FACTORS AFFECTING MAIZE PRODUCTION IN NYANDO DIVISION, NYANDO DISTRICT, KENYA

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Dedication

This work is dedicated to my dear parents Mr. and Mrs. Maurice Onyanyo Obunga for the love and guidance they have given me to be what I am today.

ACKNOWLEDGEMENTS

I wish to extend my sincere thanks to Egerton University for giving me a chance to pursue postgraduate studies. My special thanks also go to a number of people without whose assistance, co-operation and understanding, this research would not have been a success. Many thanks are due to my supervisor, Dr. Maina-Gichaba, for his continued guidance, relevant suggestions and the tolerance he exercised during the entire period of the preparation for this work.

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Last but not least, I would like to thank my friends and colleagues at the Department of Geography for their fruitful discussions during every stage of this work and particularly, Mr. Ojode, for his assistance in preparation of maps for this work.

ABSTRACT

Maize is one of the most important cash and food crops in Kenya. However, in the recent past there has been a significant decline in its production. No study has been done to establish the reasons for its continuous decline in most parts of the country. This study sought to identify the factors that affect maize production in Nyando Division, Nyando District. Random and stratified sampling techniques were used to get a sample of a hundred farmers from which primary data was acquired using questionnaire interview schedule. The study also used secondary data extracted from government agricultural reports. Descriptive statistics such as means, frequencies and standard deviation were used in the analysis. In addition, inferential statistics such as multiple regression and chi-square were also used in the data analysis. The study identified the major limiting factors to maize production as inadequate income, extension service, labor and farm size. Other factors identified were unreliable rainfall amounts, low education level of farmers and lack of draft animals. Thus, for increased maize production in the study area, ways of increasing farmers' off-farm income and extension services should be sought to enable the farmers' use appropriate maize technologies. There is also need to stop further subdivision of land among family members. Land consolidation should equally be done in the whole division so as bring together good pieces of land that can be used for maize production. It is hoped that the findings of this study will be useful to policy makers on agricultural production not only in Nyando Division, but also in the rest of the country where similar conditions exist.

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List of Acronyms

FAO Food and Agricultural Organisation

AES Agricultural Extension Services

FTC Farmers Training Centers

MOA Ministry of Agriculture

ROK Republic of Kenya

CHAPTER 1

INTRODUCTION

1.1 The Background of the Study

Portuguese introduced maize into Kenya in the 18th century. For the last 80 years it has become a major food grain in Kenya. Today, it is by far the most important food and cash crop in Kenya (RoK, 1999).

Maize contributes 20% of the total national agricultural production, 25% of total agricultural employment and 44% of per capita calories intake (RoK, 1999). It occupies the largest area (22.6%) of the 5.5 million hectares devoted to farming (RoK, 1986). However, the bulk of acreage estimated at 1.4 million hectares, is in the small farm sub-sector that yields about 60 to 70% of total production. Maize is especially important in the low-income areas where the per capita consumption level (expressed in maize flour equivalent) is estimated at 125 kg per year per person for rural residents compared to 90 kg per year per person for urban residents (RoK, 1997).

Kenya's national food security is pegged on the availability of adequate supplies of maize to meet domestic demand. National demand for maize stands at 3 million tons whereas production averages around 2.4 million tons. According to FAO (1997), despite a marked 0.4% annual increase in demand, maize production has remained low and has been declining over the years. For instance, of the total world production of 500 million tons, Kenya's share has fluctuated between 2 and 3 million tons since 1985. Indeed, average maize yield in Kenya ranges between 1 and 1.5 t/ha, which is far below that of the developing countries of between 2 and 2.5 t/ha.

The crop can grow from the coastal belt up to 3000 metres above sea level. A successful maize grain harvest, however, depends on adequate precipitation, use of better seed varieties and good husbandry practices.

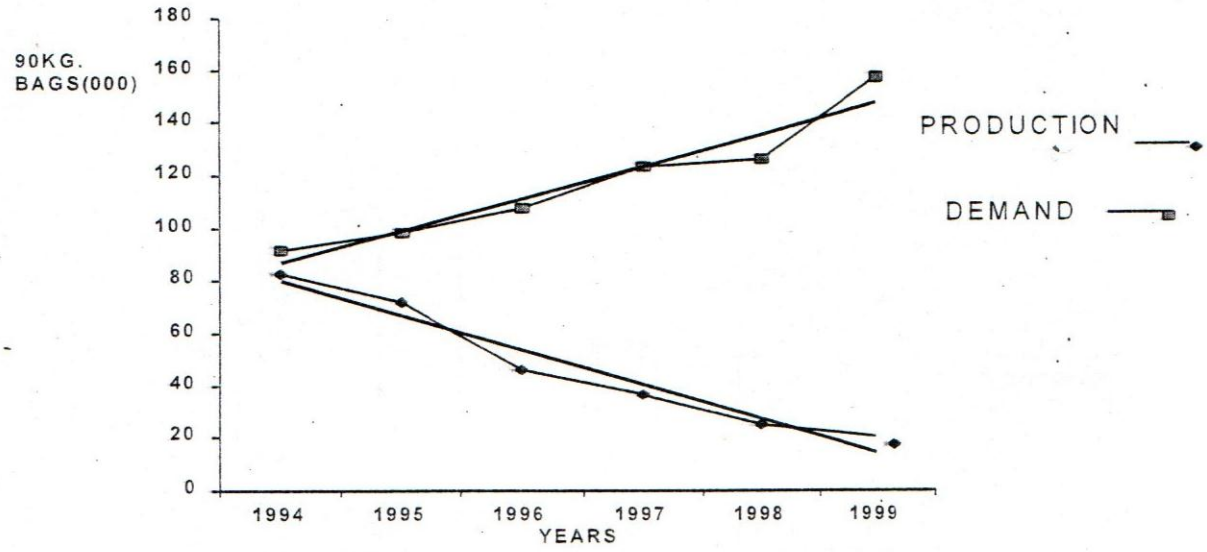
According to a government report on agriculture (RoK, 1997) there are about 30 maize varieties released for various ecological zones in Kenya to date. In addition the government is also committed to the training of extension staff for dissemination of better farming practices. However, there is still a wide variation in regional average yields within Kenya. The high potential areas of Uasin Gishu, Nandi, Trans Nzoia and Kericho Districts produce between 5-10 t/ha. The rest of the country, classified as low potential areas, produce an average of 1 to 1.5 t/ha.

This study attempted to find out the factors contributing to the low yields in Nyando Division and suggest possible ways of increasing maize production. It is hoped that the findings of the

study will be useful to policy makers and those concerned with agricultural production, not only in Nyando Division, but also in the rest of the country where similar conditions exist.

1.2 Statement of the Problem

Nyando Division lies within agro ecological zone with medium potential described as lower midlands two to four, (LM2-4) (Jaetzold and Schmidt, 1982). Available data indicates that maize yield has remained very low, and production, as compared to demand, has been declining in the division as shown in Figure 1.1. From this figure, it is clear that between 1994 and 1998, the production declined by over 60% while the demand rose by 44%. Moreover, maize is the staple food crop in the division and has an estimated requirement of 130,000-bag per annum. However, the current production is only 25% of what is required (RoK, 1997). This could partly explain food insecurity problems observed in the area (RoK 1997). Observations on fluctuation in maize production indicate that there is need to explore factors that affect its production. Such analysis may identify possible solutions to the problems that have led to the low production of maize in Nyando Division. This is particularly important since no study has been done in the area to either identify or establish the causes of maize production decline. This study therefore, attempted to identify and examine the factors causing the decline in maize production in Nyando Division.



Source: Ministry of Agriculture (1998).

Fig. 1.1 The trend of maize production and demand between 1994-1998 in Nyando Division.

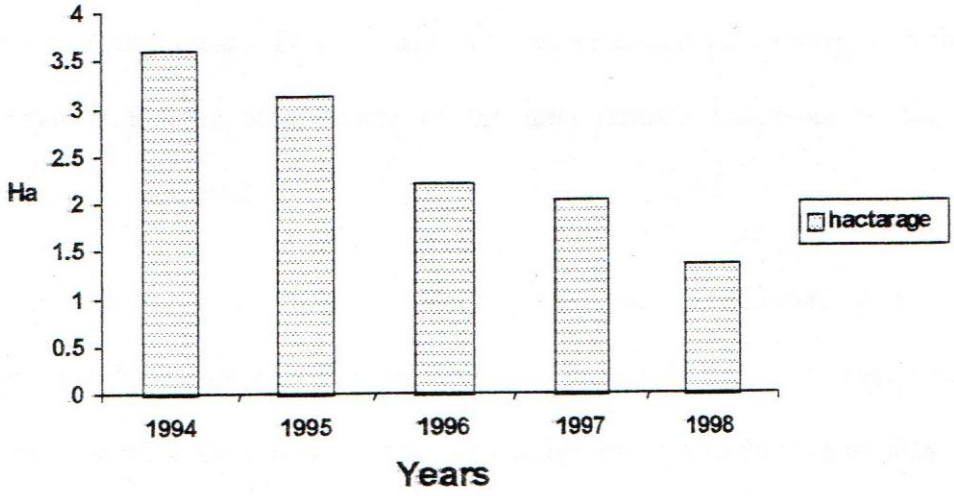
1.3 Justification and significance of the study

As already indicated, this study examines the factors affecting maize production in Nyando Division. The decrease in the production of maize in Nyando Division in the recent past has raised a lot of concern among the stakeholders.

As shown in Figures 1.1 and 1.2, there has been a decline in yields as well as in area under maize production. However, the consumption has remained high (Fig.1.1) in the division due to maize palatability and preference by majority of the people.

To ensure household food security, it is critical to establish factors that have resulted in the observed decline in maize production. The basis

of this study therefore is to investigate the causes of this decline in order to suggest ways of improving maize production in Nyando Division.



(Compiled from Unpublished Nyando Division Annual Reports 1994-98).

Fig. 1.2. The trend of land allocation per household to maize production in Nyando Division between 1994 and 1998.

Secondly past studies in Nyando Division have not adequately addressed the factors contributing to low maize production in the area. However, evidence in other developing countries particularly in Sub Sahara Africa, show that environmental and socio-economic factors are the major causes of low yields (Obara, 1983; ROK, 1995; ROK 1986; Adera, 1996; USAID, 1992 and FAO, 1997). The study by Adera (1996) recommends a further investigation on other climatic and non-climatic factors other than soil moisture. This

study was therefore geared at investigating such other factors, which would provide invaluable information for unanswered questions related to maize production problems.

Thirdly, the Kenya Government is currently attempting to effect measures aimed at accelerating agricultural production and alleviating poverty particularly in the rural areas (ROK, 1999). The poverty eradication plan may be impeded by lack of detailed information for some rural areas. This research is therefore essential in generation of the necessary information for the achievement of the government's endeavour to boost agricultural productivity in Kenya.

