include the fact that some of the important marketing and processing institutions are, for the meantime, non-functional or functioning marginally in this respect. Furthermore,

the trials of group ranches in the arid and semi-arid lands (ASAL) with the aim of gearing these areas towards commercial ranching and conservation of the environment through destocking have failed (ILCA 1977)

The Sessional Paper No.1 of 1988 of Kenya emphasizes the importance of ASAL. It states in part that:

> "This area supports 20 per cent of the country's people and half of its livestock. ASAL have fragile environments, subject to degradation as more people move into them from the over-crowded lands of medium and high potential. Yet, this important resource ...... if managed carefully, can help serve the income, employment, and food self-sufficiency goals ....".

The paper continues to point out that livestock is the basis for ASAL economy, and suggests that some of the measures to develop these lands are to: develop stock routes and water supplies; intensify links between ASAL regions and higher potential areas through a programme under which ASAL herders produce immatures from the drier areas to be fattened in the higher potential areas. If this policy of specialization can be put into practice, beef production in the district as well as in the whole country can be enhanced.

1.2   BACKGROUND INFORMATION ON LAIKIPIA

1.2.1   AREA OF STUDY

The location of Laikipia District with respect to other districts in Kenya is shown on page xiii. The district lies east of the Great Rift Valley and is generally characterised by a level plateau bounded by the edge of the valley to the west and Aberdares and Mt. Kenya to the south. The altitude varies between 1800 metres in the north and 2100 metres in the south with a maximum height in Marmanet forest of about 2600 metres (Kenya 1987).

As shown in Table 1-2, annual rainfall varies considerably from one part of the district to another. The western part of the district receives the highest rainfall which comes between May and August. The eastern and southern parts have low rainfall amounts which are received mainly during September to December.

Laikipia District has a total land area of about 971,800 hectares (9,718 sq. Km). Agro-climatic zones I and II which are classified as high potential areas consist of about 17,000 hectares (1.7 per cent of the district land). The medium potential agro-climatic zone III consists of 95,208 hectares (9.8 per cent of the total land area). About 72 per cent of the total area is found in zone IV. This is semi-arid land and it takes up an area of 697,700 hectares (Kenya 1984).

Table 1-2: Rainfall Distribution in Laikipia District

Station	Mean Annual Rainfall (mm)	Years of Record
South Marmanet Forest	987	51
Nyahururu	1074	15
Deighton Down	810	51
Nanyuki Town	745	41
Kangatia Forest	933	36
Mutara ADC Ranch	620	48
Lamuria	743	21
Rumuruti	670	72
Junction	432	16
Dol Dol	573	31

Source: Kenya 1989

Therefore the expanse of marginal land in the district explains the importance of animal production in .the region as opposed to crop production (Map 2).

Livestock Sorghum Zone

Barley Cattle Sheep Zone

RANCHING ZONE

Wheat Maize Zone

Wheat Pyr Zone

Livestock Sorghum Zone

Cattle Sheep Barley Zones

NANYUKI

N

---Zone Boundary
——District Boundary
■ Town

0 10 20 30 40 Km
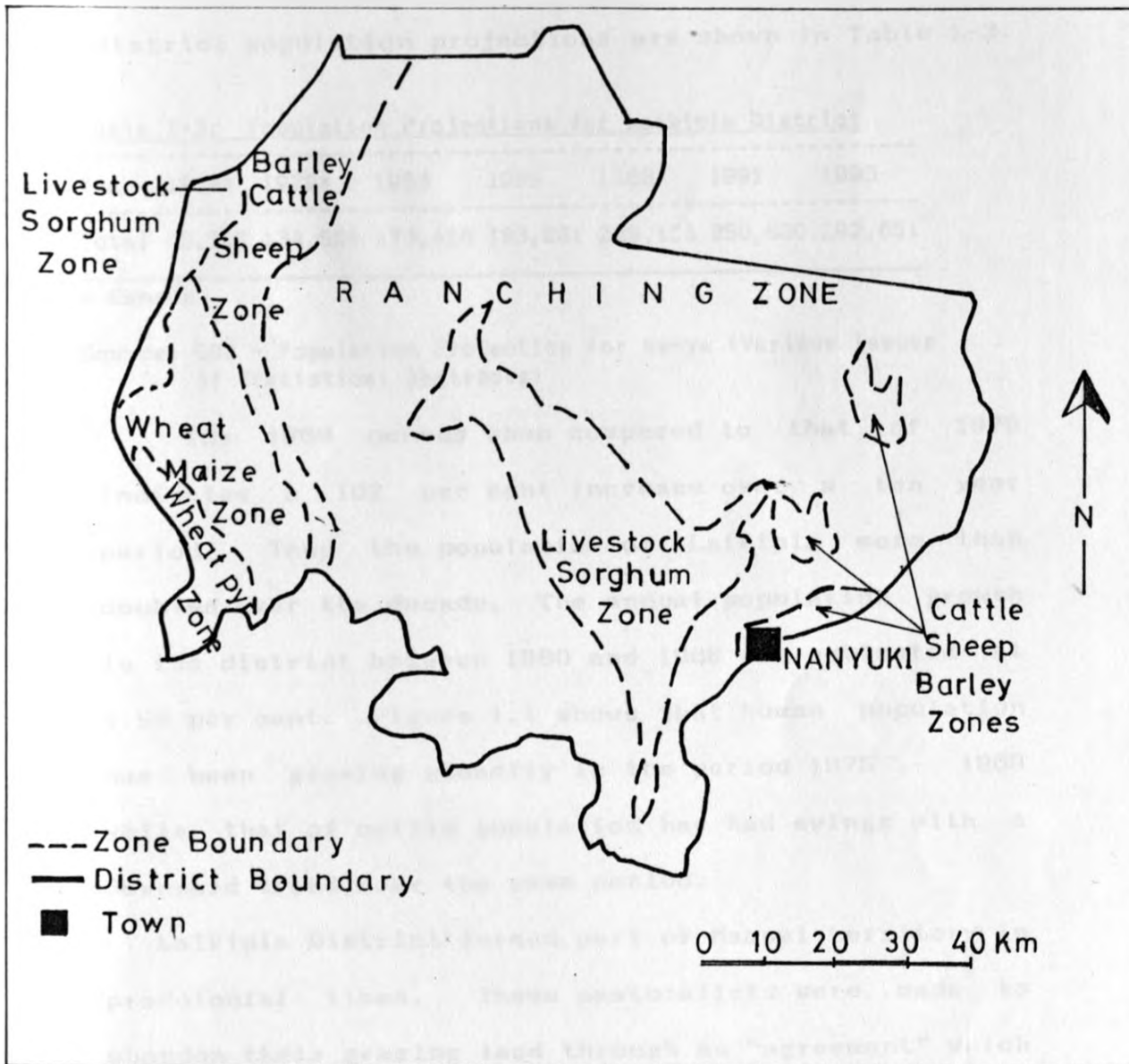
Map 2: Laikipia District Agro-Economic Zones
Source: Jaetzold and Schimdt 1983

Demographic figures for 1979 population census in Laikipia District show that the district had 134,524 people. The estimate for 1988 was 229,126. The district population projections are shown in Table 1-3.

Table 1-3: Population Projections for Laikipia District

Year	1969*	1979*	1983	1985	1988	1991	1993
Total	65,506	134,524	173,428	193,901	229,126	250,890	292,051

* Census

Source: CBS - Population Projection for Kenya (Various Issues of Statistical Abstracts)

The 1969 census when compared to that of 1979 indicates a 102 per cent increase over a ten year period. Thus the population of Laikipia more than doubled over the decade. The annual population growth in the district between 1980 and 1988 was estimated at 5.55 per cent. Figure 1.1 shows that human population has been growing steadily in the period 1975 - 1989 while that of cattle population has had swings with a downward trend over the same period.

Laikipia District formed part of Maasai territory in precolonial times. These pastoralists were made to abandon their grazing land through an "agreement" which was reached by the local leaders and the colonialists in 1912 to make Laikipia part of the so-called "Scheduled Areas" or "White Highlands" (Kohler 1987) which were reserved for European settlement.

When independence for Kenya was nearing, the colonial government reached a decision to sell to
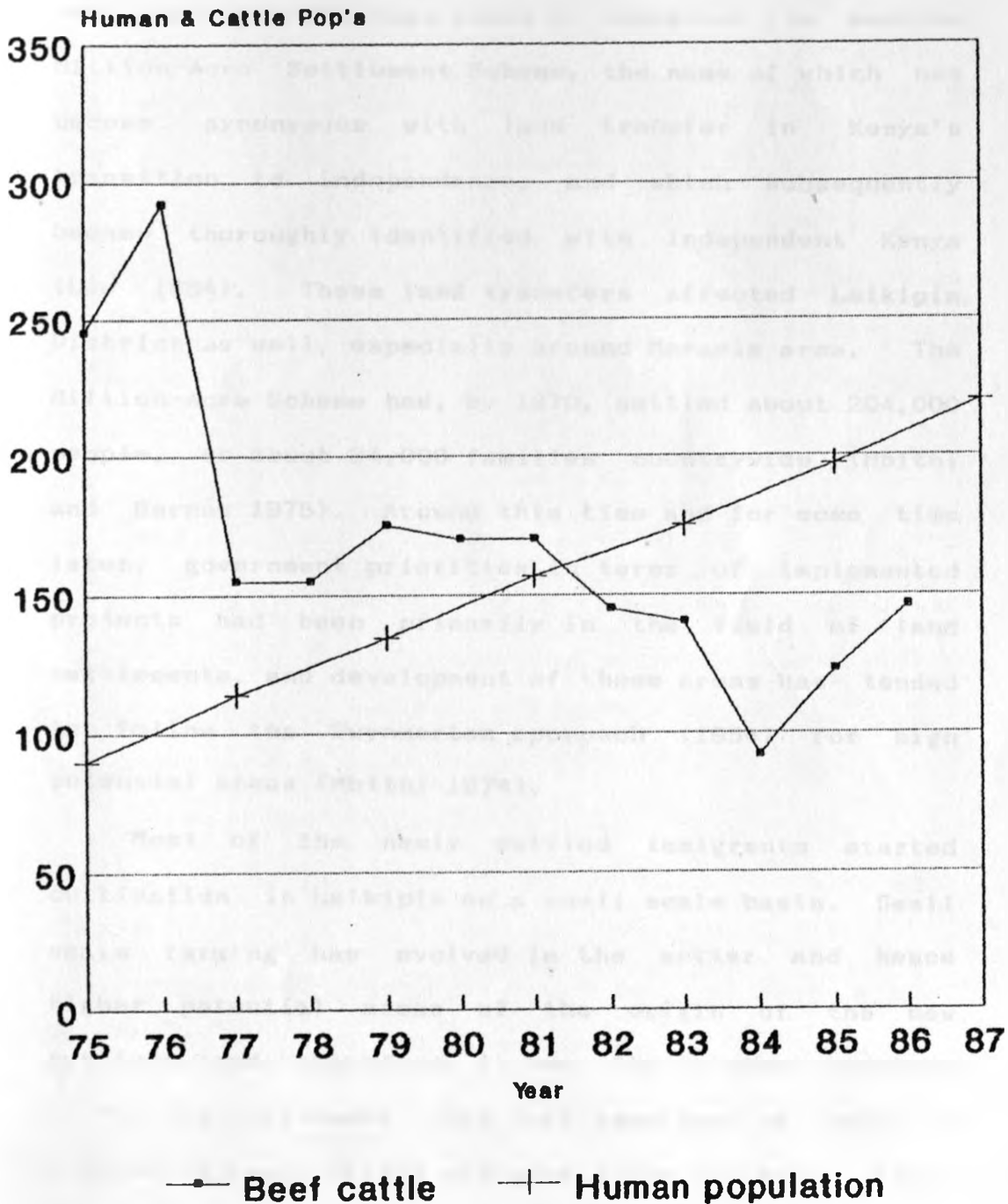
Fig. 1.1: Human and Beef Cattle Population Trends
in Laikipia District ('000)

Source: Kenya 1983 and 1989; Author 1988

Africans land that had been taken by European settlers. It developed a programme for this. The programme evolved in stages into a number of schemes aimed at different groups designed to meet different needs. The most important and best known of these was the massive Million-Acre Settlement Scheme, the name of which has become synonymous with land transfer in Kenya's transition to independence, and which subsequently became thoroughly identified with independent Kenya (Leo 1984). These land transfers affected Laikipia District as well, especially around Marania area. The Million-Acre Scheme had, by 1970, settled about 204,000 people, or about 34,000 families countrywide (Mbithi and Barnes 1975). Around this time and for some time later, government priorities in terms of implemented projects had been primarily in the field of land settlements, and development of these areas has tended to follow the Swynnerton approach (1954) for high potential areas (Mbithi 1974).

Most of the newly settled immigrants started cultivation in Laikipia on a small scale basis. Small scale farming has evolved in the wetter and hence higher potential areas of the origin of the new settlers, and, therefore, it has its inherent problems in the new settlement. The most important of these is related to insufficient and unreliable rainfall. Thus, some of the economic and social problems that beset the district have stemmed from the subdivision of the big

farms into small-scale farm units (Kenya 1989).

There were three main types of land-use that existed during the colonial days. European-owned large-scale ranching took the largest portion of land, covering approximately 80 per cent of the district. Most of this land was devoted mainly to beef ranching. The rest of the land was occupied by forests and pastoralists (Kohler 1987). Compared to the present situation, land transfers have resulted in a reduction of land under large-scale farming by about 23 per cent as can be seen in Table 1-4 (see also map 3). Ranches still take the largest portion (about 56 per cent) of the land area in Laikipia.

The transition of large-scale farms (over 1000 acres) to small farms (below 20 acres) sprang up after the Kenya Government adopted the policy of subdividing loss-making large farms in pursuit of fuller employment and profitable returns. This policy was mooted in 1972 when the International Labour Organization in conjunction with the United Nations Development Programme (ILO/UNDP) Mission met in Nairobi to deliberate on employment problems facing Kenya. Policies proposed to support the intensification strategy included, *inter alia*, a rapid development of the beef industry in semi-arid areas. A number of these policies have since been adopted by the Kenya Government.

Map 3 : Laikipia Ranches   Scale : 1:250 000

Source : Kenya 1987
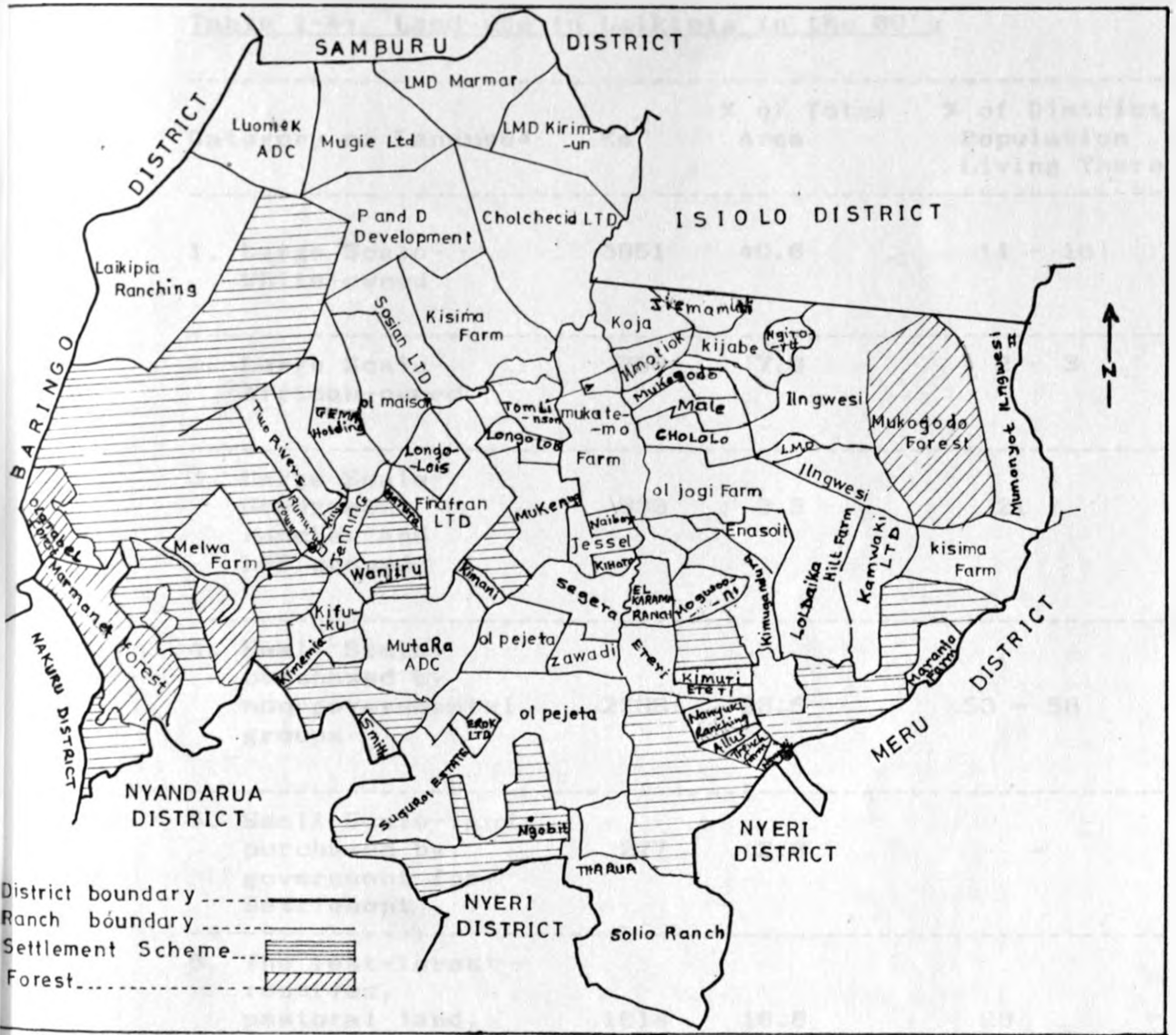
Table 1-4:   Land-use in Laikipia in the 80's

Category of Landuse*	Km^2	% of Total Area	% of District Population Living There
1. Large Scale-White-owned	3951	40.6	11 - 16
2. Large Scale-African-owned	756	7.8	2 - 3
3. Large Scale-Government ranches and LMD grounds	833	8.5	21
4. Small Scale-purchased by non-governmental groups	2288	23.5	53 - 58
5. Small Scale-land purchased by government for Settlement	277	2.8	-
6. The rest-forest reserves, pastoral land, towns and markets	1618	16.8	28
Total	9723	100%	100% = 230,000

Source: Kohler 1987; Kenya 1989 .

