THE IMPACT OF POPULATION GROWTH ON LAND AVAILABILITY AND LAND USE: THE CASE OF SIAYA DISTRICT

DOROTHY AKINYI OJOO

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DECLARATION

THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY

DOROTHY AKINYI OJOO

THIS THESIS HAS BEEN SUBMITTED FOR EXAMINATION WITH OUR APPROVAL AS UNIVERSITY SUPERVISORS

DR. A. B. C. OCHOLLA-AYAYO

(EBS)

PROF. S. H. OMINDE

ABSTRACT

This Study addresses itself to some demographic factors which have led to problems of land availability and land use in Siaya District in Western Kenya. Most studies in the past have concentrated on either aspect of land resource at the expense of the other, or have only marginally implicated the demographic element in their analysis on land use and availability. This Study has therefore examined the effects of population size, density and rates of growth on both components of land resource in a bid to arrive at comprehensive policy options which take account of the source of the problems.

Data used in this thesis was drawn from secondary sources coupled with some basic information from different reports. Interpretation of data has been achieved by use of statistical inferential methods together with some mathematical methods.

Overall, the analysis done showed that in 1979 the bulk of the population (57 percent) had either reached or were below the stipulated acreage for subsistence thereby also suffering land shortage. Furthermore the district's land potential had been overused. Specifically in 1979, 71 percent fell under grazing; 18.6 percent to 28 percent to arable use and 7 to 16.67 percent to non-agricultural use.

Besides, projections for the years between 1995 to 2000 show that if present trends in land use persist, over 71 percent of the district's potential will be committed to grazing; between 28.9 to 43.5 percent on average to arable use and between 10 to 21 percent to non-agricultural use. These are indeed alarming estimates as already the district's potential is being overutilized and problems associated with degradation of environment among others must be severe.

In all however, it is concluded that the social and legal framework within which agriculture has been pursued has been inefficient and has led to problems of subdivision and haphazard overuse of the district's land potential.

The need for an integrated land use planning policy at the district and micro-level involving an appropriate combination of crop husbandry, animal husbandry, with a link to demand for dwellings and other infrastructural services is therefore pertinent and pressing.

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

CHAPTER ONE

NATURE AND SCOPE OF THE STUDY

1.1. Introduction

Population growth and its bearing on resources have become topical in recent years. This has been particularly so for the developing countries in which a number of authors and conferences predict unprecedented crises. Most developing countries have experienced phenomenal growth in population in recent decades, this has led to an imbalance between population and resources in turn jeopardizing the welfare of the inhabitants.

While there has been a general awareness on the nature of interaction between population growth and resources, planners have not fully integrated practical solutions in the various regional and district plans. This failure to marry the two results in resource wastage and crises.

This study thus attempts to analyse the interaction between some demographic trends on the major forms of land use in Siaya District. The contention of the author is that land is and has always been an important element in Kenya's cultural life, and with the increasing population, its availability to individuals becomes a major social and economic issue.

In this chapter, the major issues examined are:- the geographical features; agro-ecological patterns and related land uses and socio-economic characteristics of the study area; the literature review and theoretical framework; the nature and scope of the problem; methodological procedures and their description and finally a summary of the ensuing chapters.

1.2 Study Area

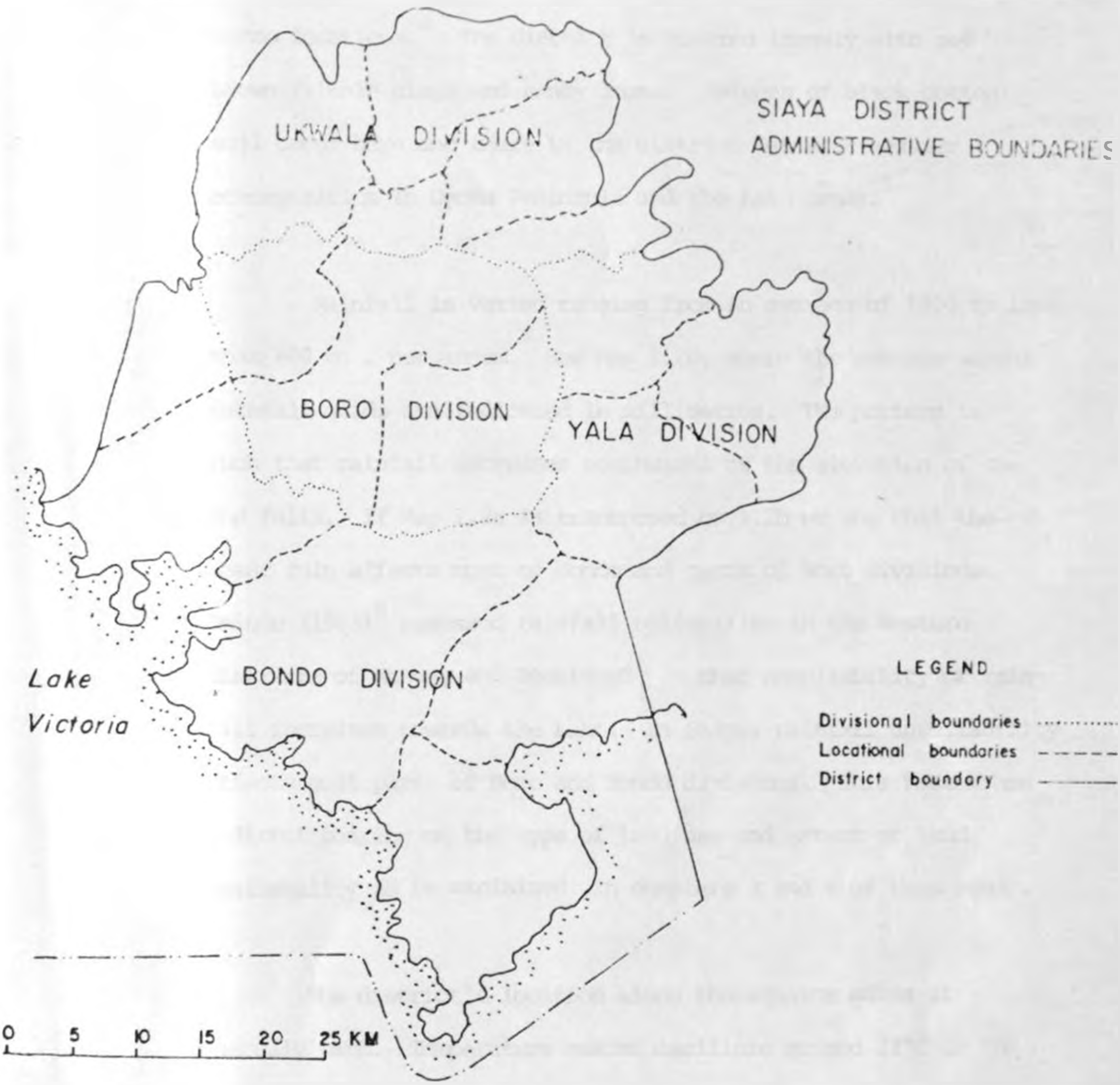
a) Geographical Features

Siaya District extends from latitude 0 degrees. 13 min. south to 0 degrees. 18 min. north and from longitude 33 degrees. 58 **min.** east to 34 degrees. 33 min. west.[1] It is one of the four districts in Nyanza Province. Its creation as a district dates back to 1967 following the split of the old Central Nyanza into the new Kisumu and Siaya Districts respectively. Administratively, the district is divided into four divisions namely:- Bondo, Boro, Ukwala and Yala. (see Map 1.2a). It has a total of 18 locations which are further subdivided into 127 sub-locations.[2] These levels of administrative units have been considered in this study with respect to comparisons and categorization as will become clear in the ensuing chapters. The district occupies some 3520 square kilometres of which 1000 square kilometres is under water.[3] Siaya district is located along the shoreline of Lake Victoria which borders it to the East, North East and South, while to the West it shares a common border with Kisumu district and forms the Nyanza boundary with Western Province to the North.

Topographically, the region forms an undulating plateau gradually sloping westwards towards the major geographical feature which is the Lake Victoria basin and Yala Swamp lying between the lower reaches of the Yala and Nzoia rivers.

Geologically, the rocks in the district are of pre-cambrian age, with occasional intrusions of granite rocks; the granite intrusions are important as they are connected with the

MAP 1.2a


SIAYA DISTRICT
ADMINISTRATIVE BOUNDARIES
UKWALA DIVISION
BORO DIVISION
YALA DIVISION
BONDO DIVISION
Lake Victoria
LEGEND
Divisional boundaries
Locational boundaries
District boundary
0 5 10 15 20 25 KM

with the gold deposits, which have been identified in Sakwa and Asembo locations.[4] The district is covered largely with red brown friable clays and sandy loams. Patches of black cotton soil occur here and there in the district but with heavier concentration in Uyoma Peninsula and the Lake areas.[5]

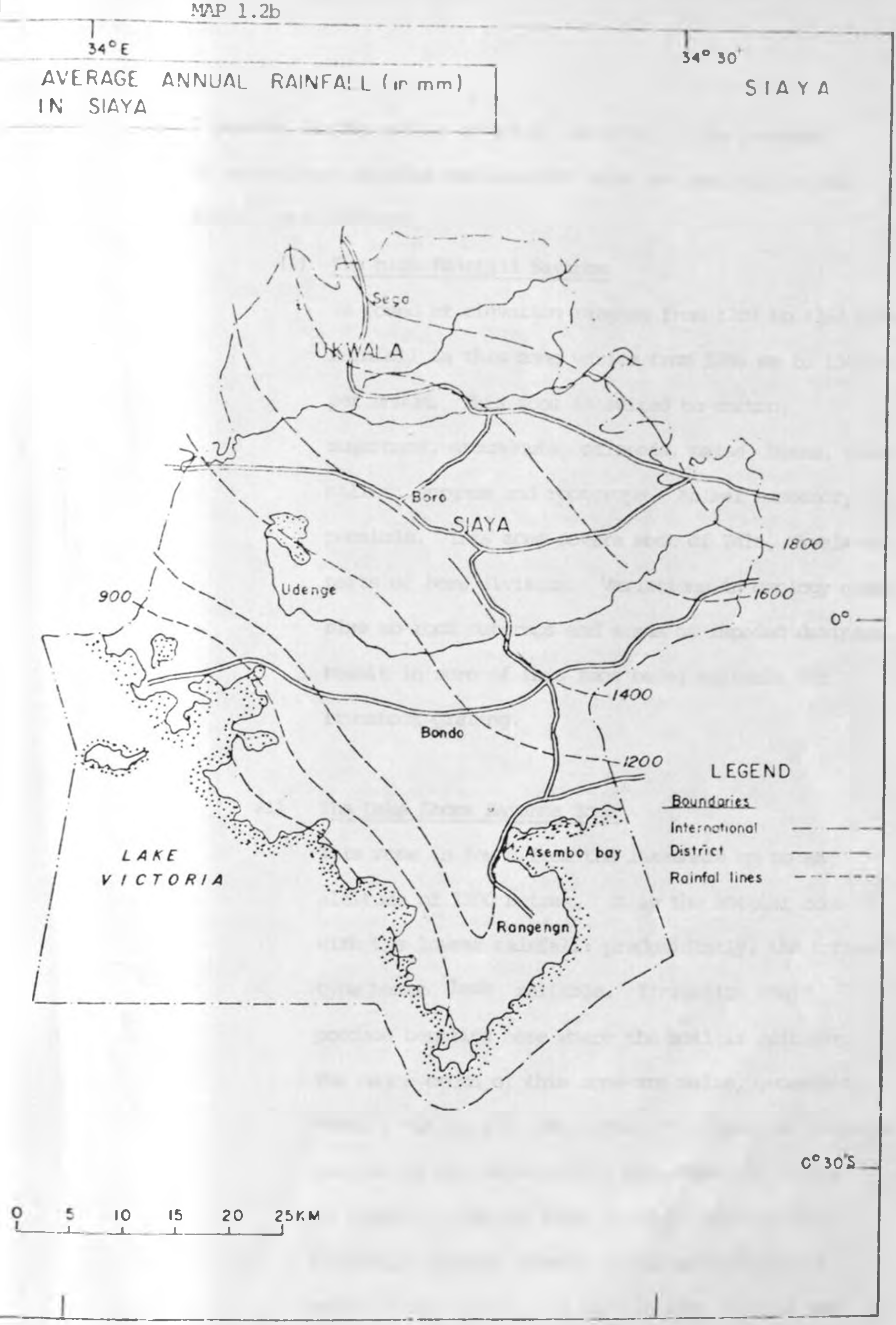
Rainfall is varied ranging from an average of 1800 to less than 800 mm . per annum. See Map 1.2b, where the average annual rainfall grids are indicated in millimetres. The pattern is such that rainfall decreases southwards as the elevation of the land falls. If Map 1.2a is transposed on 1.2b we see that the least rain affects most of Bondo and parts of Boro divisions. Ominde (1963)[6] assessed rainfall reliability in the Western districts of Kenya, and concluded that unreliability of rainfall increases towards the Lake. In Siaya, rainfall unreliability affects most parts of Boro and Bondo divisions. This factor has a direct bearing on the type of land use and extent of land availability as is explained in chapters 3 and 4 of this study.

The district's location along the equator makes it generally warm. Temperature maxima osciliate around 23°C in the higher cooler areas of Ukwala and Yala to about 30°C in the lower warmer areas of Boro and Bondo.[7]

b) <u>Agro-Ecological Zones and Land Use</u>

On the basis of rainfall amount 93 percent of the agricultural land is classified as high potential with only

MAP 1.2b


34° E
34° 30'
AVERAGE ANNUAL RAINFALL (in mm)
IN SIAYA
SIAYA
Sega
UKWALA
Boro
SIAYA
Udenge
1800
1600
900
0°
1400
Bondo
1200
LEGEND
Boundaries
International
District
Rainfal lines
LAKE
VICTORIA
Asembo bay
Rangengn
0° 30'S
0 5 10 15 20 25KM

7 percent in the medium potential category[8]. The Ministry of agriculture divides the district into two agro-ecological zones[9] as follows:-

(i) <u>The high Rainfall Savanna</u>

Is found at elevation ranging from 1200 to 1350 metres. Rainfall in this zone varies from 1000 mm to 1300 mm per annum. This zone is suited to cotton, sugarcane, groundnuts, oilseeds, maize, beans, white millet, sorghum and rootcrops. Animal husbandry is possible. This zone covers most of Yala, Ukwala and parts of Boro division. Variations in geology give rise to rock outcrops and areas of impeded drainage result in some of this zone being suitable for livestock grazing.

ii) <u>The Lake Shore Savanna Zone</u>

This zone is found from the lakeshore up to an altitude of 1200 metres. It is the hottest zone with the lowest rainfall: predominantly, the convectional type hence less reliable. Irrigation would produce benefits here where the soil is suitable. The major crops of this zone are maize, groundnuts, khenof, cotton and root crops. The range of crops is limited by the unfavourable environmental factors as compared with the high rainfall Savanna zone. Livestock rearing however is the main source of agricultural income. Major projects in this zone have been tsetsefly clearance, bush clearance and drainage of Yala Swamp.

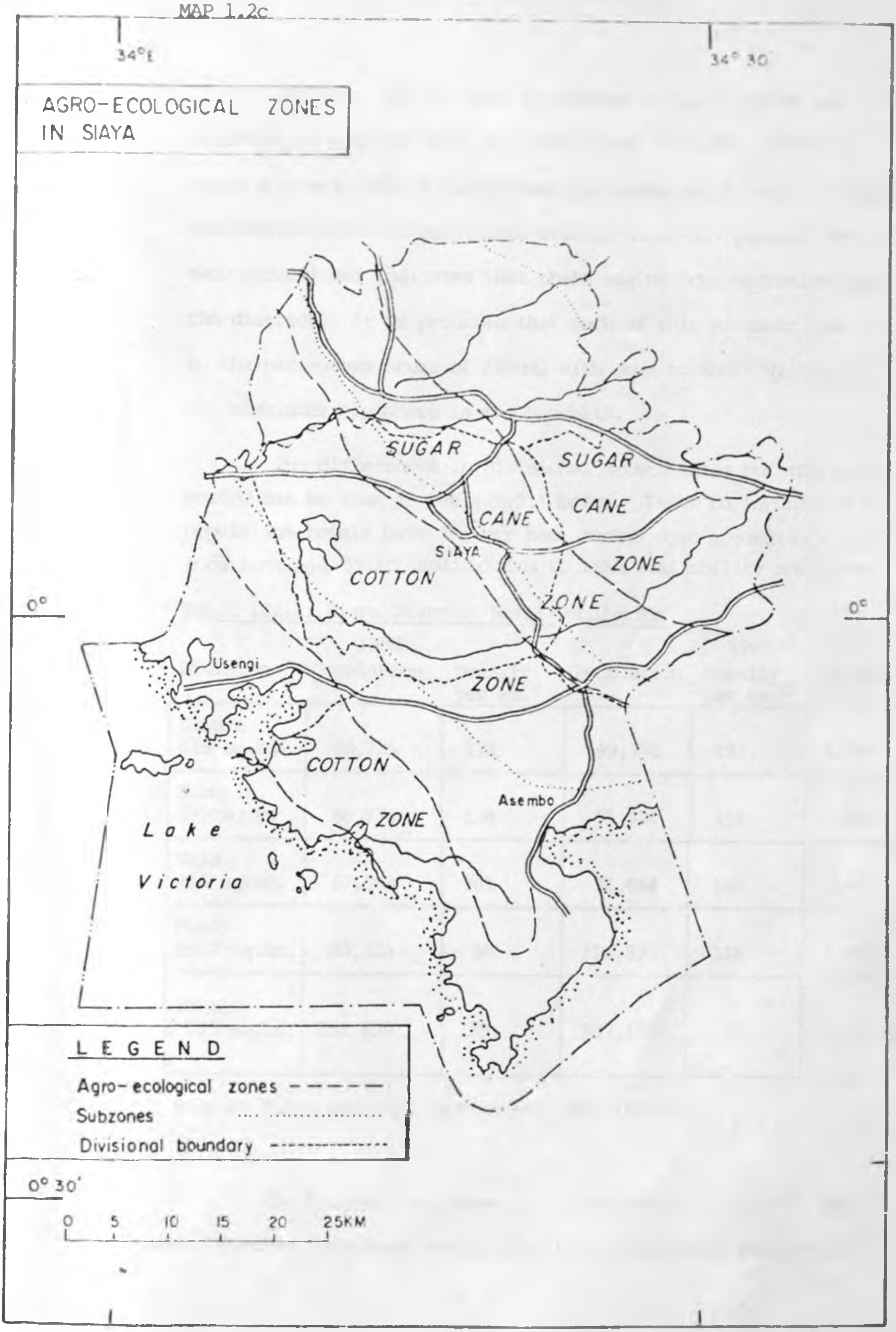
Lately Jaetzold R. (1982)[10] has attempted a more detailed classification of the district. His classification takes into account rainfall amount and reliability, and the performance of major cash crops. Map 1.2C below reveals the results of his considerations. He identifies a lower midland sugar cane zone (LMI); marginal sugar cane zone (LM2); lower midland cotton zone (LM3); marginal midland cotton zone (LM4); and lower midland livestock millet zone (LM5) as the major agro-ecological zones. Subzones of these can also be seen from the map (1.2C). On the basis of this map, meaningful land use types can be planned since the potentials of each zone is also outlined in the book.

On the basis of the above agro-ecological classifications of the district and their underlying potentials, livestock grazing demands for different years (when the population of stock has been different) have been worked out in chapter lV.

c) <u>Population Trends</u>

Although population growth in the district has been fairly moderate as compared to other districts within the province, it has nonetheless posed challenges to the inhabitants as is discussed in Section 1.3. Within the district, there has been variations in the growth rates of the different locations mainly as a result of environmental factors.

MAP 1.2c


34°E
34° 30'
AGRO-ECOLOGICAL ZONES IN SIAYA
SUGAR
CANE
SUGAR
CANE
ZONE
SIAYA
COTTON
ZONE
0°
0°
Usengi
ZONE
COTTON
ZONE
Asembo
Lake
Victoria
LEGEND
Agro-ecological zones
Subzones
Divisional boundary
0° 30'
0 5 10 15 20 25KM

In 1962, the adjusted population of the district was 352, 600 persons, by 1969, it had reached 383,188. This meant a growth rate of 2.3 percent per annum which was considered below the provincial average (i.e. 3.7 percent for the same period) and indicates that there was net out-migration from the district. It is probable that much of this movement was to the peri-urban areas of Kisumu with some to South Nyanza, the remainder elsewhere in the Republic.

The differences in divisional growth rates for the same period can be seen in Table 1.2.1 below. Later on in Chapter 11 population totals have further been broken down according to sub-locations and their implications to land availability analysed.

Table 1.2.1: Siaya District Rural Population

Division	1962 Population	1962 Density per km.^{2}	1969 Population	1969 Density per km.^{2}	Growth Rate
Ukwala 519 sq.km.	88,725	171	99,778	192	1.7%
Boro 595 sq.km.	80,778	136	91,924	154	1.0%
Yala 416 sq.km.	67,163	161	76,664	184	2.0%
Bondo 1007 sq.km.	88,934	88	114,822	114	3.8%
Totals 2 535 sq.km.	352,600	139	383,188	151	2.3%

Source: Siaya District Development Plan 1974-78

The frequent occurance of trypanosomiasis, cholera and other diseases have been responsible for considerable movements and variations of population within the district itself.

The Siaya District Development Plan[11] states that between 1962 and 1969, according to the census figures, North-east Ugenya and West Alego locations showed zero population growth rates. Assuming that there had infact been a natural positive growth rate in these areas, of as little as 2.5 percent per annum, the zero figure indicates something like 14,000 persons to have left these locations between 1962 and 1969 to settle elsewhere. On the other hand, between the same years other locations experienced phenomenal growth rates. Yimbo (5.6%), South Uyoma (4.3%), parts of South-central Alego (4.0%). This suggests that there is still an expansion of settlements in these areas though they are also areas with comparatively low densities.

Recently, according to census reports, absolute numbers of persons increased from 383188 to 474516 for the period 1969 to 1979 respectively. This represents a growth rate of 2.6 percent per annum. This growth rate has therefore relatively slackened. This has raised controversies as to the coverage of the 1979 census. "The Compendium to Volume 1 of the 1979 Population Census" concludes after various tests derived from fertility, mortality and migration estimates that an under-enumeration in 1979 was particularly serious in Nyanza Province. In fact in their projection, for the period 1980-1990, they assume a growth rate for Siaya of 3.42 percent per annum. This is a realistic assumption in view of the fact that the inhibiting environmental factors are being improved thus leading to lower morbidity and mortality levels which in turn increases total fertility rate given the high and or constant fertility levels prevailing of over 7 births per woman in the region.[12]

Population distribution is relatively even throughout the district. The crude densities show West Alego, parts of Ugenya and parts of Gem as having the highest densities while lower but moderate densities occur in most of Bondo and parts of Boro (ref. to Table 1.2.2). The differences in densities as reflected in Table 1.2.2 below is indicative of the need for differential approach in terms of agricultural land use policies within the different areas in the district. At the district level, the crude density of 151 persons per square kilometre for the period 1962-1969 has risen to 188 persons per square kilometre in 1979. These crude densities need further refinement of which the study has attempted.

Another characteristic of the population in Siaya is that of having a youthful population. Fifty six percent of the population is under 20 years of age.[13] This gives a very high dependency ratio. Moreover, if the present trends in fertility persist we can look forward to a steep increase in population.

The above characteristics of population trends and distribution, have significant implications for land use patterns and availability as will be shown in later chapters.

Table 1.2.2 : Population Distribution per Location and Division 1979 Census

Location/Division	Total Population	Square Kilometres	Density / km^2
East Uyoma	19461	113	171
West Uyoma	18992	109	173
West Asembo	18082	93	193
East Asembo	18383	83	220
South Sakwa	25761	226	113
North Sakwa	19501	161	120
Yimbo	20073	187	107
Bondo Division	140253	975	143
South Gem	28096	150	187
North Gem	28095	111	251
East Gem	37839	145	260
Yala Division	94030	407	230
East Alego	47969	242	197
Central Alego	36413	179	203
West Alego	24265	117	207
Usonga	9169	74	123
Boro Divison	117816	613	192
South Ugenya	26562	95	277
East Ugenya	27993	138	202
North Ugenya	42627	184	231
Uholo	25235	108	232
Ukwala Division	122417	526	232
SIAYA DISTRICT	474516	2522	188

Source: Compiled from 1979 Population Census Report

d) <u>Socio-economic Charateristics</u>

Economically, the population is almost wholly dependent upon agriculture (90 percent), fishing and small trades (10 percent).[14] Estimation of the average farm family income is of the order of K.Shs.1968/- per annum.[15] Mixed farming predominantly at a subsistence level is the main form of land use throughout the district.[16]

A major land policy project in this area as in the rest of the country is the demarcation of land to individual holders through adjudication, consolidation and registration. As a result of this policy, farmers are in a position to use the credit facilities available for the development of their farms and this should in turn serve to improve their income levels.[17]

The whole of Siaya District falls within the category of trustland,[18] the great bulk of which is either farmed under traditional tribal tenure customs or in the form of small holdings where land consolidation and registration has been carried out.[19]

Adjudication and registration has progressed rather slowly in the district, especially in Bondo and Boro divisions. This exercise began in Siaya in the mid sixties. Inspite of these early efforts at registration there was until recently resistance to land consolidation. Lately however, the pace of the exercise has been dictated by technical and financial disposition.[20]

It will be interesting to note the contrasting kinds of developments later in the analysis in view of the fact that registration exercise was completed much earlier in other divisions like Yala (1973) compared to the others where the exercise is still in progress.

As of 1981 over half of the land area in Siaya was registered i.e. 1436 square kilometres compared to 1042 square kilometres not yet registered.[21] It is the general view that the exercise should be completed soon to enable agricultural development in the whole district.

Technology-wise, progress has been slow. From the Annual Reports, in 1967, it was noted that ox-plough were rarely used and there was very little mechanical cultivation except on cotton blocks. Much of it was done with hand hoes. Ten years later shortage of tractors, hand tools and ox-ploughs was being experienced and only 232.9 hectares were ploughed using tractors.

Fertilizer usage is also minimal and is restricted to crops like coffee and hybrid maize. Adoption of better variety yielding crops has been slow, as will be shown in chapter 3. The need therefore for more concerted efforts in terms of modified strategies and policies by the ministries concerned cannot be over emphasized.

On the settlement scene, the picture that emerges in the district are dispersed or grouped homestead units. In addition, there are nucleated settlements which are associated with cultural institutions like missions, market centres and designated service centres like Ukwala, Asembo Bay, Siaya, Bondo, Yala etc. where there are small numbers of resident population.[22]

The above patterns of settlement in the district are likely to expand in view of growing population and increasing densities. Such an eventuality would restrict the extent of available land for the more urgent purposes like food production. Later on in the study, we will attempt to assess the extent of land which is not available for agriculture (the mainstay of the rural population) and project future requirements for the same with a view of arriving at policy alternatives.

1.3 STATEMENT OF THE PROBLEM

This study focusses on some demographic factors which have led to the problems of land availability and use in Siaya District. It attempts to portray the extent to which selected demographic variables are responsible for the present and the future forms of land use.

The assumption is that the study area has historically experienced 'population pressure'. The magnitude of the problem has however eluded most studies. Indeed early attempts to establish, the extent of the problem by Ominde (1963)[23] went a little beyond providing generalised background information on symptoms of pressure and peoples response to percieved land shortage, besides mentioning North and South Ugenya, Gem and Asembo Locations as experiencing some pressure because they had densities in excess of 400 persons per square mile.[24] While such information is useful with regard to providing the necessary background information, it however falls short of subjecting the distribution aspect of population to serious scrutiny.

For this reason, this study, apart from analysing the density situation in detail, also incorporates the crucial element of viability of available land. Such an analysis is definitely divorced from the traditional approach which emphasizes more the comparative approach to land ratio computations.

The focus of most rural studies which have dealt with 'population pressure' has been incomplete because such studies have not integrated in their analysis the two aspects of land namely availability and use. The actual extent and intensity of land use must of necessity be related to land availability and policies or factors governing land distribution; if studies of population pressure aim at recommending realistic resource development and management options.

The problem in Siaya is therefore twofold. First is the effect of increasing densities to changing patterns of land use and secondly is one in which the present system of land tenure results in land shortage. These problems are analysed in detail in Chapter 11 and 1V. It is thus the overgrowing land shortage within the district vis-a-vis the authorities efforts to encourage individual land rights and tenure that creates concern which has prompted this study.

OBJECTIVES

1.4 From the foregoing statement of the problem we set the major objectives of this study as being:-

a) (i) To show the spatial distribution of population in the district in relation to land availability.