Attempt has been made in this survey to elucidate in greater detail the influence of various factors on maize production with a view to showing how they could be used in maximising agricultural output of small holders. It is true that with proper attention to the level of farming in the small-scale sector, the sector can be monitored to produce well above subsistence level and thus help in improving the living standards of the rural people.

This study was therefore important and timely since it seeks to address food security situation, fill the existing information gap and provide the necessary information for poverty alleviation in the rural areas.

1.4 Study Objectives

The general objective of this study was to contribute to the understanding of the factors that influence agricultural production with particular reference to maize production in Nyando Division. The aim was to establish a relationship, if any, between the climatic and socio-

economic factors on maize production in Nyando Division and to suggest ways in which maize productivity can be increased in the Division. To achieve the broad objective, the following specific objectives were identified:

i To establish the influence of rainfall on maize yields;

ii To examine the household production resources and identify the socio-economic factors affecting maize production.

1.5 Hypotheses of the study

Maize production is a function of environmental and socio-economic factors; hence this study was based on the following hypotheses:

H_{01}. Variability in annual rainfall amounts received during the growing season does not account for the variations in maize yields in Nyando Division.

H_{02}. Small-scale farmers in Nyando Division do not have adequate incomes, draft power, labor, agricultural extension services, farm sizes and education necessary for increased maize production.

1.6 Scope of the study

Maize production in any area is a function of environmental and socio-economic factors. The environmental factors are both physical (climate and soil) and biological factors while the socio-economic factors are human and economic. In order to identify the causes of observed maize production decline, it was important that all the factors involved in the production be examined. However, due to time and financial limitations only a few of these factors were examined in this research including rainfall, labor, education, income, agricultural extension services, and draft-power and farm size. Maize crop production levels were based on the current technologies that are recommended by the agricultural extension system. The assessment of the effect of rainfall on maize production was limited to spatial variability in rainfall amounts received in Nyando Division. Based on agro-ecological zones and vegetation characteristics, the Division was divided into two, North and Southern regions. The two regions receive completely distinct rainfall patterns. The dependent variable for the study was maize yield, while independent variables were rainfall amounts, labour, income, draft power, land sizes, education and managerial practices such as weeding, and planting dates.

1.7 Assumptions of the study

This research was based on four assumptions namely: that farmers in Nyando Division were experiencing constraints in maize production; that the farmers interviewed provided truthful and accurate information; that farmers in the Division were increasingly growing maize since it is their staple food crop; and lastly that the rainfall stations, Ahero and West Kano effectively represent Northern and Southern regions respectively.

1.8 Definition of Operational terms

Agricultural Production

Farming practices where crops are the main products. Has also been used in this study interchangeably with maize production and food production.

Agricultural intensification

Use of farm inputs such as fertilisers, hybrid seeds and mechanical power such as tractors and draft in agricultural production process.

Draft power

Refers to animal power used in ploughing. In this study it is used to refer mainly to oxen used in ploughing.

Farming System

Stable arrangement of farming enterprises that households manage according to well-defined practices in response to physical, biological and social environments in accordance to household goals, preferences and resources.

Household

A person or group of persons generally bound by ties of kinship, who normally reside together under a single roof or several roofs within a single compound. The word has been used interchangeably with family and farmers.

Improved Farming Practices

Use of recommended farm inputs (e.g. hybrid seed and fertilizer) and techniques such as crop rotation, plant spacing and population.

Rainfall variability

Differences in seasonal and annual rainfall pattern over space.

Small Scale Farmers

Holders of less than 5 (ha) of land. (CBS, 1982).

Stakeholders

These include the key players in maize production sector in Nyando Division. The main ones among these are the farmers, the government of Kenya and the agricultural extension staff.

Maize production

This is used to refer to a process where farm inputs such as fertilizer, seeds and labour are used on the farm under the influence of environmental factors to get maize yields. It has been used interchangeably with maize yield.

Standard production theory

The theory states that the household farm output is a function of farm inputs used in the production process. In this study maize yield (output) was seen as a product farm inputs used in maize production process that is influence by environmental and socio-economic factors.

CHAPTER 2

THE STUDY AREA

2.0 Introduction

In this chapter the location of the study area is presented. The physical and socio-economic characteristics of Nyando Division are also discussed. Lastly the agricultural situation of Nyando Division, which is the basis of this study, is also discussed.

2.1 Location and Size

Nyando District is one of the twelve districts that make up Nyanza Province. The district has six (6) divisions among them Nyando Division, with Awasi Town as the District headquarters.

The present study covered Nyando Division whose location is as shown in Figure 2.1. Nyando Division is bordered to the West by Kadibo Division, North by Miwani Division, South by North Nyakach Division, and South East by Buret District in the rift valley province and west by Kisumu District in Nyanza Province. The division covers an area of 295 km^2, 29500 (Ha) of which, 236 km^2, 23600 (Ha) form arable land and the remaining 59 km^2 consist of irreclaimable hills, swamps and infra-structural features such as roads. It has five (5) locations and eleven (11) sub-locations as shown in Figure 2.2.

2.2 Topography

The study area falls in the Kano Plains which is located on the floor of the minor rift valley between the Nandi and Kendu Bay Escarpments to the North and South respectively