*:   As used in this categorization, large-scale means an
     area   of 1000 acres   or more while small-scale is an
     area of around 20 acres or less

1.3   PROBLEM STATEMENT

It has already been shown that one of the most serious constraining factors to agricultural development in Kenya is the shortage of arable land. High rates of population growth have put pressure on limited land leading to subdivision, landlessness and migration to more marginal areas. It has also been indicated that the marginal regions are not well-suited to any other agricultural production other than livestock. This then points to the fact that the drylands must be developed in line with their most appropriate form of agriculture. One of the most suited mode of production is that of ranching. The contribution of ranches towards the total national herd is high. In Laikipia District, however, the number of ranches has been decreasing. Before and soon after independence there were about 121 ranches. So far, 46 of these ranches have been subdivided (Kenya 1987). It should be noted that the Government policy is that:

> "Only those large farms that prove unprofitable will be subdivided into smaller farms where it has been shown that even small farms have high yields".

While social reasons have contributed to the decline of these farms, one of the most likely economic factors is that of profitability.

The major concern with a declining number of
ranches in Laikipia is the corresponding decline in the
number of cattle. This downward trend in the number of
cattle is also shown by a reduction in the total number
of beef cattle, not only in Laikipia but also in the
whole country, as exemplified by figures from the large
farms of Kenya shown in Table 1-5 below.

Table 1-5: Beef Cattle Population Trends in Laikipia
District and on Kenya's Large Farms

Year	Beef Cattle Population in Laikipia District	Beef Cattle Population on Kenyan large farms
1975	245,000	N.A
1976	290,000	N.A
1977	160,000	N.A
1978	160,000	421,300
1979	150,000	411,800
1980	160,000	431,500
1981	150,000	424,100
1982	140,000	403,800
1983	135,000	378,200
1984	92,000	402,200
1985	120,000	284,600
1986	145,000	303,800
1987	N.A	309,900

Source: CBS - Survey of large farms; Laikipia District
Reports - Ministry of Livestock Development
(Various issues)

As indicated in Table 1-1, there is a deficit in beef production compared to demand of about 10,000 tonnes or more. Laikipia District has been one of the major producers of quality beef (Kenya 1987). Thus, the problem is declining beef production compared to demand in Laikipia as well as in Kenya as a whole.

A strategy statement by USAID/Kenya (1986) has contended that returns from ranching are low. It states that "the present return on investment in beef production is less than 8 per cent a year; it would take 30 per cent increase in beef prices relative to other farm prices to attract private investment". Hence, apart from the land pressure that has led to migration and subdivision of large scale farms, returns are a major constraining factor and might have caused a reduction in beef production.

To add to the foregoing, considering the available literature, little is known about the factors influencing the level of returns from beef ranching in Kenya. The task of this study is therefore to determine the level of returns from beef ranching and the factors affecting the returns in Laikipia District.

1.4   <u>JUSTIFICATION</u>

Increased incomes, increased employment opportunities, and general rural development are currently Kenya's main rural development objectives (Mukumbu 1987). Such objectives make it imperative for researchers and policy makers to shift their attention to rural problems associated with agriculture. Therefore, improving and expanding productive enterprises in the range areas, where some 80 per cent of the country's cattle and an even greater percentage of sheep and goats are tended (Kenya 1989), will be a major means of enhancing rural incomes, as well as increasing protein supplies. The above goals can be achieved in these areas if emphasis is placed on a productive livestock economy that provides growing incomes and employment opportunities to the rural population .

Large-holder farms contribute 36 per cent of the total beef produced in Kenya (Stotz 1983) and 75 per cent of the dryland cattle (Hansen *et al.* 1986). Hence, since these farms contribute a substantial portion of the national cattle herd and more so of the herd in Laikipia District, they can contribute highly towards the national beef supply if upheld or promoted. One of the means to ensure this is to look for ways of improving returns from the ranching enterprise so as to attract more entrepreneurs into it and avoid loss of

land to other production activities, especially dryland cultivation. Laikipia District was, therefore, chosen as the area of study because the district engages mainly in livestock production, especially in the form of ranching for beef production.

1.5   OBJECTIVES

The broad objective of this study is to determine the socio-economic factors that have caused the decline of beef ranching in Kenya using Laikipia District as a case for study.

Specific objectives are to;

(i)   give a detailed account of the present ranching activities in Laikipia District;

(ii)   evaluate the incomes from livestock and compare them with costs of production. Returns are obtained mainly from the sale of steers, heifers, breeding bulls, breeding cows, and cullcows in cases where a rancher undertakes a cow/calf operation, which is infact the main activity. Costs include labour charges, veterinary costs, feed costs, interest on borrowed capital, maintenance costs, rent and rates, taxes, and non-cash costs such as depreciation;

(iii)   determine the factors that   influence
         incomes and offtake rates from ranching.

1.6   <u>HYPOTHESES</u>

Taking   into   consideration the   problem   and
objectives of this study, the hypotheses below are   to
be tested.

(i)   Net income from beef ranching in Laikipia
        District does not differ significantly
        from zero;

(ii)   The levels of ranch net income and offtake
        cannot be adequately explained by some   or
        all   of   the   following   factors;   ranch
        offtake,[*]   price   of   beef,   cost   of
        production, stocking rate , expected price
        of beef, time, rainfall amounts, rainfall
        distribution, and range condition[#].

Offtake   is   the number of   animals   removed   from
 the   herd each year for sale or for any other   reason.
For   the present purpose, offtake is the proportion   of
animal   units removed from a herd for sale. It is   also
referred to as commercial offtake. Range condition,   on
the   other hand, is the relative "health" of the   range
compared   to what is considered as the optimal   status.

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*: For further information on this see section 3.4

#: For further information on this see section 3.4

1.7   <u>ORGANIZATION OF THE STUDY</u>

This thesis has five chapters. The first chapter introduces the study, provides background information on the study area, and gives the problem statement, justification, objectives, and hypotheses tested.

A review of studies and publications related to livestock is given in chapter two. This includes livestock Production and marketing. The principal objectives and findings of each study have been highlighted. A summary of the whole review, especially on findings, and what the present study hopes to achieve is also provided in this chapter.

Chapter three describes the methods that were used to achieve the objectives set. The methods include the use of t-statistic and econometric models. In addition, the chapter gives a description of some of the economic terminology used in the study.

Data presentation, empirical analysis, results and discussions are provided in chapter four. The chapter begins by discussing ranch types and activities involved in livestock production in Laikipia.

The last chapter is essentially a summary of the study. It consists of a summary of the findings and conclusions. Recommendations based on the findings of the study are also provided here.

CHAPTER TWO

2.1   <u>LITERATURE REVIEW</u>

This chapter reviews the economics of livestock
production and marketing from various studies and
publications. Not much literature is available on the
economics of livestock production in Kenya, especially
on cattle production. This review, however, intends to
provide an understanding of what has been done in the
field of livestock economics.

The effect of land subdivision in Laikipia on
livestock productivity has been studied by Kohler
(1987). He indicates that since late 1970's land
purchase has lost momentum and has come to a
standstill. After the settling of the new immigrants,
there was a shift in production from ranching and beef
production to mixed farming, with cultivation of maize,
beans and potatoes. He continues to reveal that
practically no evaluation of the viability of any
investment on the land takes place if it is at stake.
Most of the land acquired in this way is often not
needed immediately, and absenteeism is common in most
of the small-scale farming areas. These facts pre-empt
the indication in the problem identification of the
present study that reduction in numbers of beef animals
in Laikipia, especially in the 1980's when subdivision
had halted, cannot be attributed merely to subdivision

of plots. It is a complex of many factors that may include economic , political, socio-cultural, ecological, and managerial dimensions. Some of the specific ones are low returns, vote-seeking politicians, land pressure and cultivation-oriented immigrants, low and poorly distributed rainfall, and poor ranch management.

Some of the studies carried out on the economics of ranching show low or negative returns from the enterprise. For example, Cook and Stubbendieck (1986) have reported that in the United States, except for a brief period in the 1880's when rates of return in cattle ranching were 25 to 40 per cent, returns have commonly been in the neighbourhood of 2 per cent per year. A study by Onchoke (1986) on the impact of co-operative, group, and individual ranching systems on resource productivity in south-central Kenya - Kajiado, Machakos and Kitui - gave a significantly negative value for net returns per capita (i.e.,returns per person supported directly by the ranch),hectare and animal unit for the indiviual and co-operative raching systems. The figures for the net returns from livestock and livestock products for the individual ranching system were Kshs. -1,753 per capita, Kshs. -98 per ha and Kshs. -203 per animal unit. Net returns from all individual ranch-related activities were Kshs. -580 per capita, Kshs.32 per ha and Kshs.-67 per animal unit. Net returns for co-operative ranches were Kshs. -9 per

ha and Kshs. -57 per animal unit from livestock and livestock products, while net returns from all ranch-related activities were Kshs. -4 per ha and Kshs. 26 per animal unit. However, the group ranching system showed relatively high positive net returns of Kshs. 13 per ha and Kshs. 58 per animal unit from livestock and livestock products, and Kshs. 22 per ha and Kshs. 96 per animal unit from all ranch-related activities.

The study also revealed that livestock sales, predominantly those of cattle, form the single most important source of income for all three ranching systems, ranging from 67 per cent for group ranches to 80 per cent for co-operative ranches. Of the cattle classes, owner raised and AFC steers constituted the largest source of income. This cattle dependency confirms the dominant role played by cattle in the rangeland economy. Thus, the use of livestock sales in the present study as a basis for defining income accruing from beef ranching in Laikipia is considered appropriate.

Aldington and Wilson (1968) studied the livestock industry in Kenya. The main objective of the study was to investigate the variables that influence the supply and demand of beef in the country. They asserted that the variables that must be improved if beef supply is to be increased in future include cattle population, offtake rate and carcass weight. This is so because

cattle population determines offtake,and carcass weight indicates the beef output per animal. Therefore the higher the population, the higher should be the offtake. In the same token, the higher the carcass weight from a high offtake, the higher the beef output. This appears to have been supported by Kivunja (1976). Variables and forces influencing supply and demand of beef have also been mentioned in the Kenya National Livestock Policy (1980). They include producer and consumer prices, offtake, and costs of production. All these variables will be used in the analyis of beef ranch incomes in the present study.

The country's offtake in 1967 and 1975 was estimated at 13.2 per cent and 14.4 per cent respectively. Pastoral areas had the lowest offtake (7.5 per cent) while commercial ranches such as those in Nakuru and Laikipia had the highest (20 - 25 per cent) and were only expected to increase this level marginally (Aldington and Wilson 1968). The study contends that increase in demand for a food product can only be counteracted by an increase in prices. Onchoke (1986) has reported commercial offtake rates of 23 and 24 per cent in Kitui and Mackakos Districts from individual and co-operative ranches respectively, and a low offtake rate (6.1 per cent) from group ranches in Kajiado District.

A study carried out by Ngumi (1976) stresses the importance of beef cattle subsector. Beef cattle make

up about 90 per cent of cattle population and constitute about 60 per cent of the total value of marketed livestock. The study points out that beef is in high international demand and this appears to agree with the contentions of USDA (1973), and Pratt and Gwynne (1977). The findings of this study concur with those of Kivunja (1976) that domestic consumption of beef is income elastic and is expected to grow rapidly with rising incomes. This has also been supported by the Kenya Livestock Development Policy (1980). There are, however, various problems affecting the beef industry as highlighted by Kivunja (1976). Some of these problems include absence of land individualization in some areas, high disease incidence, lack of information on marketing techniques and improved marketing, and low grade cattle. Other problems, as reported by Ngumi (1976), McDowell (1982), and Crotty (1980), are low offtake rates, inadequate processing facilities, and unfavourable environmental conditions, such as erratic rainfall and recurrent droughts.

One of the objectives of the study by Kivunja (1976) was to test the Von Thunen's theory of land utilisation pattern by comparing it with the livestock production distribution pattern in Kenya. Another objective was to compare the farm-gate returns for cattle producers obtained fron private markets and

those obtained from official markets. The study
concluded that Von Thunen's theory is relevant because
generally dairy cattle in Kenya are produced in
districts with high human population. Farm-gate
returns for cattle producers were found to be higher on
private cattle markets than on the official ones. The
study also showed that the demand for beef was highly
income elastic but had a low price elasticity of -0.31.
It further had a low cross-elasticity for other meats
(of 0.132). This implies that as per capita income
increases, demand for beef also goes up. It also
implies that even if prices go up, demand for beef is
not reduced substantially. This study indicates that
supply was equal to demand between 1960 and 1968, but
since 1969 demand has been higher than supply.

If supply exceeds demand, market prices are likely
to fall. Assuming that beef is a normal good,
consumption will tend to increase with a fall in price.
The opposite is expected if demand is higher than
supply. These conditions should prevail in Kenya now
that the meat price control policy is no longer in
force. With these factors in mind, taking into account
that per capita GDP in Kenya rises by about 4.7 per
cent (Kenya 1989) and that of human population by 3.5
per cent per annum, demand for beef is expected to
increase substantially from year to year.

Part-time feedlot feeding when conditions allow,
for instance conditions of surplus grain, can improve

beef production. In a study carried out in Australia by USDA (1973), with the objective of assessing the viability of feedlots, it was shown that the country reaped the benefits of strong world demand for beef. Exports were expanded to the point where Australia became the world's largest exporter of beef and veal, and surpassed Argentina. USDA indicated that:-

> "Australia is poised for more sharp gains in its cattle numbers as producers respond further to higher prices for beef and veal".

The expansion of export trade in Australia was, achieved, precipitated by the strong world demand. This study gives hope to Kenya since some of the conditions that prevailed in Australia that favoured intensive production, such as feedlot feeding, now exist in Kenya. They include decontrolled beef price, occasional grain surplus such as maize, and extensive high potential range, especially in Laikipia, for forage production and pasture improvement. The main handicap towards this last goal is scarcity of capital because feedlot feeding is capital intensive. Regardless of this fact, however, here is still scope for ranchers to introduce occasional feedlot feeding whose trial in Kenya aborted due, mainly, to high prices of grain that did not correspond to controlled (low) prices of beef, as Kariuki (1979) contends.

Feedlot feeding has also been studied by Stotz (1983). This study compared four small holder beef

production systems, namely traditional steer fattening, feeder steer production, intensive steer fattening, semi-zero grazing and intensive steer fattening zero grazing or feedlot feeding. Gross margins were used to arrive at the most attractive system. The criteria used to arrive at this were the contribution to increased land and labour productivity and the competitive position with respect to farm resource use. The results of this study were that land productivity decreases with intensification except in the feedlot system. With respect to labour productivity, a downward trend was observed in intensification. It concluded that, from the national viewpoint, only feedlot system is worth supporting because it is the only system that produces more beef per land unit. It also suggested that a widely adopted feedlot system would generate employment.

It has been observed by Penning De Vries (1983), and Sullivan *et al.* (1982) that the actual livestock productivity is low in the poorest countries. Output per head of cattle in these countries where over a third of the world's total human population lives is about 6.3 kg of beef and 45 litres of milk, compared with 63 kg of beef and 450 litres of milk in the richest nations. They have attributed this to low nutrients in the natural rangeland forages and uncontrolled communal grazing.

The low cattle productivity in Africa can be

alleviated through various means, as suggested by Sullivan *et al*. (1982). One of these is distribution of range resources from communal property to private ownership. Meyn (1970) also suggests improvement of the quality of forage since low cattle productivity which is characterized by 50 - 70 per cent calving rates, 25 - 30 per cent pre-weaning calf death rates, slow growth rates to maturity, and low commercial offtake rates are partially caused by stress due to shortage and low quality of forage.