(ii) To show the present distributional patterns of land holding in the district.

b) (i) To establish the impact of human activity on land use patterns.

(ii) To project future trends in land use demands.

c) To suggest alternatives and/or solutions to the present patterns of land use bearing in mind its availability.

1.5 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

a) Review of Literatures

The study of population resource relationship has long been debated owing to its obvious practical importance. On the whole, the debate has been characterized with two oppoing views in response to the so called population explosion.[25] Views range from those who feel that population growth should be limited on the regional, national, or global scale to avoid imminent catastrophe[26] to those who believe in man's talents at increasing means of subsistence thereby coping with increasing numbers.[27] In general such views have been branded as ideologically motivated as they have determined to various extents different governments approaches to the population resource problem.[28]

In this section an attempt will be made to discuss a few studies which have dealt with population pressure on resources per se; briefly outline a few local studies which show what happens exactly in rural areas in terms of land use and availability when subjected to sustained pressure (or heavier densities) and lastly evolve a theoretical framework.

Globally, concern with population growth has focussed more on environmental deterioration. Ekholm 1976 (cf. Bernard and Anzagi 1979)[29] is of the opinion that humans are destroying the very basis of their livelihood.which has manifested itself in the form of soil erosion, desertification, increasing flooding and declining fertility, not to mention the pollution of air and water.

Similar views are held by recent global conferences of the United Nations.[30] They point out that as the global population continues to grow, forests shrink, soils erode, deserts expand and the atmosphere are progressively less able to dilute waste. The issue of general environmental deterioration cannot be overlooked, nonetheless, proponents of such views have been charged with overreaction - as indeed living standards continue to improve thereby pointing towards better management techniques.

Since the sixties, concern has tended towards the the developing countries where unprecedented rates of population growth are recorded. Browning (1970)[31] writes on the difficulties of accommodating such growths within a short period. In fact the realization of intensified agricultural systems in terms of land use by Boserup (1965) stresses the need for gradual population growth as a precondition.

Taking the above facts into account and narrowing his study to developing regions, Tricart (1970)[32] maintains that population growth is occuring in those regions where demographic pressure is greatest and techniques remain unchanged, the food situation thus becomes increasingly severe because of the larger number of mouths to feed and also because of the drop in yields. Underlying this observation is the change in patterns of land use, where because of shortened fallow periods, the soil looses its quality and as such can only yield poorer harvests.

Mabogunje (1970)[33] sees the problem at a more general scale in less developed countries. He asserts that while there is rapid population growth, there is no corresponding economic growth as such there is need to worry on the state of population demand on resources. The problem with such regional scale studies is that they are too general to be applied to any particular area.

Although, such views of the Third World are characteristic of most scholars analysing population problem in this region, there are nonetheless, more optimistic propositions as regards the Third World population resource situation. Boserup (1965) and Clarke (1967) Case Studies reveal that population growth and consequently increasing pressure pre-empts increased food production. It is shown later in our discussion of theories that more and not fewer people will stimulate a transition to intensified agriculture. In all, the general criticism levied on global scale studies is that they fail to apply to empirical case studies like the present one. Both Clarke 1973 (cf. Bernard and Anzagi (1979) and Bernard and Anzagi (1979)[34] are of the view that such macrocosmic studies conceal regional and local differences in population resource relationships and fail to take account of shorter term global political-economic conditions which bestow special resource access to certain parts of the earth while denying it to others. (ibid).

It is in recognition of this that a number of case studies have been carried out in Africa. Hance (1970)[35] compiles the case studies in his attempt to identify pressure points in Africa based on densities per square kilometre. His calculations showed that about 47 percent of Africa and 51 percent of its population were subject to some level of population pressure. Of some 52 African States and Territories surveyed, Hance (1970) concluded that 48 States possessed some combination of population pressure, of these 23 have pervasive problems.[36]

Hance's study is of relevance to the present one because some of the variables he gave as indices of population pressure in Africa are the same ones used in this study. However, his variables are numerous and some need very elaborate measures hence use has been made of only those which can be assessed from available data.

While it is widely accepted that rapidly increasing population causes serious concern in relation to utilization of resources in developing world, especially land resources, which are obviously limited, there appears to be little concensus of views on the definition of its measurement.

In this study, this debate has been partly over looked as it is not the concern of this thesis. Nonetheless, a general definition is adopted. Thus population pressure is viewed as denoting a relationship between population which means maintenance and the resources which are the means to maintain the population. For there to be pressure an imbalance between the two becomes evident.[37] Imbalances between population and land resource have been conceived variously by different authors because as Zelinsky et al (1970) [38] assert, it is a 'multidimensional phenomena.'

Below are specific local studies which attempt to evaluate the existence of pressure in some parts of Africa basing their conclusions on mainly symptoms of pressure.

Mabogunje (1970)[39] attempts to evaluate the presence of population pressure in three West African communities. His conclusion is that, the operational definition of population pressure which is based on the simple idea of high density or high ratio of population on land, ignores the more vital variable of the standard of social well-being which the people expect to derive from their resources. On the basis of this argument he develops a model aimed at tapping the phenomena. His Model has three variables interacting namely, resource (land), population and expectations. The Model may be useful in understanding existing patterns of land use in specific communities from the sociological standpoint but becomes problematic when the use of secondary data is employed as in the present study.

Hance (1970: op cit.) identifies Kenya, and Tanzania's steppe areas as having low carrying capacities meaning that increases in human and livestock population have led to periodic droughts and famines. On the other hand, Uganda with a greater percentage of its total area in high potential lands and considerable stretches which could support greater densities has a number of sub-regions which have severe population pressure. Sections of the West Nile and Teso provinces, Karamoja and the whole of Kigezi districts, have often been cited as pressure points. Furthermore, in Kenya, Hance, mentions the districts of Kiambu, and Nyeri as having extremely high densities. Moreover, 30-40 percent of the adult males in one location of Nyeri are landless and in 1964, it was calculated that 45 percent of all holdings in Nyeri district were smaller than three acres;

the size generally considered to be adequate for subsistence farming.[40]

In another study in Kenya, Bager (1980)[41] cites Kisii district as facing similar problems of land scarcity which is worsened by a population growth rate of 3 percent per annum and the traditional inheritance system which implies that every son inherits a piece of land from his father.

Most of the studies listed above show how population pressure has been measured in Africa, their relevance to this study stems from the fact that they have employed some measurements of population on land of which the study has used in the forthcoming chapters. The Kisii land inheritance pattern/system is similar to the Luo one and the factors explaining the differentials in land distribution in Kisii are used to explain the Siaya case later in Chapter 11.

In addition to the above, in Kenya, the problem of population in relation to land resource is officially recognised. Nationally, the Kenya Government has supported land consolidation, adjudication and registration and/or reallocation of land in the former scheduled areas[42] and later family planning measures showing that formal government is aware of the seriousness of the problem of land availability. The general consensus on Kenya's population problem stems from the fact that within a very short period there has been rapid demographic change on the limited resource base.

Indeed, in 1972, Kenya's national report to the United Nations Stockholm Conference on the environment, stated the case Starkly (cf. Bernard and Anzagi 1979)[43]. It noted that Kenya's high growth rate bears heavily on the limited fertile area and consequently carrying capacities in the high potential densily settled areas, particularly in Western Kenya and Central Province have been reached or exceeded. On future employment prospects for Western Kenya it notes that with the present population growth, as many as 5 million people will have to find non-agricultural employment or migrate. i.e. if farm holdings are to be economically viable and not merely for subsistence.

While the report provides a guide to the consequences of increasing population on land regionally and nationally, it nonetheless overlooks important variations in the magnitude of pressure even at the district level of which our study is concerned.

Ominde (1975)[44] addressed the problem of population pressure in Kenya by using the ratio of arable land to population. He notes the scarcity of good agricultural land in the well populated districts of Central Nyanza and Western Provinces and observes that only in parts of Narok are there still large areas of unused and good agricultural land, while Lamu, Tana River, Laikipia and Samburu possess relatively opan land of poorer quality.

The analysis of most ot these national scale studies has been on agricultural land use at the expense of other competing uses of which this study is also interested in.

The demographic element has been responsible in Kenya for the land reform programmes. Herz (1974)[45] and Odingo (1973)[46] have discussed this in their specific Case Studies. Obwa (1976)[47] while discussing this fact restricts his analysis to the study area. He notes as a matter of fact that the programme was implemented in Siaya in May, 1966. This is the only specific study that attempts to address the impact of land policies to Siaya District. His conclusion on the basis of Siaya, is that, land reform and hence rural development in general are unrealistic because such policies have in general overloooked land tenure system as well as settlement patterns, the results of such policies have thus been the institution of landlessness, creation of unemployment and strengthening of the progressive farmer. (ibid).

Obwa's argument could be valid, but the problem with his conclusion is that he does not employ population statistics to substantively verify his arguement. Our point of departure here is to use available statistics to show the nature of land distribution in Siaya district and to show other competing land uses as done in Chapters 2 and 4 respectively.

b) Summary of Literature

The literature has dealt with a few studies which have in the past related population growth to resource/land use and availability. Two types of studies can be identified thereof based on their scales of resolution. First, is the set of studies which relates population growth to global and regional experiences and second, that set which relates population growth to local experiences. In the first regard authors like Ekholm (1976), Tricart (1970), Browning (1970), Zelinsky (1970), Brandt (1966), Mabogunje (1970), among others have been cited. While in the second regard Hance (1970), Bernard et al (1979), and to a lesser extent Ominde (1975), Obwa (1976), Herz (1974), Odingo (1973), regional development plans, have treated population and specifically land resources at a smaller scale.

Although most global and regional studies examined, offer us the wide spectrum of interaction between population and resources in general and environmental deterioration and consequences in particular and indeed this is the theme which persists throughout the literature, (excepting Boserup 1965; and Clarke (1967), these studies however fall short with regard to: (a) generalizing problems to world regions without taking account of the differentials in:- resource endowments for regions; environmental/land potentialities; social systems; economic base being either agrarian or industrial, among a host of other factors and (b) secondly, because these type of studies only implicate issues of land use and availability to growing population without clear correlation (excepting Kumar 1973) of which this study is interested in and has attempted in Chapter 111.

For the above reasons and also because of the fact that response to growing population take different forms even within localities a few case studies by Bernard et al (1979), Hance (1970), and Ominde (1975) among others have shown how concepts like environmental deterioration and carrying capacities have been measured for example by using refined density measures, and symptoms or indicators of pressure. Although the author has identified these studies, they have nonetheless, concentrated on arable land use at the expense of other land uses like grazing and non-agricultural land of which this study also focusses attention on.

Below we set out some theories which have tried to relate population change to resource use, availability, and to some extent to farming systems. It is hoped that the theories will provide a more logical picture of the interaction between population and resources than the literature has so far achieved.

c) Theoretical Background and Framework

From the foregoing literature it is evident that two lines of thought exist on the nature of interaction between population pressure and resources. The argument which, however persists throughout is that rapid population growth leads to deteriorating living standards. This argument is the brainchild of Malthus' propositions in 1798 (cf. Encyclopeadia Britannica Vol.14, 1968)[48], when he asserted that populations tend to grow in 'geometric progression' doubling in size every 25 years while food supplies can at best grow in 'arithmetic progression'; preventive checks such as countenance and delayed marriage must be introduced or positive checks such as starvation, disease and war will plague the society. He grouped these checks under the heading 'misery and vices'.

As far as Kenya is concerned, such growth rates in population have been realized and are even now far in excess of what Malthus predicted. On the average, Kenya's growth rate is 3.8 percent per annum with a doubling time of less than 18 years,[49] while Siaya district has a growth rate of 2.16 percent[50] with a doubling time of about 34 years. With improved environmental conditions and lower migration rates, there are prospects for further increase in growth rates. As concerns food supplies, there have been fluctuations in overall output although the performance of agriculture has on the whole improved with increased population. The localised cases in Kenya, of malnutrition and starvation must of necessity therefore be attributed to unreliable weather conditions and poor planning by the locals. It is therefore evident that Malthus 'positive checks' are a result of other things also and not excess population pressure per se.

Malthus overlooked the possibility of increasing food production through the use of advanced agricultural techniques and inputs like fertilizer, mechanization and intensification. Indeed it is through the application of these that Kenya has managed to stave of what might have resulted in demographic collapse.[51]

Secondly, Malthus' presentation of the whole scenario is too simplistic at least for the present level of theoretical explanation. Hart (1970)[52] maintains in his analysis that the relationship between population and resources is interactive and complex, and that the simple idea of cause and effect should be seen more holistically.

He further notes the difficulties in formulating precise operational definitions of concepts such as 'environmental potential'; 'degradation of habitat'; 'population pressure'; 'critical population density'; etc. - as these concepts should all enter in the web of interaction between population and land resource.

The second line of thought which is also discussed above is that by Herz (1974)[53], who argues that Malthus failed to account adequately for technological change in particular he failed to foresee the extent to which improvement of agricultural technology would forestall and reverse diminishing returns to labour as happened in the Kenya highlands. This is in recognition of Boserup (1965) and Clarke (1967) who posit that population growth is itself a driving force to technological change in traditional economies. In other words, demographic pressure forces greater specialization of labour and more extensive and intensive exploitation of the land, primarily through shorter fallow periods, which in turn lead to discovery of new tools and techniques of fertilizers. The economic gains thus generated forestall Malthusian degeneration of living standards and may instead allow improvements.

This line of thought may explain to some extent the position of Kenya as regards self-sufficiency in food, but we hasten to note that quite a couple of times, relief food has had to be sent and at times massive food imports are made as a result of factors beyond control which cause poor harvests.

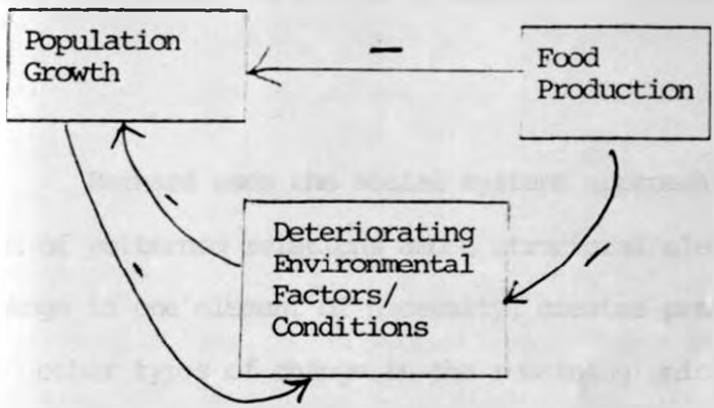
Of significance to Boserup's theory is the fact that demographic change is so rapid in Kenya that evolution of technologies may not keep pace and of critical importance to Kenya is the lack of capital to import technologies in packages.

Boserup's theory does not co-ordinate well the system of land tenure in existence, rather it is taken for granted. Malthus on the other hand, recognized the importance of the feudal land tenure system in his discussion of population growth. He postulated that the landlords would regulate the flow of hired labourers onto their farms and not allow the growing population to change their monopoly over land and property.[54] His insistence on the importance of the social system when discussing population growth is a remarkable insight, the problem however is that he did not foresee the dangers that increasing densities pose to existing patterns of land tenure and also, was wrong in assuming that no other form of tenure was possible other than that which had evolved in England by his time.[55]

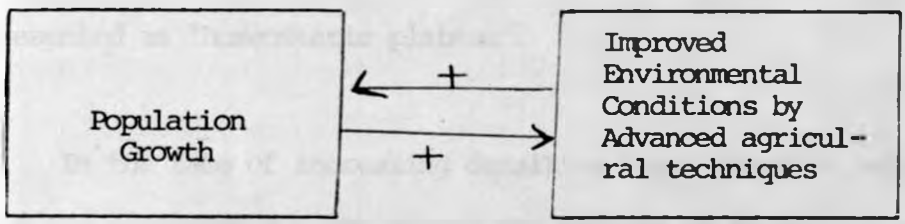
An example of a different tenure system is the Luo traditional land tenure system where ownership of the land by the wives passed on to the sons by inalienable right. Under customary law, sons had to subdivide, their father's land or alternatively, the father gave each a piece from his holding while still alive. The family was the smallest landholding unit within the subclan's territorial claim (Ominde 1963; Ocholla-Ayayo 1976)[56]. In such a system (as is in the study area) it is thus anticipated that persistently increasing densities in the long or short term would lead to excessive subdivision and landlessness.

The two dimensions of the theories already discussed can be represented as follows:

Model 1.4.1 (a) Malthusian Population Resource Relationship



Model 1.4.1 (b) Boserup's Population Resource Interaction



The interaction between population growth and resource has been shown to be negative as the arrows indicate in Model 1.4.1 (a) and positive in Model 1.4.1 (b). The arguements have been presented earlier in the discussion. Furthermore except for food production and population growth in Model 1.4.1 (a), the rest of the relationships are interactive, and it is difficult to establish population growth as a 'cause' or 'effect'.

It is thus our view that although the models have served as pointers of what is expected in case of imbalances between population and resource, they have nonetheles overlooked the complexity of interaction and as such should be incorporated or united. Bernard et al (1979)[57] has developed the systems approach and it is this contribution that we have used to explain the nature of population resource interaction.

Bernard uses the social systems approach which refers to a set of patterned relations among structural elements so that change in one element of necessity, creates pressures for adjustments, or other types of change in the remaining units. Thus, the 'Cybenetic System' represented in Model 1.4.1c 'Conceptually possesses a state of equilibrium between man and earth ... the system is capable of adjusting itself to changes in population i.e. the state represented as 'homeostatic plateau'.

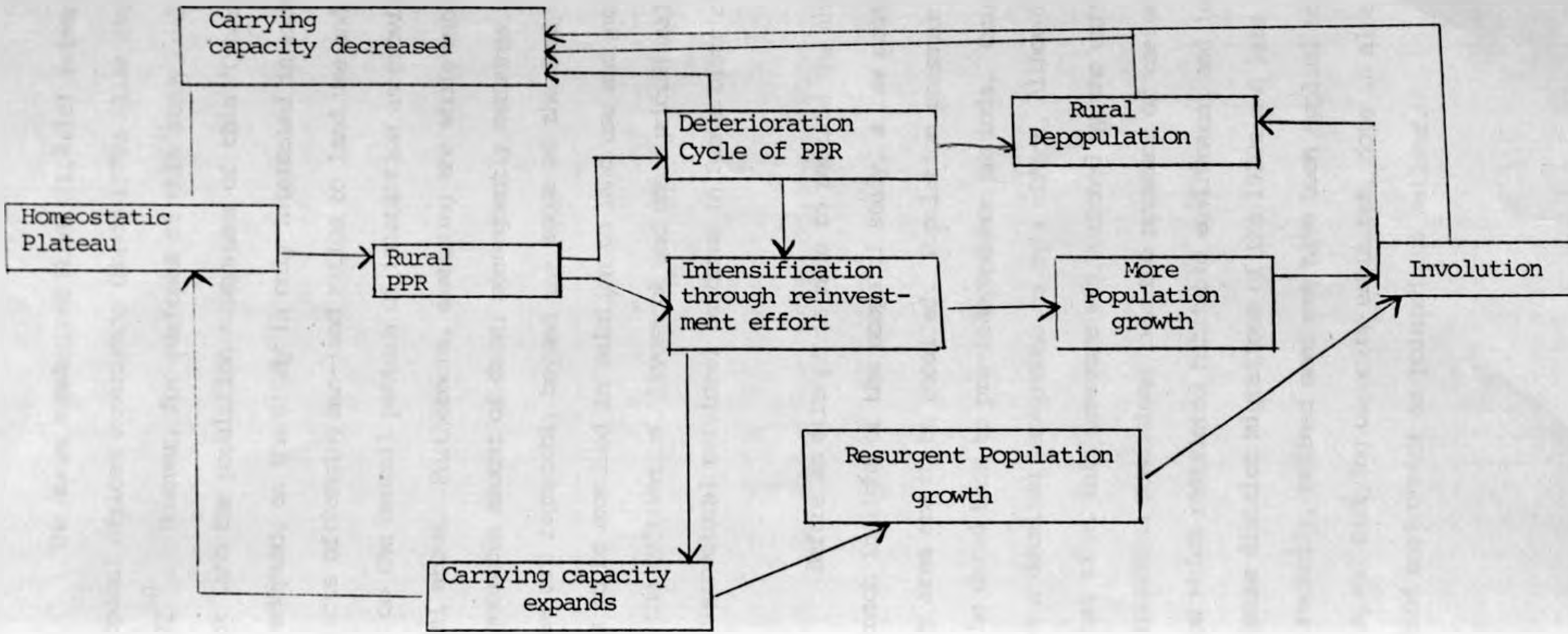
In the face of increasing densities hence pressure, equilibrium would be disturbed and the system can attempt to adjust through negative feedback in two rather opposing ways. The arrows in Model 1.4.1c explain the patterns of reactions and the nature of complexity of reactions.

In the first instance where productive potential has not been reached, it can undergo 'evolution' by intensification through reinvestment in effort. Ultimately, however, the capacity of land to support human activities reaches a limit hence with further population growth, although total productivity may increase, output per unit of labour and per unit of land must ultimately decline. The system thus experiences 'involution'. To retain the same amount of yield without major technological breakthrough, more and more labour must be invested per unit of land. This may lead to consequences such as out-migration which in turn may foster '<u>rural depopulation</u>' or starvation which ultimately will decrease the carrying capacity and restore balance to the system.[58]

Secondly, in cases of already over-crowded areas rapid increases in densities would lead to a 'toppling of the system' represented in the above model as 'the deterioration cycle of population pressure'; where cropping patterns, fallow cycles conservation measures may be altered for the worse which in turn may deplete the land base, lead to food shortages and bring on environmental deterioration which would manifest itself in the form of emigration or in increases in rates of mortality.[59]

Model 1.4.1c

A MODEL OF RURAL POPULATION PRESSURE AND AGRICULTURAL CHANGE



Adopted from: Bernard and Anzagi 1979 page 52
Note: PPR represents Population Pressure.

The above summarized Model (1.4.1c) relates well to Tropical African experience (Hance 1970; Allan 1965; Van de Walle 1972[60]. However, for purposes of this study, only a partial look into the population subsystems of this 'Cybernetic System' will be adopted, as the study is only interested in examining the effects of changing man-land ratios to land use and availability and not on the overall pattern of interaction as provided by the model above. Furthermore, examining the whole web would require an enormous amount of data, consequently measures, time and funds. These are regretably beyond the scope of the Study. The subsystems thus to be examined in relation to land use and availability, are the cultivation, livestock and non-agricultural (mainly infrastructural services) patterns in Siaya District.

Before an attempt is made to restate the above systems approach in light of the scope of study, a few remarks of the study area are to be recalled. Population pressure in Siaya can be dated back to pre-independence periods. Ominde (1963 op.cit.), gives a detailed background to this effect. Although localised, at that time, this pressure was worsened by the unfavourable environmental conditions like the presence of tsetsefly and swamps which restricted habitable environment and led to inter and intra district migrations of the 1920s and late fifties. More recently, refined measures have been applied to assess pressure levels, and carrying capacity estimates, note an already over-strained environment as pointed out earlier.

While the author acknowledges the conclusions of these studies, they nonetheless fall short of telling us how land has been used overtime with sustained pressure. The thrust of this paper is as such to fill this gap and this has been done in Chapter 111.

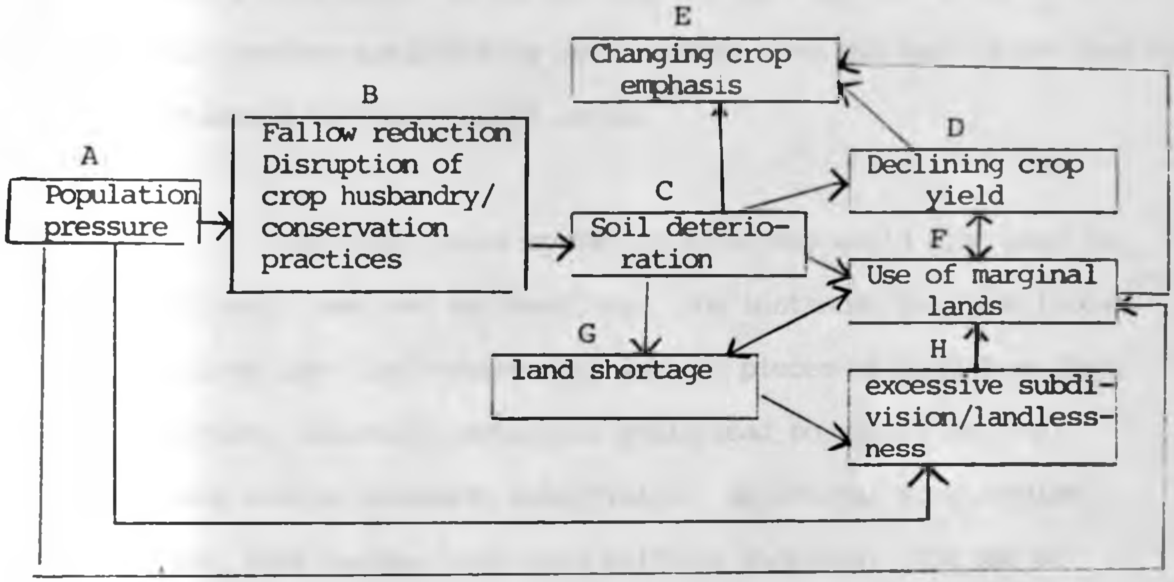
To examine patterns of expected reactions in the subsystems earlier referred, Hance's (1970)[61] study indicators were used to help in identifying changes in land use and/or activities on land and availability as a result of increasing densities.

d) <u>Indicators of changes in land use/activities and availability in Siaya District</u>

1. Declining crop yields
2. Changing crop emphasis (especially to soil tolerant crops such as maniac).
3. Large number of families with sub-economic holdings even for subsistence.
4. Increase in cultivated acreage consequently decrease in grazing land.
5. Breakdown of indigenous farming system.
6. Other land uses (non-agricultural)on the increase.

(i) Models on the Various Sectors of Land Use Patterns

Model 1.4.2: Patterns of land use and availability in the cultivation sector under increasing density



Source: Benard and Anzagi pp.54

Model 1.4.2 portrays the patterns to be expected under increasing densities - which is treated here as the independent variable causing a chain of dependent variables as can be observed from the model. Although the cultivation sector is not divorced from the livestock sector, they have been separated to make the web of interaction clearer. The linkages in the model (1.4.2) nonetheless are still varied and complex. One chain thus shows the impact of changing man-land ratios, to be first noted in the alteration of the inherent quality of the soil. In theory, as pressure builds up, fallow and other conservation techniques are abandoned, yields would eventually decline and/or there could be a change in terms of crops grown: Arrows leading to boxes A B C D and E represent this chain.

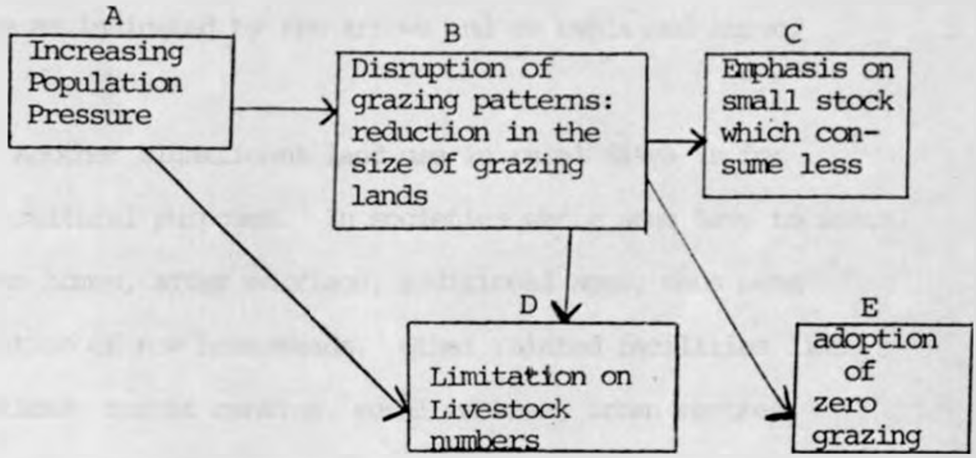
In Tropical Africa adaptation of agriculture must be interpreted precisely as the adoption of manioc, a crop that will produce satisfactory returns even when the soil is getting too exhausted for traditional crops.[62]

The land tenure system of a society would also lead to different uses and availability. For instance, in a patrilocal society like Siaya where sons inherit pieces of land from their fathers, increasing densities would lead to use of marginal lands and/or excessive subdivision. As further sons require land, they may be faced with relative shortage. The use of marginal land also serve to decrease crop yields as such lands are less suitable for crop production. (Thus A-H-F-D-E; A-H etc.) The above patterns represented in model 1.4.2 are examined or implicated later in the analysis chapters and are enough to illustrate the nature of interaction expected in the cultivation sector.