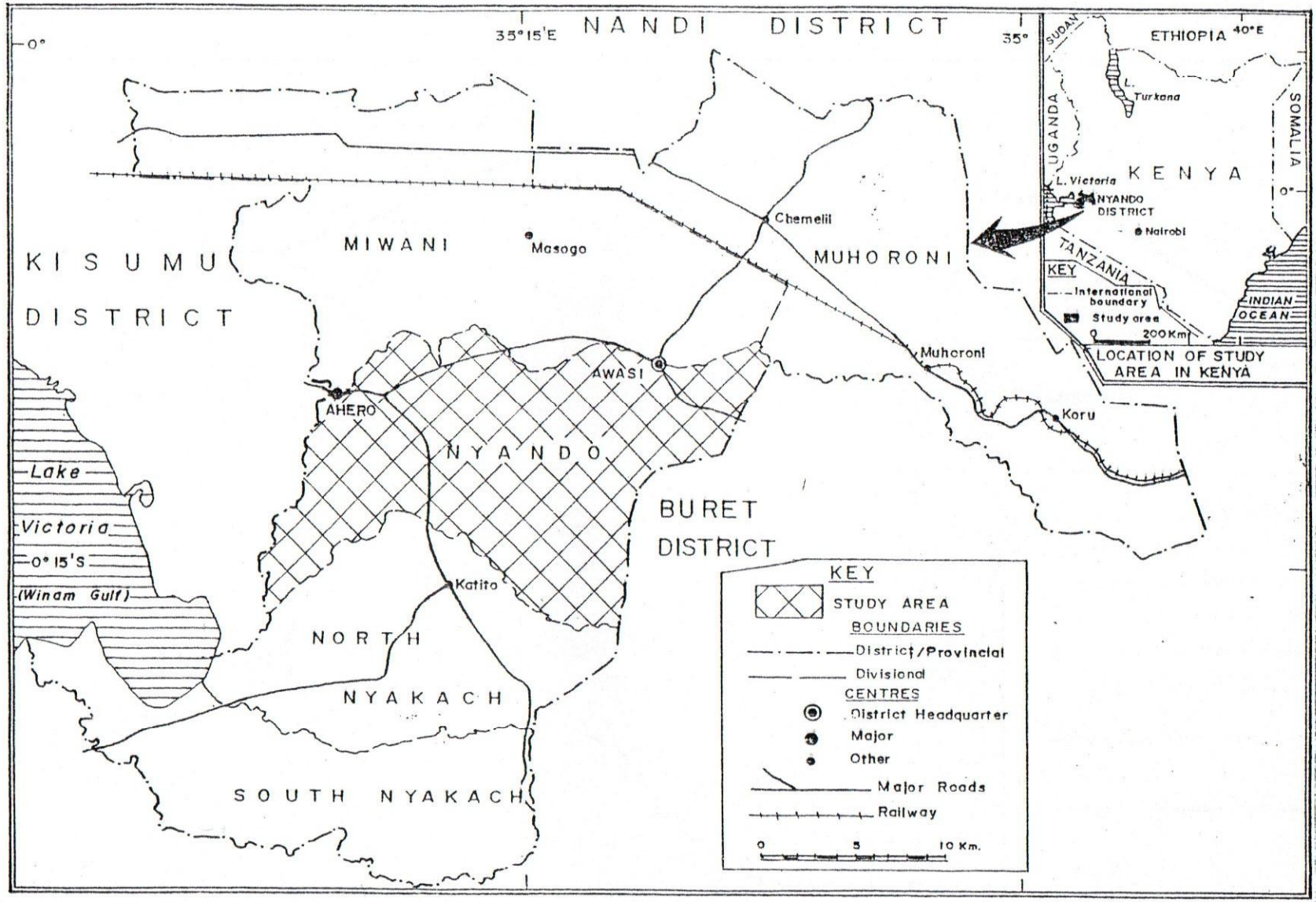


Fig. 2.1 The location of Nyando Division in Kenya and in Nyando District

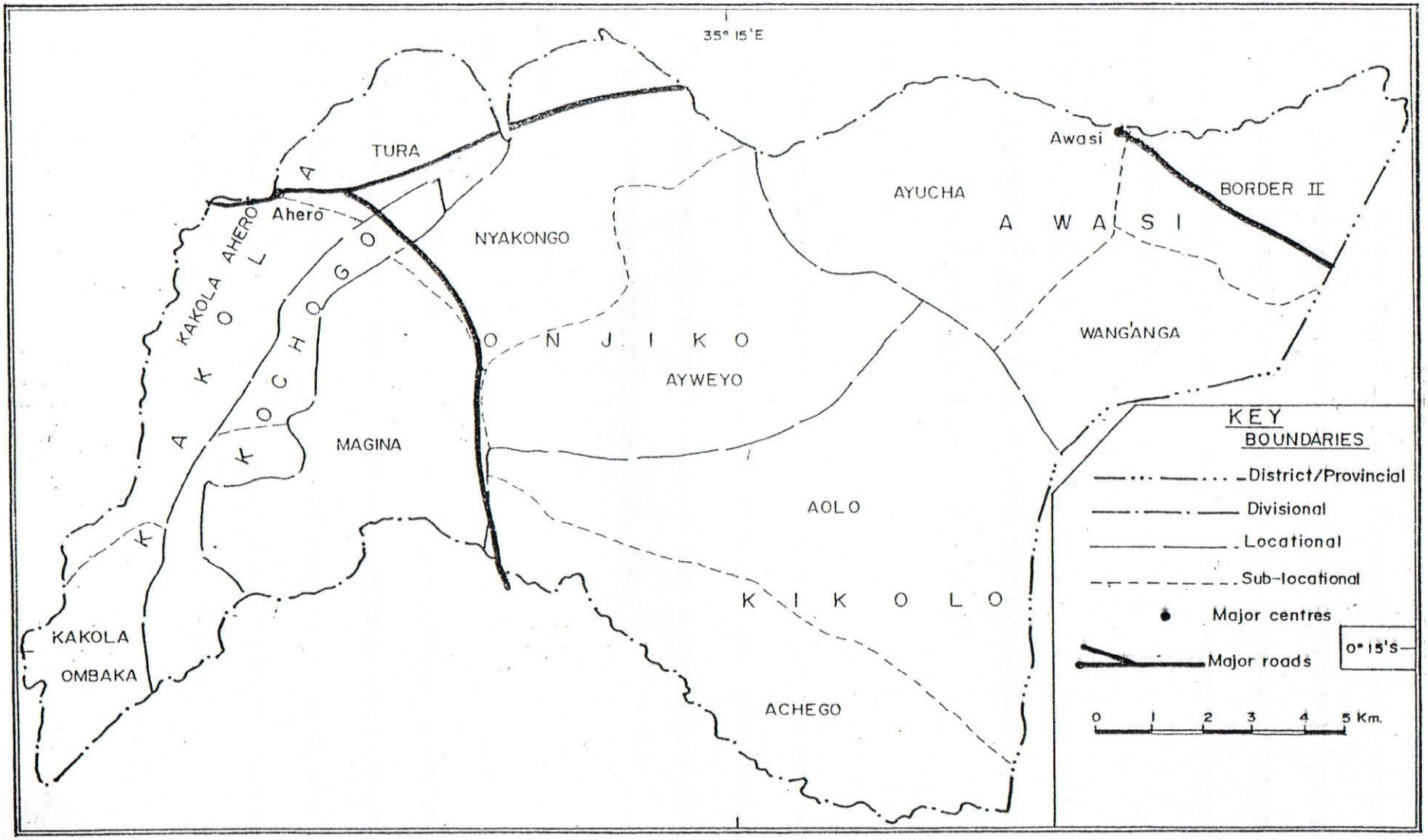


Fig. 2.2 Shows the administrative units of Nyando Division

(ROK, 1997). The plains are relatively flat with land slope varying between 0-1 degree with limited micro relief features such as paddy ridges at Ahero, termite hills and camber beds for sugarcane. The region however slopes in a westerly direction towards Lake Victoria while the foothills of the Tindret Hills form a natural boundary to the east. The landscape consists of a wide alluvial plain traversed by a number of rivers.

2.3 Climate

The climate determines the pattern of human settlement and agricultural production. It is with this realisation that climatic conditions in the area are hereby examined.

2.3.1 Rainfall

There are two rainy seasons (months) separated by dry seasons in Nyando Division. The rainy seasons are further subdivided in to long and short seasons respectively. As illustrated in Figure 2.3, the long rainy season occurs during the months of March to May, while the short rains season occurs between November and December (LBDA, 1992).

In the Kano Plains where Nyando Division falls, different climatic conditions prevail. Towards Winam Gulf, the shoreline of Lake Victoria reaches almost 100 kilometres inland. Consequently the zone of low precipitation near the lake curves eastwards over the study area. However towards the Nandi hills and Buret district (Kericho highlands), there is a zone of high precipitation. Rainfall in the study area is therefore influenced by Lake Victoria, and to some extent by the Nandi hills. Thus, in general the division can be divided into two rainfall regions as shown in Figure 2.4. The average annual rainfall in the area ranges from

600-1400mm depending on the distance from the lake and the elevation of the terrain and its proximity the Nandi Hills.

The average monthly rainfall over 16-year period (1982-1997) illustrated in Figure 2.3 below shows a significant monthly variation (LBDA, 1992). The area receives long rains during the months of March, April and May. The short rains start in October through to December. The monthly long rains are generally above 70mm while the short rains have an average of 60mm. There is however generally no dry month.

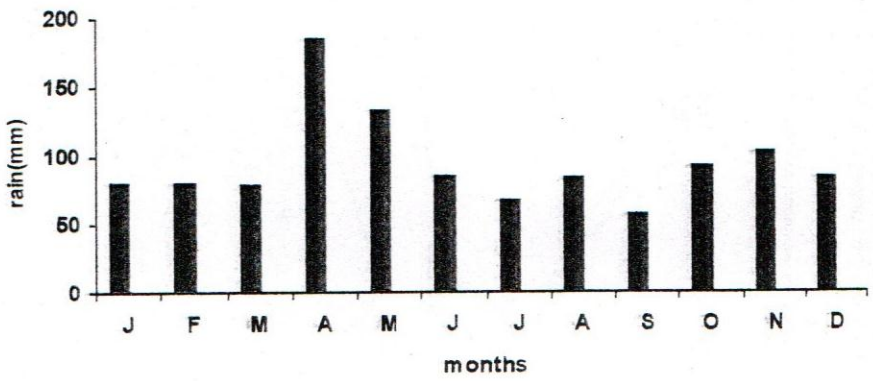
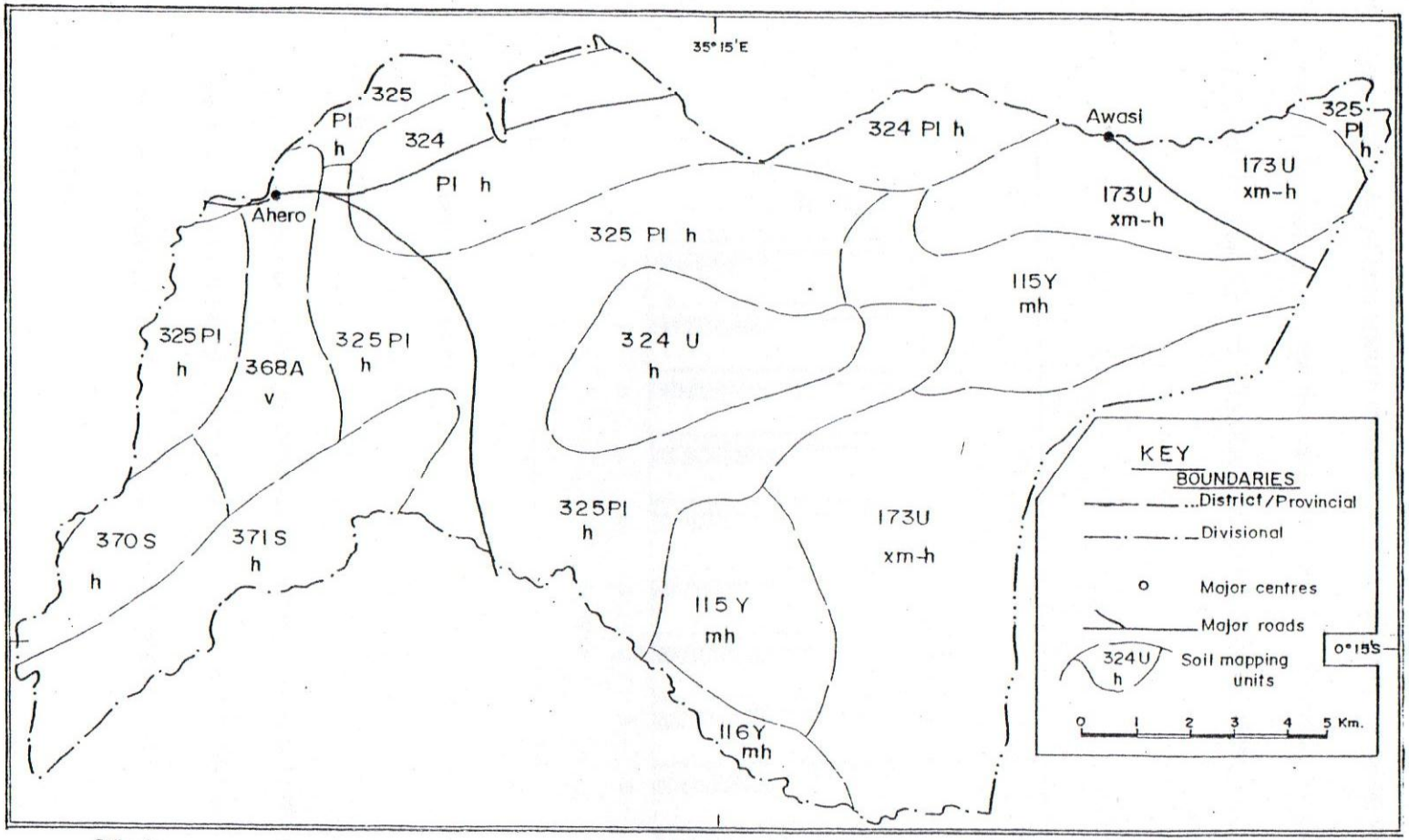


Fig. 2.3 Mean monthly rainfall in Nyando Division between 1982 and 1997

2.3.2 Temperature and Humidity

Temperature range in Nyando Division is between 34^0 C maximum and 15^0 C minimum. The annual mean maximum ranges from 27^0 C to 34^0 C and the annual mean minimum ranges from 14^0 C to 18^0 C. The lowest temperatures are experienced during the long rains while highest are during short rains especially in December and January (LBDA, 1992).



Soil units

324PI Poorly drained , cracking clay , shallow to deep, brown to dark grey- chromic vertisols.

325PI Poorly drained, dark grey to back, firm, cracking clay, dep sub soil- pellic vertisols.
370S Poorly drained, deep, firm, cracking, black-gleysols
371S Poorly drained, deep, grey to black, firm clay, acidictop soil- humic gleysols.
173U Well drained morately deep, red, firm clay-chromoiuvic phaeozems
115Y Poorly drained, very deep, dark grayish brown, firm clay- planosols.

Soil texture classes

h- heavy m-medium x-stony or boulders mh- medium to heavy

Fig 2.7 The soil types Nyando Division.

The high temperatures in the area often lead to high rates of evaporation or evapo-transpiration during the short rains and thus interferes with the cultivation of rain-fed annual crops. The seasonal trend of temperature is characterised by its widely ranging variation (Figure 2.5). The relative humidity in the area also varies between 55-75% while the annual mean evaporation is 2200 mm (Annual Reports West Kano Irrigation Scheme, 1999).