Pratt and Gwynne (1977) have indicated that there are many ways of ensuring or improving profitability, but there are also many factors over which the operator has little or no control. The prime examples are item costs and market values. Changes in the costs of inputs or in the value of products during a production period can affect the economics of an enterprise. As a result all the economic judgments need to consider both the present price structure and the extent of change that is likely. The writers continue to say that in ranching, profit margins are generally narrow and returns on investments relatively slow to materialize . Ranch development costs are high so that the profit margins and net returns to ranchers are very dependent upon sound investment procedures, good management and a ranching unit of optimum size.

Cattle owners seek to maximize their net income

over time by selling or buying stock, by breeding or slaughtering stock, by giving or withholding feed and an almost infinitely wide range of other inputs (Crotty 1980). Profit maximization is, however, not the only valid objective of ranchers, but it is an accurate predictor of producer behaviour (Ethridge *et al.* 1987). A majority of cattle owners face this complex problem of maximizing income, for the most part by repeating what they usually do or by marginally changing this action in the light of new weather or price conditions, or in the light of the experience of other cattle producers (Crotty 1980). Hence, researchers should be in a position to enlighten them on the right decisions as they try to cope with these new changes.

Njoka (1981), after carrying out a study in Kajiado District on the success of group ranch establishment, found out that the ranches were heavily overstocked before the 1975-1976 drought. He reported that one factor that might have caused the unusual increase in livestock numbers after 1968 was the response of livestock to alleviation of ecological constraints by the range development inputs that were available between 1968 and 1974. The inputs stimulated livestock increases through extensive utilization of rangelands and intensive livestock management practice.

Campbell and Migot-Adhola (1981) have espoused on the expanse of grazing land by indicating that semi-arid lands cover over 31 million ha, falling in 17

districts of Kenya. The study indicates that in 1970, these lands contributed only 20 per cent of the estimated national output and by 1975 the contribution had fallen to 13.5 per cent in the face of greater production from the more populated areas of higher potential. It also projected a 21 per cent drop in meat production by 1990 if this trend continued. The study went ahead to forecast a severe deficit in the supply of meat for the domestic market in 1990 under the then prevailing conditions of production and economics.

One main solution to this predicament, the study suggests, would be to utilize more fully the dryland livestock, either by improving individual productivity or increasing offtake. If the annual offtake rates could be raised from the present levels halfway to those found on developed commercial ranches, the contribution of the semi-arid areas to the national economy would increase, and would help alleviate the predicted meat shortage.

An estimated 154,250 metric tonnes of beef were produced in Kenya in 1981 of which the smallholder sector contributed 64 per cent (Stotz 1983). This implies that the large holder farms contributed 36 per cent. However, out of the total number of cattle kept in the 1970's, 35 per cent were found in the smallholder areas of good agricultural potential, 35

per cent were in arid pastoral areas, 22 per cent were in the marginal cropland (subsistence rangeland areas), and only 2 - 8 per cent were found in large farms and settlement areas (Kaplan *et al.* 1982). This indicates that output from large holder farms is substantially high. Stotz (1983) agrees with Kivunja (1986) and Onchoke (1986) that the national beef demand outstrips supply.

Kinyua (1988) indicates that it is necessary to minimize the cost of calf production in a cow/calf system of production by attaining high fertility and a high per cent of calves weaned in order to maximize returns. He asserts that the objective in beef production should be to maximize nutrient utilization for the total production cycle so as to lower costs of production and thus continue to make beef cost-competitive with other human foods. The study indicates that feeding exerts a strong influence on cow fertility and calf weaning weight. It also contends that although cattle producers are price-takers, by choosing the proper time and method of marketing, they can influence their costs of marketing and perhaps attain a relatively more desirable price. A regression analysis was used to show the relationship between returns on cost based on 100 cows and that of age of weaning and the length of the period from weaning until sale. The model used is shown below:

$$\text{Return (\$)} = b_0 + b_1 X_1 + b_2 X_2$$

Where;

X_1 = age (in days) at weaning and

X_2 = length of period (in days) between weaning and time of sale.

It involved extrapolation of results under United States conditions to Kenyan situation. The study indicates that returns are increased by early weaning and a reduction in the length of time between weaning and time of sale.

The results of this analysis could be very useful to ranchers in Kenya in helping them cut down on the costs of production by using the strategies of early weaning and disposition of animals and thus saving on feed costs. However, there are a few reasons why these results are not plausible and applicable to Kenyan situation. First, ranchers in Kenya carry out extensive grazing as opposed to the ranchers in the United States. This model could be applicable in the high potential areas where intensive production systems are common, but still the dilemma is that farmers in the high potential areas of Kenya are mainly oriented to dairy farming. Secondly, even if ranchers did supplemental feeding, the results of the model were quite insignificant. The regression equation was significant only at a 25 per cent level and the two regressors could only explain 46 per cent of the

variation in the returns over feed costs generated. The regression coefficient for "age at weaning" , X_1, was significant at 20 per cent level while that for "period between weaning and sale" , X_2, was significant at 10 per cent level. This further indicates that the two factors have little influence on returns over feed costs.

2.2 **CONCLUSIONS**

The review in this chapter mainly points to the major role the livestock industry plays in the economy of Kenya. It shows the objectives and findings of various studies as well.

It has been shown by Aldington and Wilson (1968) and Ngumi (1976) that the factors that affect beef production include offtake rates, cattle population, prices, costs of production, disease, and carcass weight. Prices, offtake, and costs of production are some of the factors analysed in the present study to see how they affect ranch income.

Kivunja (1976) and Ngumi (1976) have indicated that demand for beef is highly income elastic but price inelastic. They have also shown that demand for beef in Kenya exceeds supply. The fact that demand for beef is price inelastic implies that an increase in price will not reduce demand substantially. Furthermore, to the extent that demand for beef continues to be higher

than supply, farmers can increase offtake without dampening prices under conditions of a free market.

Studies and publications on rangelands, where livestock production is mainly centred, have shown that the level of production from these areas is low and has not been able to meet the demand for beef in Kenya. They have suggested that beef deficits can be avoided by utilizing more fully the dryland livestock by improving productivity or by increasing offtake.

The results of the study by Stotz (1983) have indicated that smallholder labour and land productivity in the high potential areas of Kenya responds negatively to intensification except in feedlot system. It is therefore important that lower potential lands be utilised more intensively so as to increase output.

Small-scale farming in the form of cultivation in relation to recent changes in land use systems in Laikipia has been studied by Kohler (1987). It has been shown in the study that small-scale farming in this range area is not economically and ecologically viable. This serves as a pointer to the fact that large-scale livestock production should be given more emphasis as a mode of utilizing the drylands.

The present study looks at the incomes of livestock farmers in Laikipia District. It analyses the level of returns from beef cattle production and the factors that influence these returns. This study

is specifically an analysis of returns from large-scale
beef production at the farm level in one of the semi-
arid regions of Kenya. Since most studies in livestock
economics have emphasized livestock marketing or small-
scale production in the highlands, this study hopes to
contribute well towards availing information on large-
scale livestock production in the drier parts of the
country.

CHAPTER THREE

METHODOLOGY

3.1   INTRODUCTION

This chapter describes the methods used in arriving at the results which are presented in chapter four. It shows the types of data used and how these data were collected. The methods of analysis are the statistical method, which uses a "student's" t distribution, and regression models. The t-statistic is used to test hypotheses on net income and net return on investment. Two regression models are used to determine factors that affect net income and offtake from beef ranching. Before giving a description of these methods, below are definitions of some of the economic terms used in this and the following chapters.

When computing costs, the costs are conventionally separated into fixed and variable costs. Fixed costs are those attributed to the fixed factors of production and include both cash costs such as rent, property tax, insurance and non-cash costs such as operator and family labour and interests on investment. These costs do not increase with increased production nor can

payment of the costs be avoided in the "shortrun" by halting operation. The shortrun is defined as a period of time sufficiently short that at least one production factor, such as land, is fixed.

Variable costs are those related to variable factors of production such as purchased immature cattle or grazing fees. Variable costs increase with increases in output and can be thought of as costs that can be avoided by stopping or reducing the operation. In this analysis all cash costs, fixed and variable, have been put together and are referred to as running expenses.

A non-cash cost included in the computation of net incomes is depreciation. Depreciation, unlike other expenses, is not a financial transaction between the firm and others outside the firm. Rather it represents a sum notionally set aside to allow for eventual replacement of fixed assets such as machines which will eventually wear out (George 1978). This has the advantage of allowing the firm to apply the retained portion of profits to financing net investment rather than replacement investment. It has also the advantage of reducing tax liability since firms are normally taxed on the basis of profit net of depreciation charges.

Note that there are various methods of
depreciating an asset, the three most common being the
straight-line, double declining balances, and sum-of-
the-years'-digits methods. The one recommended in
Kenya and hence used by ranchers in Laikipia is the
straight- line method.

There are other various economic terms that
have been used in this analysis whose brief description
is given below;*

(i)   Gross income - This is the value of
       total output (offtake) irrespective
       of the costs of producing the output.
       It has also been referred to as
       gross annual cash returns.

(ii)   Net cash returns - This refers to
       the remainder of the gross annual
       cash returns after subtracting all
       the annual cash costs which are also
       referred to here as running expenses.

(iii) Net ranch income is the returns of
       management, labour and total capital
       input. It is obtained by getting the
       difference between net cash returns
       and that of non-cash costs, in this
       case depreciation.

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*: For further information see Cook and Stubbendieck
    (1986).

To obtain variables related to beef cattle
alone, comparative data have been used. These
comparative data have enabled the apportionment of
variables such as income, cash costs, non-cash costs,
land area, labour and capital between beef animals and
other enterprises. Comparative data have involved the
use of what is known as animal units. Livestock
conversion rates used to obtain animal units have been
adapted from those used by UNDP/FAO (1971).

3.2   DATA

For this study to be carried out, data were
required on the following:-

(i)   Ranch size in terms of land area;

(ii)   The number, species and breeds of
         animals kept on each ranch. Animal
         species were also broken down into
         various classes in accordance with age
         to facilitate use of livestock
         conversion rates. This makes it
         possible to arrive at a uniform unit for
         the purpose of comparing ranch stock
         units and stocking rates;

(iii)   Land area reserved for grazing
         livestock;

(iv)   Rainfall amounts received on the ranch;

(v)   Capital   developments   such   as   water
         facilities,   fences,   machinery   and
         buildings;

(vi)   Offtake, viz. the number of animals sold
         compared   to   those   present   at   the
         beginning of   the year.

(vii)   Financial   figures   such   as   values   of
         capital   developments,   machinery   and
         equipment, owner's capital   contribution
         to the ranch, land valuation, and   costs
         of production - cash and non-cash costs;

(viii)   Land area under   cultivation,   returns,
         and costs involved.

3.2.1   SAMPLING

A   questionnaire was used to collect primary   data
on   several   variables   from a   sample   of   ranches   in
Laikipia   District. Some of these   variables   included
offtake   rates,   ranch size,   annual   rainfall   totals,
livestock   numbers,   ranch   income,   costs,   and   range
condition for a period of 17 years.   Even though   there
were 62   operating   ranches in the district, reasonable
financial data could only be obtained from ten ranches.

The fact that the ranches are large and far-removed from each other, coupled with poor infrastructure, makes transport difficult and costly. This, therefore, necessitated the sampling of a few ranches. The study of a portion of the ranches can be justified because these ranches are situated in a region of relatively uniform agro-ecological conditions, and their operations are reasonably homogeneous. Hence this sample is fairly representative.

By recognizing the fact that this cross-section sample was insufficient to carry out any meaningful econometric analysis, the cross-section data were pooled with time-series data to increase the number of observations. Methods of pooling have been shown by Pindyck and Rubinfeld (1981). In this case, therefore, the pooling resulted in 170 observations, from a cross-section of 10 ranches for 17 years. Hence, this number of observations was now large enough to carry out meaningful statistical analysis as shown in section 3.4.

3.2.2   DATA COLLECTION

The kinds of data collected and to some extent their sources were in accordance with the objectives and hypotheses set.

Apart from the survey which provided primary data, sources that provided secondary data included public offices such as Laikipia District reports of various ministries. The major ministries that had relevant data to this study included the Ministries of Livestock Development, Agriculture, and Water Development. Sources such as Central Bureau of Statistics (CBS), private land valuers, published materials and Laikipia Research Programme (LRP) were also very useful.

Data from interviews were collected using the aforementioned questionnaires, an example of which is shown in Appendix 1. The sample ranches fell in two divisions - Central and Rumuruti. This is where most of the ranches are found in Laikipia. The questionnaire was pre-tested on Mutara ADC ranch, which is a beef ranch, on the basis of ranch operation homogeneity in the district, and was restructured before being used in the survey.

The cross-section and time-series data which were collected from the sample ranches were used to test several lagged and unlagged parameters. These data were on variables such as livestock numbers, price of beef per kilogramme, offtake, land size, rainfall amounts and

distribution, costs, and range condition, for a period of 17 years (i.e., from 1972 to 1988).

3.3   **STATISTICAL ANALYSIS**

After obtaining means of net income and per cent returns on investment for the ten ranches, a statistical analysis was carried out in order to arrive at a decision on these two parameters.

A t-statistic was used because the sample was small ($n < 30$) and hence was assumed to follow a "student's" t distribution. The sample was also assumed to have been drawn from a normal or approximately normal population with mean, U, and standard deviation, d . $\bar{X}_1$ and $\bar{X}_2$ represent sample means while S_1 and S_2 represent the unbiased sample standard deviations of the net income and net returns on investment respectively (see Spiegel 1981).

The hypotheses tested are that:
The null hypothesis is such that the population mean net income is equal to zero, and the alternative is such that the population mean net income is not equal to zero.

When given in abbreviations it becomes;

H_o : $U_1 = 0$

H_1 : $U_1 \neq 0$

The hypothesis on net returns on investment is the same as above, and in abbreviations it is given by;

$$H_o \; : \; U_2 \; = \; 0$$

$$H_1 \; : \; U_2 \; \neq \; 0$$

The t - statistic is given below;[*]

$$t_1 \; = \; \frac{\bar{X}_1 \; - \; U_1}{(S_1/\sqrt{n})\sqrt{\dfrac{N-n}{N-1}}}$$

and

$$t_2 \; = \; \frac{\bar{X}_2 \; - \; U_2}{(S_2/\sqrt{n})\sqrt{\dfrac{N-n}{N-1}}}$$

where U_1 and U_2 = population means of net income and per cent net returns on investment respectively,

t_1 = t - statistic for sample mean net income,

t_2 = t - statistic for sample mean net returns on investment,

N = population size,

n = sample size, and

$\dfrac{N-n}{N-1}$ = adjustment factor, included because the sample constitutes an appreciable portion of the population, that is, more than 5 per cent.

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*: For more information see Freund and Williams (1975).

Freund and Williams (1975) indicate that if the adjustment factor is ignored in this case, it will lead to confidence intervals being wider than necessary and the appraisal of the error larger than necessary.

The hypotheses were tested at a 5 per cent level of significance. A confidence interval of 95 per cent for both means, U_1 and U_2, was obtained as follows:-

$$-t_1 (0.975) \leq \frac{\bar{X}_1 - U_1}{(S_1/\sqrt{n})\sqrt{\dfrac{N-n}{N-1}}} \leq t_1 (0.975)$$

and

$$-t_2 (0.975) \leq \frac{\bar{X}_2 - U_2}{(S_2/\sqrt{n})\sqrt{\dfrac{N-n}{N-1}}} \leq t_2 (0.975)$$

$$\therefore \quad U_1 = \bar{X}_1 \pm \frac{S_1}{\sqrt{n}} \sqrt{\frac{N-n}{N-1}} \; t_1 (0.975)$$

and

$$U_2 = \bar{X}_2 \pm \frac{S_2}{\sqrt{n}} \sqrt{\frac{N-n}{N-1}} \; t_2 (0.975)$$

H_0 is not rejected if absolute value of estimated t is less than critical t, while it is rejected if the absolute value of estimated t is greater than critical t.

3.4   **REGRESSION MODEL SPECIFICATION**

It has already been indicated that there were insufficient observations to estimate either a time-series or a cross-section equation in the determination of factors that affect profitability levels of Laikipia ranches. Therefore a method of combining the data was used to obtain more efficient parameter estimates.

There are several schemes of pooling data all of which have advantages as well as disadvantages. One scheme, which is used in the present analysis, is to - combine all cross-section and time-series data and perform ordinary least squares (OLS) regression on the entire data set. The second is the *covariance analysis* which involves the addition of dummy variables to the model to allow for the possible changes in the cross-section and time-series intercepts. A third technique is the *error-components* model which accounts for the existence of cross-section and time series disturbances. Lastly, there is the *time-series autocorrelation* model which considers the fact that the error term may be correlated over time and over cross-section units[*].

The technique adopted in the pooling of data in the present study assumes that both the intercept and the slopes are constant over time and over cross-section units. This will result in a large pooled regression which would give more efficient parameter

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[*]: For more details on this see Pindyck and Rubinfeld (1981)

estimates than if a regression were run with 10 cross-section or 17 time-series observations. In this case, therefore, there will be 170 observations (i.e.,10x17).