In the livestock sector, such a pattern as indicated by arrows in model 1.4.3 below would develop with increasing pressure.

ii) <u>The Patterns of Land Use and Availability in the Livestock Sector with Increasing Pressure.</u>

Model 1.4.3



The livestock sector is important in Luoland as traditionally the Luos were pastoralists. But later in history, the arable and pastoral domains became strongly integrated and as of now they practice mixed farming as was mentioned earlier in section 1.2d.

The effect of increasing pressure in the livestock sector (model 1.4.3) may first of all be noted in the alteration of grazing. In other words, as long as industrial inputs do not play a major role, a society faced with continuous population growth would gradually convert pasture into arable land.[63] Such a change would be in addition to (or coincide with) increasingly intensive use of existing land. This process would not necessarily mean that livestock be eliminated in densely settled areas rather their numbers would get fewer naturally as a result of more demand for livestock products and also owing to the change from extensively managed grazing systems to intensively managed arable/grazing system.

Alternatively, because of a reduction in available pasture, change may be in favour of the small stock which consume less. Overall, therefore, the expected trends from model 1.4.3 would be as indicated by the arrows and as explained above.

Another significant land use in rural Siaya is for non-agricultural purposes. In societies where sons have to start their own homes, after marriage, additional sons, thus mean the creation of new homesteads. Other related facilities like institutions, market centres, rural centres, urban centres, are also bound to increase with population increase, both in size and numbers to meet the increasing demands thereby consuming more land.

From the above patterns of land use expected in face of growing population, the following conceptual hypothesis explains the overall trend. It is posited that as long as industrial inputs do not play a major role in the rural agricultural system, a society faced with continuous population growth and hence increasing pressure, is likely to experience adverse changes in existing patterns of land use and availability.

The above postulate meets the requirements of a theory in terms of structure and functions and from it the hypotheses in Section 1.5(f) are drawn.

e) <u>Definition of Concepts</u>

<u>Industrial inputs</u> - is used in this study to refer to the use of improved agricultural techniques in the form of fertilizers, improved varieties of seeds (crops) the use of tractor mechanization; and also the state of intensified agriculture. Although this concept forms an essential part of the theory, its application in this study, has nonetheless been restricted to areas where it is directly applicable or can be directly insinuated. Besides, the use of industrial inputs in the study area is fairly restricted as was already seen in Section 1.2.d

<u>Rural agricultural system</u> - was treated in detail when Model 1.4.1c was being explained.

<u>Carrying capacity</u> - is used to mean a state in which population size is at balance with available land. Operationally, it is defined as: a situation where land title holders have viable acreages for agricultural production as discussed in Chapter 11. In this regard it also means a situation in which all the activities carried on land allow for some period of fallow if no form of improved agriculture exists.

<u>Non-agricultural land</u> - refers to areas not available for agriculture because either, they are occupied by schools, homesteads, market centres, roads, dams (i.e. infrastructure) or demarcated by the Government as forest reserves.

Population growth - is herein used synonymously with increasing densities, population pressure and changing man-land ratios. It means changes in absolute numbers, densities, size and percentage change in the rate of growth.

Land use - is interpreted to mean activities which go on land for instance livestock rearing, cultivation of crops and non-agricultural activities. It also means the performance of those activities in terms of yields, rates of growth in numbers and sizes.

Near landlessness - is equated to a state in which an individual or household possesses unviable agricultural units. Thus landlessness is taken to mean a state in which legally one does not own/possess land.

Pastureland - includes in this study, all natural grassland and bush whether or not in fact it is used for grazing or lying fallow.

f) Operational Hypotheses

1(a) Food crop hectarage and increasing densities are expected to have direct relationship. This should be the case when there is still room for horizontal expansion of crop production.

(b) The hectarage under cash crops should inversely relate to increasing densities. The reason being that as pressure increases on land, the more urgent and immediate uses like food crops production should assume priority.

2(a) Livestock numbers and population increase ought to relate indirectly: because of more demand for livestock products by the growing population and secondly because of pressure on available land, whereby arable use gains priority. Furthermore, new land tenure patterns evolving, do not favour high stock population.

3 Crop yield should relate negatively with increasing densities: it is assumed that when densities have reached their maximum in traditional farming systems where fallow conservation is the technique used to restore soil fertility; when this type of conservation can no longer be practised, yields of crops must progressively get lower because of depletion of the land base.

The hypotheses above have been tested statistically to show the extent of influence of changing man-land ratios on agricultural land use in Chapter 111.

It was felt by the author that some indicators of changes in land use and availability which have not been statistically tested, could better be explained by the use of mathematical tools such as percentages and/or projections: owing to the nature of available data and the kind of information required. The following thus are the indicators which have received such attention.

1. Changing crop emphasis i.e. from the less tolerant to the more tolerant types like manioc and sweet potatoes - which can withstand deficient soils more than other types of crops like maize.

2. Patterns of land use by the various subsystems have been examined to show whether or not they have expanded. The aim is to establish whether land use has been extensive or intensive.

3. Land holding patterns have also been examined in relation to densities and also the tenure system.

The hypotheses and indicators stated above have been analysed using data gathered as explained in the Methodology of this Chapter.

g) <u>Scope and Limitations</u>

The major concern of this study was to establish the extent to which increasing thus sustained densities and pressure respectively, alter land use patterns. To this end, it was necessary to view the problem in retrospect.

From the records available, analysis has been made of the trends of performance of crops, domestic animals and land distribution, in view of changing population. However, due to lack of specific and detailed records for the earlier years, we had to confine the analysis to 19C7 onwards.
For projection purposes, the period under investigation has been extended to the year 2000. Projections done for longer than 20 years often loose meaning and reliability. The year 2000 was thus felt reasonable enough to allow meaningful projections.,

The most important shortcoming in the study is that it did not deal with all the possible factors affecting land use for specific purposes. Factors like rainfall, temperatures, soils among a host of other environmental factors have just been mentioned in the study area, while we recognize the important role of such factors, the limits of time and funds have restricted further inquest.

The various types of land uses examined in relation to availability are grazing, arable and non-agricultural lands. This however is not an indepth categorization of the land use types in the rural areas. Nonetheless the major activities of the rural people fall in the above broad land categories.

More of the limitations especially as concerns data availability and interpretation will be elaborated later in the Methodology section. Despite the above limitations, attempts were made to derive meaningful analysis.

METHODOLOGY

a) Data Collection Methods and Problems

(i) Sources of Data

The data used in this study was divided into different categories according to various sources. Thus crop production statistics were obtained from the Ministry of Agriculture Annual Reports for Siaya District, Nyanza Province and Central Nyanza, for the respective years under investigation.

With regard to livestock development, statistics, were obtained from the Animal Production department formerly the Ministry of Livestock Development, but now incorporated in the Ministry of Agriculture and Livestock. Data is recorded in the Animal Husbandry Monthly and Quarterly Reports, Animal Production Annual Reports and in the Ministry of Agriculture Annual Reports. All these were used to verify and/or compliment one another. Data on actual land available for production to families was drawn from the department of Land Registration under the Ministry of Lands and Settlement in Siaya District. Complete and exact land statistics exist only for those areas where land adjudication has been completed. Data was thus extracted from the registration files of the sampled sublocations. On the basis of these statistics, land distribution patterns in the district can be seen.

The main sources of data with respect to population growth were the respective population census tables for 1969 and 1979. Furthermore for periods beyond 1983, projections were adopted from the book "Population Projections for Kenya 1980-2000" - all these are Central Bureau of Statistics Publications. Since the census' are decinial, gaps between them were filled by using simple interpolation and projections as discussed later in this section.

Information on land non-availability for agricultural utilization for one reason or the other, was obtained from the Siaya District Annual Reports for 1979 and 1980. Such Annual Reports furnish information on all aspects of development such as education, health, social services among others. All the above data proved useful in the analysis of the interaction of population and land resource.

Since there was little time to note all available registered land statistics for the district, a sample of five sublocations was used to show land distribution patterns in the district, and below is the sampling design used.

Sampling design

The type of sampling used in this study was the multi-stage sampling technique. This enabled us obtain information on exact land statistics available to land title holders.

This technique was suitable for our purposes because the statistics required are presented according to administrative units which formed the basis of our sampling. Hence in the first instance Yala and Ukwala divisions were taken as homogeneous units with respect to registration, ecological conditions and densities. i.e. both these administrative units have had complete registration of land, they have more or less similar agro-ecological conditions and in general have higher densities than the other two divisions of Bondo and Boro. These factors have already been explored in section 1.2. Hence in this first stage of sampling, each location was listed and numbered, for the two divisions. Using a table of random numbers, 3 locations were drawn. The second stage of sampling then involved listing and numbering of sublocations within each location separately, thus drawing out one sublocation from each. In total 3 sub-locations were drawn.

In the second instance Bondo and Boro had to be sampled separately. The problem here was that sampling was disorganized by the fact that land registration had not been completed for both divisions and even within locations. It was thus felt that a reasonable alternative was to directly list and number all the registered sublocations within each division and draw one sublocation from a table of random numbers thus giving a total of 2 sublocations.

Finally, 100 percent recording of statistics was done for the sampled sublocations. Due to the restrictions of time and money, it was felt that this sample which represented 5.43 percent of the total area of registered land[64] and was drawn from all the divisions, was fairly representative of the district's land holding situation.

b) Problems in Data Collection and Compilation

The major problem in data collection was misplacement and/or missing of reports. This affected the agricultural records most. Even in the Ministry of Agriculture and Livestock Headquarters Library, entries were made of reports, but tracing them was not easy. This necessitated going to Siaya to find such records where a similar problem was faced. So the investigator resorted to Provincial Annual reports which were found in Kisumu. It must be noted here that in case of such substitutions, considerable amount of detail was omitted. For instance, Provincial Annual Reports focus on the 'popular' crops only at the expense of the traditional ones like simsim, wimbi etc. Secondly, disaggregation of data to divisional level is altogether omitted. The latter problem is also common to the District Annual Records for the early years. i.e. all of 1960, and early seventies. This problem has jeopardized meaningful comparative interdivisional analysis in the study. Furthermore, where there is missing data on crop statistics, techniques such as interpolation cannot be justifiably used as would be in population data due to the fact that there is no consistent change in trend of production.

Another problem of significance to crop statistics is in the interpretation of the data. The data show in the majority of cases, the total hectarage under a given crop per year, with very scant information on whether or not the crop is grown in pure or mixed stand; similarly, no consistent recording on whether the crops were cultivated during the long or short rains. These short comings have prejudiced our choice of base year for analysis. In other words choice of period, time, year of analysis has been determined by whether or not detailed information is available for that particular year and very rarely on random sampling: thus the availability of information for some particular years have been projected to situations in which that information is not available.

These problems and the fact that the period under investigation was shortened by lack of data for the earlier years and secondly by the lack of consistent breakdown of data according to divisions for all crops for all years, may affect the accuracy of our conclusions.

Lastly, classification of land in this study was restricted by the lack of relevant data. Data was there on arable land but non on fallow land and grazing land. The results based on the 'created' classifications have as such to be seen in this context. Despite all the above problems encountered, meaningful analysis has been made on the basis of procured data.

c) <u>Methods of Data Analysis</u>

This part of the chapter, sets to outline briefly the methods that have been used in organizing and hence analysing the data in this study. However, it must be noted that the procedures are detailed in their respective Chapters and/or Appendices. While we recognise the fact that other tools of analysis exist, the methods presented here are deemed to be appropriate to the problem.

The most common tools used in this study include the different types of ratio methods like percentages/proportions and absolute numbers in trying to analyse data. These methods apart from being simple to calculate and easy to understand, offer a basis for comparisons, and help in summarizing data sets. For these measures to hold credibility an attempt was made in this study, to juxtapose them with the absolute values of the different variables examined. Examples of such ratios in this study were in the calculation of:- percentage distribution of land holders, Density of population to cultivated land, Livestock units per hectare, among others. The median was used in describing the nature of distribution of land to title holders in the district. It was derived from graphs which had cumulative values representing percentage of title holders plotted against size of holdings. The 50 percent value in these graphs thus represented the median holding size by the sampled population.

Contingency tables were used in studying relationships between variables Cross tabulations for instance had to be made for crops grown to compare their relative weights in terms of claims to the total ploughed area on **yearly** basis and over many years.

Bar and line graphs were used in this study to facilitate visualization of trends of various variables under study.

In addition to the above descriptive techniques, the regression model was used in trying to establish statistical correlations between independent and dependent variables. It is imperative to outline the model here because it was used extensively in Chapter 111 of this Study.

Regression analysis focuses on the relationship between variables and the contributions of different variables to the overall variability observed in the dependent variable. The linear model assumes that the explanatory or independent variable(s) or predictor(s) affect the dependent variable (Y) in a systematic way and that it is distorted by more or less random scatter or disturbances.[65]

The basic assumption underlying simple regression model is that the variability observed in a dependent variable is accounted for partly by a single explanatory variable and partly by a disturbance or error term that might result from the data or partly by the effect of unconsidered variables.[66] Thus simple linear regression is concerned with the relationship between two variables x and y. It is expressed as:-

$y=a+bx+e$

where:

a is the point at which the line crosses the y axis (y-intercept).

b is the amount by which the line changes per unit increase in x i.e. the slope of the line

e is the error term.

In the case of this study, and the models (1.4.1, 1.4.2 and 1.4.3) drawn out earlier, the effect of increasing densities (x) on livestock populations; hectarage under different types of crops (food or industrial) and on yield per hectare (Y's) have been examined and analysed in Chapter 111.

The regression model aims at selecting a particular straight line which best describes the trend of data. The line is called the regression line or the line of best fit. This line if fitted on a scattergram - represents the line which minimizes the sum of the squares of differences between the observed and the predicted Y values for each observed value of x. From this best fitted line one can predict the values of the dependent variable.[67]

This model is useful in the long run because it gives us also a correlation coefficient r or R depending on whether it is simple or multiple regression. This coefficient measures the degree of association between the variables and gives the investigator one summary index on the nature of relationship existing, whether inverse or direct. Hence the values of a correlation coefficient range from -1 to +1. If values are closer to +1 or -1 it indicates that a correlation exists, but if the values are low it shows that a low degree of correlation exists, while values equal to zero indicates complete absence of correlation.[68]

Most of the hypothesized relationships in Secion 1.5f were thus analysed using the regression model and on its basis certain predictive conclusions have been made.

Another technique used in analysing data in this study was the projection method. Methods of making projections have been classified in a number of different ways. Basically, they revolve around the mathematical and ratio method, various methods using a series of indicators of population change, component methods and combinations of these.[69]

In choosing the type of method used in this study, all these different methods have been evaluated according to available data and its quality and a decision was reached that the mathematical method of projection is convenient as they are the simplest conceptually and require relatively little time to apply.

The mathematical method involves the application of some mathematical formula directly to the total population from one or more censuses to derive projections of total population.[70] Due to the fact that projections were needed for a relatively short period, the geometric curve with a continuous compounding rate was adopted.

This curve is presented as follows:-

$P_t = P_o e^{rt}$

where:

r is the rate of growth

t = number of years

e is the base of the natural system of logarithms

P_t is the estimated population

P_o the initial population

The basis of all projections are a set of assumptions which must be stated clearly. In this study, use was made of latest intercensal rate of change to project population for at least 3 years from the census year. Secondly, population projections were adopted from other sources with stated sets of assumptions. Third, projections were made in the field of land use on the required amount of land to be under non-agricultural use and to be cultivated, given some hypothetical growth rate and observed population-arable land ratios respectively.

Mathematical projection methods are used in making estimates of subnational plans. Where possible, we have included alternative paths of development to cater for this methods weakness of possible over estimation. The method also facilitates comparison, a useful aspect for this study.

Last but not least, Linear Interpolation was the other type of operation also employed in compiling data on population totals for the intercensal years. The assumption was that yearly changes in population size are equal. Estimates were then made along a straight line for any intercensal date. This was done by dividing the change in the size of the total population (between P_1 and P_2) according to the point where the date of the estimate falls between the two censuses.

The estimate (P) is as follows:

$$\bar{P} = P_1 + \frac{n}{N}(P_2 - P_1)$$

where:

$\bar{P}$ is the population estimate at some date between two censuses.

P_1 is the size of the population, as determined in the first census.

P_2 is the size of the population, as determined in second census

N is the number of years between census

n is the number of years between the date of P_1 and the date of the estimate.

This proecedure has been applied in a number of studies owing to its simplicity and convenience[71], as such it was used with confidence in this study. In the foregoing section, we have thus described the methods and problems encountered in data collection and compilation and presented the methods used in discussing the data. In the next Chapter, the study deals with population change and its influence on land availability.

OUTLINE OF SUBSEQUENT CHAPTERS

Chapter two, concerns itself with distributional patterns of land in the district at both the individual and family levels. A review is however first made of population response to land pressure only in so far as availability is concerned and finally features of population characteristics in relation to land demand are also included in the discussion.

Chapter three, presents an analysis of population growth (in terms of densities) in relation to arable land use in Siaya over the years. The relationships between sustained pressure and the already hypothesized variables are established and analysed.

In Chapter four, analysis is made of the intensity of land use in the district at present and at other times. Future demands on land to be placed by the various sectors under study are also projected.

Finally, Chapter five, presents a summary of the main findings of the study and interprets the main findings of analytical chapters. Lastly, it outlines policy recommendations and areas requiring further research.

NOTES AND REFERENCES

1.	Kenya: (1984)	Siaya District Development Plan 1984-88
2.	Kenya: (1979)	Siaya District Development Plan 1979-83 - pp.1
3.	Ibid.	
4.	Kenya: (1970)	Western Province Regional Physical Development Plan pp.1-3
5.	Siaya: (1980)	Siaya District Annual Report. pp.1
6.	Ominde S.H. (1963)	pp.58-60
7.	Kenya: (1970)	Op.cit
8.	Kenya: (1974)	Siaya District Development Plan 1974-78 pp.3 also refer Obwa Oiro (1976) pp.35.
9.	Ibid	
10.	Jaetzold R. and Schmidt M. (1982)	Chapter on Siaya District pp.231-234
11.	Kenya: (1974)	Op.cit. pp.2-3
12.	Mwobobia I.K. (1982)	Maps out total fertility rate for Nyanza Province at between 7.6-8.5 births. pp.90
13.	Kenya: (1974)	Op.cit. pp.2 also in Obwa Oiro Op.cit. pp.30
14.	Obwa-Oiro (1976)	pp.7-11
15.	Ibid.	pp.3
16.	Ibid.	pp.5
17.	Ibid.	pp.11
18.	Kenya: (1981)	Statistical Abstract pp.5
19.	Kenya: (1970)	Op.cit.
20.	Odingo R.S. (1973)	pp.6-8

21.	Kenya : (1981)	Op.cit.
22.	Ominde S.H. (1963)	Op.cit. pp.141; also in Obwa Oiro (1976) op.cit. pp.30
23.	Ominde S. H. (1963)	Ibid. pp.160-163
24.	Ibid	
25.	Zelinsky et al (1970) also Bernard F.E. and Anzagi S.K. (1979)	pp.5 pp.1, 86-87
26.	Ibid.	Similar Views are shared by Mabogunje A.L. (1970) pp.115; Ekholm (1976) pp.183 cf Bernard and Anzagi (1979).
27.	Brandt K. (1973)	cf Kumar J. (1973) pp.2
28.	Zelinsky et al (1970)	op.cit
29.	Ekholm (1976)	cf Bernard and Anzagi (1979) pp.1-6
30.	Bernard et al	Op.cit. pp.4
31.	Browning H.L. (1970)	
32.	Tricart J. (1970)	pp.165, 167
33.	Mabogunje A.L. (1970)	Op.cit
34.	Clarke J.I. (1973)	cf Bernard and Anzagi op.cit. pp.6
35.	Hance W.M. (1979)	pp.406-417
36.	Ibid	pp.40
37.	Sivamurthy et al (1974)	pp.134
38.	Zelinsky et al (1970)	Op.cit. pp.581-582
39.	Mabogunje (1970)	Op.cit. pp.125
40.	Herz B.K. (1974)	pp.71-72
41.	Bager T. (1980)	pp.40

41.		Land Policies in Kenya can be traced to colonial times. Ominde (1963) pp.297 asserts that an important feature of the British rule in Kenya has been pre-occupation with the problems of land in relation to population. i.e. after tracing land policies in Western Kenya to have began as early as 1930's. Furthermore Herz (1974) and Odingo (1973) see the Settlers reaction to land problems on the nonscheduled farms to have begun in the 1940s. Meaning that land issue has been a feature of Kenya's political history from colonial times.
42.	Kenya: (1972)	cf Bernard and Anzagi (1979) pp.87
43.	Ominde S. H. (1975)	
44.	Herz B.K. (1974)	Op.cit. Chapter 11
45.	Odingo R.S. (1973)	Op.cit. pp.80-89
46.	Obwa-Oiro (1976)	Op.cit. 7, 53.
47.	Malthus T. (1798)	cf Encyclopeadia Britanica Vo.14: 1968 pp.717-718 also cf Van de Walle (1972) pp.117-122
48.	Ibid	
49.	Kenya: (1981)	Op.cit.
50.		It was noted in the Study Area that there was a definite underestimate of the population in Siaya in the 1979 Census.
51.		The term is used to denote a situation where Malthus' positive 'checks' plague the Society with the resultant effect that Crude Death Rate and Crude Birth Rate are at par.
52.	Hart J.F. (1970)	pp.95
53.	Herz B.K. (1974)	Op.cit. pp.225-227
54.	Van de Walle (1972)	Op.cit.
55.	Ibid	

56.	Ominde S.H. (1963)	Op.cit. pp.162-163; also Ocholla-Ayayo (1976) Chapter V.
57.	Bernard and Anzagi (1979)	Op.cit. pp.47-58
58.	Ibid	pp.51-53
59.	Ibid	pp.53
60.	Hance (1970)	Op.cit. pp.417-418; Van de Walle (1972) Op.cit. pp.117-118; Allan W.A. (1965).
61.		For a full list of Hance's (1970) indicators and Bernard and Anzagi's (1979) additional indicators check the latter pp.131.
62.	Bernard and Anzagi (1979)	Op.cit. pp.135-136
63.	Kumar J. (1973)	pp.130
64.		The Statistical Abstract Op.cit. gives total land registered in the district. The total area of the sampled sublocations was obtained from the 1979 Census report and then summed ; to be weighted against the figure provided in the Statistical Abstract and this gave the percentage shown.
65.	Kangi M.W. (1978)	pp.47-51
66.	Nie N.H. et al (1975)	pp.321-328
67.	Kangi M.W. (1978)	Op.cit
68.	Nie N.H.	Op.cit
69.	Shryock S. and Siegiel J.S. (1976)	pp.439-469
70.	Ibid	
71.	Barclay G.W. (1958)	pp.41,33,13,89
	Boserup E. (1965)	cf Van de Walle. Op.cit.
	Clarke C. (1967)	
	Hance W.H. (1972)	pp.36-40

CHAPTER TWO

THE ROLE OF POPULATION IN LAND AVAILABILITY

2.1 POPULATION CHANGE AND LAND AVAILABILITY

Relationships between population change (size, distribution and growth rate) and agricultural development must be among the most important and wide reaching interactions between population and socio-economic change. Underlying this web and perhaps more important to Third World countries is the availability of land. Most of the population in the developing countries, resides, works and consumes in the rural/agricultural areas.[1] This area thus plays a crucial role in the overall socio-economic development of a country.

In Kenya, the constraints to land availability is even more serious due to the fact that the agricultural core is the most heavily populated in terms of very high densities and also it is these regions that continue to have high fertility in the face of declining mortality.[2]

The situation in Siaya is no less different as it falls within the agricultural core of Kenya. Indeed projections are based on a growth rate above 3 percent per annum. This would mean a doubling of population in less than 25 years. This population has to share the available resources. In terms of land holding, in the face of little change in technology, the consequences would be excessive subdivision hence sub-economic units which in turn would lower agricultural productivity.

In this chapter, we set out to discuss land distribution patterns in relation to densities and tenure system. In discussing this the following points have been considered:- the patterns of population change and its response to land availability; the patterns of distribution of population in the district in terms of rural densities and related land holding equivalents; and finally we address the problem of land availability, within certain sampled sublocations to show the differentials in landholding within the district.

The problems associated with increasing densities in Siaya have existed since colonial times. For instance, in the 1920s the Luo people are noted to have moved from the densely settled areas of Central Nyanza (now Kisumu and Siaya districts) to the present South Nyanza district in which there was vacant land as a result of depopulation due to sleeping sickness. Similar patterns of movement are recorded in the early fifties to the peri-urban areas of Kisumu and to the southern parts of South Nyanza from the tsetse areas of Bondo and Boro.

Migrations have also been to the urban areas apart from the mentioned rural areas. In 1969 census, Siaya was amongst the major districts with high net out-migration. Ten years later, Masaviru (1981)[3] observed that Siaya was a major sending area of migrants to Nairobi from Nyanza Province. Out of a total of 14.92 percent for Nyanza, Siaya's share of the migrating population was 6.61 percent followed by Kisumu with 3.99 percent, South Nyanza 2.82 percent and 1.44 percent for Kisii.[4] The point here is that density problems and hence restriction on available land have thus resulted in out-migration to either the less densely populated parts of the Province or to the urban areas.

Migot-Adholla (1981)[5] observed a similar phenomenon for Kenya when he noted that pressure appears to account significantly for net out-migration. From his analysis, a majority of districts with the least land per capita were the dominant sending areas. These included Kakamega, Kiambu, Murang'a, Kisumu, Siaya, Machakos and Nyeri. On the other hand, districts such as Nakuru, Narok, Nyandarua, Uasin Gishu, South Nyanza which experienced in-migration were those in which land was relatively in abundance. (Refer to Table in Appendix 1 for comparison of land availability and nature of migration). Migot cautions however, that the relationship between land availability and migration is not that direct as other socio-economic factors both in the origin and destination too determine the extent of migration.

Although, from the above analysis we have shown that Siaya has a history of out-migration, it nonetheless still has high population growth. Table 2.1.1 shows the latest recorded population increase in Siaya (1969 to 1979). These are rates at which births outnumbered deaths in the district, plus or minus the net migration to or from the district. It appears that the natural growth rates of the population in the district should exceed the growth rates recorded i.e. when the fact that

Siaya experiences substantial net out-migration is considered. In the long run, however, such trends in migration might reverse as in the urban areas the industrial sector is not capable of absorbing all inmigrants and secondly with the new system of education which stresses intermediate technology, people might find it necessary to stay in the rural areas. It must be added that it is still too early to talk of the possible outcomes of the new educational system, nonetheless, the above mentioned result is one of the aims and thus its achievement is pertinent. The point is that the density problem is still very real in Siaya District.

Table 2.1.1 : Population Distribution by Division 1969-1979 ('000)

Division	1969	1979	%Increase	Area Sq.km. *	Population Density 1979/Pers./ Sq.km.
Total	382.8	474.5	24.0	2521	188
Bondo	114.4	140.3	22.6	957	143
Boro	91.9	117.8	28.2	613	192
Ukwala	99.8	122.4	22.6	526	232
Yala	76.7	94.0	22.6	407	231

* This area represents area of inhabitable land only

Source: Republic of Kenya: "Siaya District Development Plan" 1984/1985. Ministry of Finance and Planning p.8

The effects of a growing population can also be seen in the change of tenure systems, which in turn affect availability of land to families. When there exists no room for further expansion, of a tribe as in the old days, narrower systems of access to land develop in which exclusive units are held by families. This is noted to have happened in Kisii, Kiambu and Kakamega districts before independence, and it is this thrust for individual ownership by clans and families which pre-empted the Sywnnerton Plan (1954) (Okoth-Ogendo 1976).[6]

The Sywnnerton Plan thus aimed at solving problems of land fragmentation and incessant land disputes among other things, by restructuring the land tenure system through land consolidation and registration. The programme's effect continues to the present day.

The irony of this programme as a development organ is that in the process of individualization, it has created landlessness or will do so in the long run. In this chapter, we have attempted to show how through this plan's implementation there now exists differentials in size of holdings.

Odingo (1973)[7] is of the same opinion that the programme has shown the disparity between land availability and population. His conclusion is that except for the pastoral districts, where there is still relatively plenty of land, the position is deteriorating every year in the case of the country and in particular in the high potential districts like Kisii, Kakamega, Kiambu, Embu, Murang'a, Nyeri and to some extent Kericho and Siaya, where growth rates in population hence density pressure is high and persistent respectively.