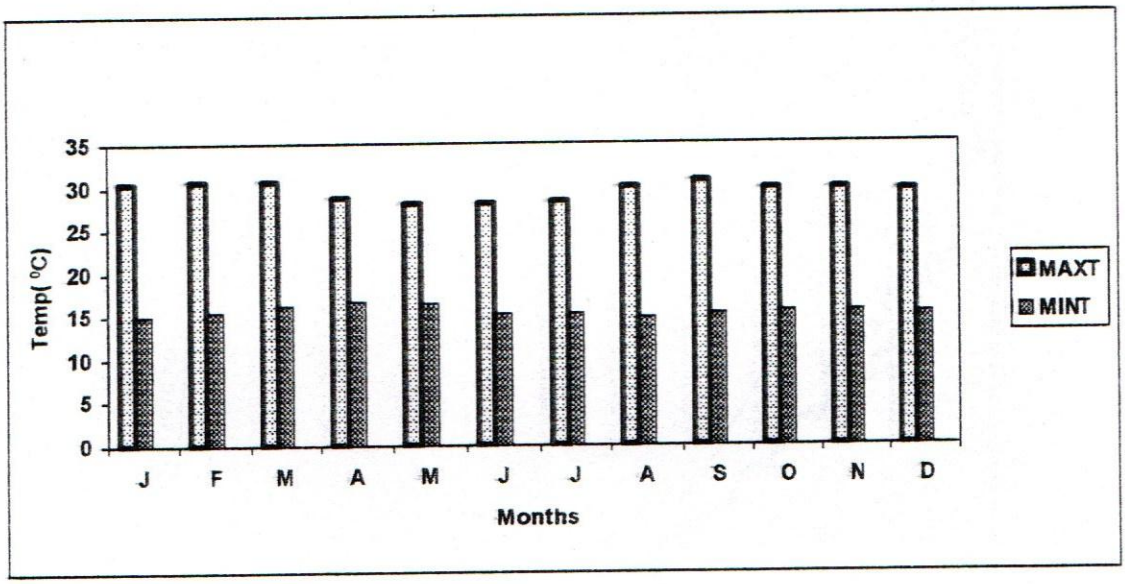


Fig. 2.5. Maximum and minimum temperatures for Nyando Division.

2.4 Drainage

There are three main rivers in the division, namely Nyando, Awach and Nyaidho. The minor rivers, which are seasonal in nature, include Oroba and Nyangeta (Figure 2.6). The seasonal rivers especially Oroba often have interrupted flows and are filled with water during the wet periods only.

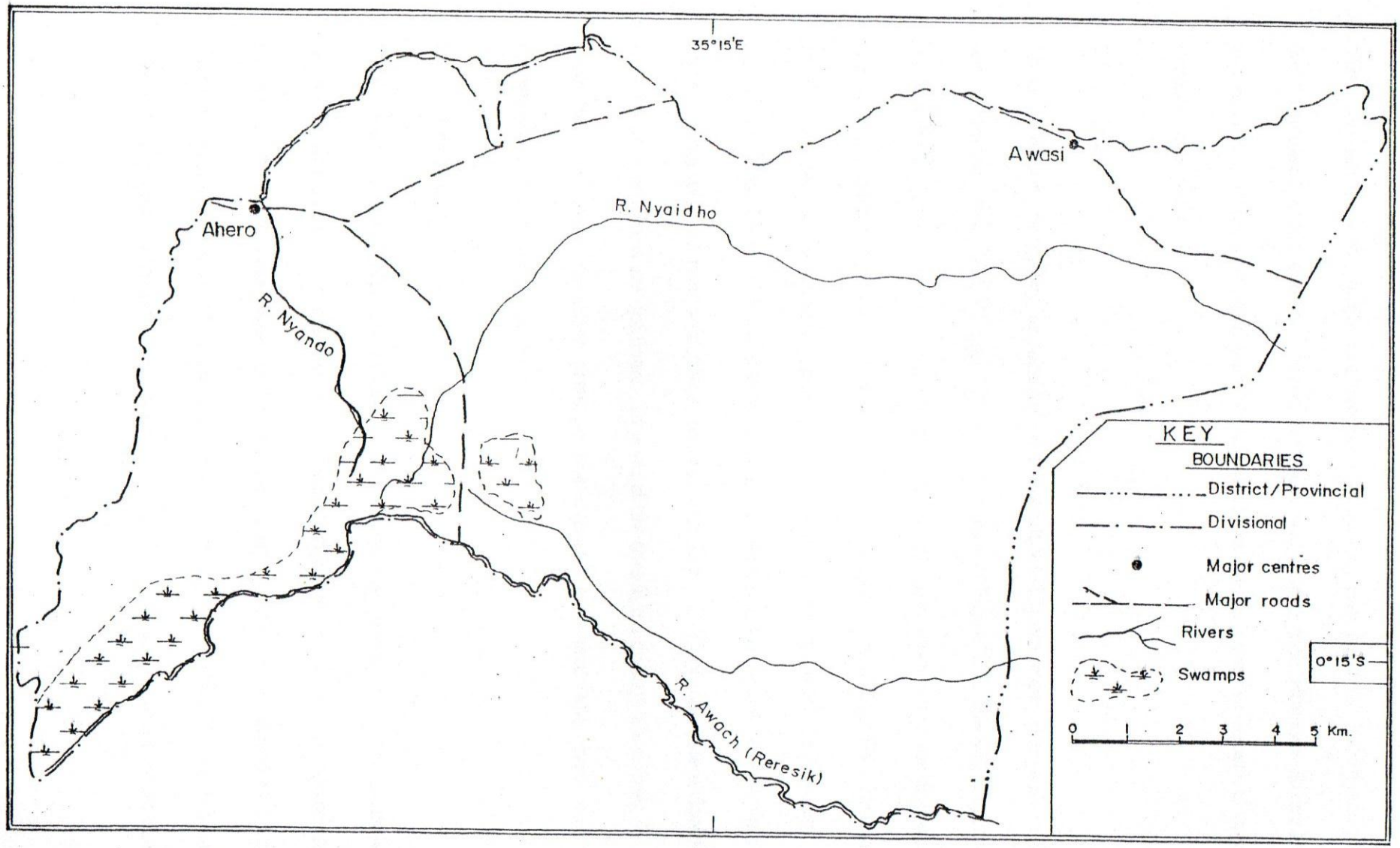


Figure 2.6 The drainage pattern in Nyando Division

The rivers are, however, important agriculturally as they provide water, for irrigation of rice and horticultural crops, and for livestock and domestic consumption. However, Rivers Nyando and Awach are often associated with floods, which results into extensive damage to crops and buildings and roads.

2.5 Soils

Nyando Division, according to Jaetzold and Schmidt, (1982) has mainly plain soils of former lake sediments (units 324 P1 and 325 P1) as shown in Figure 2.7. The soils have high to moderate fertility but subject to water logging. On the southwestern part of the division, these soils are associated with swampy areas and are mottled (370S and 371S). They have variable fertility and also show water logging. Slightly above the plains on the Eastern part of the division are upland soils with variable topsoils and moderate to low fertility (173U). On slightly higher topography, on piedmont plains, alluvial soils (unit 115Y) of moderate to low fertility with drainage problems are dominant. In general the soils in the division are suitable for maize production, however, the poor drainage characteristic associated with them makes land preparation and cultivation difficult and costly.

2.6 Vegetation

Until recent decades Nyando Division was covered by remnants of Savannah woody vegetation dominated by *Acacia ssp.* and scattered *Blamites Egyptian*. Other species such as *acacia sayal*, *A. camplacantha* and *A. fistula* could also be sighted scattered within the different locations depending on the availability of water and suitability of soil (Odhiambo, 1996). This vegetation has now been modified mainly by human activity to the extent that

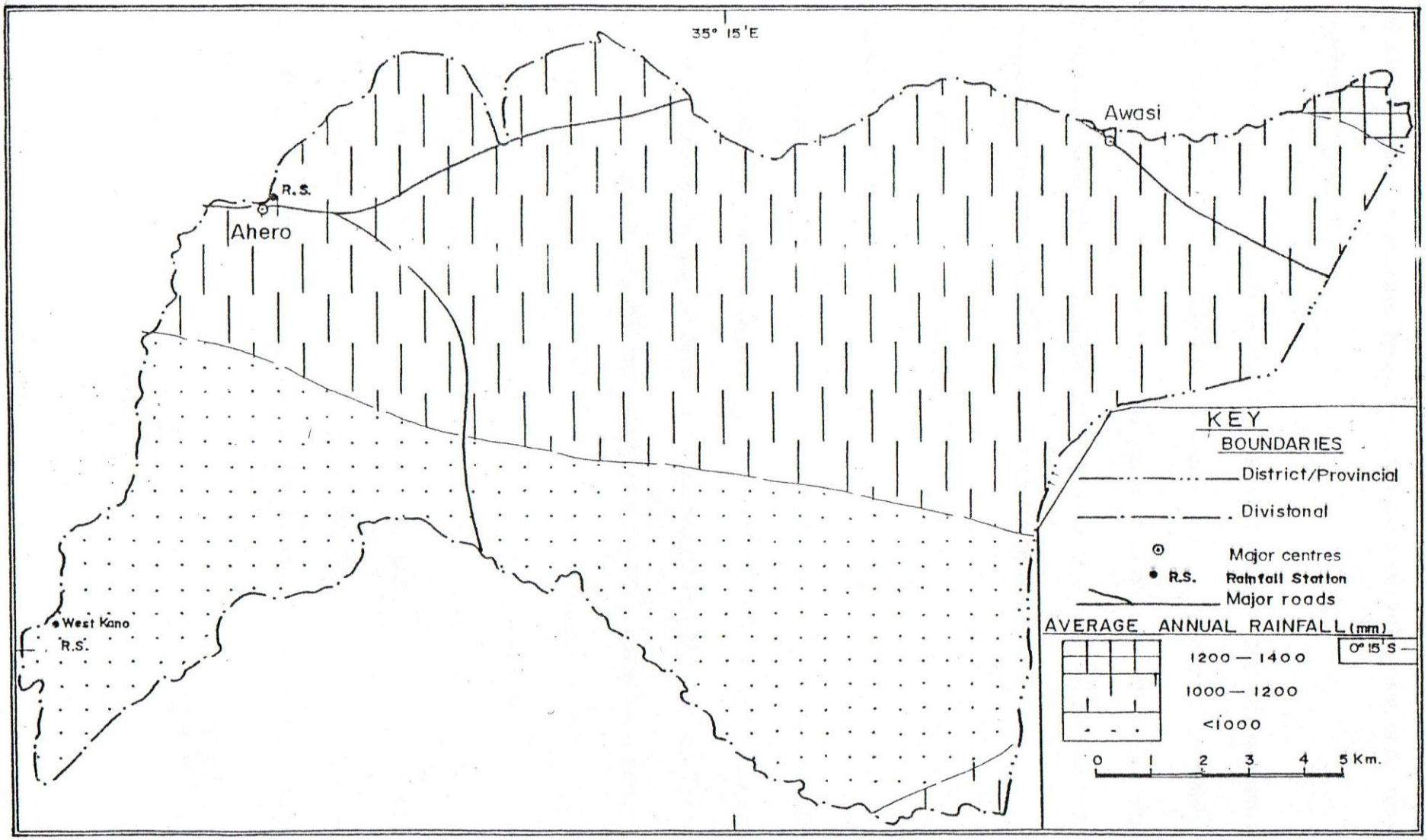


Fig. 2.4 Rainfall pattern in Nyando Division.

What now remains are scattered thorny woodlands and occasional sightings of the tree species *euphorbia candelabra*.