The advantage of using the model that postulates a common intercept and a common set of slope coefficients for all units at all time periods is that it is straight forward. The assumptions are that there is no serial correlation in the disturbances for any individual unit, there is no dependence between the disturbances for different units and the disturbance has a constant variance at all points.

The disadvantage of this method, however, is that the assumption of constant intercept and slopes may not always be true. If the constant and slopes were to vary, each seperate cross-section regression would involve a distinct model and pooling would be inappropriate. Nevertheless, since all the estimation techniques mentioned above give unbiased and consistent parameter estimates, the central issue associated with pooling is one of efficiency. The error-components model is the most efficient because it is estimated using a form of generalized least-squares (GLS) regression (Pindyck and Rubinfeld 1981). However, this model has several difficulties associated with it. First, its estimation can be computationally quite expensive. Second, the technique is not directly applicable if there are lagged dependent variables in the equation such as is the case in the model shown below; hence

the use of the OLS estimation procedure on the pooled data.

The general forms of the regression functions used are give by;

$$G = f(G,P,C,N,S,R,D,V,T), \text{ and}$$
$$S = f(S,Y,F,C,N,R,D,V,X,T)$$

But because cost, C, is related to price, P, and since inclusion of cost would lead to an identity equation after regressing with gross income, G, as the response factor, it was eliminated by subtracting it from the income to obtain net income. Net income is infact the interest of this study. The following functions were thus obtained:

$$Y = f(Y,P,N,S,R,D,V,T), \text{ and}$$
$$S = f(S,Y,P,N,R,D,V,X,T)$$

The specific models were assumed to be linear and lagged as shown below;

$$Y^*_{it} = A + B_1 Y^*_{i\ t-1} + B_2 P^*_{it} + B_3 P^*_{it-1} + B_4 P^*_{it-2} + B_5 P^*_{it-3}$$
$$+ B_6 S_{it} + B_7 S_{it-1} + B_8 N_{it} + B_9 R_{it} + B_{10} D_{it} + B_{11} T_{it}$$
$$+ e_{it} \quad\text{---------------------------------}\quad (3\text{-}1)$$

$$S_{it} = a + b_1 S_{it-1} + b_2 P_{it} + b_3 P_{it-3} + b_4 P_{it-2} + b_5 P_{it-3}$$
$$b_6 Y_{it} + b_7 Y_{it-1} + b_8 N_{it} + b_9 R_{it} + b_{10} D_{it}$$
$$+ b_{11} V_{it} + b_{12} X_{it} + b_{13} T_{it} + u_{it} \quad\text{--------}\quad (3\text{-}2)$$

$$\text{for } i = 1,2,\ldots,10$$
$$t = 1,2,\ldots,17$$

where

G = gross income per ha

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*: Prices and incomes are given in real terms. Consumer price indices (CPI) for middle income group were used to obtain constant prices (see Appendix 3)

Y_{it} = net income per ha for ranch i at time t

S_{it} = offtake rate for ranch i at time t

P_{it} = price of beef per KgLwt for ranch i at time t

N_{it} = stocking rate for ranch i at time t

R_{it} = rainfall total for ranch i at time t

D_{it} = rainfall distribution for ranch i at time t

V_{it} = range condition for ranch i at time t

X_{it} = index for the rate of price change for ranch i at time t

X_{it} = value attached to time for ranch i at time t

e_{it} = error term associated with model (3-1) for ranch i at time t

u_{it} = error term associated with model (3-2) for ranch i at time t

$t-1$, $t-2$ and $t-3$ indicate variables lagged once, twice and three times respectively.

A , $B_1, B_2, B_3, B_4, B_5, B_6, B_7, B_8, B_9, B_{10}$, and B_{11} are coefficients representing the OLS estimators of the variables in function (3-1), while a, b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, b_{10}, b_{11}, b_{12}, and b_{13} are the OLS estimators in function (3-2).

Before running regressions, data were organized in both functions by decision units (i.e., ranch units) thus;[*]

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*: For further details see Johnston (1984).

$$Y_i = \begin{bmatrix} Y_{i1} \\ \vdots \\ Y_{i17} \end{bmatrix} \quad X_i = \begin{bmatrix} X_{1i1} & X_{2i1} & \cdots & X_{11i1} \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ X_{1i17} & X_{2i17} & \cdots & X_{11i17} \end{bmatrix} \quad e_i = \begin{bmatrix} e_{i1} \\ \vdots \\ e_{i17} \end{bmatrix}$$

$$S_i = \begin{bmatrix} S_{i1} \\ \vdots \\ S_{i17} \end{bmatrix} \quad X_i = \begin{bmatrix} X_{1i1} & X_{2i1} & \cdots & X_{13i1} \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ X_{1i17} & X_{2i17} & \cdots & X_{13i17} \end{bmatrix} \quad u_i = \begin{bmatrix} u_{i1} \\ \vdots \\ u_{i17} \end{bmatrix}$$

Thus the above denotes the data and disturbances relevant to the ith ranch. The data were 'stacked' to form

$$Y = \begin{bmatrix} y_1 \\ \vdots \\ y_{10} \end{bmatrix} \quad X = \begin{bmatrix} x_1 \\ \vdots \\ x_{10} \end{bmatrix} \quad e = \begin{bmatrix} e_1 \\ \vdots \\ e_{10} \end{bmatrix}$$

and

$$S = \begin{bmatrix} S_1 \\ \vdots \\ S_{10} \end{bmatrix} \quad X = \begin{bmatrix} x_1 \\ \vdots \\ x_{10} \end{bmatrix} \quad u = \begin{bmatrix} u_1 \\ \vdots \\ u_{10} \end{bmatrix}$$

These were assumed to be *adaptive expectations* models with e_t and u_t being independently and identically distributed.

In the formulation of these regression models, the independent variables have been considered for several reasons. For instance, offtake rate, S, used here to mean the percent of animal units put on the market and

sold in relation to the number of units that were available at the beginning of the production year, is very important in beef production. This is actually a measure of output from the ranch. Commercial ranch output is, in common practice, measured in terms of fixed-quotas of livestock units rather than in terms of the number of people actually supported directly by the system (Child *et al.* 1984). This is what the present study has adopted. This variable is influenced by the number of stock units kept on the ranch. It is obvious to see that the more the animals one keeps, the more the resources needed to raise them to slaughter weight. Therefore the more one should sell each year to cover the costs of production and make a profit. As Jarvis (1974) has shown, in equilibrium a constant proportion of the herd, or category, is slaughtered each year. This number, however, may be increased or decreased depending on the desires of producers, which in turn depend on the level of certain parameters. Parameters such as the current price level or current climatic conditions affect producer expectations and thereby the size of the desired future herd. An increase in offtake without changing output prices implies higher incomes. If costs of production are not affected by the higher level of production, it will mean higher net incomes.

Offtake rates can be computed in various ways. The one chosen will depend on one's interests. White and Meadows (1981) , Nsibandze (1982), Evangelou (1984), and Njoka and Gatere (1985) reported livestock offtake rates in terms of animal sales. Grandin and Bekure (1982) reported total offtake rates in terms of commercial sales, and non-commercial transactions (i.e., exchanged, gifts, and slaughtered). Njukia (1977) showed offtake rates by including livestock sold, traded, slaughtered, dead, and eaten. Sullivan *et al.* (1985) visualized total offtake rate as being the sum total of livestock sold, dead, slaughtered, traded, and paid for dowry, while Mukhebi *et al.* (1985) figured offtake rate to be the sum of livestock deaths, losses, sales, giveaways, and home slaughter. The present study considers only livestock sales since the main interest here is commercial offtake, and this is sufficient and appropriate to achieve the stated objectives.

Prices, *P*, play an important role in any production system. They are the signals which indicate how resources should be allocated, what and how much should be produced, and who should get what is produced. Thus, the act of determining prices has far-reaching implications in any aspect of the economy.

Some of the past policies of beef production have meant keeping beef prices below the equilibrium, resulting in increased demand at a time when production of beef has slowed down (Makanda *et al.* 1987). Thus, given the misgivings of the price controls, the recent waiving of beef price control is a welcome development to ranchers and any parties engaging in the beef industry.

In a free market, it is assumed that the ranchers are rational so that when prices offered are high they will react in such a way that a large number of stock is put on the market for sale. This will obviously have a positive effect on the ranchers' income if the increase in number of cattle does not dampen prices. It is, therefore, expected that the higher the price offered, the higher the income, while the contrary is true when prices decrease. However, the higher the price in any year, or the greater the current rate of change of price, the greater is the expected price and the greater the desired future herd. This may cause reduction in offtake in the immediate future. This contention has been supported by Jarvis (1974), who argues that an increase in the price of beef which is not expected to last could lead to increased rather than decreased slaughter only in the very short-run

In the not very short - run, however, price response of slaughter is negative because animals must be withheld to permit increases in future output. It is in the long-run that price response of slaughter is positive. This negative short-run response implies that a rise in prices is unlikely to increase beef output for at least two years.

The cattle sector, therefore, presents an interesting feature because this behaviour contrasts with the supply response of most other agricultural products whose desired output and actual output are both expected to rise immediately in response to a price increase. Although actual output for crops is expected to adjust only gradually to the long-run desired output, there is never reason to expect output to fall due to price increases. Since cattle production can be increased only by increasing the size of the breeding herd and/or withholding animals for further fattening, producers must bid animals away from consumers to increase their capital stock which is the source of higher future beef production. Jarvis (1974) continues to indicate that the slow rate of biological reproduction causes the nagative supply response to persist for sometime.

Costs, C, play a crucial role in influencing incomes. Rising costs will place a limit on the number of animals which each rancher wishes to keep. A

rancher's average cost per animal unit may first decline and then later it rises as animals kept are increased so that eventually it becomes unprofitable to increase herd size. An increase in animal numbers also increases disease incidence, labour and other management requirements. Consequently, there would be an increase in the average cost of maintaining the animals up to slaughter weight. However, costs per unit output should be treated with caution. For example, it does not necessarily imply that the higher the costs involved in the production of one unit of output the lower the income. Nor does it mean that there will be a higher income with higher costs. It is possible that an increase in total cost per unit output may lead to an increase in quality. The assumption is that quality fetches more returns as is the case with beef animals. It will also depend on whether the rancher is producing at an optimal level or below or above this level. Another possibility is that costs may have no effect on net returns per unit of output for the reason that the increased costs are exactly offset by high income as a result of an increase in the number of beef units produced. Since the rancher is rational, more and more of an input will be used until a point where any extra unit of input used will not result in an increase in quantity or quality of output.

Cost was not used in the regression because when

price is also included, the result will be an identity equation and there will be a possibility of multicollinearity because the two are related.

Rainfall, R, is perhaps the single most important factor in most types of agricultural production. It is expected that the more the rain, of course up to a limit, the better the range condition, V. Range conditon is, therefore, expected to be correlated with rainfall amounts. It is worthy of note, however, that range condition is also influenced by the level of pasture management, species of grass and soil types, and one or more of these may be more important than the other. Higher rainfall amounts lead to more and better quality feed. With more feed the rancher can keep more animals or can increase output per animal. This should lead to higher offtake and hence higher income.

The total amount of rainfall *per se* may not be as important as its distribution in the range areas. Therefore, distribution, represented by the number of days of rain per year, D, has been taken into consideration. Rainfall that falls throughout the year would be more effective in increasing livestock productivity than that which falls for a fraction of the year. This is because feed will be of better quality and in plenty all the year round.

Range condition determination provides an estimate of the vegetation that is present on a given site

compared to climax vegetation. Depending on one's interest, it provides a basis for estimating trend, productivity, feasibility of the range improvements and stocking rates. As David *et al.* (1982) indicates, low condition range supports a higher per cent of plants that are low in nutritive value and forage production. This could, therefore, reduce the qualitative and quantitative intake of grazing animals, which in turn would affect their performance.

Stocking rate, N, shows the intensity of use of the available forage. If an extra cow is added to an already optimal stocking rate, that cow's presence will adversely affect the performance of others, causing average output to drop, and, maybe, increasing total output marginally. If more animals are added, average yield will decline so much that total output either remains unchanged or declines. Also, as shown by Crotty (1980), average age at maturation increases with stocking density. Therefore, if a rancher is aware of the optimal number of animals to keep per given land area of his ranch, he would not wish to hold more animals than this, however low the cost of keeping a cow is. The inclusion of this variable is, therefore, to determine whether the present stocking rates can be either increased or decreased in order to increase income. At an optimal stocking rate, moving either way will reduce offtake, and, probably, income.

Price change index ,X, is a measure of the
relative change in price and is, therefore, an indicator
of expected price. The higher the current rate of
change of price, the higher is the expected price. The
relevant expected price of animals is the price
expected to prevail at the time the animals will be
sold. Expected prices are, therefore, likely to
influence the action of ranch managers and hence the
amount of slaughter, since, as argued by Pratt and
Gywnne (1977), economic judgment should be based both
on the present price structure and the extent of change
that is likely.

The inclusion of time, T, as a factor seeks to
show whether income and/or offtake have been increasing
or reducing over time due to some variable (or
variables) that might not have been included in the
regression analysis. For example, over the period being
studied, there might have been technological changes
that have led to an increase in stocking rates or
numbers of animals sold. In this case, therefore, the
response of offtake to time will be positive. However,
if the numbers sold have been reducing over this
period due to some factor, time response will be
negative.

CHAPTER FOUR

EMPIRICAL ANALYSIS AND DISCUSSIONS

4.1   INTRODUCTION

The main objective in this chapter is to present
and discuss the results of this study. However, a
description of the five types of ranches that exist in
Laikipia District has been given below. This
description includes ranchers' livestock markets and
ranching activities. Cross-section data collected from
the sample ranches have also been compiled and
discussed in detail.

4.2   PRESENT RANCH TYPES AND ACTIVITIES

There are about 75 ranches in Laikipia District,
62 of which are operational. Thirty three of these
ranches are situated in Central Division, thirteen in
Mukogodo, and the rest in the other two divisions, that
is, Ngarua and Rumuruti. Over 50 of these ranches
range from 400 to 40,000 hectares.

The ranches are classified into various groups,
namely public and private companies, individual
ranches, partnerships, state (or parastate) ranches,
group ranches, and co-operative ranches. Most of the
co-operative ranches have already been subdivided.

4.2.1   COMPANY RANCHES

There are about 50 company ranches and, therefore, these are the largest in number in the district.   This type of ranching is formed when a group of people,   say 3 to 50, come together and form a limited company by being registered under the Company Act Cap.486 of the Laws of Kenya. The group approaches a County Council or the Government for lease of land or buys land, and in this case possesses a freehold title to land.   The management is under a board of directors and a manager and the major aim is to make profit. There   are   two types   of   company ranches; Public   and   Private companies.   Public companies differ slightly   from private companies because the shares of the former may be on offer to the general public, while among other things shares in a private company cannot be offered to the general public (Jackson 1978).

4.2.2   PARTNERSHIPS

There are 4 partnership ranches in the district. These are unincorporated associations which are started when a few persons (not more than twenty) interested in raising   livestock come together and register   as partners under the Partnership Act Cap. 29 of the Laws of Kenya (Jackson 1978). Their operations are not different from those of company ranches except for the implication they have insofar as taxes are concerned, and in the event when they run into liquidity problems.

4.2.3   PARASTATE (ADC) RANCHES

There are 2 ranches sponsored by the Agricultural Development Corporation (ADC) in the district. These are similar to the two types above in the sense that they are commercially oriented. But they have a slight difference since they are created by statute and 51 per cent or more of the investment is provided by the Government. The Government has a controlling share and hence has an upper hand in decision-making on matters pertaining to the ranch.

In addition to profit-making, the ranches have been developed to act as reservoirs of desirable genetic materials of domestic animals. A case in point here is Mutara ADC which has been the main genetic pool for Boran cattle in Kenya.

The ranches also serve as demonstration units for proper management for the other ranchers and pastoralists to emulate.

4.2.4   CO-OPERATIVE RANCHES

Co-operative ranches in the district were established in formerly foreign-owned commercial ranches. These ranches are formed by groups of people who agree to form a society under the Societies Act Cap.490 of the Laws of Kenya and raise funds to

purchase a ranch or group of ranches. Sometimes County Councils may allocate land to co-operatives for a particular period. Co-operative ranches include Gema Holdings and P & D Development shown in Map 3.

At present there are 3 co-operative ranches in the district, but all of them are expected to be sub-divided during the 1989/93 development plan period.

4.2.5 GROUP RANCHES

Initially, group ranches were established in Maasailand in Kaputiei Section in accordance with the Land (Group Representatives) Act Cap. 287. of the Laws of Kenya, commenced on 28th June, 1968. These ranches were later introduced in other districts of the country including Laikipia.

As a result of the problems that beset these ranches, especially those of poor management, they have failed (Kenya 1988). Therefore all the 13 group ranches in the district are not operating.