The picture thus far painted becomes even grimmer when calculations are made on the basis of agricultural densities in a situation where 90 percent of the population is rural. Table 2.1.2 below presents the mid 1979 population and area by density range for the study area. The agricultural density for Siaya at the 1979 census was 188 persons per square kilometre. However, examination of densities within sublocations - being the smallest administrative units in the district reveal that only 43.08 percent of the population lived at densities less than 200 persons per square kilometre on 59.54 percent of the total area of the district. The bulk of the population 56.93 percent therefore lived in densities in excess of 201 persons per square kilometre in about 40 percent of the land area. Such densities in themselves are very high by African standards. To perceive more clearly the seriousness of such high densities, landholding equivalents have been worked out by Ominde (1981)[8]. On the basis of this method a density of 100 persons per square kilometre is equal to a landholding of 1 hectare per person. This means that only 5.53 percent of the population from table 2.1.2 below have about 1 hectare of land in Siaya. The bulk of the population with densities in excess of 101 persons per square kilometre have less than 1 hectare. At a density of 201-250, which

Table 2.1.2 : Siaya Population Density Ranges

Density/km² Ranges	No. of subloca-tion	Total Area of subloca-tions sq.km.	Total Population of subloca-tions	% of total area	% of total popu-lation
0-50	0	-	-		
51-100	6	319	26,008	12.82	5.53
101-150	17	650	83,745	26.11	17.80
151-200	29	513	92,886	20.61	19.75
201-250	37	581	136,380	23.34	28.99)
251-300	26	299	84,524	12.01	17.97) 56.9
301-400	9	100	34,646	4.02	7.37)
401+	3	27	12,207	1.08	2.50)
TOTAL	127	2489	470,396	99.99	100.01

Crude density: 188

Cumulative Percentage

Density per km.	Population	Area
0-50		
51-100		
101-150	23.33	38.93
151-200	43.08	59.54
201-250	72.07	82.88
251-300	90.04	94.89
301-400	97.41	98.91
401+	100.00	99.99

Source: Method adopted from Hance W.A. 'The Crudeness of crude densities' in the BK edited by Ominde and Ejiogu. pp.36-40. Data compiled from Kenya National Census 1979.

N.B. The area of sublocations is not equal to total area of District as urban and rural centres have been excluded in the calculations.

has the largest percentage share of the population in the district, the availability of land is o.4 hectares per person.

If we compare the results from Table (2.1.2) and their landholding equivalents to the computed viable size of holding, a person should have of 0.405 hectares[9], it means that 56.93 percent of the population is either living below subsistence or is just at the level of subsistence .

In future and even now, sustained high fertility and hence accelerating population growth is bound to worsen the density problem. Kenya's recent trends in population growth are explained by the levels of trends in fertility and mortality. Generally, fertility has increased in recent years while mortality has declined. From a series of censuses and surveys, Henin (1979)[10] has shown that the total fertility rate, defined as the total number of children a woman gives birth to by the end of her reproductive life, has been increasing; from 5.3 in 1962; 6.6 in 1969; 7.7 in 1977 and 8.1 births in 1977/78. This evidence is corroborated by a very high crude birth rate of 54.6 per thousand population and a low death rate of 14.2 per 1000 population. This implies an unprecendented rate of natural increase of 40.4 per 1000 population. Mortality on the other hand has been declining. Henin (ibid)[11] shows that expectation of life at birth has been increasing in Kenya for both sexes: i.e. 51.2 years for males and 55.8 years for females compared to an earlier figure obtained from

1969 census of 46.9 and 51.2 respectively. Most of this improvement is attributed to a decline in infant and child mortality. In 1969 the infant mortality rate was 119 per 1000 children born compared to 83 infant deaths per 1000 children born in 1977. The crude death rate has also been shown to decline from 16 in 1969 to 14 deaths per 1000 population in 1977. These trends imply exceptional growth in population. Such trends are uniform for most rural areas plus or minus a few points depending on the environment. These trends bear heavily on resource demands as they lead to excessive density increases in a very short time. In future if such trends in fertility and mortality persist, Kenya will have to avail land to double its present population in less than 18 years. This may mean drastic changes in land use within this very short period.

The trends in population growth portrayed above for Kenya, reflect at a general level what happens in the high and medium potential districts in Kenya, where land availability is increasingly posing renewed challenges to the users owing to the need to provide for an increasingly larger family size.

2.2 LAND AVAILABILITY ACCORDING TO FAMILY HOLDINGS

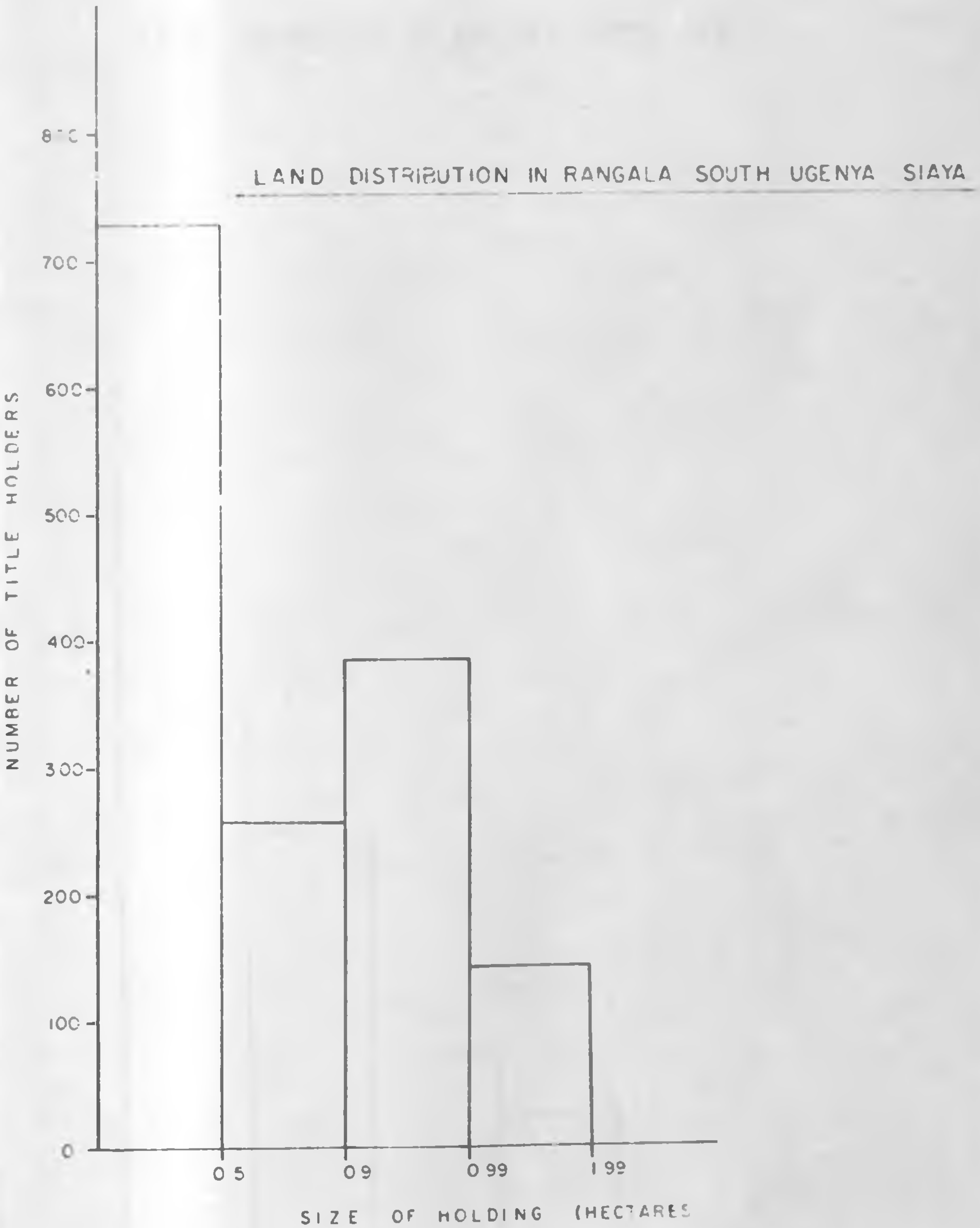
The situation of land availability and viability is clearer when family size holdings are considered. This has been done within the context of what the Ministry of Agiculture in Kenya recommends: i.e. it maintains that under traditional farming methods each family requires 1-1.5 hectares of land in the wetter areas like most of Yala and Ukwala and parts of Boro divisions and as much as 3 hectares of land in the drier areas of Bondo and Southern Boro divisions to obtain a subsistence standard of living.[12]

The 1979 census, shows that Siaya had an average of 5.25 members per household. This means that for every head of family the land he holds (whatever the size), has to cater for just over 5 members. This fact combined with the projected growth rate of over 3 percent per annum and the practice of traditional inheritance system, which implies that every son inherits a piece of land from his father, presents serious threats to land sizes in the district.

The distribution patterns in land holding in the district are to be presented from a sample of 5 sublocations. Figures 2.2.a to 2.2.e below show land distribution patterns. The corresponding percentage distribution of holders according to holding size are represented in Tables 2.2.1 to 2.2.5 for the respective sublocations.

Overall figures 2.2.a to 2.2.e show that the general pattern of distribution of land in terms of size of holdings is positively skewed. This means that the majority of title holders, own only small holdings. Specifically, the median size of holding is 0.6 ha. in Rangala; 1.11 hectares in both Maliera and Nyandiwa; 3.02 hectares in Nyawita and 0.92 hectares in Ojuando 'B'. This means that 50 percent of the population hold less than the above stated hectares in their respective sublocations. In terms of viability of these

Fig 2 2 a


LAND DISTRIBUTION IN RANGALA SOUTH UGENYA SIAYA
NUMBER OF TITLE HOLDERS
700
600
500
400
300
200
100
0
0 5
0 9
0 99
1 99
SIZE OF HOLDING (HECTARES

2 2b

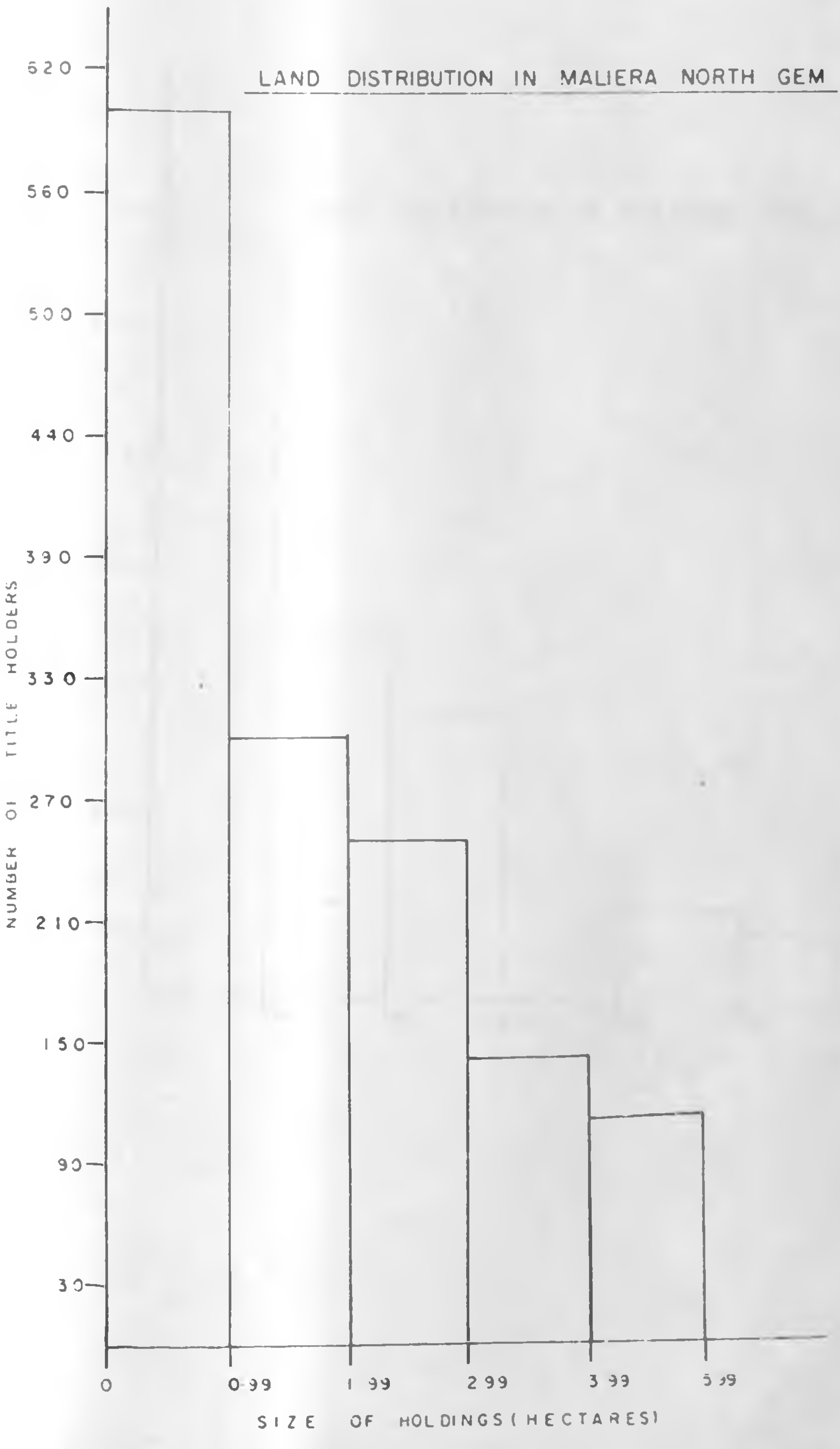

LAND DISTRIBUTION IN MALIERA NORTH GEM
620
560
500
440
390
330
270
210
150
90
30
NUMBER OF TITLE HOLDERS
0
0·99
1·99
2·99
3·99
5·99
SIZE OF HOLDINGS (HECTARES)

Fig 2 2 c

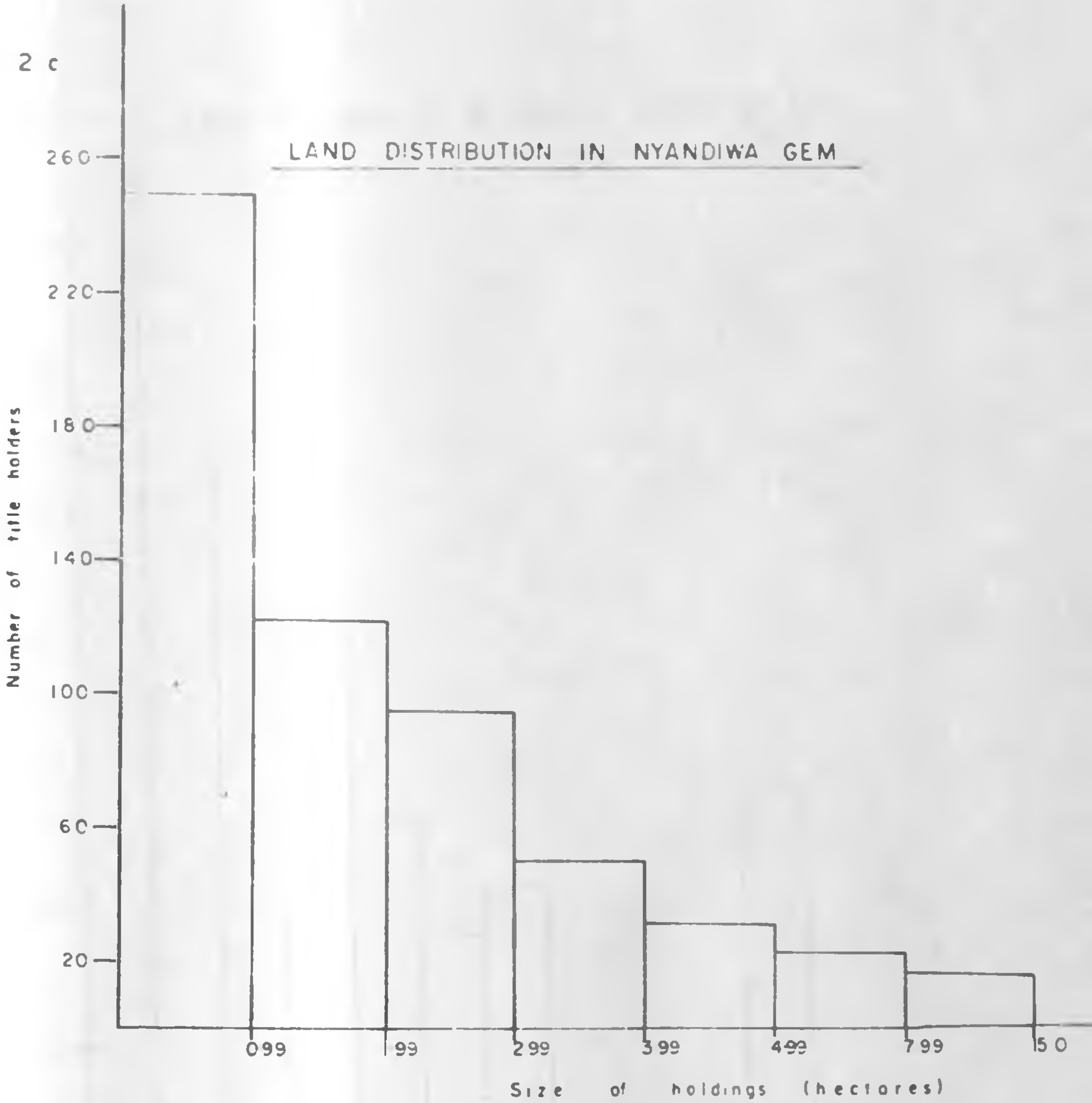

LAND DISTRIBUTION IN NYANDIWA GEM
Number of title holders
260
220
180
140
100
60
20
0 99
1 99
2 99
3 99
4 99
7 99
15 0
Size of holdings (hectares)

Fig 22 d

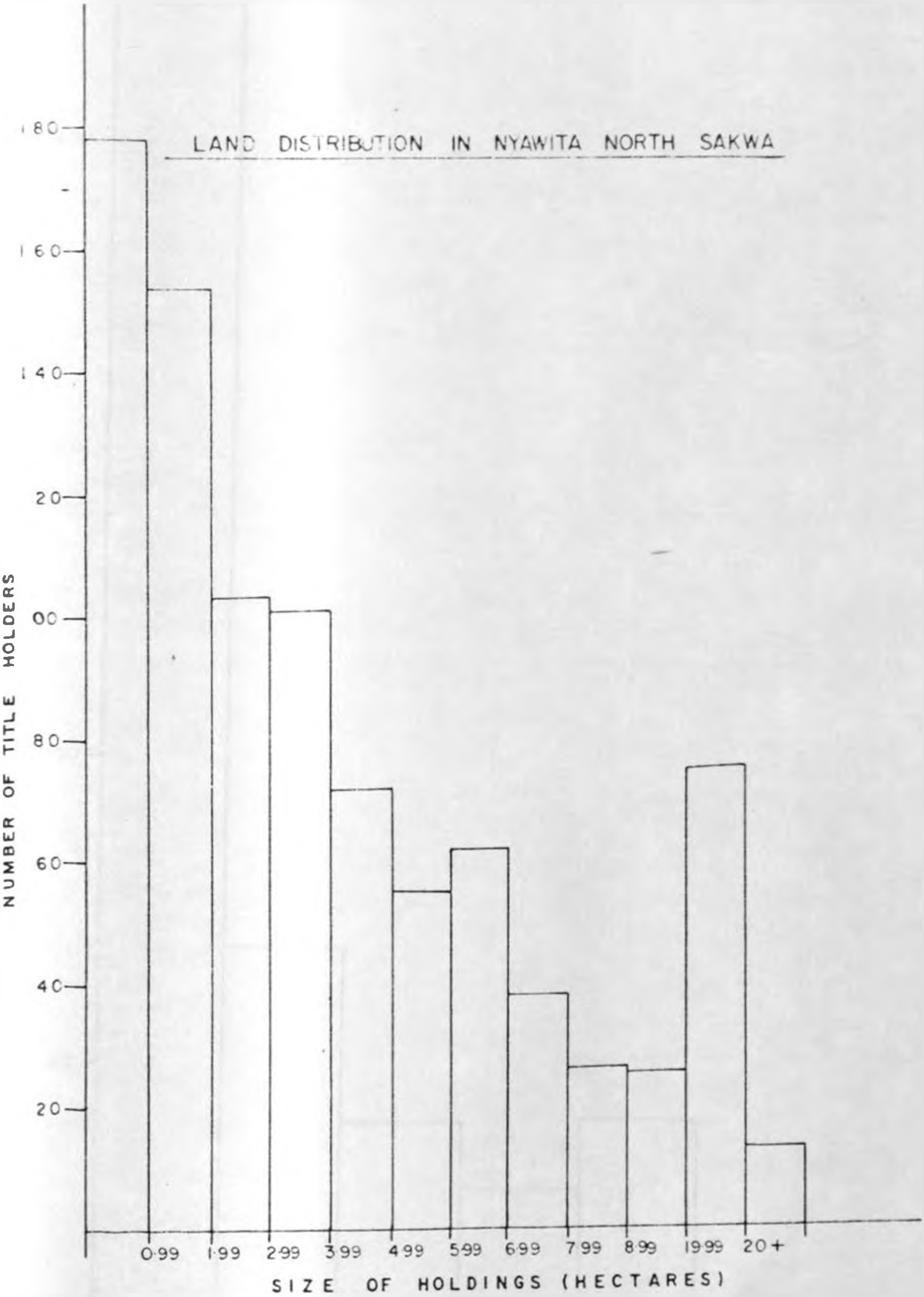
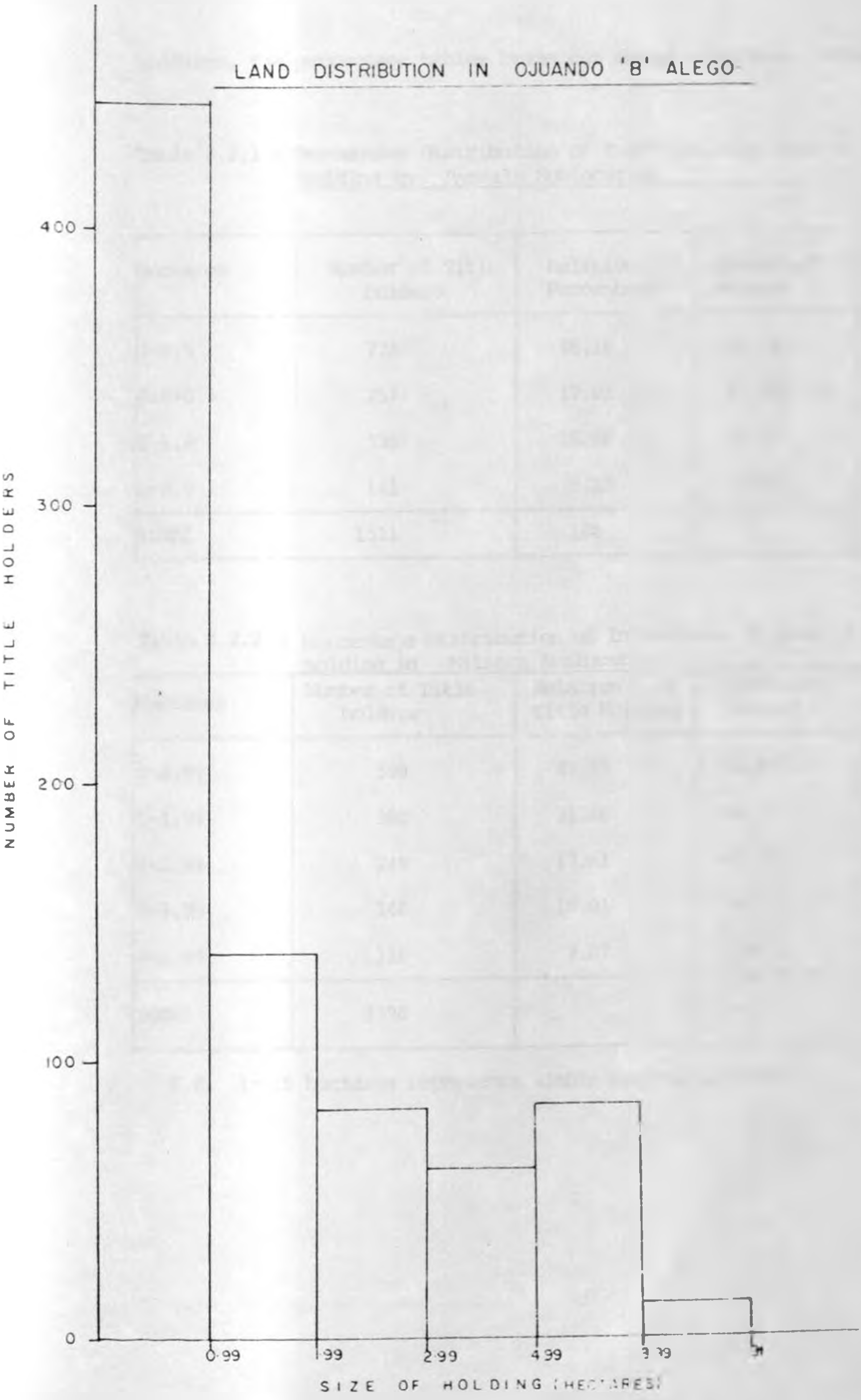

LAND DISTRIBUTION IN NYAWITA NORTH SAKWA
NUMBER OF TITLE HOLDERS
180
160
140
20
00
80
60
40
20
0·99
1·99
2·99
3·99
4·99
5·99
6·99
7·99
8·99
19·99
20+
SIZE OF HOLDINGS (HECTARES)

Fig 2-2 e


LAND DISTRIBUTION IN OJUANDO 'B' ALEGO
400
300
200
100
0
NUMBER OF TITLE HOLDERS
0·99
1·99
2·99
4·99
SIZE OF HOLDING (HECTARES)

holdings, the percentage tables bring out the picture more clearly.

Table 2.2.1 : Percentage Distribution of Individuals by Size of holding in Rangala Sublocation

Hectares	Number of Title holders	Relative Percentage	Cumulated Percent
0-0.5	728	48.18	48.18
0.6-0.9	257	17.01	65.19
1-1.9	385	25.48	90.67
2-2.9	141	9.33	100
TOTAL	1511	100	

Table 2.2.2 : Percentage Distribution of Individuals by Size of holding in Maliera Sublocation

Hectares	Number of Title holders	Relative % of Title Holders	Cumulated Percent
0-0.99	599	42.85	42.85
1-1.99	300	21.46	64.31
2-2.99	249	17.81	82.12
3-3.99	140	10.01	99.13
4-5.99	110	7.87	100
TOTAL	1398		

N.B. 1-1.5 hectares represents viable agricultural unit.

Table 2.2.3 : Percentage Distribution of Individuals by Size of holding in Nyandiwa Sublocation.

Hectares	Number of Title holders	Relative % of Title holders	Cumulated Percent
0-0.99	250	42.88	42.88
1-1.99	121	20.75	63.63
2-2.99	95	16.3	79.93
3-3.99	50	8.5	88.43
4-4.99	31	5.3	93.73
5-7.99	21	3.6	97.33
8-15.0	15	2.5	99.83
TOTAL	583		

N.B. 1-1.5 hectares represents viable agricultural unit.

Table 2.2.4 : Percentage Distribution of Individuals by Size of holding in Nyawita Sublocation.

Hectares	Number of Title holders	Relative % of Title holders	Cumulated Percent
0-.99	178	19.73	19.73
1-1.99	154	17.07	36.8
2-2.99	103	11.42	48.22
3-3.99	101	11.19	59.41
4-4.99	72	7.98	67.39
5-5.99	55	6.10	73.49
6-6.99	62	6.87	80.36
7-7.99	38	4.21	84.57
8-8.99	26	2.88	87.45
9-9.99	25	2.77	90.22
10-19.99	75	8.31	98.53
20+	13	1.44	99.97
TOTAL	902	99.97	

N.B. 3 hectares represents viable agricultural unit.

Table 2.2.5: Percentage Distribution of Individuals by Size of holding in Ojuando 'B' Sublocation.

Hectares	Number of title holders	Telative % of Title holders	Cumulated Percent
0-0.99	445	54.00	54.00
1-1.99	139	16.87	70.87
2-2.99	83	10.07	80.94
3-3.99	61	7.40	88.34
4-8.99	84	10.19	98.53
9+	12	1.46	99.99
TOTAL	824	99.99	

N.B. 3 hectares represents viable agricultural unit.