The division is also covered by papyrus marshes and scattered swamps while depressions have reeds and grasses. The relatively higher lying areas with slightly better soil permeability have bush and trees characterized by acacia and grasses. Sisal and scattered trees are also found around the homesteads. Most of the vegetation is able to survive well since there is water, adequate sunshine and, in most cases soils are fertile (Odhiambo, 1996).

2.7 Socio-economic Characteristics of Nyando Division

2.7.1 Agricultural Practices

As mentioned earlier agriculture is the main economic activity in Nyando Division. The Luo community who are the main inhabitants of the division live in homesteads scattered across the countryside, they till the soil and weed mostly using the hand hoe. The women do most of the agricultural work. Increasingly since the 1920s, animal drawn ploughs have also been used though not extensively. A large variety of cereals such as maize, sorghum, finger millet and root crops are grown. In recent decades, white maize has become the dominant and preferred grain. Moving uphill from the shores of the Lake, the common crops grown are cotton, sugarcane, and cassava. The cattle, traditionally cherished by the Luos, are kept and herded by men while women and children help in looking after goats and sheep. Other livestock in most households include donkeys for pack loading and chicken.

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2.7.2 Population, Settlement Pattern

Nyando Division is inhabited predominantly by the Luo community except in the trading and administrative centres where non-Luos are found. The population in the division has been increasing yearly as follows: In 1998, population figures indicate a rise of 1.6% from 1997 while in 1999, the population figure stood at 105,060 (RoK 1999). Majority of the people are below 50 years and many are female. Currently the population density in Nyando Division is estimated at 340/person per ha. According to Jaetzold and Schmidt, (1982), 5 ha. of medium potential agricultural land per person is considered the minimum requirement to maintain soil fertility under the present level of technology. The average land sizes in the region (2 ha) far are far below the minimum requirement. This implies that the population pressure on land resources in the division is already too high. Therefore, unless remedial measures are taken the population growth in the area may continue and lead to pressure on land for maize production.

Moreover, the rapid population growth in the division has thus altered the farming activities resulting in a more intensive land use. At the same time it has led to more scramble for income off the land. Rural-urban and rural-rural migrations are therefore important in supplementing incomes and diets throughout the division (Obara, 1983).

The settlement pattern in the area is characterized by a concentration of scattered homesteads on the higher grounds. The physical conditions and frequency of floods primarily influence this pattern. Settlement also competes with agriculture over land use as most settlements are established on slightly raised grounds where maize crop can do well. Although the traditional lay out is still being observed in the area, increasing population density has narrowed the possibility of putting up new homesteads. Presently, homesteads are much smaller than in the

past as they are frequently subdivided due to increasing number of maturing sons. Consequently, cultivation in the area around each homestead has become a problem, further worsening the maize production in the area (ROK, 1995).

2.7. 3 Land Tenure System

A complex system of rights and obligation define traditional tenure arrangement in the area. Accordingly, the control and access to land rights were based on lineage principle, whereby land was held and used collectively by the "jokakwaro" or lineage group. Land rights passed from the family head to the male descendants (Odhiambo, 1996). Land registrations have however resulted in considerable changes in the land tenure arrangements. Further commercialisation of agriculture through introduction of cash crops as well as land transaction have led to a more skewed distribution of land, leading to reduction of land for agriculture (ROK, 1995). Although the land tenure system still prevails in the area, the system has shown signs of changes through the Land Registration Act.

Traditional land tenure practices have also been changing in the area. New rules have been created on the basis of which the lineage leaders could solve land litigation cases. More important, however, was the shift of power over land tenure systems from the lineage group to household head that acquired a much greater control over its use. The resulting individualisation of land tenure has led to a considerable buying and selling of land, a process that affected a significant number of farmers and their families. In some cases, household heads have been enticed to sell all or a major portion of their land leaving their families with insufficient land.

2.8 Agro-ecological zones of Nyando Division

According to Jaetzold and Schmidt, (1982), the arable lands in the country can be divided into (four) agro-ecological zones based on annual rainfall figures. These include the high potential zone (annual rainfall 1000-2200 mm), the medium potential (700 - 1800 mm), the low potential (short scanty rainfall duration and the coastal strip with humid belt and saline soils.

Nyando Division is situated within the medium potential (from lower midland two to four, LM2-4) land as shown in Figure 2.8. in this area. The region has three main crop zones, i.e. the sugarcane zone, the cotton zone and the marginal cotton zone. In this zone, mixed farming involving cultivation of several crops and keeping of animals is practised. Medium varieties of maize such as katumani, which can be grown in two seasons a year, are appropriate in this area. The inhabitants are able to cultivate both cereals and legumes as well as keep a variety of livestock (RoK, 1999).

2.9 Farming in Nyando Division

Agriculture is the main source of income of the majority of the working population within Nyando Division. Arable agriculture mainly focuses on production subsistence crops such as maize beans, sorghum and millet. Maize together with millet form the local staple foods and occupy about one third of the total area under cultivation. Sorghum, sweet potatoes, vegetables and cassava are also widely grown by almost all-farming households for subsistence (ROK, 1995). Food crops are grown in small quantities.

In addition a number of commercial crops such as rice, sugarcane and cotton are cultivated. Rice, cotton and sugarcane are the most important cash crops in the area. However, the poor

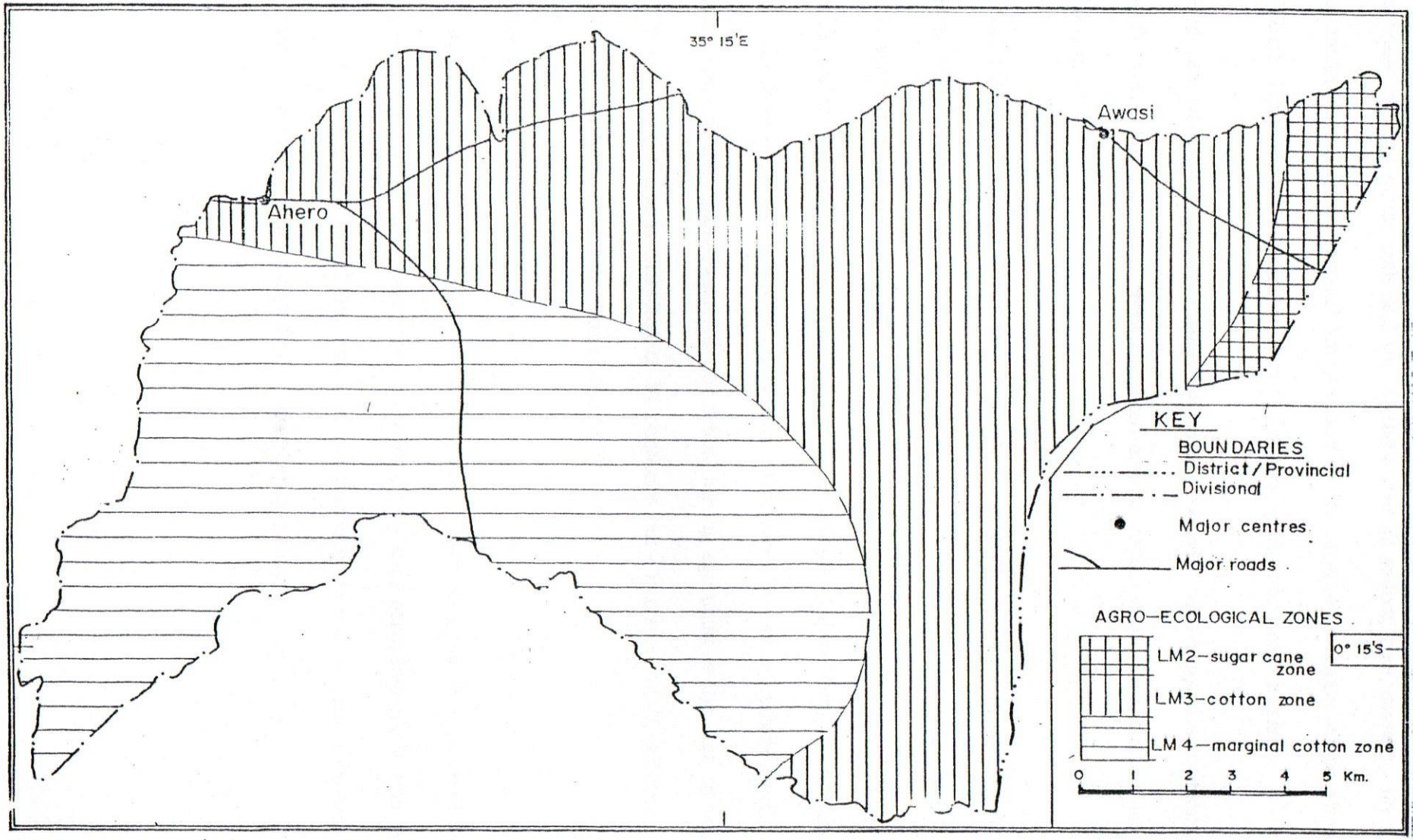


Fig. 2.8: The Agro-ecological Zones in Nyando Division.

drainage capacity of the soils and the unreliable rainfall pattern, poor marketing and low payments, as well as the general low standard of crop husbandry hamper cotton growing (Obara, 1983). These problems have resulted in poor yields of cotton per hectare.

Both cash crops and food crops (mainly maize) are produced over the limited agricultural land in the area. The rest of the crops cultivated cover relatively small area and are of limited importance.

Stock raising also plays an important role among the originally pastoral Luo. The small-scale farmers supplement their subsistence and cash income to varying extent, with regular and irregular off-farm income activities. These activities are mainly limited to casual labour on the neighbouring large-scale sugar plantations, irrigation schemes and the farms of individuals. Nyando Division has a large working population. However, there are few possibilities for the employment of the rapidly expanding population, leaving agriculture as the main employer. Consequently, the area is characterized by continuos out - migration, which deprives it of agricultural labour, skills and innovative ideas (ROK, 1995).

Table 2.1 shows the yields for major crops between 1995 and 1997 for Nyando District as a whole. The data underline the importance attached to cash crops at the expense of food crops with rice, sugarcane and coffee occupying a very large percentage of the total land devoted to agriculture. The Table further shows that as hectare under cash crops such as cotton increase, the hectare under food crops especially maize reduces.

Table 2.1 Crop production in Nyando District

Crop	1995		1996		1997	
	Ha	Tons	Ha	Tons	Ha	Tons
Sugar cane	31797	95926	32012	1308835	24177	431129
Cotton	3411	597	4509	1498	4985	1026
Ground nuts	829	596	1228	773	1690	1032
Fruits vegetables	2170	22432	2289	25013	2808	31018
Maize	5138	32698	13965	28907	12069	26069
Sorghum	8813	11826	8256	11192	8660	8540
Beans	3931	3537	3420	2462	3679	1177
Rice	2767	11132	2983	11186	3260	12225
Root crops	174	19174	2091	19256	2636	23218
Coffee	176	646	190	87	6190	244
Total	60806	198564	70943	1409209	70154	535678

Source: Ministry of Agriculture (1998).