4.2.6 RANCHERS' LIVESTOCK MARKETS

Several institutions existed in 1960's, 1970's and part of 1980's that functioned as inlets and outlets for ranchers' stocks, namely Kenya Meat Commission, extra-KMC organised markets, Livestock Marketing

Division (LMD), and non-organised markets, that is subsistence, of which little is known from the ranchers' point of view. Some of these institutions exist even today.

4.2.6.1   The Kenya Meat Commission (KMC)

The KMC was established by Ordinance with effect from 1st June 1950. The Commission started meat processing in 1953 (Aldington and Wilson 1968).

The KMC pricing policies were used by the Government as a means of influencing the Kenyan meat market. At the time it started, it seemed that KMC followed a policy of maximising returns of the Europeans who were the main producers. Under conditions that existed then, this policy was followed with some success. But later governments changed and their policies changed with them. What emerged from the deliberation on a suitable pricing policy for KMC was that any policy must be flexible. But this was not the case and it was clear that the inflexible pricing policy was definitely not suitable in this context. At present, therefore, KMC plays a limited role in Laikipia because most ranchers sell their animals to non-organised markets which offer higher prices and also pay promptly.

4.2.6.2   The Livestock Marketing Division (LMD)

LMD is a division of the Ministry of Livestock Development which was formed to assist in the marketing of livestock. It had various functions in this respect. One was to purchase low value stock from "Northern Frontier Districts" as part of a destocking programme. The second was to assist in putting a floor price in the market for cattle from the pastoral areas by acting as the buyer of last resort and so preventing the creation of price swings. The third was to act as a sole buyer in remote areas. The fourth was to act as an official channel through which the cattle from North-eastern and Eastern Provinces could pass to the finishing areas. Aldington and Wilson (1968) report that one of the most important finishing areas was Laikipia District, which is a high potential grazing land.

It was realised that, due to climatic differences, some parts of the country were suitable for fattening or finishing immatures and others could be best used for breeding and rearing the immatures. This idea has been supported by Jarvis (1974), who points out that producers recognize differences in costs of production and hence choose different parts of the production process. He shows, as an example, that breeding operations will usually take place in areas where the

opportunity cost of feed is cheap, that is, where the cost of maintaining a cow year round is less than the value of a calf at birth. Therefore, it will not be profitable to maintain breeding herds in higher-cost feed areas unless producers there are more efficient, that is, unless their herds have higher calving rates and lower mortality rates than herds elsewhere. This form of specialised production which is known as "stratified livestock production" is believed can lead to efficient use of resources. The LMD, therefore, operated as a "middleman" in a distributive chain and at the same time held the responsibility to purchase cattle from producers or traders without regard to the market situation facing it at the next point of sale. This means that the producers were assured of a market for their animals.

The LMD no longer gives these marketing services. The Kenya Government discontinued allocating funds for the purchase of livestock because of financial constraints (Kenya 1989). Since then the main functions of LMD have been the provision of advisory services and maintenance of stock routes and holding grounds.

Apart from the LMD, markets outside KMC included the then Kenya Farmers' Association (KFA), now called Kenya Grain Growers Co-operative Union (KGGCU), and local butchers and livestock traders. The KFA also

ceased to operate as a livestock market.

At present there is no public institution actively involved in organising livestock markets except KMC which is being revived now. Ranchers depend mainly on livestock dealers and local butchers. This means that ranchers find themselves in a situation of uncertainty about where to market their animals. Therefore they are not in a position to plan their production and marketing strategies properly.

4.2.7   <u>LIVESTOCK OPERATIONS</u>

Livestock production systems in Laikipia and everywhere else in the country are quite complex. For example, they include many different species of livestock, especially cattle, goats, sheep, camels, donkeys, and to a lesser extent horses. Although these are lumped together as livestock in discussions of use of grazing and carrying capacities, their needs may differ greatly. Goats are browsers while sheep are grazers. Cattle are far more water-dependent than camels, and donkeys and horses may be able to thrive on the dry grasses which have insufficient proteins for ruminants. Therefore, these similarities and differences must be appreciated in order to understand various livestock operations and the inherent management problems that accompany them.

The majority of ranchers in Laikipia carry out a cow/calf operation. This means that they breed and raise their own cattle. This was not the case when KMC was fully operational and when LMD assisted in marketing of immatures from the more arid regions of Kenya. The reason for this was that farmers were assured of a regular supply of immatures and a number of ranches were involved in fattening and subsequent sale of steers. This kind of operation was referred to as keeping a flying herd.

According to most ranchers, KMC down-graded steers raised from immatures obtained from pastoralists in the north. The reason for the down-grading was the KMC's claim that beef from these steers was infested with measles. The prices of these animals were consequently low and farmers were discouraged from raising steers that originated in the north.

As shown in Fig. 4.1, dairy cattle constitute 10 to 15 per cent of the total cattle herd in Laikipia. Furthermore, there is not a single ranch that specializes in dairy alone without some element of beef production.

All ranches surveyed keep small-stock which include goats and sheep. This practice is common mainly because small-stock, especially goats, apart from being a source of revenue, are used as a

Livestock Numbers
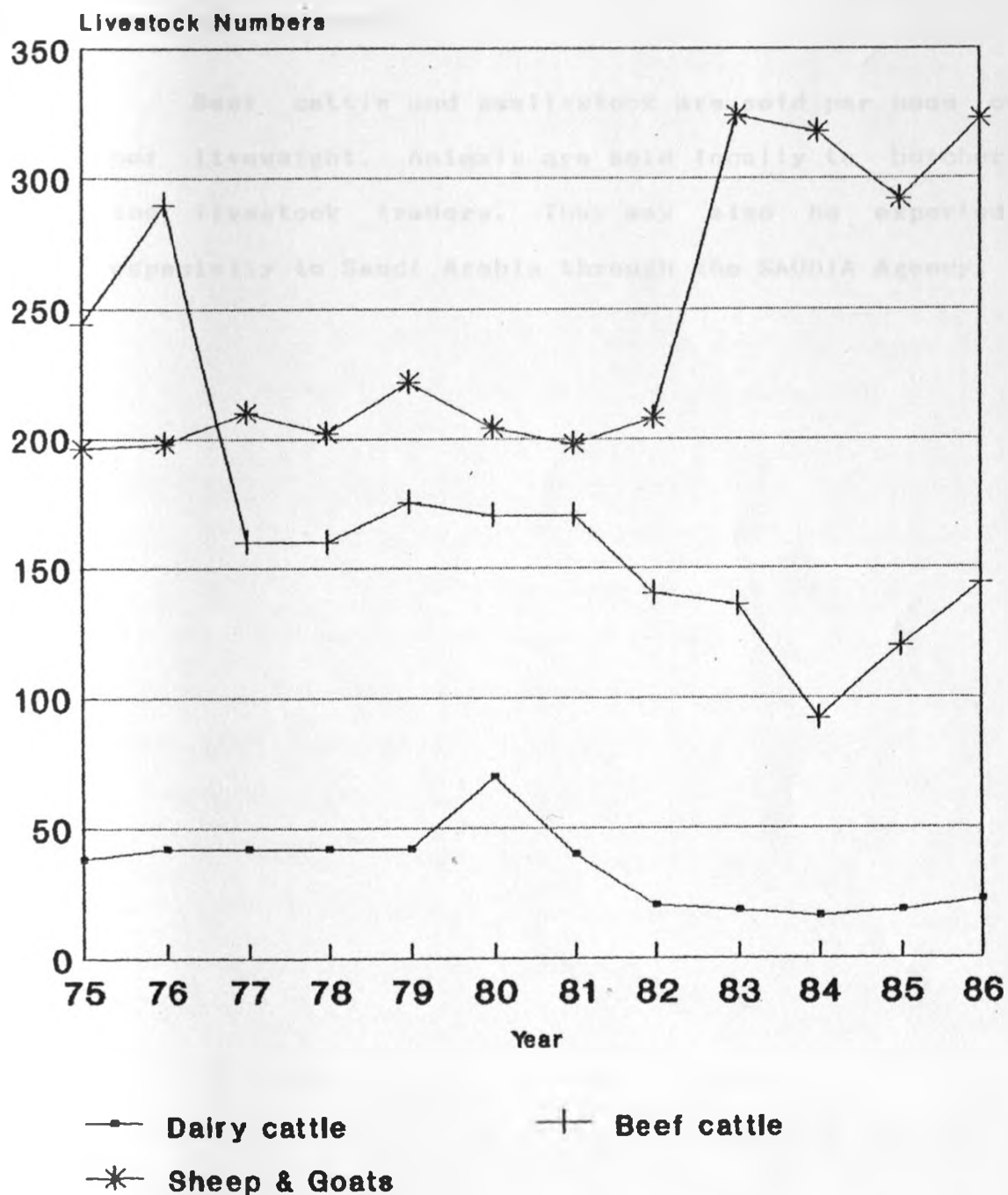
Fig. 4.1: Livestock Population Trends in Laikipia
District ('000)

Source: Kenya 1987; Author 1988

management tool. This is so by way of browsing and hence reducing bush encroachment and also getting rid of ticks by browsing ahead of cattle in a rotational grazing management.

Beef cattle and small-stock are sold per head or per liveweight. Animals are sold locally to butchers and livestock traders. They may also be exported, especially to Saudi Arabia through the SAUDIA Agency.

4.3   DATA PRESENTATION AND DISCUSSION

   Table 4-1 shows the number of stock units per
ranch.   Cattle aged over 2 years have been considered
as adults and a conversion rate of 1.0 has been used to
convert them into stock units[*]. Heifers and steers
of age between 1 and 2 years have been converted into
stock units by using a conversion rate of 0.6 while
calves have been converted at a rate of 0.2.   These
conversion rates have been used on horses and camels
too.   A conversion rate of 0.6 has been used for adult
donkeys.   Sheep and goats have been equated to stock
units by using a conversion rate of 0.11 while a rate
of 0.14 has been used for pigs.

   Investment in livestock is shown in Table 4-2.
These values are apportionments between livestock and
cropping.   The ranches that do mixed farming are
Kamwaki Public Company , Murera Partnership
and Tharua Private Company .

        Kamwaki ranch has about 48 ha of irrigated
fodder and maize out of a total of about 12,210 ha.
Maize is grown for use on the ranch.

   _____

        *: Conversion rates have been adapted
           from UNDP/FAO (1971) interim report

Table 4-1: Total Stock Units (SU) per Ranch (F_i)

F_i Type and Class of animal	Kaawaki F_1	Murera F_2	Mutara F_3	Marania F_4	Gianni F_5	Allu's F_6	Ol Donyo Lemboro F_7	Ol Jogi F_8	Mogwooni F_9	Tharua F_{10}
Beef Cattle										
> 2 years	1700(1.0) = 1700	15(1.0) = 15	3482(1.0) = 3482	386(1.0) = 386	1058(1.0) = 1058	189(1.0) = 189	915(1.0) = 915	1923(1.0) = 1923	664(1.0) = 664	200(1.0)=200
1-2 years	850(0.6) = 510	10(0.6) = 6	1744(0.6)= 1046.4	124(.06)= 74.4	490(0.6) = 294	17(0.6) = 10.2	300(0.6) = 180	243(0.6) =145.8	258(0.6)= 154.8	97(0.6)=19.4
calves	900(0.2) = 180	16(0.2)= 3.2	854(0.2) = 170.8	69(0.2)= 13.8	208(0.2) = 41.6	43(0.2) = 8.6	145(0.2) = 29	121(0.2) = 24.2	206(0.2) = 41.2	
	Total = 2390	Total =24.2	Total = 4699.2	Total = 474.2	Total = 1393.6	Total = 207.8	Total = 1124	Total = 2093	Total = 860	Total= 219.4
Dairy Cattle										
> 2 years	950(1.0) = 950	40(1.0) = 40	----	12(1.0) = 12	59(1.0) = 59	91(1.0) = 91	---	---	33(1.0) = 33	123(1.0)=123
1-2 years	400(0.6) = 80	30(0.6) = 18		5(0.6) = 3		18(0.6) = 10.8			32(0.6) = 19.2	325(0.6)=195
Calves	600(0.2) = 120	31(0.2)= 6.2				43(0.2) = 8.6				90(0.2)=18
	Total 1150	Total = 64.2		Total = 15	Total = 59	Total = 110.4			Total = 52.2	Total = 336
Sheep & Goats (Adults)	3440(0.11)	536(0.11)	1434(0.11)	6010(0.11)	6855(0.11)	631(0.11)	1231(0.11)		674(0.11)	668(0.11)
	Total = 378.4	Total = 59	Total = 157.74	Total = 661.1	Total = 754.1	Total = 69.4	Total = 135.4		Total = 74.1	Total =75.7
Horses										
Adults	---	---	---	29(1.0) =	---	---	7(1.0)	16(1.0)	10(1.0) = 10	20(1.0)= 20
Calves	---	---	---	---	---	---	---	---	1(1.0) = 0.2	10(0.2)= 2
							Total = 7	Total = 16	Total = 10.2	Total = 22
Donkeys	--	2(0.6) = Total = 1.2	---	---	3(0.6) = Total = 1.8	---	---	--	--	--
Camels										
> 2 years	---	---	---	---	---	---	---	64(1.0) = 64	---	---
1-2 years	---	---	---	---	---	---	---	14(0.6) = 8.4	---	---
Calves	---	---	---	---	---	---	---	23(0.2) = 4.6	---	---
								Total = 77		
Pigs	---	---	---	---	---	---	---	---	---	454(0.14)=63.6 Total = 63.6
Grand Total	3918	149	4857	1179	2209	388	1266	2186	997	717

Source: Author's Survey and Computation

Murera farm, which is managed by Africans, cultivates an area of about 91 ha out of an area of about 611 ha. Wheat and potatoes are irrigated for sale. Wheat takes an area of about 81 ha and potatoes cover 10 ha.

Tharua ranch, which has an area of about 4,274 ha, cultivates an area of about 121 ha, where lucerne, maize and rhodes grass are grown. Lucerne and maize are used on the ranch while hay, which is made from rhodes grass, is sold. The remaining ranches specialize in livestock production.

It can be noticed that ranches that carry out mixed farming tend to have higher values of investments per ha. The reason is that cultivation is not wholly rain-fed and involves irrigation. Irrigation tends to be comparatively expensive. The amount of investment shown in Table 4-2 is in livestock alone. The assumption that a linear relation exists among enterprises, and the allocation of costs and investment in light of this might not be as appropriate in comparing livestock and cultivation as it may be in apportioning between livestock enterprises alone. The author could not think of any better method of apportionment. However, where resources were enterprise-specific, for instance the use of tractors for cultivation alone, allocation did not pose any problem.

Table 4-2: Investment in Livestock (Kshs)

Item Ranch	Land (Market rate)	Labour	Capital	Total Investment	Total Investment Per Ha	Size of Ranch (Land Area in Ha)
F_1	45,000,000	1,800,000	14,754,000	61,554,000	5,041	12,210
F_2	1,820,000	480,000	2,295,782	4,595,782	8,686	611
F_3	94,500,000	2,142,370	18,586,800	115,229,170	4,493	25,647
F_4	18,540,000	2,604,000	35,501,200	56,645,200	13,918	4,192
F_5	30,000,000	780,000	9,125,350	39,905,350	4,902	8,140
F_6	2,400,000	300,000	4,161,300	6,861,300	21,047	328
F_7	17,000,000	160,000	4,049,230	21,209,230	3,065	6,919
F_8	78,400,000	1,680,000	10,558,000	90,638,000	3,977	22,792
F_9	21,619,560	528,000	5,489,620	27,637,180	4,208	6,567
F_{10}	18,900,000	782,752	5,196,548	24,879,300	5,821	4,274

Source: Author's Survey and Computation 1988.

Generally, the smaller the ranch, the higher the investment per ha tends to be. This indicates that, the less the available land, the more capital intensive the ranch tends to be. It may also imply a more intensive use of land.

Market rates for land in the district were used to indicate investment in land. Where a rancher had knowledge of the rates in areas next to the ranch or had sold part of the ranch around the year 1988, the price at which the land was sold was used. Land valuation for Allu's ranch was rather high because the ranch is in a slightly better agro-ecological zone and is next to Nanyuki Municipality.

Costs involved in raising beef cattle are shown in Appendix 2. Again, Allu's ranch had quite a high figure (of Kshs.2,057.70) for total costs per ha. It was not very clear why this was so. One of the possible reasons is that of mispresentation of information by the interviewee. It would also seem likely that the rancher incurs higher land rates and labour costs due, first to better land potential, and secondly to higher wage requirement because of more expensive life for the labourers who stay in or near Nanyuki town. The other reason could be that the ranch is small and/or has a higher fraction of dairy cattle compared to beef cattle. Allu's and Murera ranches tend to spend more per ha (see also Table 4-4).

Among other things, Table 4-3 shows stocking rates. Stocking rate is the number of animals kept on a unit land area over a period of time . Stocking rates show the intensity of use of grazing land. It should be realised, however, that with improvements of the range by seeding with palatable grasses, and some supplementation with fodder crop, stocking rates can be increased substantially. Theoretically, in eco-climatic zone IV a rancher should graze one stock unit on four ha (4ha/SU) throughout the year for sustained production that takes into account conservation measures. To go by the computations in this study, most of the ranches sampled are slightly overstocked. The overstocked ranches include Kamwaki, Murera, Marania, Gianni and Allu's. The rest are understocked, with Ol Jogi having a very low stocking rate.