Thus 42.9 percent of families in Nyandiwa (Yala); 80.9 percent in Ojuando 'B' (Boro); 48.2 percent in Nyawita (Bondo); 65.2 percent in Rangala(Ukwala) and 42.9 percent in Maliera(Yala) have less than stipulated acreage for subsistence production. Furthermore in Rangala, Maliera and Nyandiwa a similar percentage as the above not only have unviable units but have pieces less than 1 hectare. This means that the bulk of families in most of these sublocations are experiencing acute land shortage. This may have a direct bearing on their incomes and food requirements.

In our sample, land sizes ranged from 0.2 to 20 plus hectares. As mentioned earlier, all land is inherited, hence the difference in sizes are determined by: (a) the fact that families with grown up or older or many sons subdivide land quicker than those with few or younger sons. So actually,in our sample, the pieces of plots recorded could have been subdivided to younger or older sons to give the very small hectarages observed and/or the bigger parcels could in some cases be still under the father's title deed although in it (the title deed) specification is made on what each son should get in case of his death. Nonetheless for our analysis, we have assumed that the sizes of parcels specified support families. This, we think is a fair assumption as the number of title holders in all sublocations is far less than their respective total population.

(b) Another factor determining plot sizes is the fact that original lands of the forefathers to which now the younger generation owe claim were not of equal sizes.

(c) Lastly, although land sizes in traditional Luo society are to be distributed fairly equally between sons, there were nonetheless, cases where for instance sons with more children, especially male children received larger pieces of land than the ones with few or none.

Having looked at the various reasons which dictate sizes of farms in the district, it is pertinent to note the consequences of these farm sizes.

The range of size of holdings is particularly small in Rangala, followed by Maliera, Ojuando 'B', Nyandiwa and Nyawita sublocations in that order. Land differentiation according to size is significant as it relates directly to one's status defined by his state as having a viable or unviable holding.

While in the long run if population continues to grow most of the households will be landless; in the short run families with 1 hectare and less are already landless or near landless as the plots they own are subeconomic. The rates of creation of landlessness in the district are thus determined by the growth of population and the practice of inheritance which is related to the size of holding: the underlying factor of registration which individualizes land speeds the process up.

The differentials in land availability within the district has other far reaching effects other than the above mentioned landlessness. For instance with little land, most families have very small acreages to farm hence this directly influences the available food to them and to a large extent, the surplus that they could sell to get cash income. This means that the bulk of families in this district could be experiencing inadequate nutrition. Also incomes in the district which have been viewed as generally below the average in the country (Mwagiru 1979)[13] could be partly explained by these diffentials.

This chapter has thus attempted to address the different dimensions of availability of land within Siaya District. The conclusion, is that the bulk of the population resides in areas where land carrying capacities are in excess of the recommended.

This means that the bulk of the population has inadequate farmland. The repercussions are diverse and affect the overall socio-economic development in Siaya.

While distributional patterns do present a dimension of land problem to the rural agricultural population, it however overlooks the actual uses that people put the land to. This is our concern in the next two chapters.

NOTES AND REFERENCES

1. Bilsborrow R.E. (1976) : pp.99
2. Ominde S. H. (1981 : pp.136-171
3. Masaviru R. (1981) : pp.87-88
4. Ibid
5. Migot-Adholla (1981) : pp.114-135
6. Okoth-Ogendo H.W.O. (1976) : pp.176-183
7. Odingo R.S. (1973) : pp.6-8
8. Ominde S.H. : Op.cit. pp.145
9. Since the densities presented have not been broken down according to agro-ecological zones, to find the recommended average viable size of holding (which was available for a given family size) the lowest and highest acreage required in the district were summed and divided by two.

   therefore: $1.25+3= \frac{4.25}{2} = 2.125$

   The result (2.125) represents the average viable size of holding in the district for a family of 5.25 members.

   Thus other things controlled for, each individual would require:

   $$\frac{2.125}{5.25} = 0.4047619 \text{ hectares}$$

This value 0.405 hectares is taken as the computed viable size of agricultural holding per individual in the district.

10. Henin R. A. and Mott S.H. (1979) : pp.6
11. Ibid. : pp.7-8
12. Kenya (1970) pp.1-13
13 Mwagiru W. (1979) : pp.200-220
   Hance W.A. (1972) : pp.36-40
   Rempel H. (1974)

CHAPTER THREE

THE ROLE OF POPULATION PRESSURE IN DETERMINING ARABLE LAND USE AND LIVESTOCK POPULATION

3.1 Introduction

In the preceding chapter, land availability using different measures to determine the nature of land distribution to individuals and the family unit was examined and discussed. It is therefore in this context and also in the context of factors outlined in Chapter 1 that this chapter sets to examine how sustained population growth has affected the extent of arable land use in the past years for which data was available at both the district and divisional levels. In this regard all the hypotheses and objectives pertaining to crop production and livestock performance have been examined.

This study has treated density increase as a measure of population pressure and at other instances synonymously with population pressure. We realize that the two concepts do not necessarily overlap in all situations in reality. However, continued or persistent increase in density in a locality is bound to change in one way or another existing types of land use either in the short or long term - thus creating pressure. Besides, it has been established that more than 50 percent of the district's population lives at densities in excess of the optimum and as such, they are experiencing population pressure.

Also in this study, types of crops have been differentiated (and categorized) for convenience of analysis and also owing to the different purposes they serve. Hence food crops as distinct from industrial crops. The use of cash crop as a category has been avoided because it overlaps with the other two categories. Thus for instance, in areas where the range of industrial crops that can be grown is restricted by environmental conditions like in Siaya, food crops serve the purposes of cash crops,as the surplus is normally sold in the local markets or to the marketing boards, apart from its use for consumption at home (refer to Table 3.2.2 and 3.2.3). Thus crops like maize, sorghum, wimbi, pulses, bananas, vegetables among others serve dual purposes. On the other hand, industrial crops are not readily consumed at home hence they are sold for cash.

Another factor which influences interpretation of results in parts of this chapter and also in parts of chapter lV is the nature of crop husbandry. It is <u>normally</u> the practice in the district that pulses (i.e. food beans, cowpeas, greengrams) are interplanted with maize or sorghum/millet. It is consequently assumed in this study, that pulses have been interplanted with maize or sorghum for all years under consideration.

This explains why acreages of pulses although considerable in the district, have been excluded in our analysis in section 3.2.

There are other crops which are also interplanted, but the degree of this, although not easy to account for is normally very restricted. We have overlooked this possibility, because it has further been assumed that any underestimation which may result from omission of these hectarages is catered for in the sense that not all pulses are interplanted with maize or sorghum (though, the bulk of it is), thus such possibilities cancel with that for other interplanted crops (like wimbi and sorghum) which have been overlooked. Since data broken down into the actual hectarages interplanted for most crops is not available, it is felt that these assumptions are within reasonable limits.

3.2 Patterns of Arable Land Use

Historically, changes in land use patterns have been identified. In Kenya, this became evident in the 1930s when utilization of land in the non-scheduled areas began to take a more settled pattern. Later in the 1940s growth of cash crops was permitted on African farms. These changes have been seen to have responded to increasing population pressure on agriculture (Senga et al 1981)[1].

In this section, patterns of arable land use are to be examined with regard to trends in arable land use and type of arable land use. It is expected in a settled traditional farming society, that as population increases continually, far more land is needed for production of crops. However, since there are limits to the extent that arable land can grow horizontally due to other competing uses, climatic and environmental factors, such a state fosters more intensive exploitation of the land primarily, through shorter fallow periods which in turn lead to discovery of new tools, crop varieties, techniques of fertilizer, (Boserup 1965)[2] and may necessitate alterations in emphasis placed on certain types of crops.

The above anticipated conditions may well be applied to Siaya. However we note that the district, records low usage of fertilizer and mechanized tools as was already pointed out in section 1.2.d.

The remaining conditions have therefore been examined by use of the methods below:-

(a) Computing proportions of the district ploughed annually and plotting these on fig.3.2.a

(b) Computing proportions of land occupied by specific crops and observing on yearly basis the relative share of each crop as in the Table in appendix 11.

(c) Calculating means of proportions of hectarage occupied by specific crops to show ranking of crops and also to enable comparisons with some selected years (Table 3.2.1).

Figure 3.2.a below shows trends in the proportions of total cultivated hectarage over the past 17 years in the district. Overall, trends in cultivation of all crops have fluctuated. The years between 1967 to 1970 and 1976 to 1980 saw a general trend of increase in hectarage under crops while between 1971 to 1975, the general trend was that of decrease which is more or less similar to that between 1980 to 1983. While we can observe clear changes in arable land use, it is nonetheless difficult to assert a definite pattern of change as cultivation of crops in the early years compare to some extent favourably with that of some later years. This may mean that while there may have been a slight expansion in hectarage planted over the years, there is nonetheless reason to believe that for years when total hectarage planted has been below that of 1970-1971 and 1980 to 1982 periods or even below that of 1967, when densities have been increasing, there has either been:- an intensification of arable land use system to meet the food requirements (of a growing agricultural population) in the form of adoption of better variety yielding crops and better farm management techniques without necessarily using only fertilizers, or alternatively, it is possible that the population must have suffered food shortage as a result of the drop in hectarage under arable use (if the above pattern was not observed).

On average as can be seen from Table 3.2.1 below only 28 percent of the district's total area is cultivated in any given year, being the total area cultivated both during the long and short rains. This percentage if we compare with that of the

Fig 3·2·a

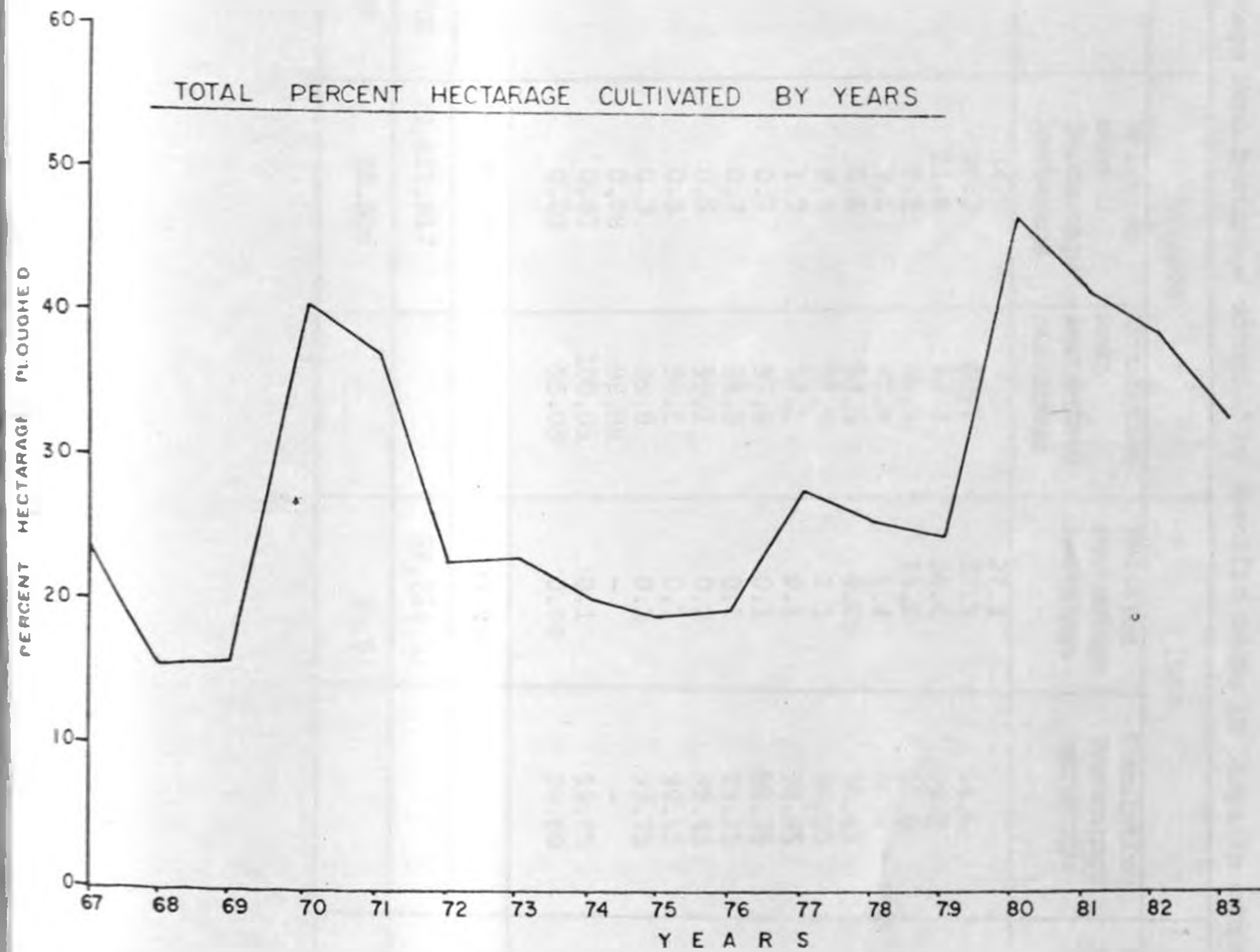

TOTAL PERCENT HECTARAGE CULTIVATED BY YEARS
PERCENT HECTARAGE PLOUGHED
60
50
40
30
20
10
0
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
YEARS

Table 3.2.1 : Percentage Mean hectarage occupied by specific crops in Siaya in comparison with other years

	Average		1967		1983	
	Relative mean Percentage hectarage	Cumulative mean Percentage hectarage	Relative Percentage hectarage	Cumulative Percentage hectarage	Relative Percentage hectarage	Cumulative Percentage hectarage
1. Local maize	34.5		27.3		34.0	
2. Mixed sorghum	26.2	60.7	27.3	54.6	16.0	50.0
3. Cassava	11.6	72.3	24.6	79.2	15.7	65.7
4. Cotton	8.2	80.5	15.8	95.0	7.7	73.4
5. Hybrid maize	7.4	87.9	1.4	96.4	16.1	89.5
6. Sugarcane	5.6	93.5	0.05	96.45	0.9	90.4
7. Sweet potatoes	2.4	95.9	2.1	98.55	4.5	94.9
8. Groundnuts	1.2	97.1	0.1	98.65	0.9	95.8
9. Serena sorghum	0.7	97.8	0.1	98.75	1.9	97.7
10. Wimbi	0.7	98.5	0.5	99.25	0.4	98.1
11. Bananas	0.6	99.1	0.2	99.45	1.2	99.3
12. Vegetables	0.5	99.6	0.1	99.55	0.6	99.9
13. Simsim	0.3	99.9	0.2	99.75	0.7	100.6
14. Sunflower	0.08	99.98	-	-	-	
15. Coffee	0.07	100.05	0.1	99.85	0.07	100.67
16. Rice	0.03	95.08	0.04	99.89	0.02	100.69
TOTAL PERCENT	100.08		99.89		100.69	
ACTUAL HECTARAGE PLANTED	70,417.817		59,284.52		84,358	
PERCENT HECTARAGE UNDER CROPS	28.006		23.5		33.4	

initial year (1967) is 1.2 times more and 0.8 times less than that of the last year (1983) considered. This would seem to suggest that hectarage under cultivation of crops has continued to increase but at a very slow pace. Overall, however, there has been no clear response in cultivation of crops with increasing agricultural density and it is possible that the probable conditions put earlier may be prevailing in part.

Table 3.2.1 also summarizes the results of Table 3.2.2 in Appendix 11 with regard to the position/ranking of crops, in terms of percentage hectarage occupied by each. The purpose of this Table (3.2.1) is to show whether or not type of arable land use has changed (as was anticipated) with increasing pressure.

The Table (3.2.1) shows that local maize, mixed sorghum, cassava and cotton in that order, have on average occupied four fifths (80.5%) of arable land use. This percentage if compared to that of the other years is 0.8 times less than, and 1.1 times more than that of 1967 and 1983 respectively. This means that the percentage share of these crops of arable land use has continued to decrease slowly. Besides, apart from local maize which experienced expansion in hectarage others experienced substantial percentage decline in 1983. Thus in 1983, hybrid maize has picked up ranking second in terms of hectarage devoted to it. Sweet potatoes, bananas and serena sorghum have also experienced gradual increase in their percentage share of arable land.

From the results of Table 3.2.1, it is evident that types of crops have not changed (excepting sunflower which was later abandoned), but emphasis placed on certain crops has.

The crops which have received increasing attention include improved varieties of hybrid maize and to a lesser extent serena sorghum. The reason for adoption of the former may lie in its obvious advantage of having higher yields than the local variety which has also increased in acreage considerably. Serena sorghum on the other hand is experiencing a slow adoption rate, perhaps due to the fact that people in this area may not as yet have realized or 'appreciated' fully its 'advantage' over the local mixed variety.

Overall, cultivation of maize regardless of variety has increased from just over one-fourth to half the total cultivated area between 1967 to 1983. This may partly be explained by the fact that for most areas in the district, maize is a leading staple food as well as cash crop in the area. It is also possible that the returns from maize cultivation are more tangibly felt than for other cereals, thus encouraging farmers to grow it more.

Tables 3.2.2 and 3.2.3 below show for the various agro-ecological zones the nature of disposal of crops. Admittedly from the tables, the bulk of crops are used for food and sale. However when nearly half the percentage of maize produced goes

Table 3.2.2 : Percentage Disposal of Crops in Lower Marginal Cotton Zones 3 to 4

Crop First Rains	% Sold to Marketing Board & Local Market	% For home Consumption
Maize	35	65
Maize & Beans	52	47
Maize & Cowpeas	18	82
Maize & Others	42	58
Beans	41	59
Wimbi/Fingermillet	60	40
Fingermillet and Sorghum	6	94
Sorghum	28	72
Cowpeas	66	44
Groundnuts	65	35
Sweet potatoes	0	100
Sweet potatoes IPC	0	100
Sunflower	100	0
Cotton	100	0
Second Rains		
Maize	50	50
Maize & Beans	0	100
	Permanent Crops	
Nil		

Source: Adopted from Farm Management Handbook Western Kenya Vol.2 pp.254-255.

Table 3.2.3 : Percentage Disposal of Crops in the Upper Midland Zone and Lower Midland Zone

List of Crops Disposed of in First rains	Percentage sold to Marketing Board and local market	Percentage to home consumption
Maize	31	69
Maize and Beans	44	66
Maize and Sorghum	0	100
Beans	55	45
Beans/PC	32	68
Sorghum	21	79
Groundnuts	80	20
Sweet potatoes	0	100
Sunflower	100	0
Cabbage	97	3
Onions	86	14
Tomatoes	71	29
Second Rains		
Maize	18	82
Maize and Beans	39	61
Beans	75	25
Beans IPC	75	25
Sunflower	-	-
Onions	100	0
	Permanent Crops	
Cooking Bananas	89	11

Source: Ibid.

into sale (considering its role also as a staple food crop), it is possible that when cultivating, such a factor is taken into account. Hence the continued expansion in maize hectarage.

As far as other crops are concerned (interms of relative share of percentage hectarage or emphasis placed on them), from Tables 3.2.2 and 3.2.3, it may be that crops which serve basically one purpose, (in the sense that such crops have two-thirds and over of their produce committed to one category), experience relatively less attention because their need for use is restricted somehow. This may explain partly some of the results in Table 3.2.1 where some food crops and industrial crops have had percentage decrease in hectarage or maintained fairly stable growth.

From the analysis given above, on average, only 28 percent of the district's total area is cultivated in any given year being the total area cultivated both during the long and short rains. This is very small considering that the district is mainly an agricultural district. Perhaps the main reason as to why arable land use in Siaya is restricted, may be found in the differentials in patterns of land distribution already examined in Chapter 11 and/or may be due to the pressure exerted by other uses as will be seen in Chapter lV.

All in all, the trend on crop production in the past has been unpreditable. It is therefore possible that either the returns in terms of yields have been very high so as to meet the food requirements of the population, or alternatively, population density may not have reached the optimum in most areas of the district to reverse the trend to one of a definite increase.

3.3 Population Pressure and Food Crop Production

It was hypothesized that with increasing population densities, land being used to grow food crops would expand. This increase in hectarage under food crops production is expected to dominate arable land use patterns as long as industrial inputs do not play a major role in the agricultural system and secondly as long as there is room for expansion of cultivation. From our earlier review of the study area, the patterns outlined above seem to predominate in Siaya, where there is minimal use of chemical fertilizers and mechanical devices excepting draught power. Also from the above analysis of land use in the district, we have seen that about 28 percent of land is used for crop production on average.

These charateristics of the district imply for our analysis that the correlation between, land use for food crop production and population pressure would be high where densities are high and low where densities are low.

Table 3.3.1 below shows the results of the correlation analysis between population pressure (the independent variable), and food crop production (the dependent variable). Food crop production has been measured by the total area cultivated with food crops in a particular year for all years; while population pressure was measured by density change.

Table 3.3.1 : Correlation between Density of Population and Food crops Acreage.

Name of District/ Division	Dependent Variable	Independent Variable	Correlation Coefficient	Percentage of Variation explained
Siaya	Food crops acreage	Density	0.49452	24.5
Ukwala	Food crops acreage	Density	0.72406	52
Yala	Food crops acreage	Density	0.92382	85.3
Boro	Food crops acreage	Density	0.23865	5.7
Bondo	Food crops acreage	Density	0.12135	1.5

The results from Table 3.3.1 above, show that the relationships between population pressure and food crop production is positive in the case of the whole district and divisions. Generally, the correlation is high in the whole district, being very high in Yala and Ukwala, and relatively low in Boro and Bondo. Furthermore, in the case of the whole district, population pressure explains 24.5 percent of total variation in cultivated hectarage under food crops; in comparison with 85 percent for Yala; 52 percent for Ukwala; 5 percent for Boro and 1.5 percent in Bondo.

On average, the results above show that population pressure is a fairly important element in explaining variation in food crop production as can be seen from the district figure. However when smaller administrative units are examined, the differential influence of population pressure on land availed to food crop production becomes clearer. From the percentage of variation explained, it is evident that population pressure explains 1.6 times; 14.9 times and 56.7 times of food crop land utilization in Yala than it does in Ukwala, Boro and Bondo respectively.

The reasons for this differential, may lie in the fact that the two divisions of Yala and Ukwala form the areas with the highest densities in the district and hence could be emphasizing more on food crop production. On the other hand, Bondo and Boro experience relatively less pressure of population, as such the need to expand hectarage for food crops is presumably, not yet as pressing as in the two former divisions.

It is recalled from section 1.2.d that registration of land was completed much earlier in Yala and later on in Ukwala division. In the other two divisions (Bondo and Boro) however, consolidation and registration is still in progress. This means that in the former two divisions, there could have developed more effective land use patterns bv individual title holders (than in the latter case) - as this is one of the aims of individualizing land.

Another reason which could explain these differentials, but which nonetheless has not been given due attention in this study owing to reasons enumerated earlier, may be found in the fact that Yala and to some extent Ukwala, have rainfall throughout the year. As such, variations in climatic factors particularly rainfall have very minimal influence on intensity of land use, as for instance when compared with the influence of population pressure because rainfall in this instance is seen as a constant factor while population pressure changes in intensity. The reverse pattern is to be expected in areas with less reliable rain as in most of Bondo and parts of Boro divisions where intensity of land use could be determined to a considerable extent by occurence of rain.

In this section we have thus from the analysis verified the hypothesis that utilization of land for food crop production responds to population pressure. In other words, where pressure is high hectarage under food crop production becomes larger and vice versa where pressure is relatively less. This is the case, when there is still room for expansion of cultivation vis a vis other land uses.

3.4. Population Pressure and Industrial Crop Production

It was posited that industrial crop production should inversely relate with high densities alternatively, where threshold/maximum densities have not been reached but are nonetheless high, there should be a very low positive relationship.

The logic stems from Allan's (1965)[3] argument. He saw that the cultivation of an annual crop like cotton, has the same degenerative effects on land as population pressure itself, especially in a system where traditional land use is the norm-such an annual crop modifies the system to one of lower carrying capacity in degree which is proportional to the area under industrial crop. This logic can be examined in terms of the results of our analysis in Table 3.4.1 below.

Table 3.4.1 : Correlation between Density of Population and Industrial Crop Production

Name of unit	Dependent Variable	Independent Variable	Correlation Coefficient	Percentage of Variation explained
Siaya	Industrial crops acreage	Density of population	0.74343	55.3
Ukwala	Industrial crops acreage	Density of population	0.09622	1
Yala	Industrial crops acreage	Density of population	0.08642	0.7
Boro	Industrial crop acreage	Density of population	0.46142	21.3
Bondo	Industrial crops acreage	Density of population	0.17917	3.2

The results of the analysis in Table 3.4.1 above show that the relationship between population pressure (the independent variable) and industrial crops cultivation (the dependent variable) is positive at all the various levels of administration considered. However, the magnitude of influence of population pressure on industrial crop production is different for all the divisions and even not averaging the case of the divisions at the district level. In other words, the correlation is veryhigh for Siaya; fair for Boro; low for Bondo and very low in the case of Yala and Ukwala. Furthermore, population pressure explains 55.3 percent of the need to plant industrial crops in Siaya; 21.3 percent for Boro; 3.2 percent for Bondo; 1 percent for Ukwala and 0.7 percent for Yala.

In other words, population pressure explains 79 times more variation in the cultivation of industrial crops in Siaya than it does in Yala: This being the highest contrast in the district: The case for Ukwala is 55.3 times; Bondo 17 times and Boro about 3 times.

The above results tend to suggest that as population pressure increases so does the production of industrial crops. This assertion is vividly brought out in the case of the whole district and Boro and to a lesser magnitude in Bondo - where the results are definitely positive.

An interesting feature of these results is the fact that the case of Siaya does not reflect an average correlation for all the divisions, as earlier noted. This could be due to the fact that Siaya covered in this analysis more cases (years) than was the case with the divisions. This shortcoming in available data, has been noted earlier and may explain partly the discrepancy in our results.

Although these results do not precisely agree with what was postulated earlier, they are nonetheless within limits of interpretation. Hence in the two divisions of Bondo and Boro, where population pressure is relatively less in magnitude, than in Yala and Ukwala, it is possible to cultivate larger hectares with industrial crops than in the latter two divisions. We recall, that the correlation between, population pressure and food crop cultivation was also low for Boro and Bondo; This could be due to the fact that perhaps as yet, pressure to plant large hectarages for consumption is not yet as pressing as when compared with the situation in Yala and Ukwala. The two types of arable land use can therefore compete favourably in Siaya as a whole - where 60 percent of the land area is occupied by 43 percent of the population at densities less than the optimum (as was shown in chapter 11).

Alternatively, it is possible that in areas of Yala and Ukwala, where densities are in excess, people have realized the dangers of an annual crop to the soil (Allan 1965) and are as such restricting its growth. Besides, in areas of excess densities, people would naturally give priority to faster maturing crops which give quicker and immediate returns than the annual and most other industrial crops, which mature relatively slowly and are not used for consumption immediately.

In conclusion, from the analysis, it is evident that population pressure in the district and even to some extent in the divisions has not yet reached its maximum level to reverse trends in industrial crops cultivation as was hypothesized. In depth inter-divisional comparison however, show the possibility of decreasing hectarage under industrial crops with increasing population pressure; perhaps as long as most food crops in the district serve dual purposes, there may be a tendency to abandon industrial crops in future.

3.5 Population Growth and Performance of Crops

The performance of crops measured by output per hectare has long been associated with chemical inputs, rainfall amounts and reliability, practices of soil conservation among a host of other factors. In areas where carrying capacities have been reached and/or in areas with continually increasing populations, farming practices are bound to change, as such, traditional conservation techniques like fallowing (in all its various stages) give way finally to permanent cultivation. Such alterations in practices have a direct influence on the quality of the soil.

It is conceived rightfully, that carrying capacities of soils are finite and in the face of additional use, people living on these soils are bound to reap progressively smaller harvests unless deliberate efforts are made to sustain soil quality. A state of 'involution' earlier mentioned in Section 1.5.c depicts the first part of the above stage.

In Siaya, (as we have seen from section 3.2), although arable land use has fluctuated, on average only 28 percent of the district's total area has been cultivated annually. This area should allow for bush fallowing in the district, because the approximate area cultivated at any one time (especially during the long rains) may be only 18.6 percent or less[4] which is slightly less than one-fifth the total area of the district. This would allow for at least 4 years of fallow. However, because other equally important competing land uses also exist, like livestock rearing, fallowing may not be as effective. The point is that these land uses may already be imposing too much strain on the environment and hence may reflect in the yields.

An attempt has been made in Table 3.5.1 below to show the effect of increasing densities on the output per hectare for some crops. This has been done with the use of the regression model. The results in Table 3.5.1 show a positive relationship between population pressure (the independent variable) and yield per hectare (the dependent variable) for the crops under consideration.