2.10 Farm Management Practices in Nyando Division

The cropping pattern on smallholdings in Nyando district as a whole shows a predominance of food- crop cultivation for subsistence purposes. However, cash crops such as rice and sugar cane dominate in the few commercial farms in the area.

There are two farming seasons, during the long rains and the short rains. The main crops grown in the area include maize, sorghum rice and sugarcanes. With the exception of sugarcane these other crops are cultivated under small-scale for subsistence.

The farmers in Nyando Division practice mixed where the farmers are keep livestock along side with the production of crops. The main livestock include cows for milk and ploughing while the crops grown are mainly for subsistence use and to a limited extent commercial.

The farmers also practice inter cropping. Sometimes up to four crops are grown per farm. Although this technique does not lead to a high output per farm, for each crop, it is a form of spreading risks, which is well adapted to the climatic conditions of the area. For the crops grown, the seeds are usually taken from the previous harvest. Most of the inputs are generally applied on cash crops at the expense of food crops.

A variety of tillage methods are used in the division. These include manual with hoes and draft power and mechanical where tractors are used. However the mechanical tillage method is used to a very limited extent since it involves costs which majority of farmers could not meet.

Almost all farmers in the division do not apply farm inputs such as fertiliser and certified seed. The soils are assumed to be fertile and hence do not require the use of such inputs.

CHAPTER 3

LITERATURE REVIEW

3.0 Introduction

In this section literature on the factors affecting agricultural production with specific reference to maize, have been reviewed. Studies conducted in Kenya and in other developing countries, particularly in Sub Sahara Africa, have showed that environmental and socio-economic factors are major causes of low agricultural yields (Obara, 1983; RoK, 1997; RoK, 1989; Jaetzold and Schmidt, 1982; Adera, 1996).

3.1 Environmental factors affecting Agricultural Production

The environmental factors include both physical (climate and soil) and biological factors. Past studies in Nyando Division (Adera, 1996 and Obara, 1983) found that soils and biological factors did not have much influence on agricultural production in the area and recommended an investigation on socio-economic and other climatic factors particularly rainfall variability.

3.1.1 Rainfall and its Variability

According to Riebsime (1989) rainfall determines not only the spatial extent but also the duration of agricultural activities. The pattern of rainfall distribution varies in time and space (Mollar, 1996, Fosbrook, 1973, Summer, 1984, Jackson, 1985). Not only do annual, seasonal and monthly rainfall amounts depart from average conditions in individual years but also the ways in which they differ vary from area to area. For a particular

period, rainfall can be well above average in one region but below average in another (Jackson1985). Thus even when large areas such as Nyando Division can be described as rainy, in reality the rains will comprise cells of often-intense rain separated by areas of dry conditions of only light falls or no rainfall at all.

These aspects of rainfall variability have been found to exert a great influence upon agricultural systems. According to Wangati (1984) and Odum (1971) rainfall variability determines the agricultural potential of any region in terms of crops to be produced, farming systems to be adopted, the nature and sequencing of farming operations and the targets to be achieved in agricultural activity. Odum (1971) further notes that variability of the amounts and duration of rains closely influence farmers' cropping strategies. In regions where most agricultural production relies on seasonal rainfall, the variation in the timing and quantity of the rains determines agricultural crop performance. According to Mollar (1996), variability at the start and end of the rains is particularly important in agricultural production in areas with marked seasonal regimes. Timely planting and adequate amounts of soil moisture are essential for good performance of crops during the growing season and eventually good yields (FAO, 1975).

The variability in amounts of rainfall also affects performance of crops and hence farmers' willingness to allocate more resources to the production of a given crop (Riebsime, 1989). Studies carried out in humid and semiarid tropics show that rainfall variability determines the technology adopted in agricultural production (Fukui, 1979; Mattei, 1979).

Besides determining the daily program of the farmer, FAO (1997) and Steiler, (1989) found that rainfall also controls the spread of fungal diseases, insects and pests, which can affect crop growth.

In India, Mooley, (1981) found that variability in the seasonal rainfall affected crop production negatively. The impact of marked deficit was stressful on plants while that of marked excesses normally resulted into floods with associated crop damage. The study revealed that in some parts of India rainfall is above average and while at others it is either below average, marginal or nil. In the former there was sufficient water for growing of some kinds of crops while in the latter there was either provision for irrigation or drought resistant crops through dry farming techniques According to Williamson (1980), a variability in excess of 20% implies a great risk to farming.

Variations in rainfall amounts from year to year and even from season to season, when frequently marginal in amounts, become critical for agriculture since high-yielding crops can be less tolerant to fluctuations in water supply. This is because the small-scale operations of the peasant farmer and their limited resources in terms of irrigation make such marked variations particularly significant.

Thus, the variations in rainfall can be of sufficient magnitude to create considerable differences in crop yield even over small distances, one farmer or village having a good year while another only a short distance away experiences average poor years. The degree of localization of rainfall has therefore been regarded as a point in favor of differences in

yields on peasant holding (Mattei, 1979). However the magnitude of such local variations in rainfalls is not normally appreciated and even if they are accepted, satisfactory conditions nearby may promote disbelief. This may be illustrated by a quotation from an official report in Kenya 1999, which states that:

> 'It is only better class of leaders who do not do so (report famine). He only appeals to the administration when the affairs go beyond his control. There is of course the whining class of leaders who immediately upon a partial shortage of food in his area reports famine' (RoK, 1999).

Thus only a few local leaders act on the impact of localization of rainfall while most others do not even appreciate the impact of such local variations.

3.2 Socio-economic factors affecting Agricultural Production

Agricultural production is not only a function of rainfall variability but also Socio-economic factors. The socio-economic factors which have been identified by many scholars include, farm inputs, education, agricultural extension services, farm size, income and labor (USAID, 1982; FAO, 1997). In this section a review of literature on how these factors affect agricultural production is presented.

3.2.1 Farm Inputs

Farm inputs refer to the implements used on the farm during production process. These include seed, fertilizers/manure, labor and mechanical power. Use of farm inputs has been at the heart of capacity of the world agriculture to respond to the challenges arising from the explosion of the world population. While agricultural practices continue to expand,

there would be little arable land for agriculture, hence the need to develop and promote farm inputs that increase or sustain productivity (Dillon, 1984).

For the East African countries, Kenya in particular, the physical challenge to increasing agricultural growth and reducing rural poverty is formidable. There is little high potential agricultural land not already being cropped or grazed. Intensification of land use using high quality farm inputs such as fertilizer, improved seeds, improved farming practices such as timely weeding and planting, plant spacing, is the only available option in most areas (RoK, 1986; Pant, 1993). The potential in the better-endowed areas of Africa are said to be five to ten times the actual productivity per hectare, if only the available farm inputs were applied by the farmers (Dillon, 1984).

Empirical support for the theory of technological innovations (farm inputs) has generally been positive. In Japan, with rising land scarcity associated with population pressure, the course of technological change was directed at raising land and labor productivity in agriculture. Similarly, a regression analysis carried out in United States over the period 1980-1990 showed that increased technology in agriculture led to an increase in agricultural output (Schwartz, 1992).

In Kenya and other developing countries, the role of farm inputs in promoting agriculture in has been increasingly recognized. Increase in agricultural productivity demands high levels of production efficiency, use of farm inputs such as tractors, high yielding variety seeds, chemicals, bio-fertilizers; and technical knowledge (Uchandu, 1975). Indeed

mechanical, biological and chemical inputs are the basic parameters of modern inputs influencing farm production. However, the presence of these factors in terms of quantum, quality and price varies spatially, affecting the relationship between them and their effects on the development of individual farms. At the same time, each of the factors does not only depend on availability but is influenced by technical, economic, social and environmental conditions, which may or may not permit its utilization and its substitution by another factor.

That is, despite impressive results of using the technology, attempts to introduce new technology in Kenya and East Africa in general have been disappointing. Goal, (1983) in a review of technology for subsistence farmers, noted that the East Africa community is divided over the issue of availability of technology bringing a substantial increase in smallholder production. According to the study, agricultural technology suffers from problems of equity and failure in achieving stability and sustainability in production. Furthermore, there is evidence of diminishing returns from intensive production with high yielding varieties (Governed, 1990).

However, according to Jackson, (1985), the low adoption of modern technology by most small scale farmers in East Africa could be attributed to their' conservative nature. The traditional systems under which they operate have evolved over very long periods of time taking environmental conditions including disasters into account. Hence farmers have valid reasons for maintaining the status quo until they are convinced that change will benefit them.

Norman (1995) listed mechanical power, fertilizer/manure, seed, and management practices such as crop rotation, timely planting and weeding as the main factors that control crop production in any given environment.

3.2.1.1 Draft Power and Mechanical Power

More efficient farm implements such as "draft" power and tractors play a useful role in agricultural production especially as labor saving devices. They raise the per hectare yields by making possible more intensive cultivation and application of biological and chemical technologies. Thus use of such technologies can increase the area cultivated. Moreover, by using them a farmer can be more effective. For instance, in developed countries, by applying such technology, less than 10% of the economically active population provides food to the entire population compared to over 70% in developing countries, yet the national food supply in developing countries is still inadequate to meet the existing demands. Unhand and Anthony (1975) further notes that in cases where rainfall characteristics are not the main cause of decrease in yields, use of such technology can improve agricultural production.

3.2.1.2 Fertilizer/Manure

Yields can rise in most situations through the use of fertilizer and herbicides. The use of fertilizer is particularly important in tropical regions (Kenwar, 1976). Most soils in the tropical regions, especially in the low rainfall areas are of low fertility and almost universally deficient in nitrogen (N_2) and phosphorus (P_2O_2). Sulphur deficiency is also common in most parts of Africa where annual rainfall exceeds 600 mm. Use of fertilizers

in such areas may be the only option for increasing crop yields. For instance experiments of cultivators' fields with maize in semi-arid India have given average gains of 14 kg of grain per kg of N_2 and 7 kg of grain per kg of P_2O_2 (European Service Program, 1980).

3.2.1.3 Farming Practices

Farm management practices such as timely planting, timely weeding, agrochemical applications, harvesting and post harvest yield management have great influence on yields. According to FAO (1975), planting early when the rains start will generally ensure good yield in most areas. Soils also become cold after being wet (rainfall) making germination almost impossible.

In addition, timely weed control measures are also important in both soil conservation and in avoiding competition with the standing crop. A study by Brian (1971) showed that poor weed control could reduce crop yield by 50% or more. The use of herbicides or weeding reduces the loss caused by such weeds. For example, the rate of return for maize in Kenya has been estimated to be between 40-60%. Such returns imply that investment in agricultural technology should be implemented in areas where they are lacking. Also storage of crop with pesticides reduces the loss that could be caused by pests.