Table 4-3: Stock Units, Stocking Rates, and Land Apportionment

Item Ranch	Total Stock Units (SU)	Total Beef Stock Units	Stocking Rates (Ha/SU)	% Beef Stock Units c.f Total Units	Grazing Land under Cattle (Ha)	% Land under Beef Cattle	Beef Stock Units sold
F_1	3918.4	2,390	3.1	61	7448.1	61	800
F_2	148.6	24.2	3.6	16.3	86.3	14	17
F_3	4857.0	4699.2	5.3	96.8	24826.3	96.8	1577
F_4	1179.3	474.2	3.5	40.2	1636.1	39	150
F_5	2208.3	1393.6	3.7	63.1	5136.3	63.1	505
F_6	387.6	207.8	0.8	53.6	174.7	53.6	70
F_7	1266.4	11,224	4.9	88.8	6,144	88.8	225
F_8	2,186	2,093	10.4	95.7	21,812	95.7	200
F_9	996.5	860	6.6	86.3	5667.3	86.3	400
F_{10}	716.7	219.4	5.8	30.6	1268.6	29.7	139

Source: Author's Survey and Computation 1988.

In eco-climatic zone III the theoretical requirement is about 2 ha per stock unit, in which case therefore, the stocking rate of 0.84 ha/SU in Allu's ranch is an indication of overstocking. However, too low stocking rates are economically undesirable because they waste land resource.

Table 4-4 shows the allocation of investment in various resources plus the allocation of costs per ha to beef cattle alone. Total investment and total costs per ha tend to be directly related. The higher the investment, the higher the costs tend to be. This is expected because high investments lead to high maintenance costs and non-cash costs such as depreciation. This can be seen in the case of Murera and Allu's ranches.

Table 4-4: Apportioned Investment in Beef Cattle (Kshs)

Item	Investment in Land	Investment in Labour	Investment in Capital	Total Investment	Total Investment per Ha	Total Cost per Ha
Ranch						
F_1	27,450,000	1,098,000	8,999,940	37,547,940	5,041	229.30
F_2	296,855	67,200	321,409	685,464	7,943	1158.75
F_3	91,476,000	2,073,814	17,992,022	111,541,837	4,493	228.00
F_4	7,230,600	1,015,974	14,345,604	22,592,178	13,809	233.60
F_5	18,930,000	492,180	5,758,096	25,180,276	4,902	253.60
F_6	1,286,400	160,800	2,230,457	3,677,657	21,047	2,057.70
F_7	15,096,000	142,080	3,595,716	18,833,796	3,065	63.70
F_8	75,028,800	1,607,760	10,104,006	86,740,566	3,977	236.90
F_9	18,657,680	455,664	4,737,5422	23,850,886	4,208	349.50
F_{10}	5,609,520	232,321	1,542,335	7,384,276	5,821	369.50

Source: Author's Survey and Computation 1988.

Gross and net incomes have been shown in Table 4-5. Kamwaki ranch has a high positive return while Ol Jogi ranch shows a very high negative return. One of the possible reasons why Kamwaki ranch has this high return is that the rancher has improved the range by maintaining about 3,049 ha of established giant star grass - a highly palatable grass type. The most likely reason for losses experienced by Ol Jogi ranch is that the ranch is very understocked and hence land resource is wasted. This results in the lowest offtake (17.8 per cent) among the ranches sampled (Table 4-6).

Murera ranch may be making losses because its land size (526 ha) is small and even a particularly smaller area (86.3 ha) is under beef cattle (Table 4-3 and Table 4-6).

An example of how income was obtained for each surveyed ranch has been shown in Table 4-7. This can be considered as an income statement prepared by the author by using figures given by the rancher. Note that Mutara ranch does not pay corporate tax by virtue of its parastatal status. However, to put all the ranches on the same footing for the purpose of analysis, the assumption that it pays the tax should be made. Otherwise the analysis would result in misleading conclusions about profitability.

Table 4-5: Apportioned Income from Beef cattle (Kshs)

Item Ranch	Gross Beef Income	Gross Beef Income per Ha	Net Beef Income per Ha Before Tax	Net Beef Income per Ha After Tax (55% of Net)	Net Return on Investment Before Tax (%)	Net Return on Investment After Tax (%)
F_1	5,200,000	698.20	468.90	257.90	9.3	5.12
F_2	91,800	1,063.70	-91.30	-91.30	-1.15	-1.15
F_3	9,217,000	371.30	130.00	71.50	2.9	1.60
F_4	843,750	515.70	282.10	155.15	2.04	1.12
F_5	2,531,487	492.90	239.25	131.60	4.88	2.68
F_6	376,250	2,153.20	98.05	53.90	0.47	0.26
F_7	840,938	136.90	73.20	40.30	2.4	1.31
F_8	1,269,000	58.30	-178.70	-178.70	-4.5	-4.50
F_9	2,100,000	370.50	21.00	11.60	0.5	0.28
F_{10}	813,150	641.00	271.30	149.20	4.66	2.56

Source: Author's Survey and Computation 1988.

Table 4-6: Various Information on Cross-section Variables

Item	Price of Beef per KgLwt in Kshs	Cost of Producing 1 KgLwt of Beef in Ksh	Area of Land under Beef Animals in Ha	Offtake in %	Rainfall Amounts in mm	Range Condition
Ranch	(P)	(C)	(L)	(S)	(R)	(V)
F_1	13.00	4.30	7,448.1	33.0	700	1
F_2	12.00	13.30	86.3	20.0	900	0
F_3	13.00	8.45	24,826.3	30.2	676	1
F_4	12.50	5.65	1,636.1	31.0	800	1
F_5	11.0 0	5.70	5,136.3	34.8	750	1
F_6	12.50	11.95	174.7	22.0	1079	1
F_7	11.50	5.35	6,144	19.0	821	0
F_8	13.50	54.95	21,812	10.0	600	0
F_9	12.50	11.80	5,667.3	43.9	821	0
F_{10}	13.00	7.50	1,268.8	50.0	900	1

Source: Author's Survey and Computation 1988.

Table 4-7: Computing Income - An Example of Mutara Ranch (F₃)

Gross annual returns		Kshs.	Kshs.
Breeding bulls	(17)*	494,000.00	
Immatures	(77)	117,000.00	
Bulling heifers	(257)	1,670,000.00	
Cull cows	(504)	3,276,000.00	
Fat stock	(377)	2,450,000.00	
Cull Bulls	(186)	1,209,000.00	

			9,216,000.00

Annual cash costs:		
Labour and Management	2,142,370.00	
Repairs	895,000.00	
Transportation	800,000.00	
Veterinary	1,400,000.00	
Water Supply	220,000.00	
Registration	64,000.00	
Sundries	464,146.00	

96.8% of total (Share of beef cattle)		-5,660,783.00

Net Cash		3,555,217.00
Depreciation (of 96.8% of total fixed assets)		- 329,120.00

Net ranch income before tax		3,226,097.00
Tax (45% net ranch income)		-1,452,194.00

Net ranch income after tax, also referred to as net income or net return		1,774,353.35
Net ranch income per ha before tax		130.00
Net income (after tax) per ha		71.50
Total investment per ha		4,493.00
% net return on investment before tax		2.89%
% net return on investment after tax		1.59%

*: Number of animals sold in brackets

4.4 RESULTS OF STATISTICAL ANALYSIS

Before carrying out statistical analyses, means of net income and per cent net returns on investment have been calculated:

Mean gross income per ha (MGI/ha) is given by:

MGI/ha = Kshs 1/10 (698.20 + 1,063.70 + ... + 641,00)

= Kshs. 650/=

If Allu's ranch is not included because it is in a different eco-climatic zone, then

MGI/ha = Kshs.483/=

Mean net income per ha (MNI/ha) is given by;

MNI/ha = Kshs.1/10(257.90 + -91.30 + ... + 149.20)

= Kshs. 60.10

Without including Allu's ranch MNI/ha is about Kshs. 60.80. Therefore there is no much difference.

Per cent mean net returns on investment ($MNRI$) is given by;

$MNRI$ = 1/10(5.12 + -1.15 + ... + 2.56)%

= 0.93%

Ignoring Allu's ranch again, the *MNRI* for ranches in eco-climatic zone IV is approximately 1.00%.

Note that the means given here apply to the year 1988 only. Therefore they are "single period" mean incomes and mean rates of return respectively.

Below are *t*-tests on the mean net income and mean net returns on investment of the sample ranches.

For the mean net income, the hypothesis tested is;

H_o : U_1 = 0

H_1 : U_1 ≠ 0

For the mean net returns on investment the hypothesis is;

H_o : U_2 = 0

H_1 : U_2 ≠ 0

For the mean income, t-statistic is given by;

$$t_1 = \frac{\bar{x}_1 - U_1}{(S_1/\sqrt{n})\sqrt{\frac{N-n}{N-1}}}$$

while for mean net returns on investment it is given by;

$$t_2 = \frac{\bar{x}_2 - U_2}{(S_2/\sqrt{n})\sqrt{\frac{N-n}{N-1}}}$$

Testing was done at a 5 per cent level of significance and *n-1* degrees of freedom.

Absolute values of t_θ were considered because this is a two-tailed test. It does not matter, therefore, whether t_θ is negative or positive.

Let x_{1i} = the net income per ha for ranch '*i*', and

x_{2i} = the net returns on investment for ranch *i*.

∴. the sample means will be $\bar{x}_1$ and $\bar{x}_2$ respectively.

$\bar{x}_1$ = Kshs. 60.80

$\bar{x}_2$ = 1.00% (ignoring ranch F_6)

4.4.1   _T_-TEST ON MEAN NET INCOME

$$\bar{x_1} = 60.80 \qquad S_1 = 134.8$$

$$N = 62$$

$$n = 9$$

$$df = 8$$

$$t_{1e} = \cfrac{60.80}{\cfrac{134.8}{\sqrt{9}} \sqrt{\cfrac{(62 - 9)}{(62 - 1)}}}$$

$$\therefore \quad t_{1e} = \underline{1.45}$$

$$t_c = 2.306$$

$$\therefore \quad |t_{1e}| < t_c$$

$\therefore$ H_o can not be rejected. Hence, at 0.05 level of significance the _t_-test fails to reject the hypothesis that the mean net income is equal to zero. This implies that net income from beef ranching does not differ "significantly" from zero. Therefore, ranchers who specialise in beef ranching are not making profit. This test does not show that they are making losses. Also a one-tailed test gives a _t_-value of 1.860 at 0.05 significance level. This test also fails to reject the null hypothesis since t_c is still higher than t_{1e}. This second test indicates that one cannot assert that the rancher is making losses or gains. It emphasizes the fact that whatever the income, it is not significantly different from zero. The 95 per cent

confidence interval for U_1 is given by;

$$U_1 = x_1 \pm t_{1c} \frac{S_1}{\sqrt{n}} \sqrt{\frac{N-n}{N-1}}$$

$$= 60.80 \pm 2.306 \times \frac{134 \cdot 8}{\sqrt{9}} \sqrt{\frac{53}{61}}$$

$$= 60.80 \pm 96.58$$

$$\therefore \quad -35.78 < U_1 < 157.38$$

The confidence interval indicates that one can assert with a probability of 0.95 that the true mean net income from beef ranching in Laikipia lies between Kshs. -35.75 and Kshs. 157.40.

4.4.2 T-TEST ON MEAN NET RETURNS ON INVESTMENT

The results in 4.4.1 may suffice for one to conclude, even before testing, that the mean net returns on investment is not significant. This test is carried out to be sure.

Testing the mean of net returns on investment:

$\overline{x}_2$ =   1.00%

S_2 =   2.69%

N =   62

n =   9

df =   8

t_{2e} = $\dfrac{1.00}{(2.69/\sqrt{9})\sqrt{\dfrac{(62-9)}{(62-1)}}}$

     =   __1.196__

t_c =   2.306

As expected, $|t_{2e}| < t_c$ and the test fails to reject the null hypothesis that the mean of net returns on investment does not sifnificantly differ from zero.

The 95 per cent confidence interval for U_2 is given by;

$$U_2 = x_2 \pm t_{2c} \left(S_2/\sqrt{n} \sqrt{\frac{N-n}{N-1}} \right)$$

$$= 1 \pm 2.306 \times 2.69/\sqrt{9} \sqrt{\frac{53}{61}}$$

$$= 1 \pm 1.93$$

$$\therefore \quad -0.93 < U_2 < 2.93$$

Therefore, the true mean net returns on investment can be said, with a probability of 0.95, to lie in the interval between -0.93 and 2.93 per cent.

4.4.3   DISCUSSION OF RESULTS

There are two reasons that can be advanced to explain the low incomes: (i) There is virtually no rancher with 100 per cent beef animals. All ranchers operate several enterprises, such as keeping goats and sheep. A few even practice mixed farming. All ranchers therefore adopt some form of "multiple use" of the rangeland resources.

Range resources are more fully utilised when grazers and browsers are kept together. So these two

species complement each other, as neither competes with the other for forage. Hence ranchers are able to reap more returns from this practice rather than that of specialization in beef production. (ii) When one looks through the example given of net income computation for Mutara ranch, one realises that land appreciation is not included as a return. This is because consistent land appreciation figures were not available. However, land generally appreciates in Kenya, and, as indicated by child *et al.*(1984), land value appreciation is often a more important actual component than are the livestock products. For instance, land values from ADC headquaters show that Mutara ADC ranch was bought in 1976 at Kshs. 159/= per acre. This value included permanent improvements. The average land value obtained from ranchers now, without permanent improvements, is Kshs. 1,500/= per acre. The ranchers indicated that if permanent improvements were included, the value would double to Kshs. 3,000/= per acre. This is actually the market value in the area at present.

To find out how much land value has risen, inflation must be considered. By using Nairobi Consumer Price Indices (CPI), the average inflation rate between 1976 and 1987 has been estimated in the Kenya Development Plan of 1989/93 as being about 10.3 per cent per annum (see Appendix 4). So, if the 1976 land value of Kshs. 159/= per acre is inflated

over the 12 years by this rate, the present value should be given by;

$$F = P(1 + i)^t$$

where

F = the 1988 value,

P = the 1976 value,

i = the inflation rate,

t = the period over which to inflate.

:. F = 159 $(1 + 0.103)^{12}$

     = <u>516</u>

Hence, if land does not appreciate, one acre at present should be selling at Kshs. 516/= or thereabouts, by taking into account the general rise in price levels. Therefore, the difference between the market value and this value is Kshs. 2,484/=. This is an average increase of about Kshs. 512/= per ha per annum over the twelve years. This value can be considered as capital gain and can be added to the rancher's net income. If one does this, the following is observed in the t- test on the mean net income:

$\bar{x}$ = 512 + 60.80

    = 572.80

S = 134.18

N = 62

$$n \quad = \quad 9$$

$$df \quad = \quad 8$$

$$t_{1e} \quad = \quad \dfrac{572.80}{(134.18/\sqrt{9})\sqrt{\dfrac{62-9}{62-1}}}$$

$$\therefore \quad t_{1e} \quad = \quad \underline{14.74}$$

A large t-value indeed!

Recall that the critical t-value was 2.306. Hence $!t_{1e}! > t_c$ and the test now rejects the null hypothesis that the mean net income is equal to zero.

A one-tailed test will show that the alternative hypothesis, H_1 : $U > 0$, cannot be rejected by the t-test.

Note that by treating land like this does not mean that it is an output. Rather, it is a factor of production or an input that contributes to capital formation from the rancher's view point. So the rancher receives some capital gain even if he does not put the land into any productive activity. However, this capital gain cannot be considered as being beneficial to society as a whole but a benefit to the owner accruing from a resource being under-utilized or wasted. Hence, the phenomenon of land appreciation can only be logically used to explain the results obtained above.

With the above results, one is now able to answer the two but related questions, viz. (1) how does the rancher survive in the livestock business? and (2) why should he continue ranching?

Replies given from 70 per cent of the managers of the surveyed ranches to the inquiry about the owners of the ranches were that, either the owners are employed elsewhere or have other types of business such as running shops and hotels or some kind of trade across borders. In fact most owners do not reside on the ranches. These answers then should be a clear indication that the rancher is normally not wholly dependent on ranch income but supplements it with off-farm income.

The second question can be answered by the fact of land appreciation. Even if one bought land and did not invest in it, one expects capital formation from it over time. That is to say, if one assumes land appreciation of the magnitude shown above, then beef ranching is "profitable" from the rancher's point of view. This is a special profitability in that one does not achieve it until and unless one sells off the land. In other words, part, or the whole, of the enterprise has to be sold! To look at it from another angle, ranchers have actually "invested" in land and not in livestock production as such. High land prices,

apparently much higher than can be justified by livestock production, are perhaps the best proof that expected land appreciation is at least as important to the investor as income from livestock production.