Table 3.5.1 : Correlation between Population Pressure and Yield per Hectare of Some Crops - Siaya

Dependent Variable in yield per hectare of crops	Independent Variable	Correlation Coefficient	Percentage of Variation explained
local maize	Density of population	0.26721	7.1
hybrid maize	"	0.10975	1.2
serena sorghum	"	0.14628	2.1
mixed sorghum	"	0.68419	46.8
food beans	"	0.80933	65.6
sugarcane	"	0.53626	28.7
sweet potatoes	"	0.25705	6.6
cotton	"	0.07218	0.5

This would seem to suggest that with increasing pressure the yield per hectare of the crops also increases. Furthermore, from the analysis, population pressure explains 66 percent of food beans yield; 47 percent of mixed sorghum yield; 29 percent of increase in sugarcane yield; 7 percent of local maize yield and 6.6 percent of sweet potatoes yield. Excepting foodbeans, the above percentages should be compared with the yields of crops which have improved varieties in them, or are solely improved varieties like hybrid maize, serena sorghum and cotton. In other words, the variation in yield per hectare explained by population pressure for the local varieties is more than that for improved varieties with an exception of foodbeans.

From the above results it is possible that the low association observed between population pressure and improved varieties is a result of little change in yields of these varieties. Besides, the use of these improved varieties normally entails as a pre-requisite, fertilizer application, so being faced with more or less similar crop husbandry practices only minimal change can be anticipated when densities continue to exert pressure on available land.

As far as food beans is concerned, the yields of the improved varieties (e.g. Mex.142, Mwezi Moja and Roscoco)have been taken together with the yields of traditional varieties. These new varieties and additions of still newer varieties in this combination must be affecting the yield per hectare considerably. It is possible that with the adoption of each new variety, there occurs a boost in yield per hectare.

Local varieties on the other hand, may now be experiencing improved crop husbandry practices, such that for the moment, these could be progressively increasing yield per hectare. Such a situation is further corroborated by the fact that families are continually finding themselves with smaller and smaller holdings in the exercise of land individualization and registration. As such more intensive and better management techniques of plots are a condition to meeting family food and cash demands.

Although possible explanations have been put above to explain the results from Table 3.5.1, they however do not reflect what was anticipated (i.e. yield per hectare of crops should relate negatively with increasing pressure). Together with the above explanations, it is possible that the time span needed to witness such a change in trend ought to be longer than that for the period this study has regretably been limited to.

3.6 Population Pressure and Livestock Growth

It was postulated that under increasing densities, livestock numbers ought to decline, naturally, as a result of more consumption and furthermore as a result of progressively limited pasture. It was further stipulated that population pressure exerts a differing effect on type of stock, this variant influence stems from the fact that the demands (in terms of pasture and water) of these livestock is different in quantity and quality. To test these hypotheses, regression analysis was used whereby livestock numbers (i.e. cattle and sheep plus goats separately) was regressed on density of population. The results of this analysis are shown on Table 3.6.1 below.

Table 3.6.1 : Correlation between Population Pressure and Livestock Population Growth.

Unit	Dependent Variable	Independent Variable	Correlation Coefficient	Percentage of Variation explained
Siaya District	Total cattle population	Density of human population	0.04309	0.2
Siaya District	Total sheep & goats population	"	0.33193	11.0

The results shown on Table 3.6.1 above go contrary to what was hypothesized earlier (namely a negative correlation was expected) instead a positive correlation exists between increasing densities and overall livestock numbers. However, further observation of the table reveals that the degree to which population affects the type of stock is different. The correlation of human population on cattle population is very small; while the same on small stock population is definitely positive. i.e. 0.04309 compared with 0.33193 for the latter type of stock. This implies that as human population increases or grows so does livestock populations. The variation explained for cattle by population is only 0.2 percent while for small stock is 11.0 percent. This means that population explains 55 times more variation for the small stock population than for cattle.

It is difficult to explain why trends have gone contrary to what was hypothesized, nonetheless, a few explanations are possible. It may be that population growth or increase has not yet reached its maximum especially in livestock keeping areas so as to reverse trends in livestock growth; alternatively, since Luos have a bias towards stock they could still be giving their grazing needs priority in turn, retaining size of herds. It is however important that small stock population should have a definite positive relationship. What this suggests is that preference could have been diverted to small stock because of their inherent limited demands. Alternatively, it may be that the cattle population has not changed much with increasing densities while that of small stock has experienced a fair amount of increase.

In general, livestock rearing has been a committment to agricultural land use in the district. It is the purpose of the next chapter to establish the intensity of grazing in view of other land uses in the district.

REFERENCES

1. Senga et al (1981) p.17
2. Boserup E. (1965) pp.15-18
3. Allan W.A. (1965) p.377
4. The basis of this proportion is explained further in Chapter lV.

CHAPTER FOUR

LAND-USE DEMANDS

4.1 Introduction

Land use delineation for any particular unit of study is basic to planning since all forward planning must start from knowledge of the existing land use pattern. No specific and comprehensive analysis on land use has been provided for Siaya except generally characterized as a small-scale farming area in which people practice 'mixed farming'. While we do not dispute this fact it however does not provide us with much information as to the extent and/or intensity of land use for various activities: an objective which this chapter sets to examine.

To achieve the above objective this chapter proposes:- to delineate the major categories of land use by making provision on the estimates of the amount of land in each category, thereby showing the extent and/or intensity of land use in the various respective categories; and to show past trends in land use either in terms of growth rates of specific case examples or in terms of actual hectarage devoted to particular uses over many years and on the basis of these trends and their explanations, make projections on future land requirements and/or argue out the likely trend in land use in future.

Data used in this chapter have been extracted from annual reports, and with the use of projections and their underlying assumptions and other mathematical techniques, some interpretations have been made. Land in this study has been divided into that for agricultural use and land not in agricultural use. For purposes of analysis and convenience, the former category is further subdivided into : (1) arable/or cropped land and (ii) grazing land. They will be treated individually in this section although allowance is made when in the analysis, there is an overlap with the respective category under review.

4.2 Non-Agricultural Land Use

The rate of conversion of rural land to non-agricultural uses during the last 30 to 40 years, coincides with population growth that is very rapid in the rural and urban areas. The importance of such shifts of land to non-agricultural uses stems from the fact that these are less reversible to the agricultural use when urgent need arises, and also they reduce the agricultural land base at least in the near future.

In this section, we are concerned with structural and other projects which transform the agricutural landscape. These include the development of urban centres, schools, churches, homesteads i.e. generally built up areas and other projects like forest reserves and dam construction which impinge directly on available land.

Population growth has had a direct bearing on demand and supply of basic services such as health, food, education and shelter.

Taking provision of education as a case in this study; in Kenya, the Government has been concerned since 1963 at providing educational facilities for the ever growing number of people. Emphasis was first placed on the provision of primary education as a basic human right and as a means of achieving literacy in the Republic.[1]

Enrolment in schools attest to this fact. In 1963, enrolment in primary schools was 891,553 pupils. In 1973, it had increased to 1,816,617. This raised enrolment ratio from 37 percent in 1963 to 73 percent in 1973. With the institution of free primary education since 1974, enrolment rose to 2,734,398 (in 1974). The percentage of the 6-12 age group enrolled rose from about 73 percent in 1973 to 108 percent in 1974 and with further elimination of school fees in Standards 5,6, and 7 in 1978, 1979 and 1980 respectively, enrolments further increased.[2] These enrolments have meant a lot in terms of demand and supply of schools not to mention educational costs, provision of teachers and other social facilities.

On the supply of schools aspect, which is our concern in this study, in Kenya between 1969 to 1979, total primary schools grew at a rate of 4.64 percent per annum while secondary schools exhibited a growth rate of 9.5 percent per annum over the same period. These growth rates have been worked out in Appendix 111. While we note that the yearly growth rate of the development of schools varied it has been found necessary to translate them into annual growth rate to enable comparison with the population growth rate for this particular period. Thus, growth rate for school establishments for this period was far in excess of the Kenyan population growth rate for the same period which was 3.8 percent.

In Siaya, since 1973 primary schools have grown at a rate of 9.3 percent per annum while secondary schools at 5.45 percent per annum. (These growth rates are also worked along with Kenyan growth rates in Appendix 111 referred to above). The population growth rate for the same period for Siaya was relatively modest at about 2.16 percent per annum. From the above cases of provision of educational facilities, it is evident that their rate of growth for accommodation of population in general has to be far in excess of the population growth rate. This has far reaching implications in terms of land use.

While the stated trends of growth are important to note in view of the growing populations, it is equally important to establish the actual hectarage occupied by physical structures; infrastructure and their surrounding.

The method used was fairly straight forward for most of these amenities excepting homesteads. It involved multiplying the total number of units[3] under consideration with the respective standard recommended[4] acreage to be occupied by a specific unit of analysis. The results were then summed and finally expressed as a percentage of the total area of the district. Appendix lV contains the computations and further explanation. Underlying this method is the assumption that all units conform to their specified standards - whether or not this is actually true. Acreage estimation for homesteads has been given special consideration because we lacked data on the total number of homesteads in the district. Also the area by individual homesteads are estimates. The method and computation is also available in Appendix lV.

From the method above, we found that 7 percent of the district is not available for agriculture being the area occupied by social and developmental amenities. However a study carried out in 1982[5] indicates that non-agricultural land claims 16.67 percent of the district's total area.

Although we have reason to believe the results of this study, mainly because it was empirical and detailed - and in this regard covered all aspects of non-agricultural land which regretably we could not get all the details of in the records relied on for this thesis, we are nevertheless faced with the problem of projecting for individual structural aspects because non-agricultural land categories (in the above referred to study) have been lumped together in 3 broad categories: namely, unsuitably steep slopes; forest reserves, lakes and swamps; and others which include roads, rivers, homesteads etc.

The analysis of the rates of growth of school establishments earlier on, has shown that there exists differentials in rates of growth even within a specific uniform category. Thus the issue of isolation of categories is important and its inclusion in the above study referred, would have facilitated our computations and analysis.

Furthermore, as far as data used for this study is concerned, specific land use types for two points in time with fairly large intervals (of about 10 years) was lacking; it has as such been difficult to work out meaningful long term specific growth rates for the various types of non-agricultural land use. This problem has been further complicated by the fact that these facilities have in the past shown no consistency in annual growth rates as has been the case to some extent with human population, which is fairly consistent in growth. Despite these setbacks however, we have reason to believe that with population growth non-agricultural land must of necessity claim increasingly large hectarages; even for the unquantified uses like marginal lands, it is expected that if deliberate afforestation and soil conservation measures are not undertaken, then there will be definite degradation of environment which makes agricultural land turn into non-agricultural. Thus with such anticipated and the already established trends from past experience, it is expected that non-agricultural land will definitely be on the increase.

In the above regard, therefore, if a hypothetical growth rate of 2 percent is applied to the percentage area of the district claimed by non-agricultural uses of between 7 to 16.67 percent, by 1995, between 10 percent to about 21.6 percent[7] will have been converted into non-agricultural use. It must however be pointed out that this hypothetical growth rate is rather modest and does not necessarily reflect the past as the case of 'schools' have shown. Moreover, the momentum for homestead development (if the traditional inheritance system persists) has reason to be higher than previously because of the relatively recent yet increasingly high growth rate in population as has been alluded to in section 1.2.c. Thus land falling annually to homesteads should definitely increase at a faster rate.

The point here is that the rural agricultural land which is continually being shifted to development projects and other non-agricultural uses should be expanding in acreage faster than the estimate above allows for, due to increasingly heavier demands.

In all, concern for the 'vanishing farmland'[8] stems from the fact that if the current trends in land use continue, the results would be undesirable in future and even now as they lead to questions like whether or not the supply of agricultural land is sufficient to meet the demands of a growing population in terms of employment, income and food· Besides, with the development of each new homestead particularly, there has to be subdivision of land. As was seen in chapter 11, already some families have unviable economic land units; this means that their very basis of livelihood is at stake and unless a solution is found, most families have to be content with nearlandlessness and its repercussions. The concern with the 'vanishing farmland' is as such real and needs policy attention and intervention.

4.3 Arable Land Use and Future Demand

In the previous chapter we saw that 28 percent of the district is used annually for crop production on average. It was further indicated that if one season (being that of the long rains when maximum hectarage is planted) is taken to determine how much land is used for crop production at any given time, the above percentage could be as low as 18.6 percent - the rationale and method of obtaining this figure will become apparent later.

Having established on average the extent of arable land use, it is the purpose of this section to observe future demands on arable land use -based on these averages and also on the facts of some selected year .

The method that has been used in calculating future demands for cropping purposes in this thesis is further based on various assumptions regarding crop husbandry practices, acreage under utilization and rate of growth. This has been related to the rate of growth of the population projected for 1990. The method of projection has been discussed in section 1.6.c and worked out in Appendix V.

The sources of data used for these projections are the district and provincial reports which give information on farming practices and cultivated land statistics, and the Central Bureau of Statistics publication on projection of population for Kenya Districts.[9]

This study takes 1980 as the base year for projection because the more difficult data to come by on crop production by season was available for this particular year for the district. On the basis of this information, it was therefore assumed that generally two-thirds of the total cultivated area in a given year, is planted during the long rains. (This explains the basis of 18.6 percent earlier referred to).

Two types of projections have consequently been made being type 1 and type 11. The distinguishing factor is that in the first type (1) of projection, it is assumed that only two thirds of the hectarage cultivated for 1980 or of the average (18.6 percent)is necessary for crop production at any given time.

The second type of projection takes the total area cultivated during the year as the total area needed to feed the district's population sufficiently at any given year regardless of season.

Underlying these 2 types of projections are additional assumptions - which have been mentioned above and elaborated on here. It was assumed that the present patterns of crop husbandry practices in the forms of use of inputs, crop types and interplanting of pulses as has already been explained in sections 1.2.d and 3.2 would be maintained.

Also in the above regard, it was assumed that the type of farming practised would continually be extensive for the realization of more yield and consequently increased food production for the growing population. This assumption may not necessarily be true as was observed in Section 3.2 but logical if the former assumption holds. However, as earlier mentioned, there is a limit to which arable land would expand as other competing uses come to force, but we have reason to believe that as yet it is slowly increasing.

Finally, the population medium projection provided by the Central Bureau of Statistics[10] was taken as the base for all types of projections made. This is based on the fact that the medium projection more often than not reflects the approximate situation than the other sets which have problems of over and under enumeration.

The calculations for the two types of projections are presented in Appendix V as already noted, whereas the summary is presented in Tables 4.3.1 and 4.3.2 below. The former Table (4.3.1) shows the percent of district to be under arable use by different years basing the projections on 1980 data on acreage cultivated during the long rains (Type 1) and that cultivated during the whole year (Type 11), while the latter Table gives the same information, but the basis of the projections is the average of the district that has been cultivated in the past 17 years for the long rains and whole year respectively.

From the results of both Tables, the area to be brought under cultivation is definitely on the increase. Except for Type 1, assumptions in Table 4.3.2, the other set of assumptions show that between 43.5 to 73 percent of the district's area will be under cultivation in the year 2000, either at once or during the whole year. If conditions under the various assumptions do not change, then definitely land in the district will be over-utilized.

In terms of livestock rearing, which is just as important to the district's overall output as crop production, the grazing area will be limited extensively. This may lead to a drastic reduction in livestock numbers and/or change in the farming system of the inhabitants of the district.

Table 4.3.1 : Percent of District to be under Cultivation by Different Years Using Actual 1980 Estimates

Years	Type 1 Percent of Area	Type 11 Percent of Area
1980	31.3	46.9
1990	46.9	70.3
2000	48.5	73

Table 4.3.2 : Percent of District to be under Cultivation by Different Years Using Average Estimates

Years	Type 1 Percent of Area	Type 11 Percent of Area
1980	18.6	28.0
1990	27.9	42.0
2000	28.91	43.5

Furthermore, in terms of fallowing (which enables the soil to restore fertility), the continually growing population with the concomitant increase in demand for cultivation will affect the length of fallow period adversely; and if deliberate soil conservation measures and other farming ways are not taken, then it is expected that marginalization of land will be increasing at a faster rate.

From this analysis, it is therefore necessary that the demand of land for cultivation be controlled to levels that other uses also fit into, as will be seen in our recommendations.

4.4 Livestock Prospects in Siaya

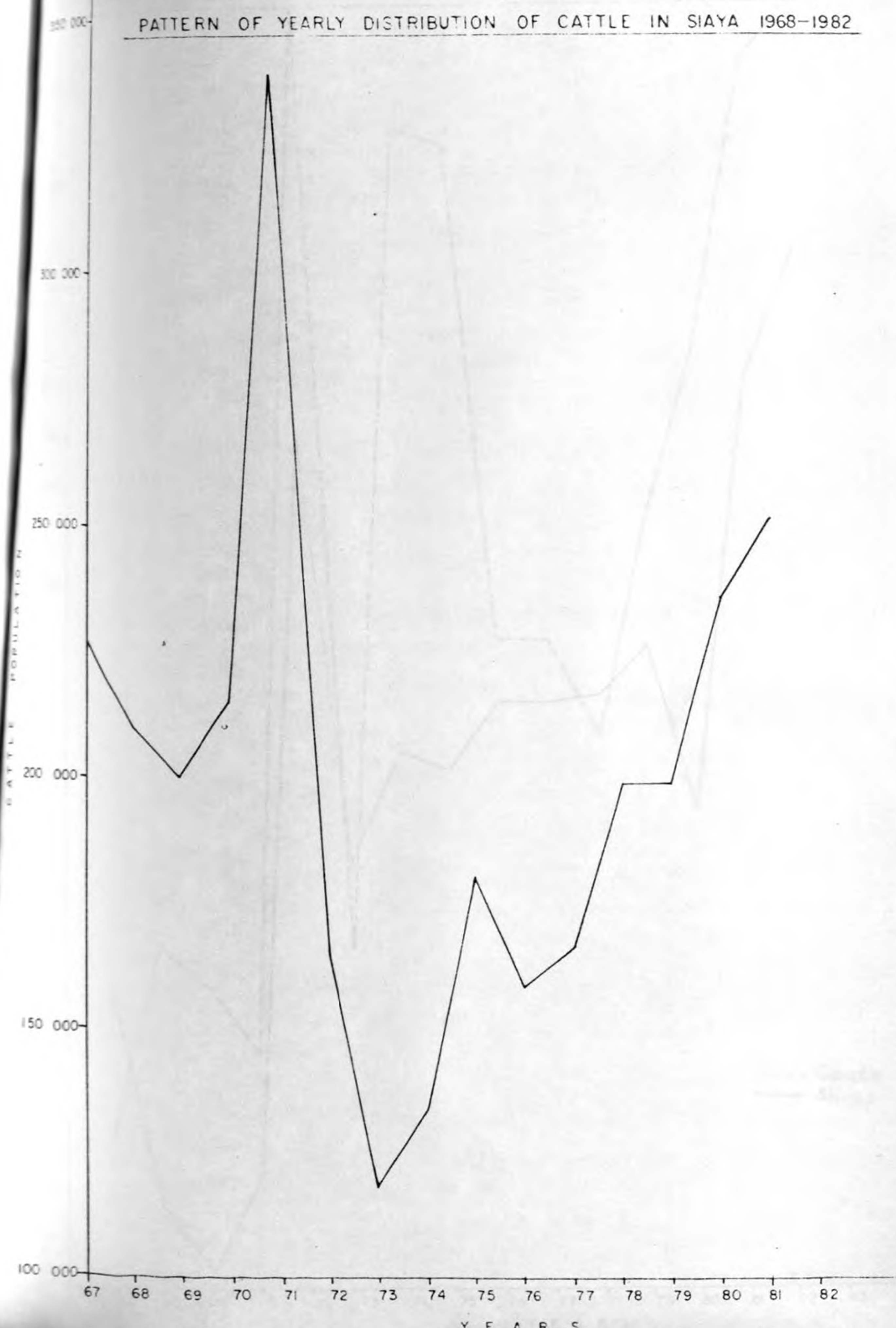
Although a positive association between increasing densities and livestock population has been established in chapter lll, it is nonetheless necessary to examine past trends in livestock population in detail, to extend the scope of explanation for this positive association and second and more important to this chapter to enable us examine the extent of grazing in the district with a view of arriving at a desirable course of growth of livestock population in relation to other land uses.

Figure 4.4.a and 4.4.b below show trends in growth of livestock population over the past 16 years for the whole district. Interpretation of these figures have been made by the use of mainly Table 4.4.1 and figures 4.4.c to 4.4.e (below) which show annual offtakes measured by recorded sales of hides and skins in the district. Thus relative percentage offtake has been worked out and plotted in the table and graphs respectively.

Overall, from fig. 4.4.a between 1968 and 1974, there was a general trend of decrease in cattle numbers except for 1972 when there was a sharp increase in cattle and between 1974 to 1982, there was an increasing trend. The general trend of sheep population from fig. 4.4.b is that of fluctuation up to 1973. Thereafter, there was a general increase except in 1980 when there was a slight drop. In comparison, the population of goats, experienced phenomenal fluctuations up to 1978 when thereafter, a fairly consistent increase occured.

When figures 4.4.a and 4.4.b are analysed in terms of figures 4.4.c to 4.4.e, it is significant that for most years when offtakes were increasing, the population of stock decreased and vice-versa. This is the case even with the goat population which has been most unstable. For instance in terms of offtakes, the 1972 and 1974 rise in goat population coincides with the drop in offtakes for the respective years, while the 1973 and 1976 drop in population of goats also coincides with the 1973 and 1976 steep rise in offtakes.

Table 4.4.1 which shows the computed proportionate offtakes verifies the observations being made. For example if we examine some rather extreme increases and decreases from figure 4.4.a in relation with figure 4.4.c, it is significant in 1972, that cattle population rose drastically when the offtake decreased considerably in comparison with other years. Proportionate wise, as can be seen from Table 4.4.1, the offtake was lower by 0.58 times that of 1971 and by 2.5 times that of 1973. Furthermore, in 1974, the downward trend persisted, perhaps as a result of the previously higher offtake,


PATTERN OF YEARLY DISTRIBUTION OF CATTLE IN SIAYA 1968–1982
350 000
300 000
250 000
200 000
150 000
100 000
CATTLE POPULATION
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
YEARS

YEARLY PATTERN OF SHEEP AND GOAT DISTRIBUTION 1968-1982 SIAYA

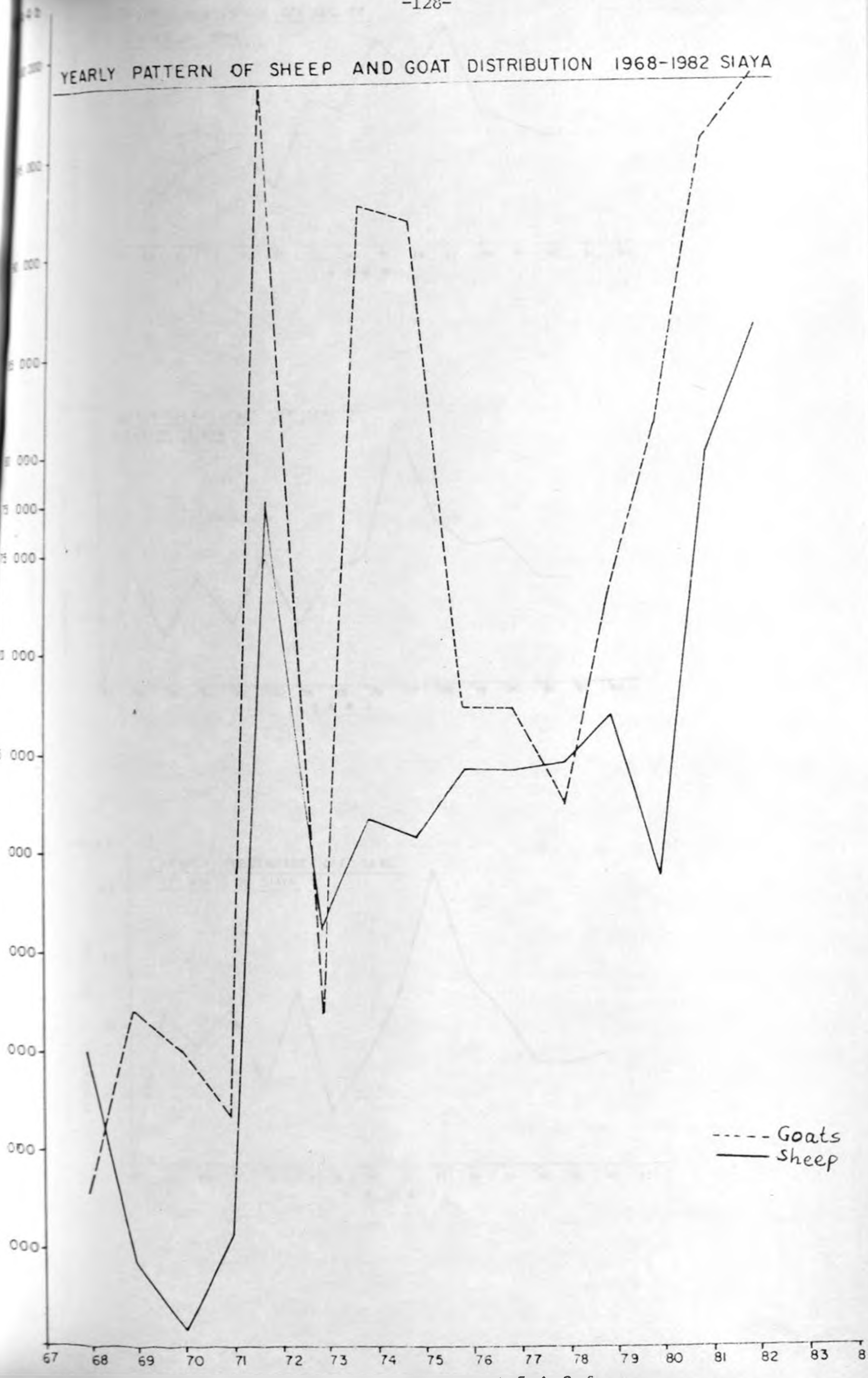


FIG 4.4 c

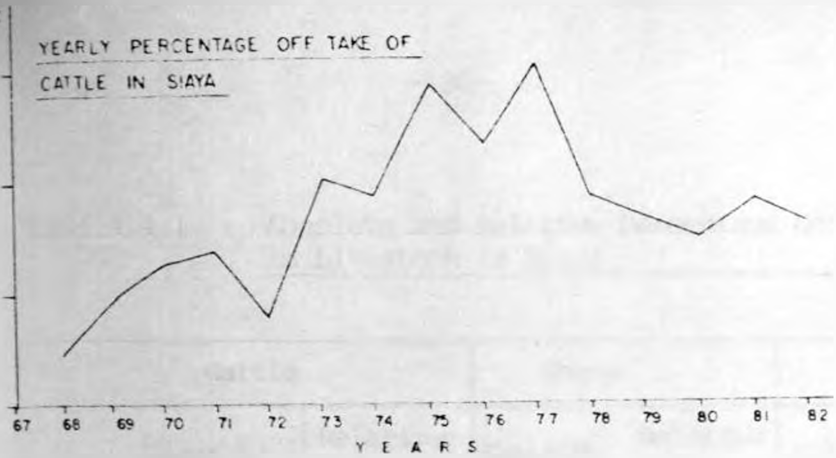


FIG 4.4 d

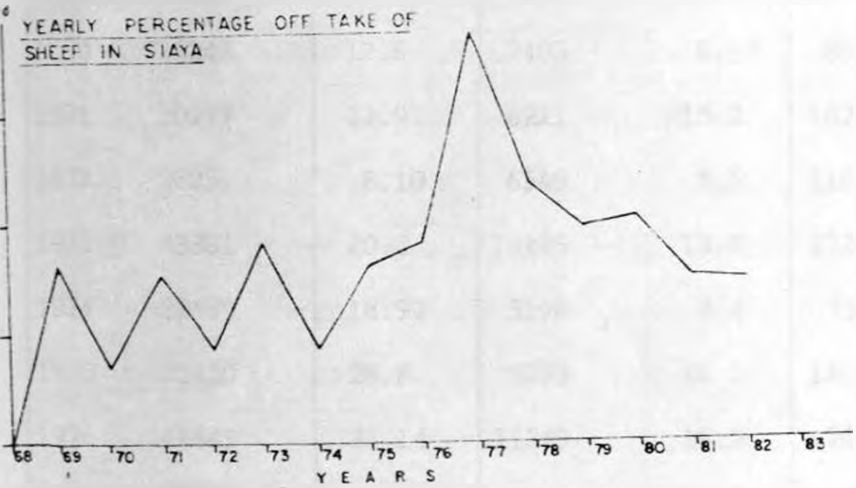


FIG. 4.4 e

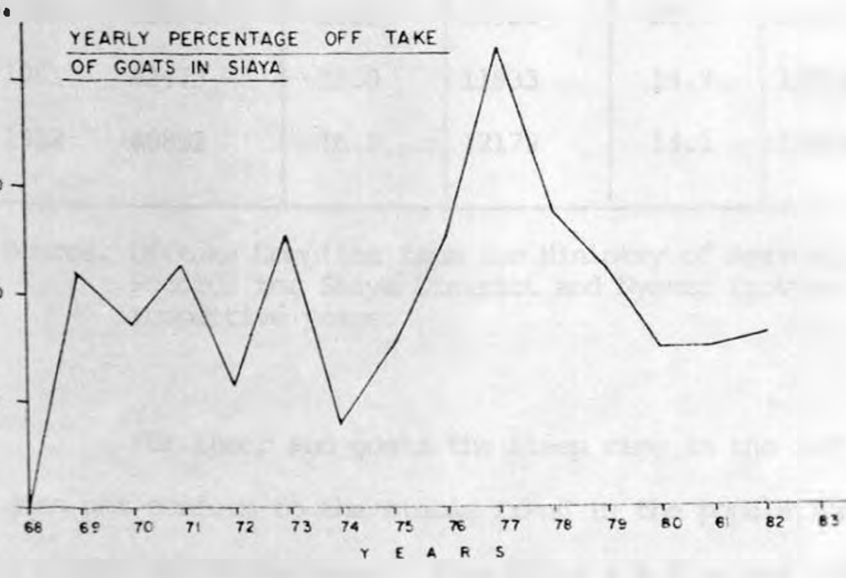


Table 4.4.1 : Absolute and Relative Percentage Offtake in Livestock in Siaya

	Cattle		Sheep		Goats	
	Hides No	Relative %	Skins No	Relative %	G/Skins No	Relative %
1968	9758	4.3	90	0.18	68	0.16
1969	19862	9.4	6457	16.4	11485	22.0
1970	25243	12.6	2403	6.69	8546	17.1
1971	30177	13.97	6221	15.2	10720	22.9
1972	27281	8.10	6549	8.5	11005	11.17
1973	33381	20.2	10145	18.0	13202	25.3
1974	22439	18.97	5198	8.4	7322	7.9
1975	38410	28.8	9779	16.0	14050	15.3
1976	41649	23.14	11749	18.2	17412	25.8
1977	47946	30.0	23626	36.7	29999	43.0
1978	30821	18.5	15154	23.4	17318	27.6
1979	33488	16.8	12780	19.1	16184	22.14
1980	29256	14.7	11923	20.3	12277	15.03
1981	42473	18.0	11933	14.9	14350	14.97
1982	40852	16.3	12179	14.1	16089	16.24

Source: Offtake Compiled from the Ministry of Agriculture Annual Records for Siaya District and Nyanza Province for the respective years.