3 .2.1.4 Seeds

According to Lake Basin Development Authority (1992) report, the use of high yielding seeds increase crop yields per hectare. The study showed that areas with short growing seasons require first maturing seeds and that improved seeds varieties and hybrids often

have better yields than local varieties. Accordingly Walden (1978) observed that new varieties of maize and other common crops have strong positive response to fertilizers and hence agricultural production. For example the introduction of hybrids in mid 1960s in Kenya really changed production per hectare. These seeds which include coast composite (low altitude), Katumani (medium altitude ASALs) and Kitale hybrids (high altitude increased maize yields in various regions of the country. After liberalization in the 1990's there are also varieties of maize seeds from Tanzania and South Africa.

Even though these inputs may be available, many of them need considerable on - station adaptive research and infield testing before they can be described as viable. Much more research effort is essential to tailor technology to socio-economic and environmental requirements of the farmers. In many parts of mid -Africa, such inputs as improved seed varieties only exist at research stations but not on farmers' fields (Walden, 1978).

3.2.2 Education

Formal education is not in itself a sufficient condition for development of agriculture, but it is certainly a necessary condition. Nearly all elements of agricultural development are based on improvement in labor force, which are intern the product of education (Saito and Spurling, 1992). Saito and Spurling argue that formal education enhances ones ability to receive, decode and understand information, and that information processing and interpretation is important for performing or learning to perform many jobs. In farming, the ability and willingness of persons to identify and apply the most relevant information is the basis for increasing output of crops.

According to World Bank (1991), formal education provides foundation for agricultural development. More educated farmers earn higher returns from the land than less or uneducated ones. Thus, increasing the average level of education of the labor force raises the GDP. In Swaziland, for example, it was found that four years of primary education increased the productivity of farmers by 8.7% overall and by 10% in cases where modernization was prevalent (Lockheed, 1980). Lack of educated farmers is therefore bottleneck to agriculture, and agricultural development programs have failed because they are ill conceived.

Given that education is of critical importance to agricultural development and that it does not require substantial capital, it is indeed fortunate that education is directly consistent with the ultimate objectives of the development process. Therefore to achieve increase per capita output to farm, formal education and training must be oriented towards use of efficient resources, development of decision-making ability and motivation for change.

3.2.3 Extension Services

Agricultural Extension Services (AES) play an important role in agricultural production (FAO, 1985). They bridge the gap between technical knowledge and farmer's practices and are generally cost effective. Extension services have significant and positive impact on farmers knowledge and adoption of new technology and therefore on farm productivity and rural incomes (Saito and Spurling, 1992). Indeed, AES have been identified to be directly related to agriculture as well as maize production. Farmers need to be trained on

proper utilization of inputs, credit and land preparation for improved agricultural production (RoK, 1981). Without technical assistance, information and training, farmers are limited in their ability to adopt new technologies and plant varieties. Most of the time they use low input cultivation techniques and by so doing reduce the intensity of cultivation. This results in lower crop yields and hence food insecurity (Owuor, 1995).

By providing informal education and advice to the farmers AES, helps in improving the efficiency of the farm business, increasing farm income and raising farmers living levels (FAO, 1985). The availability of AES is therefore a pre- condition to increasing productivity when other factors are held constant.

In Kenya, in most developing countries AES machinery is highly encouraged but other intervening factors such as FTEs' are not focused on small-scale farmers ((FAO, 1985, RoK, 1997). The government, due to financial constrains wants to become just a regulator. Hence the farmers do not know what exactly to do even if they had the required resource for agricultural production. Moreover, the training facilities are not available or too few for the farmers who are seldom appropriately informed of the necessary agricultural inputs to apply. Extension services are normally directed to the most progressive farmers with an expectation that the adoption will trickle down to the small-scale farmers. However, under conditions of "dualistic" development, agricultural innovation is rarely communicated in this direction (Lockheed, 1980). Furthermore, the farmer training centers (FTC's), which could be utilized for group extension methods, are not able to fill the classes. In most parts of the country, the centers usually work at less

than 50% capacity due to poor advertisement (RoK, 1997). The majority of farmers who fill these classes are not real farmers but agricultural officers, traders and generally men with high status in society. It should also be noted that FTCs often do not include the women who are the "farmers" in practice. This defeats the purpose of farmers training centers in Kenya.

3.2.4 Farm Size

Land is the most important production asset that determines the distribution and access to food in rural areas. Production among rural households is closely linked to land ownership and size (FAO, 1989). There is, however, a minimum land holding necessary for subsistence agriculture and this may vary from country to country. The minimum land holding is the minimum area needed to employ a family to satisfy its nutritional requirements, and to produce a basic income. The same piece of land can produce varying income depending on the cropping pattern; intensity of land use, rainfall pattern and technology employed (FAO, 1989).

Many scholars are of the view that farm sizes normally determine how economical adopting innovations are, particularly where cash inputs are involved. According to USDA, (1982), using fertilizer on small-scale farms produces higher yields than on large ones. This is largely because of the intensity by which small holding farms are worked (Goal, 1983).

There is an inverse relationship between farm size and farm productivity. The relationship is attributed to inherent soil fertility and quality (Kampen, 1980). Senderson and Roy, (1979) on the other hand, disputed this explanation and sought to explain it in terms of higher labor input and lower labor costs on small farms. However, in western Kenya, Onyango, (1975), noted that large farms often have higher returns than the small farms. The farmers who adopted ox plough cultivation practices in the country had larger farms than those who use hand cultivation. However, Lele (1974) argues that while all things are equal, there was no evidence to indicate that small farms were less productive than large ones. But if the package of inputs, credit and extension reached both small and large-scale farmers in a similar fashion, marginal productivity of capital on small farms might be lowered.

In most less developed countries (LDCs), the highly unequal structure of land ownership is the single most important determinant of the highly uneven distribution of rural income and wealth (Todaro, 1985). Todaro cited above therefore asserted that land size has a significant influence on crop production, which in turn, determines rural income.

Despite the growing importance of land in agriculture, increasing number of people in developing countries find themselves without sufficient food to feed their family or worse, without land at all (Owuor, 1995). It has further been observed that at the time when total agricultural output in LDCs is declining as the population growth expands (3.2% overall and as high as 4% in some countries), concern over future capabilities of agricultural land to meet the demand can not be over emphasized. Many scholars agree

that in order to minimize further land subdivision that reduce food production, there is need to check on population growth. Other scholars, however, blame the policies of most LDCs that encourage the cultivation of cash crops at the expense of food crops, for the reduced food production (Onyango, 1975).

Similar studies conducted in Kenya confirmed that land sizes devoted to cash crops among small-scale farmers as opposed to food crops differ significantly. The size of land per household devoted to cash crops was more than that devoted to food crops (Jaetzold and Schmidt, 1982). Farm size is therefore an important factor in crop production and should not be ignored in the measures aimed at increasing agricultural production.

3.2.5 Income and Credit

Adoption of technology involves incurring costs that can prove expensive to the farmer. Off-farm and on-farm income as well as credit serves as a source of capital for farm households. According to Berlett (1978) and Bhalla (1979), farmers adopting new technologies are usually those who can afford to experiment with new technologies. Mbithi (1973) in his study on dissemination of agricultural technology in Kenya found that the adoption of new farming practices and the purchase of farm inputs needed for farm productivity, were positively related to the level of an individual income.

3.2.6 Labor

Several studies have demonstrated that labor is an important factor in agricultural production (Jackson, 1985; Kamunga, et. al., 1989). Labor indeed is essential in understanding food production dynamics particularly at the household level (Kamunga, et.

al, 1989). However, the demand for labor for agricultural production, especially food crop production often clash with other activities. In the case of Zimbabwe, it was observed that most of the farmers in low rainfall areas were involved in off -farm activities (Kamunga, et. al., 1989). Similarly in Tanzania Jackson (1985) observed that labor demands for off - farm income tended to clash with the labor required for crop production. This deprived the farms of the labor especially during the critical periods such as planting and weeding hence influencing agricultural production negatively.

In agricultural production, labor demands for cash and food crop cultivation has also been found to clash especially during the peak farming periods. Owour, (1995) noted that in Mumias, farmers attend to sugarcane cultivation most of the day to the extent that they have very little labor time left for food production. The labor available for cash and food crop production coincide resulting to decline in food crop production since the majority would opt for cash crop production. Similarly, Mose (1996) study on socio-economic factors affecting maize food production in Kenya found that small-scale farmers in Western Kenya spent more time in the rice production activities as compared to maize production. There is therefore need to address labor issue in food production especially among small-scale farmers.

3.3 Factors affecting Maize production in Nyando Division

From the Literature reviewed, it is evident that maize production is a function of both climatic and socio-economic factors. Therefore, to improve agriculture in Kenya and Nyando Division in particular, there is need to arrest the current decline in productivity

and capture possible gains from proven technologies within existing farming systems. Improvements in the incentive structure such as better pay from farm returns; better extension services and easy access to credit need to be instituted or to be part of the agricultural development policies/strategies. Secondly, a potential source of growth is to upgrade the performance of the existing farming units through technical change. This means using technology such as new plant varieties and better farming practices. A third option is to make agricultural technologies developed within the region more suitable for transforming subsistence farms into more commercial enterprises (Dillon, 1984). There is thus a considerable scope for improving traditional maize production systems through better farming methods, putting the environmental and socio-economic factors discussed above into consideration.

Past studies in Nyando Division, have not adequately addressed the issue of maize production in relation to environmental and socio-economic factors. These studies which include Obara (1983), RoK (1997), Jaetzold and Schmidt (1982) and Adera (1996) noted that environmental and socio-economic factors floods could be the major causes of low yields. A study by Obara (1983) revealed that parts of Nyando Division are intensively cultivated due to lack of alternative land. However the study did not offer suggestions on how the additional land or how the existing land under production could be made more productive in order to improve maize production in the division. Jaetzold and Schmidt (1982) found that less land is devoted to maize production as compared to cash crops. However the study did not determine the extent to which other factors such as labor, education, and draft power and rainfall variability influence maize production. Further

more, due to change in climate, the study may be outdated and therefore cannot be relied upon to explain the current situation. The study by Adera (1996) found that soil moisture was not significant in maize production. The study however failed to address other climatic parameters such as rainfall, its variability and reliability in relation to maize production but only recommended a further investigation on other climatic and non-climatic factors.

These scholars thus, did not give adequate attention to the effect of rainfall variability on maize production. Moreover they mostly concentrated on cash crops such as cotton, rice and sugarcane. This study therefore aimed at filling the existing gap by providing information on maize production in Nyando Division. An investigation of both climatic and socio-economic factors will clearly provide invaluable information for unanswered questions related to maize production problems.

3.4 Conceptualization of the Study

The study investigates the factors affecting maize production. From the literature reviewed it is evident that maize production in Nyando Division is influenced by rainfall variability and a number of socio-economic factors. The basic assumption is that the household maize production is positively related to aforementioned factors.