There are many more reasons, though, less convincing that were given by 30 per cent of the ranchers interviewed. These ranged from those of sticking in ranching because "it is a way of life" to those of the investors' perception that a ranch or farm is the best place on which to settle after retiring from active life elsewhere.

4.5   ## RESULTS AND DISCUSSION OF REGRESSION ANALYSES

Equations derived from the regression of function (3-1), where net income per ha, Y, is the response factor with ten explanatory variables, are given in the section below. All regression equations were tested on a 5% level of significance.

> The results of regressions are presented as follows:
>
> Equations are written and t-values are presented in parentheses immediately below each coefficient.
>
> The presence or absence of an asterisk next to the parentheses indicates the significance of the coefficients, where;

( )   = Significance level of 5% or less,

( )* = Not significant (i.e., significance
       level of over 5%.

4.5.1 <u>REGRESSION ANALYSIS WITH NET INCOME AS THE RESPONSE FACTOR.</u>

It has already been mentioned that these regression analyses make use of a combination of cross-section and time-series data, obtained from 10 ranches in Laikipia District. Time-series data on all variables were available for a period of 17 years-from 1972 to 1988. The limited quantity of cross-section and time-series data made it imperative to pool the data in order to obtain parameter estimates for each of the functions postulated in section 3.4.

Twelve explanatory variables were regressed against net income using the ordinary least squares technique. Range condition was represented by a dummy variable. Observations in this case were designated as 'good' if the range had desirable grasses for pasture with little bush encroachment and erosion features, while a ranch with obvious bush encroachment and little grass with frequent features of erosion was regarded as having a 'poor' range condition. All this was determined by interviewing ranchers. The dummy variable is given below:

$$V_t = \begin{cases} 0 \text{ if } t \text{ indicates an observation of 'poor'} \\ \quad \text{range condition} \\ \\ 1 \text{ if } t \text{ indicates an observation of 'good'} \\ \quad \text{range condition.} \end{cases}$$

The equations obtained from these regressions are a result of an implicit assumption of constant intercepts and slopes during the period of study. They are distributed lag models with lagged dependent variables included as regressors. Another assumption is that they are *adaptive expectations* models. All these assumptions make the OLS regression a relevant tool. The Durbin-Watson tests for regressions containing lagged values of the dependent variables were carried out on the best equations or fits.

Regression results are given below:

$$Y_t = -2.40 + 0.55 Y_{t-1} + 2.179 P_t - 15.55 P_{t-1} - 4.33 P_{t-2}$$
$$(-0.15)* (6.42) \quad (3.95) \quad (-2.08) \quad (-0.63)*$$
$$+ \quad 5.92 P_{t-3} + 2.02 S_t - 1.66 S_{t-1} - 4.90 N_t +$$
$$(0.91)* \quad (8.83) \quad (-6.21) \quad (-5.80)$$
$$0.13 D_t - 0.05 T_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4-1)$$
$$(2.04) \quad (-0.15)*$$

$$R^2 = .80 \qquad F_{(10, 129)} = (49.64) \qquad d = 2.10$$

n = number of observations = 160.
*: Not significant at 5% level

Equation (4-1) shows that seven out of the ten explanatory variables tested are significant at 5% level. Rainfall, R, and range condition, V, were dropped because they did not show significance. The R^2

value is high and it indicates that 80% of total variation is explained by the explanatory variables. The F -statistic is significant and hence indicates that the explanatory variables as a group have a significant influence on income. The Durbin-Watson test statistic, d, is close to the desired value of 2. However, further tests will be carried out for serial correlation.

At the level of 5% the intercept is negative and insignificant. The intercept shows the value of net income if all the explanatory variables are held at zero. If it is positive and significant, it indicates that even when variables tested assume a value of zero, the ranchers get some net income. The contrary is true if the intercept is negative and significant when the variables are held at zero. The equation implies that previous earnings have an influence on the current earnings as shown by the lagged net income, Y_{t-1}. Also, current and previous prices, current and previous offtake rates, stocking rates and rainfall distribution affect current net income significantly. It is, however, interesting to note that time, T, affects income negatively (although insignificantly). This shows that real beef net income has been declining with time.

Since the contribution of some of the explanatory variables in influencing the dependent variable was

low, they were dropped in a step-wise regression method
and the following equation was obtained:

$$Y_t = 5.36 + 0.60Y_{t-1} + 23.51P_t - 16.65P_{t-1} + 1.96S_t -$$
$$(0.43)* \quad (8.44) \quad (4.97) \quad (-2.96) \quad (9.16)$$
$$1.63S_{t-1} - 4.85N_t \dots\dots\dots\dots\dots\dots\dots\dots (4-2)$$
$$(-6.83) \quad (-5.72)$$

$$R^2 = .80 \quad F_{(6,153)} = (100.76) \quad d = 2.20 \quad n = 160$$

*: Not significant at 5% level

All the explanatory variables in equation (4-2)
are significant and, therefore, this equation provides
a better fit. The intercept has not changed much even
after dropping 4 variables. The R^2 has not changed at
all. This is an indication that multicollinearity is
not a serious problem. The only variable affected
significantly after dropping the four insignificant
variables was rainfall distribution, D_t, which was
consequently dropped. The R^2 value shows that 80% of
total variation is explained by the independent
variables and the $F-$ statistic indicates a significant
influence of the independent variables as a group on
net income. The Durbin-Watson statistic indicates a
value of 2.20. However, this value alone cannot be used
directly to decide whether or not the error terms are
autocorrelated because of the presence of the dependent
variable among the explanatory variables. Thus, this
necessitates a different test, but using the OLS
computed Durbin-Watson statistic. The statistic for
this test is given by

$$h = r \sqrt{\frac{n}{1-n \ var(B_1)}} \quad \dots\dots\dots\dots\dots\dots\dots (4\text{-}3)$$

where

n = sample size

$var(B_1)$ = estimated sampling variance of the coefficient of Y_{t-1} in the OLS regression of equation (4-2).

r = an approximation by $r = 1-d/2$

If $h > 1.645$ there is a positive first-order autocorrelation at the 5% level of significance, while if $h < -1.645$ there is a negative first-order autocorrelation.

In equation (4-2), $d = 2.20$, $var(B_1) = 0.0024$ and $n = 160$. Substituting these values in equation (4-3) the result becomes

$$h = 1 - \frac{2.20}{2} \times \sqrt{\frac{160}{1-160 \times 0.0024}}$$

$$= -1.612$$

This figure shows that first-order autocorrelation in the error terms is not a serious problem. Therefore, one can say with confidence that the above explanatory variables - previous net income, current beef price, previous beef price, current offtake rate, and stocking rate - affect beef income from ranching. Equation (4-2), therefore, verifies the expected result that an increase in beef price and offtake rate lead to higher

beef income. It also supports the results of earlier
computations that show that ranches in Laikipia are
generally overstocked, by considering the nagative N
coefficient. This implies that when stocking rates are
increased, income tends to decrease. The reason for
this is that if stocking rates are increased above the
present level they will affect output by, say, slowing
down animal growth rates, thus reducing weight at
slaughter age and maybe prolonging slaughter age,
hence reducing annual incomes. A reduction of stocking
rates will thus avail more pasture for faster animal
growth and higher weights during slaughter. It is
interesting to note that when stocking rates are at
their optimal level, moving either way (i.e., reducing
or increasing the rates) will reduce output and, very
likely, income. This is because, either way, total
output will be reduced because of different reasons. If
rates are reduced, forage will be under-utilized and
hence output per land area will be less than optimal.
If in contrast stocking rates are increased, there will
be over-utilization of the range forage resulting in a
reduction in output per animal and hence overall
output.

The lagged income shows a positive relationship
with the current income probably because the factors
that lead to increased income act over a period of one
year. These factors are such as increased offtake rates

which are maintained over one year. Another reason is that drought may have an effect on income over a period of more than one year. In the first year of low rainfall, offtake is increased substantially, and even if prices reduce due to a glut of slaughter stock in the market, the net effect may be an increased income. In the second year slaughter stock will still tend to be higher than in the normal year as by then the range will have not recovered well from the effect of drought. However, this time slaughter will be much lower and this may make price to rise and the result will be an increased income.

The current price and the first-order lagged price have opposite effects on income. A rise in price in the current year is unlikely to cause change in the level of animals sold because the present level of sales is, to a great extent, determined by expected price rather than price pertaining in this particular year. So income will rise due to this; hence the positive effect.

Income has a negative response towards first-order lagged price . Expected prices are based on past prices, and the implication here is that the higher the expected price the lower the income. The only way this can be explained is that ranchers tend to hold onto their animals when they speculate higher prices in the future because they want to expand their herd size and eventually increase their offtake rates. These

responses will be discussed further when offtake rates are analysed in the next section.

Offtake rates of the current and previous one year have different effects on income as well. An increase in slaughter stock is not likely to affect prices significantly in the current year due to the fact that prices to be offered by traders will have been reached by considering the previous year's slaughter and hence they will be willing to offer that same price. So, if, for some reason, slaughter stock increases, income will be increased. However, this higher price will not be maintained for long as ranchers will soon flood the market with slaughter stock and hence prices will come down leading to a reduced income. A negative income response to a first-order lagged offtake rate is an implication that if offtake rates are higher this year they will result in a reduced income next year. This can be explained by the fact that an increased offtake rate will reduce prices not in the current year but in the next year as livestock traders will be willing to offer lower prices based on their previous experience. However, there are also the exogenous variables, such as drought. When drought is severe, ranchers dispose of most of their animals for slaughter, and, even though prices may be reduced, the net effect is increased income. The following year's production will be based on a reduced herd size and consequently offtake rates

will be low leading to reduced income.

Equation (4-2) gives only the variables that affect ranchers' beef income significantly, and it identifies beef price, offtake and stocking rates as the major factors. The very short-run price response of ranch income is positive. However, in the not very short-run the response is negative. As shown in equation (4-1), the price response of ranch income becomes positive later as shown by the positive P_{t-3} coefficient (though not significant). This period, as explained before, is when ranchers start marketing the animals that are as a result of a decision made about three years earlier. The reason for this is that a young animal takes three years to reach slaughter weight and hence this production process cannot respond immediately after a price rise. Ranchers' immediate response to higher prices is a reduction in sales because they would like to achieve higher long-run offtake rates.

4.5.2 REGRESSION ANALYSIS WITH OFFTAKE AS THE RESPONSE FACTOR

Perhaps a more interesting relationship is that of offtake and factors influencing it. This is particularly so because the Kenya Government over the years has had efforts towards increasing offtake rates, especially from pastoral herds. Pastoral systems, as shown by Aldington and Wilson (1968), and Campbell and

Migot-Adhola (1981), have very low offtake rates in comparison to commercial ranching. Though these are different systems of production, there may be common factors affecting them. Other than social factors, there are easily quantifiable economic and ecological factors that can be manipulated for the benefit of improving offtake rates which should, in turn, lead to increased ranch income.

Below is an equation with offtake as the dependent factor:

$$S_t = 9.79 + 0.84 S_{t-1} + 0.06 Y_t - 0.06 Y_{t-1} - 3.44 P_t + 3.50 P_{t-1}$$
$$(3.15)\ (14.99)\ (7.67)\ (-6.29)\ \ \ \ (-5.90)\ \ (4.78)$$
$$+ 0.02 P_{t-2} - 0.33 P_{t-3} - 0.57 N_t - 0.01 R_t + 0.11 D_t -$$
$$(0.38)^*\ \ \ (-0.46)^*\ \ (-1.95)\ \ (-3.22)\ \ (2.30)$$
$$1.02 V_t - 3.22 X_t + 0.94 T_t\ \text{------------------}(4-4)$$
$$(0.83)^*\ (-1.20)^*\ (1.17)^*$$

$$R^2 = .83\ \ \ F_{(13, 126)} = (48.00)\ \ \ d = 2.17\ \ \ n = 140$$

*: Not significant at 5% level

In the above equation nominal values have been used for price and income. The use of nominal values is deemed appropriate because ranchers make production decisions not with respect to real terms of prices but by considering price changes in current terms. Therefore prices and incomes in equations (4-4) and (4-5) are 'different' variables from those in equations (4-1) and (4-2).

It has already been stated in earlier sections

that it is not unusual for offtake to show a negative response to price increase. So, it need not be surprising that this is actually the case as shown in equation (4-4) above. Current and first-order lagged prices have a significant effect on offtake, while second-order and third-order lagged prices have an insignificant effect. Current price shows a negative effect, while first-order lagged price shows a positive effect. Even though the outcome of a negative response of a product to increased producer price is not found in most agricultural production as this behaviour contrasts with the supply response of most of these goods, it has already been indicated that it is not uncommon in the livestock sector. Since cattle production can be increased only by increasing the size of the breeding herd, ranchers will hold onto animals for higher future beef production. They may also withhold the animals for further fattening.

The negative response of offtake to current price increases can also be explained by the fact that the decision to increase slaughter is not, and cannot be, instantaneous. Ranchers in the event of a price rise may have already made production decisions on the basis of the expected prices, which are arrived at by considering past prices, and hence they will have in mind a ratio of their herd that they wish to put on the market. So, unless they have a backlog of animals that are ready for slaughter due, may be, to unattractive

prices offered the previous year, they will fail t
respond to such price increases unless they sell par
of their breeding herd - which is their capital stock
and which will, therefore, imply an irrational action
The fact that there is an increased price with n
response might cause the nagative coefficient fo
current price in the equation.

In regard to the negative coefficient again
Laikipia ranch offtake rates may be responding to othe
non-economic factors such as low rainfall totals o
poor rainfall distribution. This may be one of the
reasons for the shown price response pattern. Wher
droughts strike, there is a tendency for ranchers tc
reduce the herd size to avoid losing a lot of their
animals. This causes a glut of slaughter animals in the
market. As a consequence, prices fall. The result
of this in a regression equation will be a rise in
offtake due to a reduction in prices or, conversely,a
rise in prices due to a reduction in offtake. In the
aftermath of a drought there is generally a reduced
herd size which leads to low offtake rates. Since
supply will have been reduced, demand will be high and
prices will increase. Again, this will show itself in a
regression equation as if increased prices lead to
reduced offtake and vice versa. The question that
remains now is whether this latter reason or the former
argument overrides. If the former is the reason, then

one can bring forth an economic reasoning for the
outcome. The latter reason does not render itself to
this. However, what tends to invalidate the argument of
weather is that droughts do not occur one year after
another and they may, probably, not be the cause of the
result shown in equation (4-4). Another reason that
tends to discount this argument is that the current
offtake rate is positively related to the first-order
lagged offtake rate, suggesting that an increase in
offtake this year follows an increase in the same the
previous year or vice versa. This is not likely to be
the case if drought is the reason for increased
offtake. But the positive effect of first-order lagged
price on offtake tends to support the argument of
weather. This is because if it is true that drought is
the cause of increased offtake, there will be low
prices. In the following year offtake rates will be
lower not because of low prices but due to the lagged
effect of drought. In this (following) year prices
will go up, responding to lowered offtake. But recall
that price in the current year is low due to drought
and will, therefore, be positively related to low
offtake the following year.

Nonetheless, all the above arguments
notwithstanding, if prices are increased and stay high,
offtake rates are expected to rise in the long-
run, assuming that ranch production capacity has not
been exhausted given the prevailing technologies and

resources. If there is no capacity to do so, an increase in prices may have little positive effect or may actually have a negative effect on production. The latter occurs when stocking rates move towards the biological maximum, leading to a decline in physical output. This indicates that a mere rise in beef prices does not necessarily bring about offtake increase. Other factors also come into play and must be considered if one expects to improve offtake. This further implies that there is a threshold (per cent) for cropping a herd, beyond which its productivity is overstretched, the result of which is reduced production unless new technologies are introduced .

What is of significant importance in equation (4-4) is that income is positively related to offtake and one will ensure an increase of one by increasing the other. Therefore, if one can increase ranch income by whatever means, one is likely to improve offtake rates and vice versa. The result of a negative response of offtake to the first-order lagged income is,however, difficult to explain economically in connection with commercial ranches. Hence the most logical explanation is that of weather effects. That is to say,if an increase in income in the current year is due to an increase in offtake as a result of drought effects, offtake is likely to decrease the following year and

hence this will reduce income. This may project itself in the regression equation as offtake reduced as a result of increased lagged income.

Stocking rates have shown a negative effect on offtake. The most likely reason for this is that the ranches in Laikipia have been overstocked over the period of study, which indicates that if stocking rates are lowered, there will be increased offtake rates as forage will cease to be a limiting factor. There will be faster weight gains and hence lower slaughter age.

The negative response of offtake towards rainfall is relatively easy to explain. A rancher can sustain a herd from one production period to another in years of high rainfall amounts with the objective of fattening his animals to higher slaughter weights. Hence, a good number of animals that would have otherwise been sold are withheld to be fattened on the abundant forage available. Thus, offtake rates are kept low as a consequence. During drought, the ranchers' strategy is to reduce animal numbers to even below the size of the breeding herd that they wish to keep to ensure the survival of the herd through the dry spell. As a result, animals are disposed of regardless of the beef prices then pertaining. The outcome is, therefore, a lower offtake rate in wetter years compared to drier years; hence the negative response of offtake to rainfall totals. There is little, however, a rancher can do about rainfall other than employing pasture

management   techniques   that   make   use   of   rainfall
efficiently for forage production.