For sheep and goats the steep rise in the 1977 offtake does not conform to the stable trend in the populations observed for that particular year. From Table 4.4.1 we see that double the off-take occured for sheep in 1977 as compared to that of the previous year(i.e. 36.7 percent against 18.2 percent) while for the goats, the off-take rose by more than half that of the previous year (43 percent as compared to 25.3 percent respectively).

While most trends can be explained with respect to offtakes and proportion decline or increase in off-takes when compared to preceding years, some of these trends, however, have to be accounted for by use of these and other factors. These include trends like those in which populations of stock increase when there is an increase in off-takes as in the years 1968 to 1969 for goats and 1974 to 1975 for cattle among others; and also where the margin of growth or decrease is proportionately larger than can be explained by observed off-takes - as in 1972 for all types of stock.

In the years preceding 1976 for goats, 1974 for cattle and 1973 for sheep when trend of growth of livestock was more inconsistent, growth of population of livestock in the face of high off-takes may be attributed to factors such as prevailing good pasture conditions throughout the year as a result of adequate rainfall. This factor has been shown to relate directly to animal reproduction[12] and/or there could have been significant importation of stock to the district. It is also possible that the slaughterings and especially deaths which occured during such years could have affected mostly the old worthless and to some extent mostly male stock, thereby leaving mainly the reproductive females; it could further be explained by the fact that livestock, particularly goats - which experienced the most unstable trend of growth, have a capacity to replace themselves faster than other stock even if exposed to similar conditions.

The increasing trend for all stock that has been described earlier for the later years inspite of more off-takes than in some early years, may be further attributed to increasingly improved veterinary services. Perhaps just like with human populations at the initial stage of development, when livestock experience a fair amount of veterinary attention in the form of vaccinations, quarantines and dipping, morbidity hence mortality conditions are lowered thereby leading to a rise in fertility.[13] Moreover, the fact that communal grazing is still being practiced especially in the non-consolidated and major areas of stock rearing(namely Bondo and Boro divisions) may imply that the need for limitation of herds by individual farmers is not yet being seriously felt.

The above probable situation is further complicated by the fact that the people of this area have had a historical and traditional bias for cattle because of the functions it served(s) in society.[14] While this fact is appreciated, it is imperative to note that the relative increase that can be seen for all livestock from figures 4.4.a and 4.4.b, particularly for cattle is not expected to continue for a long time especially after land consolidation is completed.

In other parts of the country where consolidation has taken place, livestock numbers have consequently decreased. This is true of Central Province and Kisii District where emphasis is currently on improved stock which are tethered around the home. Furthermore percentage of holdings with no cattle are increasingly becoming more.[15] Apart from factors such as complete consolidation leading to a reduction in size of herd, the value placed upon cattle by pastoralists is expected to change as more people go through formal school which in itself also deprives the rural areas of potential herders.

In the foregoing part of this section, we have thus reviewed the livestock trend of growth in the whole district in terms of mainly off-takes. This is based on the fact that reliable and consistent data existed for this aspect only. Besides, this data on off-takes has explained the variations in trend of growth for most parts of the livestock population trends to acceptable levels. Nonetheless factors like pasture conditions as a result of rainfall performance during the year for all years which in turn affect fecundity and fertility, varying livestock replacement capabilities when placed in similar environment, veterinary services impact, livestock importation and exportation (i.e. in terms of movement and sales) also have important roles to play (when differentials exist in them) in determining the trend of livestock growth. However, due to data limitations on these aspects, we had to construe their effect only minimally, when discrepancies in population of stock and off-takes were larger than usual.

The conclusion that is apparent from the above analysis, is that a multiplicity of factors have contributed to livestock apparent positive performance. It is possible in future, that the trend of growth in livestock population could stabilize, especially if policies are geared towards improving quality of stock.

It is our view that while a definite trend of growth in livestock population is difficult to imagine in view of the prevailing conditions, the domestication of animals nonetheless will continue to be an important component of agricultural activities within the district and even in Kenya as a whole due to the products got from them and the fact that in some instances, they form a major source of draught power and more important, is that in some areas, they are a major viable form of agricultural land use.

It is the concern in the rest of this section to establish the extent of grazing in the district given the data and information at our disposal. It must however, be remembered that the extent of land available to grazing is difficult to assess because land requirements of the animal population is normally regarded by farmers as either a major committment to a person's holding or incidentals for whom a farmer makes no conscious provision[16], especially in areas where communal grazing is still the norm.

While realizing the limiting effect of such factors in estimating grazing land, it is however, true that at any given time livestock have to feed on common pasturage and upon the fallow lands after cultivation.

The method that has been used in here is that used by Langlands (1971)[17] when he estimated the extent and intensity of grazing in Ugandan counties. The basis of this method and calculations are provided in Appendix Vl. Briefly, the assumed area under grazing was found by multiplying the district's or division's cattle population with the carrying capacity index for the dominant grass type of the district or division[18]. The result is then divided by 640 to convert from acres to square miles, multiplied by 2.6 to convert from square miles to square kilometres. This was then expressed as a percentage of the total area of the district or division.

To facilitate the use of this method, a few assumptions were made regarding land use. Hence it was assumed that at least 7 percent of the area of each division was not available for agriculture due to committment to non-agricultural uses, as was earlier discussed in the case of the district.

This percentage was therefore subtracted from the total area of each division, and district.

It is also our view that land under many types of crops do provide fodder to livestock after harvest and that their period of occupancy of such land in the district is relatively short (especially in areas where we have mainly one cropping season being the areas which form the main livestock areas) and indeed coincides with a time when there is rain in the district. This is an important consideration because many studies have related forage supply to seasons concluding that the area needed to graze a stock unit decreases with adequate rains.[19] Moreover, the area occupied by permanent crops is very small (i.e. about 40 hectares[20] of coffee in any given year. Bananas though classified as permanent, are used to feed cattle). Besides, the district's total area that has been cultivated annually, on average, has been shown to be fairly small (i.e. between 18.6 to 28 percent). For the above reasons, it was therefore assumed that apart from non-agricultural uses, the rest of the district can be grazed by livestock.

Calculations to find the intensity of grazing were made for 1972 and 1979. The former year was chosen deliberately because it represents the year when cattle numbers was at their greatest for that whole period. 1979 on the other hand was randomly selected.

The calculations showed that in 1972, the whole district had 100.9 percent of its area potential under grazing; Bondo 143 percent, Boro 117 percent, Ukwala 109 percent and Yala 119 percent. Thus all these units had more than 100 percent of their area potential given to cattle. We recall that the trend of growth in livestock population was at its highest in 1972, for all types of stock and sharply declined in 1973. The above percentages reveal that in 1972, the district was seriously overgrazed. This could have affected the fecundity and hence fertility of the animals and in view of the high off-takes, livestock numbers decreased and hence the drastic decrease in livestock population that was observed between 1972 and 1973 (Fig. 4.4.a to 4.4.e).

As of 1979, the results of Appendix Vl show the amount of land devoted to grazing to have decreased for the district to 71 percent. These trends of grazing observed show that much of the districts potential is devoted to grazing. Even from the increasing trend in stock population (ref. Figs. 4.4.a and 4.4.b) it is clear that the district has been unquestionably overgrazed and unless contemporary techniques of cattle husbandry and deliberate reduction of cattle numbers to at least 50 percent grazing levels are adopted a drastic and vituallly permanent degradation of soil, vegetation and water resources is likely to occur. The situation is being aggravated by the continued although slow expansion of settlements and cultivation which seriously reduces extent of grazing lands.

While appropriate conclusions have been drawn from the index above, it nonetheless falls short of many factors. Langlands (1971) outlines most of these shortcomings, however, some have been taken care of in this thesis.

From the results of the computations, it is evident that the carrying capacities which have been assumed are too generous and bear little relation to the amount of land actually required to support a poor quality beast.[21] The point is that the proportion of each division or district given over to livestock is in actual fact lower than the percentages would want us believe. However, for divisions, like Bondo and Boro which have fairly extensive areas given over to livestock grazing,(due to the fact that consolidation efforts are still at an early stage, and generally have lower densities compared to Yala and Ukwala), the picture painted may be fairly accurate for the former two divisions and definitely inaccurate for Yala and Ukwala.

Also the index does not take account of the age-structure of the herd and hence overlooks the differences that indeed do exist in consumption of feeds by age. In this and the above regard, the use of the arithmetic means when extreme values exist may have thus influenced part of these results.

However in all, the apparent conclusion is that, since the district is inhabited by people practicing mixed farming, the large cattle population must be assumed to be creating problems of land use pressure, not to mention the inherent inadequacy of pasture to support cattle in a healthy state. The need to reorganize farming systems to accommodate livestock, arable farming and populations is therefore real and pressing.

Secondly, when allowance is made for cultivated land (although this was not done in this section), the future trends for cropped land requirements point to a situation in which very small parts of the district will be left to graze livestock. This will greatly jeopardize animal production. Even at present if the acreage in cultivation is subtracted for the respective years, no doubt, the district will still show unprecedented over-grazing patterns, which we think would not represent the true picture.

4.5 Conclusion

The present chapter has focussed on the various facets of land use in the study area, showing largely the extent, and to some extent intensity of use, and where possible future trends in use if the present patterns of use persist. The conclusion is that total land in Siaya has been over utilized for most years. In 1979, 71 percent of the area fell under grazing, between 18.6 to 28 percent on average fell on crop production[22], further, during the year between 7 to 16.67 percent was under non-agricultural use.

From the results, there is a definite overlap in use especially between the two categories of agriculture. In terms of projected future demands, we expect from the analysis that the crisis situation already in existence will become worse due to pressure of use juxtaposed with the earlier discussed land availability problems and the consequent marginalization and degradation of habitat. The need for deliberate policies on improving usage of land is therefore real and pressing.

NOTES AND REFERENCES

1. Masaviru R.A. (1981) p.10

2. Ibid pp.10-11

3. Information on total number of units (like schoools, health centres, churches etc.) was obtained from 'The Siaya District Annual Report' for 1980 and the 'Siaya District Development Plan 1979-1983'.

4. The Standard recommended acreages of most institutions, and road - widths, are contained in the handbook by Lock.Sc. (1971). It is the author's assumption that most of the discussed institutions in Appendix lV conform to these standards. Otherwise information on areas of other centres, which was not available in the census report, was approximated depending on the facilities a centre has, as is contained in the District Annual Reports.

5. Jaetzold R. and Schmidt H. (1982) : pp.225-230.

6. Ibid

7. The hypothetical growth rate of 2 percent which is used in projecting possible land under non-agricultural use is also used for 16.67 percent hence 21.6 percent.

8. This concept has been borrowed from Brewer M. (1981) as it describes aptly what is happening to the rural farmland.

9. The reference is "Population Projections for Kenya 1980-2000." Ministry of Economic Planning and Development. Central Bureau of Statistics. Republic of Kenya, 1983.

10. Kenya 1983, Ibid.

11. The method used involved, summation by season of the 1980 data on cultivated hectarage and then expressing this as a percentage of the districts total area: underlying this method was the assumption that interplanting of pulses was practiced.

12. F.A.O. (1967) "East African Livestock Survey. Regional - Kenya, Tanzania, Uganda." Vol.11 p.9 - Undernourishment is shown to relate with low calving rate.

13. Similar paths of development by the human population population is discussed by Conde J. (1971) pp.1-7.

14. Ocholla-Ayayo (1976) pp.34-37 outlines the functional role of cattle in traditional Luo Society.

15. Kenya 1982: Integrated Rural Surveys 1976-1979 p.96

16. Langlands B.W. (1971) p.53

17. Ibid.

18. Jaetzold and Schmidt op.cit. pp.231-234 provide such carrying capacities as is elaborated on in Appendix Vl.

19. Ibid. pp.231-234 where this factor is implicated also in Batilol P. (1974) p.19.

20. The average hectarage under coffee in the past 17 years was worked out to be 42.4 hectares annually.

21. Langlands B.W. Op.cit. pp.54-60.

22. Although the area under crops annually was assumed to be available to grazing, it has nonetheless been included in the conlusion, because here we are interested in the totality of use of land in the district: moreover its omission in the index showing intensity of grazing must have led to considerable underestimation of the extent of overgrazing in the district.

CHAPTER FIVE

5.1 SUMMARY AND CONCLUSIONS OF ANALYTICAL CHAPTERS

In Chapter Two, the relationship between the size of agricultural population and agricultural land was examined using data on population densities and registered land statistics.

Specifically, we established the demographic implication of agricultural density to in or out migration and found that in most areas of Kenya, the study area inclusive, the smaller the size of holding the larger the outflow of migrants. The reverse pattern applies to areas where land is relatively in abundance. Besides migrations, increasing pressure, has been related to change in landholding patterns from communal to individual holdings. The Sywnnerton Plan (1954) has been seen as a response to the severe fragmentation and subdivision of plots which characterised the late '40s and '50s in Central Kenya as a result of population pressure. Paradoxically, if the plan is implemented to conclusion it renders most people landless.

To establish the extent of pressure on available land (in 1979) in Siaya, population was categorized by density (range) and the results show that 57 percent of the population have either reached the minimum stipulated viable size of holding being 0.405 hectares per person or have less than this.

The factors of population growth mainly fertility and mortality in Kenya have been used to show that since 1962 family size has changed from 5.3 to 8.1 births per woman in 1977/78. Mortality on the other hand has decreased. This change has meant a faster rate of subdivision of land within families. If therefore the trends in fertility and mortality observed in Chapter 11 persist, then Kenya is in for a further crisis situation in land availability.

Included in this chapter, finally is the actual distribution of land based on some sampled sublocations within the district. The farm sizes in the district range from 0.2 to 20 plus hectares per holder. The differentials in size of holding has been attributed to traditional inheritance practice sealed in the official policy of land registration. On the basis of the differential distribution of land, it is argued that most families in Nyandiwa (42.9 percent); Ojuando B (80.9 percent);Nyawita (48.2 percent); Rangala (62.5 percent); and Maliera (42.9 percent) have less than the stipulated acreage for subsistence production. Furthermore, a similar percentage as the above for Rangala, Maliera and Nyandiwa have less than 1 hectare. This indicates that the bulk of families in these sublocations are experiencing acute land shortage. 'This may have a direct bearing on their incomes and food requirements.'

Although, changing sizes of land due to population pressure triggers off many other socio-economic responses, the factors outlined above have helped in achieving the objective which was to show the patterns of distribution of land in the district and some demographic and other factors affecting these patterns.

On the basis of the above findings, it is generally concluded that subdivision is a function of population growth (which is evident in increasing densities and changing family sizes) and the system of land tenure.

In Chapter Three, data on crop production statistics in terms of yearly hectarage occupied by each crop ,crop yield statistics on yearly basis and livestock population census were used to test and examine the hypotheses and objectives laid down in Chapter 1 respectively.

Apart from percentages, and a line graph which was used to show trends and type or nature of arable land use, most of the analysis in this chapter was done by using the regression model.

The results of the analysis between agricultural densities and arable land use showed no clear pattern because of fluctuations on arable land use over the years.

It is argued that while there could have been some increase in overall hectarage ploughed over the years, there is nonetheless a possibility of intensive use of arable land since some hectarages for the early years compare favourably with that of some later years when in terms of what has been discussed in chapter two, there was definite pressure of population on land resource. Perhaps what has restricted extensive patterns in arable land use, is the existing differentials in patterns of land holdings with most families owning less than 1 hectare in the district.

In terms of possible change in emphasis placed on certain crops with increasing agricultural densities, the results show that types of crops have not changed over the years (excepting sunflower which was later abandoned) but emphasis has changed to some extent. Thus for example, maize both local and hybrid variety has continued to occupy increasingly more percentage share of arable land while sorghum, which was initially at par with maize has decreased its percentage share considerably. Besides, crops like cotton and cassava have also experienced relative decrease in hectarage, while sweet potatoes and serena sorghum experienced some increase in percentage share of arable land.

The change in roles of most crops, has been attributed partly to their performance in terms of yield (and this explains why hybrid maize is continually occupying more hectarage) and partly to the purposes they serve for the community. Thus crops which are readily marketed and consumed like maize have experienced unprecedented increases in hectarage while those which serve basically one purpose as indeed the case of industrial crops, mixed sorghum, sweet potatoes and cassava have experienced relative drop or just minimal increase in their share of arable land.

From the above analysis it is evident that the less soil tolerant crop (maize) has increased its share of arable land at the expense of the more tolerant crops like sorghum, sweet potatoes and cassava. It is possible that farm management techniques have improved considerably to enable growth of such crops at a time when land is under pressure of use as was seen in Chapter 1V.

Food crop production has shown positive relationship with increasing population pressure more so in the divisions of Yala and Ukwala which have higher densities than Boro and Bondo. Furthermore, population pressure explains 85 percent and 52 percent of the need to cultivate food crops in the former divisions respectively: while in the less populated divisions, population pressure explains only 5.7 percent and 1.5 percent of the variations in Boro and Bondo respectively. On the basis of the above results, the hypothesis that food crop production is directly related to agricultural densities has been verified.

The analysis on the relationship between Industrial crops production and agricultural densities, also showed positive association. In Siaya, the correlation was 0.74343; Ukwala 0.09022; Yala 0.08642; Boro 0.46142; Bondo 0.17917 with 55.3 percent; 1 percent; 0.7 percent; 21.3 percent and 3.2 percent as the variation in cultivation of industrial crops explained by population pressure respectively. These results have been viewed with scepticism because the district case, does not reflect an average for the divisions. It has been suggested that the discrepancy may be attributed to lack of data for the divisions for the earlier years. Siaya in this analysis covered more years than the divisions.

Although the results of the analysis have gone contrary to what was hypothesized (namely an inverse relationship was expected between industrial crop production and increasing agricultural density) they nonetheless showed differences in magnitude of explanation when divisional comparisons were made. Thus Yala and Ukwala with heavier densities showed almost negligible positive correlation while Bondo and especially Boro had some definite positive association. It was argued out (in the case of Yala and Ukwala) therefore, that while there is a possibility of increase in hectarage under industrial crops production, the increase has been very gradual. This is mainly because (as was shown earlier) food crop production is more immediate in returns and hence in the case of pressure, it would definitely assume priority while in Bondo and Boro with relatively less pressure, the two types of crops may be competing equally.

The case for the whole district, may have resulted from the fact that Bondo and Boro may have downplayed the role of population pressure in Yala and Ukwala to the extent that as yet people have not fully appreciated the need to concentrate mainly on the production of food crops. Overall, however, the possibility of decreasing hectarage under industrial crops with increasing pressure is not ruled out as the case of Yala and Ukwala have shown.

In this chapter, the relationship between agricultural densities and performance of crops measured by their output per hectare was also examined. The yield of all crops analysed (local maize 0.10975; serena sorghum 0.14628; mixed sorghum 0.68419; food beans 0.80933; sugarcane 0.53626; sweet potatoes 0.25705 and cotton 0.07218) showed a positive association with increasing agricultural densities. The degree of association is particularly high for food beans and mixed sorghum. High for sugarcane and lowest for cotton. The variation in yield explained by population pressure ranges from 66 percent for food beans to as low as 0.5 percent for cotton. These results suggest that with increasing agricultural density so does yield per hectare increase.

The local varieties like local maize and mixed sorghum exhibit the positive association more than the improved varieties such as hybrid maize and serena sorghum. It was suggested that this observation was likely to be a result of improved crop husbandry practices, which have been necessitated by population pressure and by differential patterns of land distribution on the one hand for the local varieties and on the other hand, agricultural densities do not determine largely the yields of improved varieties as mostly such varieties are adopted with specified crop husbandry practices, as such any improvement in the latter aspect, does not alter the performance of these crops much. Food beans, is an exception because in it both local and improved varieties have gone to determine yield per hectare. It may be that the consistent adoption of newer and newer varieties is continually boosting the yield.

The above explained results, however did not confirm the hypothesis that increasing agricultural densities should relate negatively with yield per hectare. Probably because the changing and improved crop husbandry practices continue to sustain higher yields.

Finally, in this chapter, the relationship between agricultural densities and livestock population was analysed and inverse relationship was hypothesized: Furthermore, due to different demands by type of stock, a variant influence of population pressure was anticipated. The results, showed positive association with a correlation coefficient of 0.04309 for cattle and 0.33193 for small stock (sheep and goats):

Besides population pressure explains 0.2 percent and 11 percent increase in population of cattle and small stock respectively. From the above results, the differential influence of population pressure on stock has been verified: while the inverse relationship anticipated between livestock and agricultural densities has not been found. Although, the scope of explanation for this positive association has been part of the subject matter in chapter 1V, it is nonetheless possible to allude that livestock needs are still given priority in the district, inspite of increasing pressure on land.

In conclusion to the above analyses of agricultural densities on arable land use and livestock population, it is evident that so far a positive association has existed. Whatever the magnitude, it is possible, that population pressure at least up to 1979 had not reached a maximum limit as to reverse trends in the production of both food and industrial crops and also to limit further growth of livestock population. It is on this note that Chapter 1V examined the actual extent of land use by the various categories put together.

Under the category of non-agricultural land use, our analysis showed that between 7 to 16.67 percent was not available for agriculture in 1979 and that between 10 and 21 percent will be under similar use in 1995. The results of our analysis have further shown that agricultural land is continually being shifted to non-agricultural uses and/or rendered unviable owing to the type of tenure system being practiced and the ever increasing demand for development oriented projects as the case of the growth of schools both for primary and secondary education have shown. Although the growth rates have been compared with the population growth rate for similar periods, with the apparent conclusion that schools have grown at a faster rate than the population, it is nonetheless beyond the scope of this study to find out whether or not, the schools which were established over the period met the demands of the population.

On arable land use, the results of the analysis showed that on average between 18.6 to 28 percent is cultivated annually and that if this is projected to the year 2000, between 28.9 to 43.5 percent has to be availed to arable use annually. Another set of projection used 1980 crop production statistics and analysis of the results showed that in 1980 between 31.3 to 46.9 percent of the total district hectarage was availed to arable use and if the present crop husbandry practices persist, then by the year 2000, between 48.5 to 73 percent of the district will be under cultivation of crops. If such trends persist, there will be definite effect on other land uses, to the extent that livestock population may be drastically reduced and the environment may experience general deterioration. However, from past records of arable land use, it appears that extensive use of land for arable purposes is a most unlikely trend because of the present land tenure system which results in excessive subdivision of plots.

Livestock population trends were also examined in this chapter: and the trends in growth of livestock which explain to large extent, the positive association that was established earlier between increasing agricultural densities and livestock population was attributed mainly to differentials in off takes and to some extent to other factors such as pasture conditions as a result of rainfall performance which in turn affects fecundity and fertility; stock replacement capabilities; increasingly extensive veterinary services impact and to livestock movements and sales.

In view of the past trend, it was difficult to establish a definite trend of growth of livestock in future, but on the basis of its use and other environmental considerations, it was concluded that this industry would continue to be an important aspect of farming in the area.

An examination of past grazing patterns for some two years, showed that the district has been overstocked and consequently overgrazed. In 1972 about 100 percent of the district's potential was under grazing while in 1979, about 71 percent fell into similar use. Although there is a definite overlap in categories, the results of this analysis have shown that there has been no planning as far as grazing needs are concerned, and with the increasing trend in livestock population up to 1983, it is likely that livestock in Siaya are malnourished and the district is experiencing severe soil erosion due to overgrazing.

In all therefore, the apparent conclusion from these chapters is that the social and legal framework within which agriculture is being pursued is inefficient: as land use for crop production is handicapped by the land tenure and inheritance system. Besides, subdivision of plots is not a solution to access to land as the units created become agriculturally unviable and more acreages are converted to non-agricultural use.

The difficult problem in Siaya is on how to improve access to land presently underutilized because of the tenure system in existence. From the above analysis, the results have shown that on average (in 1979) between 18.6 percent to 28 percent of the area was used for growing crops, 71 percent for grazing and between 7 to 16.67 percent on non-agricultural uses. This shows that already Siaya is overutilized in terms of livestock rearing and may affect its capabilities as to crop production and even livestock rearing itself because of the continued degradation of environment. Moreover as the population continues to grow, more demand on land will be placed for various activities.

If therefore an alternative path of development is not adopted, then the situation in land access and use is expected to deteriorate further. Below are policy options which may help allievate the problems being faced with regard to land use and availability.

RECOMMENDATIONS

5.2 On the basis of the conclusions already drawn, we recommend the following strategies with a hope of improving access to land and also minimizing haphazard overutilization of the district.

1. Overall, there should be an integrated land use planning policy at the district level involving an appropriate combination of crop husbandry, animal husbandry, with a link to demand for dwellings and other infrastructural services.

2. In the densely settled regions, there is no option but to stop further subdivisions and achieve a vertical growth in agriculture especially in Yala and Ukwala divisions.

3. In light of No.2 there should be movement of populations to the rural market centres already created. This will not only enable the provision of social amenities to be done cheaply, but also solve the problem of subdivision which in itself jeopardizes productive agricultural systems.

4. There should be a breakdown in the social and legal framework within which access to land is determined, this will enable fuller utilization of available land.

5. There is need to encourage zero grazing by improvement of available pature, fencing (consolidation) and provision of adequate water points. These measures will enable easier persuasion of livestock owners to reduce their stock and hence improve quality of stock, and further, will help in easier determination of desired stock unit per hectare thus the overgrazing problem would be solved.

6. Efforts should be intensified in the district to create awareness on improved crop husbandry practices and on available alternatives to already existing crop varieties, inputs and machinery.

7. Family planning is needed in this district - which has prospects of an increasing growth rate - with its repe rcussions on access to land.

8. Land conservation techniques and afforestation programmes should be more aggressively pursued.

9. Vertical expansion of structures in institutions and homesteads should be seriously considered especially in areas where optimum densities have been reached.

5.3 RECOMMENDATIONS FOR FURTHER RESEARCH

1. This study used only one variable (population growth) to explain the patterns of land use and availability. The list is however not exhaustive. There is still need to investigate the role played by other factors especially rainfall and environmental factors in determining patterns of land use and availability.

2. There is a definite need to relate more the factors of population growth namely fertility and mortality with availability of land at the micro-level.