Distribution of rainfall - the number of days rain
is   received per year - shows a positive   influence   on
offtake.   The   period   rain   falls,   if   well   spread
out, prolongs the length of time of pasture growth.   In
most   range areas where all rainfall in a year   may   be
concentrated   in   a   few   days, say 30   or   so,   it   is
important that the   rainy   days be spread out so as   to
be   effective   in   maintaining   pastures   over   a   long
period. Again, rainfall distribution is a factor beyond
the control of the rancher.

Range   condition   and the ratio   of   price   change
(price index) have a negative effect but do not seem to
affect offtake significantly. Also, the time effect   is
not   significant   but   is   positive,   indicating   that
offtake   rates have been increasing but   slightly   over
the period of study.

Equation   (4-5)   below   shows   the   relationship
where   all the included variables are significant   and
is therefore the better fit

$$S_t = 10.46 + 0.83 S_{t-1} + 0.06 Y_t + 0.06 Y_{t-1} - 3.33 P_t + 3.62 P_{t-1}$$
$$(4.17)\ (8.46)\qquad (8.46)\qquad (-6.84)\qquad (-7.23)\qquad (7.15)$$
$$-0.54 N_t - 0.02 R_t + 0.10 D_t \ ------------------\ (4-5)$$
$$(-2.17)\qquad (-3.90)\ (2.59)$$
$$R^2 = .84 \qquad F_{(8,151)} = (95.62) \qquad d = 2.14 \qquad n = 160$$

It   can be seen from equation (4-4) and   (4-5)   that

there is no much change in the intercept even after dropping the five insignificant variables. The R^2 value and the Durbin-Watson statistic have also changed very slightly showing that this equation is a good approximation of the relationship. The F - statistic is highly significant and 84% of the total variation is explained. The absence of autocorrelation can be proved only by using equation (4-3), again because of the presence of the dependent variable among the regressors, thus;

$$d = 2.14, \quad var\ (b_1) = 0.0023 \quad n = 160$$

$$\therefore \quad r = 1 - d/2 = 1 - 2.14/2 = -0.07$$

Substituting the above values in equation (4-3) one obtains;

$$h = -0.07 \sqrt{\frac{160}{1-160 \times 0.0023}}$$

$$= -1.114$$

The figure shows that there is no negative or positive first-order auto-correlation of the error terms. Hence this is a strong relationship. Note that equation (4-5) includes all the important variables already discussed and these variables relate the same way to offtake as in equation (4-4). The discussion of the variables in equation (4-4) is still valid with respect to equation (4-5).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1   SUMMARY

This study was carried out to examine the economic factors that influence beef ranching in Laikipia District.   An   account   of   the   present   ranching activities   was   given.   Ranch   income   analysis   was undertaken to determine the level of ranch net income. A statistical   test was used for this purpose.   An econometric model was used to determine factors   that affect the ranchers' income.   Two hypotheses were tested.   Hypothesis (i) was used to test whether ranchers' income differs significantly from zero.   The results of the statistical analysis showed that it does not.   Therefore, low income from ranching is considered one of the likely factors that have led to a decline in beef ranching in Laikipia District.

Hypothesis (ii) was used to test which factors influence the levels of ranch income and offtake.   The factors tested in this respect included price of beef, offtake, weather – which was represented by two factors, namely rainfall totals and the number of rainy days per year (also referred to as rainfall distribution), range condition, stocking rate, and time.

Two regression models were used. They were both distributed lag models, each of which was used to obtain the determinants of beef ranch income and offtake respectively. Both models use a combination of time-series and cross-section data which were pooled in order to increase the number of observations. An OLS regression analysis was carried out to obtain results.

In the regression involving net income as the response factor, constant prices were used to obtain real income. The results of the regression are shown in equations (4-1) and (4-2). From the results, equation (4-2) which is the better fit shows that the intercept is negative and insignificant at a level of 5 per cent. First-order lagged income, current price and offtake have a positive influence, while first-order lagged price, first-order lagged offtake, and stocking rate have a negative effect on net income at a 5 per cent level of significance.

The regression involving offtake as the response factor uses current prices, for these are what ranchers use in deciding their production levels. The results of the regression are given in equations (4-4) and (4-5). Equation (4-5)- the better of the two fits - indicates that the major factors that determine ranch offtake are income, price, stocking rate, rainfall totals, and rainfall distribution.

5.2   CONCLUSIONS

A number of conclusions have been drawn from this study. More studies are however needed, especially to determine optimal ranch size with respect to income and offtake. By using a large sample of ranches of different sizes, one may be able to find out how much ranch size affects income and offtake, particularly after subdivisions that have occurred in the district in the recent past.

When net income is compared with stocking rates and offtake, it can be shown that negative or low beef net income is associated with low stocking rates and the resulting low offtakes. This can be exemplified by Murera (F_2) and Ol Jogi (F_8) ranches as shown in Table 4-6. However, most of other ranches are overstocked as can be shown by the regression analysis, and their low income is related to this.

By considering the mean net returns on investment of the sample ranches, the net returns on investing in beef ranching can be said to be in the neighbourhood of 1 per cent per annum.

The results of the t- statistical analysis show that ranch net income and net returns on investment do not differ significantly from zero. This implies that low income realized from beef production is one of the

likely economic reasons why beef ranching is declining in Laikipia District. Despite the low incomes, ranchers have continued to operate. The fact of land appreciation can be postulated as being the major reason why beef ranchers have persisted. Land appreciation (of about Kshs.512/=) per ha per year was shown to be higher than that of net returns (of about Kshs.60/=) per ha over the same period. Therefore, even though the profitability of ranching appears to be low, the appreciation of land and livestock contributes to income in terms of capital gain and therefore could be the reason why ranchers continue investing in ranching.

The results in equation (4-5) show that beef price increase does not raise beef output immediately (in terms of offtake) from Laikipia ranches. However, this happens in the very short-run, and in the longer-run, price does actually increase offtake. Rainfall amounts and stocking rates have a negative effect on offtake. The possible reasons for these have already been highlighted.

Another factor that may explain the decline of beef ranching is that of land subdivision. It can be seen in Map 3 that about 25 per cent of the land area in Laikipia District has been settled by small-scale farmers who are mainly involved in cultivation. Fig. 4.1 also shows that cattle numbers have been declining

over the years from 1975 while those of small-stock
have increased rapidly over the same period.
Subdivision is one of the main explanatory factors for
this. Settlements have led to segmentation of the land
such that it has become increasingly difficult to raise
a cow in the resulting diminutive plots.

This study has shown that the major factors that
influence net income from beef ranching are price of
beef, offtake, and stocking rates. According to the
regression results, these are the factors that have to
be manipulated to improve beef ranch income.

It has also been concluded that income, price,
stocking rate, rainfall total, and rainfall
distribution determine ranch offtake. Current price is
positively related to income but has a negative effect
on offtake. The fact that this is so may seem
contradictory. However, this need not be necessarily
the case. Price may reduce offtake but the overall
effect becomes an increased income - that is, one unit
of price reduces offtake by less than one unit.

5.3 RECOMMENDATIONS

There is need in Kenya for the application of
rational planning to zone the drier parts of the
country according to the uses to which they can be put.
The loss of high potential land for livestock

production to cultivation at a time when Kenya is no longer self-sufficient in beef does not seem to be in the national interest and, therefore, should not be allowed to continue unabated. One way to ensure continued production and/or improvement of beef production· is to make the enterprise attractive by improving income.

From the results of the regression analysis, beef prices have a positive effect on ranch income. Therefore, as prices rise, ranch income also rises. Since the prices of beef are no longer controlled, the rancher has to depend on the market situation to determine the price at which to sell the animals. In this situation, prices can be improved and stabilized by improving the marketing channels so that ranchers may have better marketing information on how and where to market their animals. This will make planning on production much easier. Also, if new markets are exploited, extra demand will be created and prices will rise.

The opposite effect of price on net income and offtake, and more especially its short-run negative effect on offtake may seem to pose a policy dilemma. But this should not be so because the nagative response is temporary for reasons already mentioned, and persistently high prices should eventually raise

offtake rates. And, in any case, one cannot propose price reduction because this will have the expected result of reducing ranch income. So, under liberal price policies, like those now prevailing in Kenya, that tend to increase beef prices, offtake rates from ranches will reduce in the short-run but may be increased in the long-run. This then implies that, if beef output has to be increased, focus should be on how to increase price and income.

There are of course alternative means of increasing incomes other than those of raising prices. One of the alternatives to price increase could be cost reduction, since these two factors act in opposite directions on income. The more the rancher is able to reduce costs of production, the higher should be the income, other things being equal. Cost can be reduced by choosing the less costly inputs that will result in a relatively similar income as the more costly ones. Examples could be by employing cheap labour rather than using machinery, using locally available resources, say in fencing, and evading some veterinary charges by employing better livestock management policies.

Alternatively, costs can be brought down by subsidizing the prices of the major livestock production inputs. These inputs may include veterinary medicine and minerals. Improvement of infrastructure such as roads to reduce marketing costs is yet another

avenue for increasing income. A reduction of corporate tax and rates will also improve incomes. Costs can further be reduced by ensuring a ready market for ranchers' livestock. The recent revival of KMC will help meet this goal. The purchase and sale of livestock, if started by LMD, may also assist in marketing. With a ready market for livestock, the ranchers can avoid the extra cost of maintaining animals that are ready for sale.

Offtake can be increased by raising beef prices which, in turn, will increase income. The waiving of beef price control policy will hopefully achieve this. Offtake can also be increased by improving on the management of livestock and pasture land by harnessing most of the precipitation for forage production. Better pastures mean higher carrying capacities of land. The other means of increasing offtake is by reducing the number of livestock per land area since it seems the ranches are overstocked. Lower and correct stocking rates should result in higher weight gains and ensure sustained production as this will take into consideration range conservation measures. The policy of the Kenya Government is to identify the large farms that make losses to be subdivided so as to increase employment opportunities and improve production. This study can not ascertain that if the large ranches are subdivided, beef production will or

will not be jeopardised. Offtake figures from the sample ranches studied do not indicate that larger ranches have higher offtake rates. Some large ranches have lower offtake rates than the small ones and vice versa. Because of limited resources and time, the analysis of this fact could not be carried out. If studies can be made on the relationship of ranch size and offtake, then recommendations can be made on subdivision of large ranches to small units that can still maintain high offtake rates and at the same time be viable to run. This will result in an increased number of ranch units and a likelihood of improved management. The expected net effect is creation of more employment.

One fact that may be clear, though it needs further research, is that, if farms are reduced to small units of a few tens of acres, in an agro-ecological zone such as Laikipia's, it may become economically and ecologically difficult to raise large-stock. This has been inferred from livestock population trends shown in Fig. 4.1.

The recommendation is, therefore, that the viability of land should be assessed on the basis of the production to which it is best suited before it is subdivided in order to avert the possibility of reduced productivity.

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APPENDIX 1

QUESTIONNAIRE - APPLYS TO 1988

CONFIDENTIAL

1. Name (Status) of respondent.............................
....
2. Name of ranch ....
....
3. Status of the ranch ....
....
4. Title of land (tenure)..............................
....
5. Ranch (farm) size (ha/ac)...........................
....
6. Location of the ranch (Division)....................
    (Location).....................(Sub-location)......
7. Kinds of Livestock kept ....
....
8. Area under grazing (ha/ac)...........................
9. When ranching was started...........................
10. Which other grazing areas are available? ....
....
11. Climate and Ecology ....
....
    Agroecological zone................................
    Soil type..
    Rainfall amounts...................................

12. Has management of livestock, pastures or overall
    organization changed? If yes, from what to what?..
    ....
    ....

13. Animal Numbers

    <u>Cattle</u>   <u>Source</u>   <u>Number</u>

    Dairy   ....

    Beef   ....

    Dual   ....

    <u>Sheep</u>   <u>Source</u>   <u>Number</u>

    Wool   ....

    Meat   ....

    <u>Goats</u>   <u>Source</u>   <u>Number</u>

    Dairy   ....

    Meat   ....

    Hair   ....

    Pigs   ....

    Camels   ....

14. Original source of capital to purchase livestock..
    ....
    ....

15. Dairy cattle ....
    Total bulls.......................................
    Bull calves.......................................
    Dry cows..
    Lactating cows....................................

    Heifers..

    Calves..

16. Beef cattle...................................

    Total bulls (+2)..............................

    Total steers (-2).............................

    Breeding cows (total).........................

    Bulling heifers (total).......................

    Heifers in calf (total).......................

    Calves (total)................................

17. <u>Goats</u>

    Total adults..................................

    Total kids....................................

18. <u>Sheep</u>

    Total adults..................................

    Total kids....................................

19. <u>Donkeys</u>

    Total adults..................................

    Foals...

20. <u>Camels</u>

    Total adults..................................

    Calves..

21. Source of water...............................

22. Structures in the ranch.......................

    ....

23. <u>Product sold/yr Sale   Where sold   Price/Unit</u>

    Beef   ....

    Sheep   ....

    Goats   ....

Milk   ....

24. Problems affecting livestock production (i.e.,
    constraints to production)........................
    ....
    ....
    ....

25. The value of available resources:

25.1 Capital i.e., permanent structures, machinery and
equipment (in itemized monetary terms)................
....
    ....
    ....
    ....

25.2 Livestock value
    cattle...................................
    Goats....................................
    Sheep....................................
    Camels...................................
    Donkeys..................................
    Others...................................

25.3 Any other resources and their value.............
    ....

26. Credit (loan) source...........................
    ....

26.1 Amount received from each source of credit or
loan..

26.2 Repayment of debt (Loan)......................

....

26.3   Amount paid.....................................

26.4   Outstanding loans...............................

26.5   Interest rates on the loans.....................

26.   Owner's capital contribution (Equity) to the

        ranch...

28.   Land valuation..................................

28.1   Value of rent (if rented land)..................

29.   Running expenses (itemized)-e.g., can be obtained

from Ranch Budget.

        Labour costs (wages).............................

        Salaries...

        Transportation costs.............................

        Maintenance costs................................

        Taxes..

        Veterinary costs.................................

        Other costs (sundries)...........................

        ....

        ....

30.   Depreciation method.............................

30.1   Total depreciation..............................

31.   Is cultivation carried out in the ranch? ......

31.1   If yes what crop (s) is (are) cultivated?.....

        ....

31.2   Total output/ha/ac..............................

31.3   Price of crop(s) per unit ....

31.4   What are the total costs involved?............

        ....

APPENDIX 2

Cost Per Annum (Kshs.) Incurred in Beef Cattle Production

Cost Ranch	Running Expenses	Depreciation	Total Cost (FC + VC)	Land under Beef (Ha)	Total Cost per Ha
F_1	2,600,000	200,000	2,800,000	7448	229.30
F_2	662,000	50,000	99,651	86	1,158.75
F_3	5,846,916	340,000	5, 660,783	24,826	2281.00
F_4	680,759	99,241	382,200	1,636	233.60
F_5	1,914,060	150,000	2,064,060	8,140	253.60
F_6	571,000	100,000	670,000	174	2,057.70
F_7	429,703	11,246	440,949	6,144	63.70
F_8	5,100,000	300,000	5,4000,000	21,812	236.90
F_9	2,145,000	150,000	2,295,000	5,687	349.50
F_{10}	1,507,523	72,477	468,870	1,269	369.50

Source: Author's Survey and Computation 1988.

APPENDIX 3

Nairobi Consumer Price Indices (C.P.I.) - Middle Income Group

Year	CPI*	Jan. 1975 = 100
1972	70.8	
1973	79.5	
1974	91.3	
1975	105.1	
1976	114.1	
1977	130.4	
1978	142	
1979	155	
1980	173	
1981	216	
1982	256	
1983	282	
1984	312	
1985	342	
1986	350	
1987	360	
1988	385 .	

Source: CBS - Statistical Abstracts (various issues)

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*: The month of December is considered each year.

APPENDIX 4

Inflation Rates Measured by Nairobi Consumer Price Indices

Year	Average Inflation rate
1972/71	2.6
1973/72	9.8
1974/73	15.3
1975/74	15.6
1976-81	10-13
1982/81	22.3
1984/83	9.1
1985/84	10.7
1986/85	5.7
1987/86	7.1

Source: Kenya 1989 - National Development Plan 1989/93.

APPENDIX 5

Growth Rates of Real GDP

1964 Prices for 1964-71 and 1982 prices for 1972 onwards

Year	Agricultural Contribution	Total GDP
1964-71	4.2	6.5
1972	7.6	6.8
1973	4.4	4.1
1974	-0.2	3.1
1975	4.6	3.1
1976	3.7	4.2
1977	9.5	8.2
1978	8.9	7.9
1979	-0.3	5.0
1980	-0.9	3.9
1981	6.1	6.0
1982	11.2	4.2
1983	1.6	2.3
1984	-3.9	0.8
1985	3.7	4.8
1986	4.9	5.5
1987	3.8	4.8

Source: Kenya 1989 - National Development Plan 1989/93