3. Other districts and even smaller localities should receive similar attention as Siaya has, as indeed the intensity of land use ought to be established for other areas to give policy guidelines on rural farming with special reference to the problems of a particular area.

4. The socio-economic implications of changes in land availability and land use, which have altogether been overlooked, should be investigated thoroughly, with the use of statistical techniques.

5. There is need to establish clearly, the extent and/or intensity of land use by size of holding.

The above list is not exhaustive and hence it is likely that other fields of research will come out of this study.

APPENDICES

APPENDIX 1

Estimated Land Availability and Net Migration in Some Selected Districts in Kenya

District	Land Availability in Ha/Person 1969	Net Out-Migration 1969
Kisii	.3	+ 30,541
Kiambu	.4	- 66,198
Machakos	.4	- 62,652
Kakamega	.4	-310,927
Murang'a	.5	-131,105
Nyeri	.4	- 74,252
Embu	.6	+ 5,820
Kisumu	.6	- 54,113
Siaya	.6	-28,860
South Nyanza	.9	+ 44,013
Nakuru	1.0	+101,746
Nandi	1.1	+ 1,739
Baringo	1.2	+ 8,777
Nyandarua	1.5	+ 77,609
Trans Nzoia	1.7	+ 56,440
Uasin Gishu	1.7	+ 99,867
Narok	7.3	+ 25,174

Source: Compiled from Faruque et al. 'Population Growth and Agricultural Development in Kenya',Occasional Paper No.39 IDS. University of Nairobi, 1981.
and from:
Henry Rempel: 'An Analysis of the Information on Inter-District Migration provided in the 1969 Kenya Census Working Paper No.142, IDS, University of Nairobi, 1974.'

APPENDIX 11

Cultivated Hectarage for Crops by Years (Siaya District)

Name of Crops	1967 Actual ha.	1967 % ha.	1968 Actual ha.	1968 % ha.	1969 Actual ha.	1969 % ha.	1970 Actual ha.	1970 % ha.
Local Maize	16194	27.3	16400	41.9	12180	30.7	24678	24.2
Hybrid maize	809.72	1.4	404.8	1.0	660	1.7	1435	1.4
Serena sorghum	81	0.1	100	0.3	68	0.2	200	0.2
Mixed sorghum	16194.3	27.3	1214.6	3.1	19857	50.1	40515	39.7
Wimbi	323.9	0.5	121.5	0.3	350	0.9	500	0.5
Sugarcane	28.3	0.05	259.1	0.7	360	0.9	1500	1.5
Sweet potatoes	1234.8	2.1	1010.2	2.6	450	1.1	500	0.5
Cotton	9339.7	15.8	4453.4	11.4	1550	3.9	640	0.6
Groundnuts	81	0.1	485.8	1.2	1000	2.5	1050	1.0
Rice	24.3	0.04	24.3	0.06	70	0.2	50	0.05
Bananas	121.5	0.2	182.2	0.5	700	1.8	515	0.5
Coffee	68.4	0.1	68.8	0.2	118	0.3	69	0.07
Sunflower								
Vegetables	72.9	0.1	72.9	0.2	100	0.3	100	0.1
Simsim	141.7	0.2	161.9	0.4	180	0.5	304	0.3
Cassava	14569	24.6	14164.3	36.2	2000	5.4	30000	29.4
Total %		99.39		100.06		100.05		100.02
District total hectarage ploughed	59284.52		39123.8		39643		102056	
% of District total hectarage ploughed		23.5		15.5		15.7		40.4

APPENDIX 11 (continued)

List of Crops	1971 Actual ha.	1971 % ha.	1972 Actual ha.	1972 % ha.	1973 Actual ha.	1973 % ha.	1974 Actual ha.	1974 % ha.
Local maize	40693	43.3	27928	48.8	23886	41.2	14500	28.4
Hybrid "	2654	2.8	1703	3.0	3097	5.3	3674	7.2
Serena sorghum	307	0.3	1454	2.5	574	1.0	985	1.9
Mixed "	33062	35.2	16863	29.5	18000	31.1	13070	25.6
Wimbi	678	0.7	686	1.2	1095	1.9	290	0.6
Sugarcane	900	1.0	1169	2.0	280	0.5	7225	14.4
Sweet potatoes	700	0.7	654	1.1	1508	2.6	2730	5.3
Cotton	5166	5.5	4103	7.2	3412	5.9	3411	6.7
Groundnuts	1100	1.2	400	0.7	1300	2.2	936	1.8
Rice	40	0.04	40	0.07	10	0.02	7	0.01
Bananas	368	0.3	389	0.7	200	0.3	115	0.2
Sunflower	31	0.03	44	0.08	10	0.02	45.0	0.09
Vegetables	35.9	0.04	277	0.5	127	0.2	200.0	0.4
Simsim	313	0.3	160	0.3	150	0.3	120.0	0.2
Cassava	7906	8.4	1333	2.3	4283	7.4	3730	7.3
Coffee	13	0.01	24	0.04	24	0.04	24	0.05
Total %		99.82		99.99		99.98		100.15
Total Area of District ploughed	93966.9		57227		57956		51062	
% of Total Area of District ploughed		37.2		22.7		23.0		20.2

APPENDIX 11 (continued)

List of Crops	1975 Actual ha.	1975 % ha.	1976 Actual ha.	1976 % ha.	1977 Actual ha.	1977 % ha	1978 Actual ha.	1978 % ha.
Local maize	12874	26.4	15100	30.7	20982	29.8	25414	38.9
Hybrid "	2954	6.1	4096	8.3	6539	9.3	8400	12.9
Serena sorghum	252	0.5	29	0.06	70	0.1	399	0.6
Mixed "	16529	33.9	11794	24.0	23701	33.6	12129	18.6
Wimbi	326	0.7	200	0.4	269	0.4	411	0.6
Sugarcane	7102	14.6	7443	15.1	8525	12.1	7926	12.1
Sweet potatoes	1476	3.0	765	1.6	1593	2.3	1232	1.9
Cotton	2869	5.9	3884	7.9	5486	7.8	5695	8.7
Groundnuts	721	1.5	734	1.5	772	1.1	944	1.4
Rice	6	0.01	4	0.01	26	0.04	31	0.05
Bananas	100	0.2	163	0.3	89	0.1	77.9	0.1
Coffee	24.4	0.05	22.2	0.05	22.2	0.03	24.0	0.04
Sunflower	28	0.06	26.0	0.05	187	0.3	97.4	0.1
Vegetables	325	0.7	419.0	0.9	618	0.9	472	0.7
Simsim	106	0.2	30.0	0.06	116	0.2	220	0.3
Cassava	3110	6.4	4432	9.0	1482	2.1	1791	2.7
Total %		100.2		99.93		100.2		99.69
Total Area of District ploughed	48802.4		49141.2		70477.2		65263.2	
% of Total Area of District ploughed		19.3		19.5		27.9		25.9

APPENDIX 11 (continued)

List of Crops	1979 Actual ha.	1979 % ha	1980 Actual ha.	1980 % ha.	1981 Actual ha.	1981 % ha.
Local maize	17243	27.7	50281	42.5	33662	32.1
Hybrid "	5869	9.4	14970	12.6	14285	13.6
Serena Sorghum	79	0.1	298	0.3	682	0.7
Mixed "	8823	14.2	23830	20.1	22771	21.7
Wimbi	237	0.4	515.6	0.4	1411	1.3
Sugarcane	9756	15.7	1080	0.9	1080	1.02
Sweet potatoes	1069	1.7	4724	4.0	3883	3.7
Cotton	8621.4	13.8	12005	10.1	11086	10.6
Groundnuts	768	1.2	1500	1.3	625	0.6
Rice	9	0.01	12	0.01	14	0.01
Bananas	199	0.3	900	0.8	1200	1.1
Coffee	30.8	0.05	45.8	0.04	44	0.04
Sunflower	12.7	0.02				
Vegetables	463	0.7	472	0.4	500	0.5
Simsim	864	1.4	114	0.1	87	0.08
Cassava	8231.3	13.2	7624	6.4	13558	12.9
Total %		99.88		99.95		99.95
Total Area of District ploughed	62275.2		118371.4		104888	
% of District Total hectarage ploughed		24.7		46.9		41.6

APPENDIX 11 (continued)

List of Crops	1982 Actual ha.	1982 % ha.	1983 Actual ha.	1983 % ha.
Local maize	38122	38.8	28665	34.0
Hybrid maize	14000	14.3	13557	16.1
Serena sorghum	540	0.5	1589	1.9
Mixed sorghum	22000	22.4	13529	16.0
Wimbi	678	0.7	350	0.4
Sugarcane	1055	1.1	735	0.9
Sweet potatoes	2590	2.6	3788	4.5
Cotton	10531	10.7	6465	7.7
Groundnuts	238	0.2	794	0·9
Rice	14	0.01	20	0.02
Bananas	1000	1.0	980	1.2
Coffee	44	0.04	55	0.07
Sunflower				
Vegetables	515	0.5	499	0.6
Simsim	50	0.05	55	0.7
Cassava	6830	7.0	13277	15.7
Total %		99.9		100.7
District Total hectarage ploughed	98207		84358	
% of District Total Hectarage ploughed		38.9		33.4

APPENDIX 111

Computation of Growth Rates for Schools Using the Formula

$$\frac{P_2}{P_1} = (1+r)^n$$

where:

P_1 represents total number of schools at initial time

P_2 is the total number of schools at time two

n is the interval in years

$(1+r)$ is the annual rate of growth

(1) Estimation of Rate of Growth of Primary Schools in Kenya and Siaya

a) Kenya

1969 Total Number of Schools = 6111

1979 Total Number of Schools = 9622

$n = 10$ years

Therefore:

$$\frac{9622}{6111} = 1.57454$$

$$\log(1+r) = \log\frac{(1.57454)}{10}$$

$$= \frac{0.197153}{10}$$

APPENDIX 111 (continued)

$$\log(1+r) = \frac{0.197153}{10}$$

$$(1+r) = 0.0197153$$

$$1+r = 1.04644$$

$$r = .04644$$

Primary School growth rate is thus 4.644 percent in the past 10 years in Kenya.

b) Siaya: with n=6

$$\frac{404}{237} = 1.70464$$

$$\log(1+r) = \log\frac{1.70464}{6}$$

$$= \frac{0.231632}{6}$$

$$\log(1+r) = 0.0386054$$

$$1+r = 1.092963$$

$$r = 0.92963$$

Primary Schools growth rate is thus 9.296 percent for Siaya in the past 6 years.

(2) Estimation of Secondary Schools Growth Rates for Kenya and Siaya

a) Kenya : n=10

$$\frac{P_2}{P_1} = \frac{1721}{694} = 2.47983$$

APPENDIX 111 (continued)

$$\log (1+r) = \log \frac{2.47983}{10}$$

$$= \frac{0.39442}{10}$$

$$\log (1+r) = 0.039442$$

$$(1+r) = 1.09507$$

$$r = .09507$$

Thus, the growth rate for Secondary Schools in Kenya is 9.507 percent.

b) Siaya: n=6

$$\frac{P_2}{P_1} = \frac{55}{40} = 1.375$$

$$\log (1+r) = \log \frac{1.375}{6}$$

$$\log (1+r) = 0.0230504$$

$$(1+r) = 1.05451$$

$$r = .05451$$

r = 5.45 percent which is the growth rate for Secondary Schools in Siaya for the 6 years period for which data was available.

APPENDIX lV

Computation of Acreages Occupied by Physical Natural and Infrastructural Facilities in the District

Method A

Step (i) Total number of units multiplied by Standard acreage.

Step (ii) The sum of results is expressed as a percentage of district total area.

1. Acreage of Institutions

(a) Primary Schools

Total number= 404

Average acreage = 5 acres

Therefore total acreage of Primary Schools = 404x5

= 2020 acres.

(b) Secondary Schools

Total number =55

Average acreage = 26.25

Therefore total acreage= 55x26.25=1443.75 acres.

(c) Polytechniques

Total number=12

Average acreage = 17.5

Therefore total acreage = 17.5x12= 210 acres.

APPENDIX lV (continued)

(d) Nursery Schools

Total number = 214

Average acreage = 0.75

Therefore total acreage = 214x0.75= 160.5 acres.

(e) Churches

Total number = 258

Average acreage = 1

Therefore total acreage = 258 acres.

(f) Health Centres

Total number = 32

Average acreage = 1 acre

Therefore total acreage = 32 acres.

2. Roads

Total length in the district = 1107.5 kilometres

Average width = 0.006 kilometres

(i) Area= LxW=1107.5x0.006 km = 6.645 square kilometres.

L= length
W= width

(ii) Conversion to acre

6.645x247.105= 1642.0127

(iii) Total acreage of roads therefore is 1642.0127 acres

APPENDIX lV (continued)

3. Towns and Market Centres

Information on sizes of towns was based on Census reports and deductions were made of the already computed values.

(a) Yala town= 1 sq. km.=247.105 acres

Already computed acres =38.75

includes 1 Secondary School	=26.25 acres
2 Primary Schools	=10.00 acres
1 Health Centre	= 1.00 acre
Approx. road acreage	= 1.5 acres

Thus 247.105-38.75 =208.355

Therefore approximate acreage of Yala = 208.355

(b) Siaya Township = 5 sq. km.

Computed values = 41.75 acres

Converted total acreage of Siaya = 1235.525 acres

1235.525-41.75 = 1193.775

Therefore total acreage of Siaya = 1193.775

(c) Divisional Headquarters (3 in number)

Total acreage of 1 divisional headquarter = 46.621 acres

3 divisions therefore is 3x46.621=139.863

Acreage of all divisional headquarters = 139.863 acres

APPENDIX lV (continued)

(d) Market Centres

Total number =193

Average acreage = 2.5

Total acreage therefore = 2.5x193= 482.5 acres

N.B.

Local markets acreage are based on average estimations given the facilities present in such centres of which records are available.

4. Other Areas not Available for Cultivation

(a) Cattle dips

Total number =48

Average acreage =.33

Total acreage therefore = 48x.33 = 16 acres

(b) Tree Nurseries

Total number = 9

Average acreage = 2.5 acres

Total acreage = 22.5 acres

(c) Total area of reserved forest = 4285.0 acres.

(d) Fish Ponds and Dams

Total number = 343

Average acreage = 1.5 acres

Total acreage = 514.5 acres

APPENDIX 1V (continued)

(e) Chief Camps

Total number = 18

Average acreage = 0.75

Total acreage = 18x0.75= 13.5 acres

5. Estimation of Acreage of Homesteads in Siaya

Method B

To approximate the total acreage of homesteads in the district, the projection method had to be used in view of the limitations of available data.

Use was made of the 1969 Census Report Vol.111 which gave data on number of heads of households in the district. From this it was assumed that the number of heads is equal to the number of homesteads in the district. Although this may not be necessarily true, it represents a fair approximation as traditionally mature sons who are also heads of households have to move out of the father's homestead to start their own - thereby creating new homesteads.

The 1969 heads were then projected to 1979 using the growth rate of population for this period as data on number of heads of homestead was not yet available for 1979 at the time of writing.

APPENDIX 1V (continued)

Average acreage of a homestead was taken as 0.5 of an acre given that the kraals are situated within the homestead, this is a fair estimate.

Calculations:

1969 Census heads of homesteads =61635

Growth rate of district population = 2.16

Projection = $\frac{616.35}{102.16}$

Number of heads 1979= 62966.3160

Average acreage of homestead = 0.5

Therefore total acreage = 62966.316x0.5= 31483.158 acres

44129.414(acres) is the district total acreage occupied by all social developmental facilities and other natural and physical features (non-agricultural land). This represents 7 percent of the district total area.

Siaya's Projected Acreage to be Under Non-agricultural Use by the Year 1995

Formula used:

$$\bar{P} = P_o e^{rn}$$

where:

$\bar{P}$ = is equivalent to estimated total acreage

P_o = is equivalent to initial acreage

APPENDIX 1V (continued)

e is the base of the natural system of logarithm

n = number of years

$\bar{P} = 44129.414 \times e^{0.02x15}$

$= 59386.65$ acres

which represents 9.55 percent of total area of district.

Estimation of the District's Total Area Under Non-agricultural Use Assuming the Results of the Study by Jaetzold (1982)

16.67 percent of the total area of district

=103928.43 acres

Therefore $\bar{P} = 103928.43xe^{0.02x15}$

$= 134787.91$

which represents

21.617 percent of the district total area.

APPENDIX V

Projections for Arable Land Use Demands Under Different Sets of Assumptions

Method

Step 1 Total hectarage ploughed (annually or during the long rains) divided by the total population for the same year. This gives the cultivated ratio or hectares per person.

Step 11 Cultivated ratio multiplied by the total population for 1990.

Step 111 Application of the population projection formula $P_1 = P_o e^{rt}$ and substituting population values with hectarages.

$$r = \frac{\ln P_1 - \ln P_o}{t}$$

N.B.

Step 11 has used the medium projected population for 1990. Underlying all these steps is the assumption that land is held communally and so can be used freely without the restrictions imposed by the system of tenure in which land is individually held. This as we saw in Chapter 11, is not the case for Kenya and the district but it is a necessary assumption, when projections on arable land use are to hold.

APPENDIX V (continued)

(a) Projections on Arable Land Use Based on the Average Cultivated Acreage in Siaya

(i) Type 1 Projection

Population 1980 =516,000

Population 1990 =773,000

Average hectares ploughed during the long

rains (1980) = 46928.749

Step 1

therefore cultivated ratio = $\frac{46928.749}{516000}$ = 0.091 hectares per person.

Step 11

therefore in 1990 at a rate of 0.091

hectares per person total hectarage availed to

arable use during the long rains will be

773,000 x 0.091

= 70343 hectares

Step 111

$$r = \frac{\ln\left(\frac{70343}{46928.749}\right)}{11}$$

r= 0.0367957

r= 0.037

hectares therefore needed in the year 2000 = 1.037 x 70343

=72945.691 = 28.91 percent of the district

total area.

APPENDIX V (continued)

(ii) Type 11 Projection is

Based on average hectarage ploughed annually

of 70660.566 (1980)

Step 1

$$= \frac{70660.566}{516000} = 0.136939$$ approximately 0.137 hectares per person.

Step 11

1990

773,000 x 0.137 = 105,901 hectares

Step 111

$$r = \frac{\ln\left(\frac{105901}{70660.566}\right)}{11} = 0.0368$$

In the year 2000

1.037 x 105,901 = 109819.34 hectares

= 43.5 percent of district total area will be used for cultivation.

b) Projections on Arable Land Use Based on the Actual 1980 Cultivated Acreage in Siaya

(iii) Type 1 Projection is

Based on actual cultivated hectarage during the long

rains in 1980.

Step 1

$$= \frac{78914.267}{516000} = 0.153$$ hectares per person

APPENDIX V (continued)

Step 11

773,000 x 0.153 = 118218.47 hectares

Step 111

$$r = \frac{\ln\left(\frac{118218.47}{78,914.26}\right)}{11} = 0.0367$$

hectare needed in the year 2000

= 1.0367 x 118218.47

= 122474.33 hectares which is 48.5 percent of the district's total area.

Type 11 Projections

Based on actual cultivated hectarage during the year 1980.

Step 1

$$= \frac{118371.4}{516000} = 0.2294019 \text{ hectares per person}$$

Step 11

in 1990 hectarage cultivated will be

= 773,000 x 0.229 = 177,327.7 hectares

Step 111

$$r = \frac{\ln\left(\frac{177,327.7}{118,371.4}\right)}{11} = 0.0367429$$

In the year 2000:

1.037 x 177,327.7

184,066.15 hectares will be used for cultivation which is 72.95 percent of the district's total area.

APPENDIX VI

Calculation of Intensity of Grazing in the District

Method:

Step (i)

Total population of the different types of stock was extracted from the Monthly Report for March on animal production for the respective year.

Step (ii)

The populations of sheep and goats were converted to cattle equivalents on the basis of 1 cattle = 10 goats or 10 sheep, so as to have uniformity in stocking units.

Step (iii)

Area not available for grazing was subtracted from the division or district total area to get total area available to grazing livestock.

Step (iv)

Average carrying capacity of divisions and districts was got by superimposing the map of agro-ecological zones on administrative boundaries (ref. Map 1.2C) and identifying the major vegetation types and finding averages based on the number of identified vegetation types and their carrying cpacities.

APPENDIX Vl (continued)

Step (v)

Overall therefore the method used in the calculations below is cattle number or cattle equivalents multiplied by the average carrying capacity of the unit area; this is divided by 640 to convert from square miles to square kilometre. The result is then expressed as a percentage of the unit area.

Application of Method above

Step (i)

Data: 1972: Total number of livestock in district by divisions

Division	Cattle	Sheep	Goats
Bondo	107156	22668	29854
Boro	79536	27350	30600
Ukwala	70239	12000	30000
Yala	29359	4970	5250
Siaya	286290	66988	95704

Step (ii)

Cattle equivalents

95704 goats = 9570.4 cattle

66988 sheep = 6698.4 cattle

16269.2+

286290.0

Therefore cattle in the district = 302,559.2

APPENDIX VI (continued)

Total cattle in Boro = 85331

Bondo=112408.2

Ukwala = 74439

Yala = 68938

Step (iii)

Table on Area after a 7 percent Deduction in Square kilometre

Usual Area		Deducted Area
Bondo	975	906.75
Boro	613	570.09
Ukwala	526	489.18
Yala	407	378.51
Siaya	2523	2346.39

Step (iv)

Estimate of carrying capacity of Ukwala as an example.

$$= \frac{LM_1 + LM_2 + L/M + LM_3}{4}$$

Step (v) applied:

Siaya 1972

302559.2 x 1.9266÷640 x 2.6

= 582910.5 ÷ 2346.39 x 100 = 100.92 percent of the district's total area potential was under grazing.

APPENDIX V1 (continued)

Bondo (1972)112408.2 x 2.84 ÷ (640 x 2.6) ÷ 906.75 x 100

= 143 percent of Bondo's total area potential was under grazing.

Boro (1972)85331 x 1.93 ÷ (640 x 2.6) ÷ 570.09 x 100

=117.4 percent of Boro's area potential was under grazing.

Ukwala (1972) 74439 x 1.76 ÷ (640 x 2.6) ÷ 489.18 x 100

= 108.8 percent of Ukwala's area potential was under grazing.

Yala (1972) 68938 x 1.16 ÷ (640 x 2.6) ÷ 378.51 x 100

= 118.7 percent of Yala's area potential was under grazing.

Siaya (1979) 212817.1 x 1.9266 ÷ (640 x 2.6) ÷ 2346.39 x 100

= 70.98 percent of the District's area potential was under grazing.

N.B.

Step 11:

This conversion was facilitated by the availability of a standard international conversion unit adopted from Williamson and Payne (1961) p.80.

Step (iv)

Jaetzold and Schmidt (1982) have identified the dominant types of vegetation in each

APPENDIX V1 (continued)

agro-ecological zone and have further recommended a range of hectares that would support livestock units comfortably under natural grazing and improved pastures. Thus in the lower midland sugarcane zone which covers over half of Yala and Ukwala divisions, a head of cattle would require 0.5 hectares down to 0.13 hectares under improved pasture. The marginal sugarcane zone, are given a carrying capacity of 0.6-0.8 hectares per head of cattle on high grass savanna with hyparrhenia and panicum dominating: down to 0.15 hectares per livestock unit on improved pasture. This zone covers parts of Ukwala, Yala and Boro divisions;. In the lower midland cotton zone with two marked rainy seasons, 0.7-1.1 hectares per livestock unit on mixed savanna with star grass down to 0.2 hectares per livestock unit feeding on Napier grass and fodder legumes. This zone covers southern parts of Boro and northern parts of Bondo Division. There is a transitional zone i.e. the lower midland cotton zone with a medium and very short cropping season, in this zone 0.9 to 1.2 hectares are recommended per head of cattle. In the marginal cotton zone, a stocking unit requires 1-2 hectares down to 0.8 hectares when palatable shrubs are planted.

APPENDIX Vl (continued)

For purposes of this thesis, averages (as in Step iv) have been taken for the carrying capacity of pasture ranges given of unimproved vegetation. The rationale being that improved pastures occupy negligable[1] hectarages in the district and are mainly for the few heads of improved stock whose population fluctuates between 500-1500[2] within the district. This category of stock has been omitted in our computation.

APPENDIX Vl (continued)

Notes and References

1. From the Animal Production Reports, improved pasture in the whole district is estimated at between 20 to 30 hectares on average. This represents about 0.0099 percent of the district's total area.

2. These figures are provided in the Animal Production Reports for Siaya.

A. Computation of Growth Rates for the Various Divisions in Siaya Using Projection Formula

$$(1+r)^n = \frac{P_2}{P_1}$$

where:

$\frac{P_2}{P_1}$ represents a ratio figure for the total population

P_1 is population at time one

P_2 is population at time two

n is the number of years

r is the rate of growth whose value is found by reference to a table of logarithms.

(i) Boro Division

1969 Population = 91941

1979 Population = 117816

$$= \frac{117816}{91941} = 1.2814$$

$$\log (1+r) = \log \frac{1.2814}{10} = \frac{0.1077}{10}$$

$$\log (1+r) = 0.01077$$

$$(1+r) = 1.0251$$

$$r = 0.0251$$

or 2.51 percent per annum

(ii) Yala Division

1969 Population = 76664

1979 Population = 94030

$$\frac{P_2}{P_1} = \frac{94030}{76664} = 1.2265$$

$$(1+r)^n = 1.2265$$

$$\log \frac{P_2}{P_1} = n \log (1+r)$$

$$\log (1+r) = \frac{\log \frac{P_2}{P_1}}{n}$$

$$\log (1+r) = \log \frac{1.2265}{10}$$

$$= 0.08867$$

$$= 0.008867$$

$$(1+r) = 1.0206$$

$$r = .0206$$

or r = 2.06 percent per annnum

(iii) Bondo Division

1969 Population = 114387

1979 Population = 140253

$$= \frac{140253}{114387} = 1.2261$$

$$\log (1+r) = \frac{\log 1.2261}{10}$$

$$= 0.08853$$

$$= 0.008853$$

$(1+r) = 1.020594$

Approxim. 1.0206

$r = .0206$

or 2.06 percent per annum

(iv) Ukwala Division

$$(1+r)^n = \frac{P_2}{P_1}$$

$$\frac{122417}{99778} = 1.22689$$

$$(1+r)^n = 1.2269$$

$$\log \frac{P_2}{P_1} = n \log (1+n)$$

$$\log (1+r) = \frac{\log \frac{P_2}{P_1}}{n}$$

$$\log (1+r) = \frac{\log 1.2269}{10}$$

$$\log (1+r) = \frac{0.0888}{10}$$

$$\log (1+r) = 0.00888$$

$$(1+r) = 1.0206$$

$$r = .02066$$

or 2.07 percent per annum

B. Intercensal Total Populations Using the Growth Rates for the Respective Divisions above in the Formula below

$$\overline{P} = P_1 e^{rn}$$

(i) Example 1

1970 $\bar{P}$ of

Boro Division = $91941.e^{0.0251 \times 1}$

= 94278

Example 11

1971 $\bar{P}$

Boro Division = $91941.e^{0.0251 \times 2}$

= 96674

1972 = 99131

1973 = 101651

1974 = 104235

1975 = 106884

1976 = 109601

1977 = 112387

1978 = 115243

1979 is provided in Census Report

1980 = 120811

1981 = 123881

1982 = 127030

1983 = 130259

(ii) Yala Division Population by Years

1968 = 75101	1976 = 88556
1969 = 76664	1977 = 90399
1970 = 78260	1978 = 92280
1971 = 79889	1979 = 94030
1972 = 81552	1980 = 95987
1973 = 83249	1981 = 97985
1974 = 84981	1982 = 100024
1975 = 86750	1983 = 102106

(iii) Bondo Division Population by years

1968 = 112055	1976 = 132130
1969 = 114387	1977 = 134880
1970 = 116768	1978 = 137688
1971 = 119198	1979 = 140253
1972 = 121679	1980 = 143172
1973 = 124212	1981 = 146152
1974 = 126797	1982 = 149194
1975 = 129436	1983 = 152299

(iv) Ukwala Division Population by years

1968 = 97734	1977 = 117748
1969 = 99778	1978 = 120211
1970 = 101865	1979 = 122417
1971 = 103996	1980 = 124977
1972 = 106171	1981 = 127591
1973 = 108391	1982 = 130260
1974 = 110658	1983 = 132985
1975 = 112973	
1976 = 115336	

District Population by years

1968 = 375000

1969 = 383188

1970 = 391555

1971 = 400105

1972 = 408841

1973 = 417768

1974 = 426890

1975 = 436211

1976 = 445736

1977 = 453568

1978 = 465413

1979 = 474516

1980 = 484877

1981 = 495464

1982 = 506283

1983 = 517338

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