The study is based on the premise that households in Nyando Division practice subsistence farming. The conceptual framework guiding the analysis of farm household output as a function of rainfall variability, and socio-economic factors is explained in the standard

production theory (Ilbery, 1989). According to the theory, household's farm output (yield) is a function of farm inputs used in the production process. The inputs include extension service, labor, draft power, fertilizers and seeds. The production process which involves cultivation, planting, weeding and harvesting is however influenced by the farmer's characteristics (education, farm size and income) and environmental factors such as rainfall amounts (Figure 3.1). Production decision is normally made before each production process while allocation of production resources are based on returns (yield) from the field. In making production decision, farmers are not concerned with how much yield they expects to get from an acre of maize farm but what output (income) is likely to be repeated given their farming environment. As explained above the arrows in the figure (Figure 3.1) show the direction of influence. The factors mentioned under inputs are used in the production process to produce output (yield). However the output also directly affect the use of inputs as mentioned above. Rainfall amounts on the other hand affect the production process directly through its influence on farm sizes allocated to production and indirectly through its effect on inputs used in the production process. Rainfall also affects yields directly.

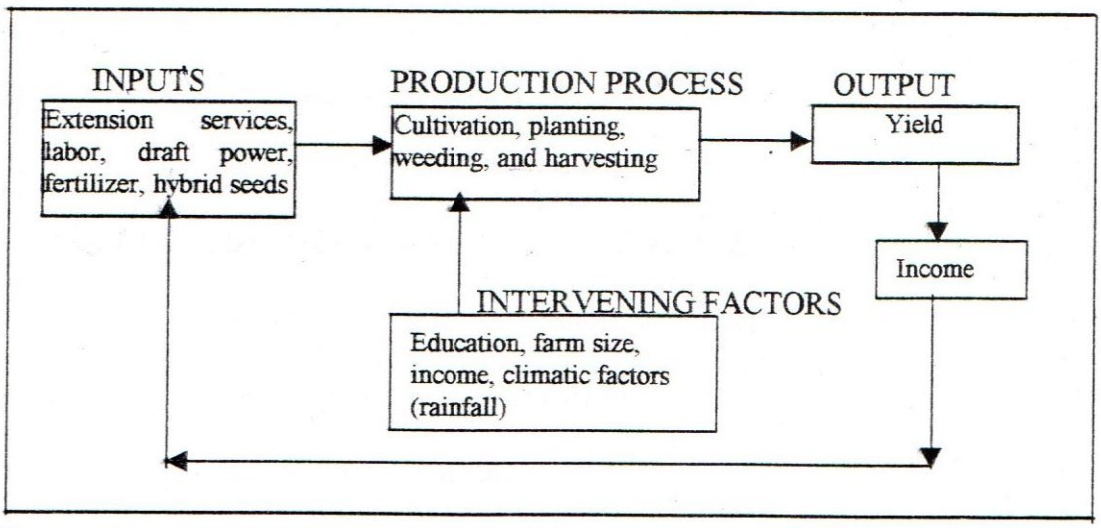


Fig. 3.1 Maize Production Framework

As can be seen from the figure above, maize production is assumed to depend partly on income. The income can either be from off-farm or from the farm. It is assumed that farmers generally invest any money at their disposal on the farm. Farmers who invest less in the farm are more likely to get low output. On the other hand, those who spend more in purchase of the required inputs are likely to receive higher outputs. Thus amount of money spent for crop production will be positively related to the production achieved. Low incomes restrict the farmers' use of improved farming practices; while high incomes allow farmers to use the required farm inputs and achieve higher yields.

Apart from income, production is also influenced by environmental factors mainly rainfall. Farmers cropping strategies such as levels and timings of input use and planting date are closely influenced by the amount of rainfall expected. The farmer will tend to invest more resources for the growing of maize if he/she perceives that the rainfall amounts will be adequate for the crop given that changes in rainfall amounts grossly affect production process and hence crops yield. Areas with high reliable amount of rainfall are therefore likely to have higher productivity than those with low rainfall.

The availability of labor is also a determinant of crop production. This is measured in terms of household composition and size. The number of adults available together with hired personnel can be used to estimate the labor hours spent on the farm for crop production. The higher the labor hours, the higher the maize production and vice versa.

Household production is also greatly influenced by the information available to the farmer. The main source of agricultural information is the extension programs. It is assumed that farmers with closer contact with extension staff are more aware of the appropriate farming practices and are likely to use them to increase yields. Farmers' deficient in such information most likely use low input cultivation techniques which result to low crop yields.

All production processes however takes place on land. Therefore the availability of arable land is of utmost importance. Farmers with larger farm sizes are likely to have higher yields unlike those with small farm sizes. Thus, the size of the farm determines the kind of farming practice a farmer adopts. Those with large farms easily adopt mechanized form of cultivation while those with small farms generally rely on "hand" use. The application of mechanized technology such as (ox plough), enables farmers to be timely on their farming practices.

Farm production is also influenced by education of the farmer. The more educated farmers are expected to get better yields.

The preceding conceptual production framework can be expressed mathematically as follows:

$$\mathbf{Y = f\,(F, L, I, S, R, P, E)}$$

Where Y-Maize yield, F-Farm size, L-Labor, I-Income, S-Extension service, R-Rainfall variation, P-cost of crop inputs, E- Education of the farmer.

CHAPTER 4

SOURCES OF DATA AND METHODOLOGY

4.0 Introduction

In this section the methods used in data acquisition and analysis are discussed. The main topics covered include; sampling, data sources, data analysis and the research limitations.

4.1 Sampling and Sampling Procedures

Sampling has been identified as a very important process by which a relatively small section of the populations is selected and analyzed in order to represent a population. This study is based on a sample of farmers in Nyando Division.

4.1.1 Sample Frame

A sample frame generally refers to a list of all the objects in a given population. Such a frame is useful in tracing all the objects to be included in the required sample. In this study, the population census list of the Nyando Division of 1999 extracted from the population office was used as a sample frame.

4.1.2 Sample Size

Nyando Division was ~~established~~ estimated to have a total of 14,000 households. The ideal sample size for such a population according to Kathuri and Pals (1993) is 375 households. However, due to time and financial constraints, the researcher considered a sample of 100 households. According to the Central Limit Theory, any sample greater than 30 units is

considered large enough for any statistical comparison. Large samples usually consider 100 units as the minimum number used to get a true representation of the population (Owen, 1992). Hence the use of 100 farmers in this study was justified in consideration of the researchers financial position as well as that the number is acceptable in research studies.

4.1.3 Sampling Method

Stratified and simple random sampling techniques were used to select the sampling units. As discussed earlier, Nyando Division lies within different agro-ecological zones extending LM2, LM3 to LM4. Partly based on these zones the study area was divided into two, the Northern and the Southern regions. Random sampling was then used to select the required sample of the farmers. This was particularly preferred as it allows every farmer in either of the two regions an equal chance of being included in the sample. From the list of farmers in these regions, random numbers were used to select the households to be interviewed. In total 50 households were randomly chosen from each of the regions.

4.2 Data Sources

Data was collected on several variables. These included socio-economic characteristics of the sampled farmers such as age, education background, sex, family size, farm size and income. Other variables on which data was sought include farm inputs used such as labor, draft power, fertilizer and improved seeds. In addition to the socio-economic data, rainfall data was obtained from meteorological stations within the study area.

4.2.1 Nature of Data used

Data was collected from both primary and secondary sources. Primary source of data is the data gathered from the fields, which is the outcome of observation and personal interview. On the other hand, secondary sources of data provide data that have been transcribed from original sources and where the promulgating authority is different from that which controlled the collection of data.

4.2.2 Primary Data Collection

Primary data was mainly collected from sampled farmers, field observations and key informants. The data collection was undertaken by use of questionnaire (Appendix). The questionnaire consisted of a series of structured questions directed to individual farmers. Personal interview technique was also used to gather the required information. The heads of the households were interviewed in each case, but in their absence, the person in charge of the farm was targeted for interview. This was intended to help obtain correct and reliable information.

4.2.2.1 The Questionnaire Interview Schedule

The use of questionnaire was preferred among other data collection methods. This is particularly because a structured schedule questionnaire, such as the one used, not only is it administered personally and therefore provides an opportunity to the researcher to establish rapport with respondents but also ensures almost complete returns and

economizes time and expenses of investigations. The interview schedule also allows for standardization of the responses.

4.2.2.2 Research Assistants

In order to collect the data required, research assistants were recruited. The research assistants were familiar with the area and therefore were an asset in instrumentation and implementation of the research survey. They were trained on data collection and on factors, which may interfere with the validity of the data collection process.

To facilitate the training, a pilot survey was done. The researcher and the assistants conducted some interviews together and went through them carefully, discussing the possible problematic areas including editing the questionnaire where necessary. Together the researcher and the assistant carried interview on the first 10 households thus pre-testing the questionnaire and allowing the assistants an opportunity to gain experience in administering the questionnaire. At the end of the exercise several revisions were made to the survey instrument.

The use of research assistants was particularly preferred for two reasons. The assistants were very familiar with the study area; this ensured collection of accurate data. In addition, the assistants were also very instrumental in faster collection of data. Moreover, the questionnaire was long and covering a hundred farmers without the help of the research assistants could have taken long.

4.2.2.3 Key Informants

A number of farmers not included in the sample population were interviewed. These included retired chiefs, businessmen, teachers and influential farmers in Nyando Division. This was done in order to supplement the views expressed in the study area on factors affecting maize production. Discussions with the key informants made it possible for the researcher to gain further insight into the problem of maize production. The discussions were flexible and open ended, thereby allowing the key informers, as well as the researcher, an opportunity to discuss different aspects of farming in greater depth.

4.2.2.4 Personal Observation

The researcher also conducted field observations on such variables as land sizes devoted to maize production, topography and settlements. Field observations helped the researcher to validate the information given by the farmers as well as incorporate more information not given or explained adequately by the sampled farmers.

4.2.3 Secondary Sources of Data

Secondary data was also sought to supplement primary data for the same characteristics namely, population size, land sizes, labor structure, the use of agricultural inputs, and also the physical background of the study area.

Secondary sources of data included both published and unpublished materials such as district and divisional annual reports from Ministry of Agriculture, National Archives, libraries, Co-operatives offices, Public Administrators (Chief's Office) and from the

meteorological stations in the study area. Other sources of secondary data included agro-ecological maps and newspapers.

4.3 Methods of Data Analysis

A number of statistical techniques were used in the analysis and interpretation of the data. All the required statistics, for example means, standard deviations, and simple frequency distribution, were derived. These were used in summarizing the numerical data for the purpose of describing the data and patterns arising. Besides descriptive statistics the study also sought to determine relationships between the dependent variable (maize yield) and the independent variables (land size, rainfall amounts, farm inputs, income, education and draft power). Several statistical summaries were therefore generated from the data.

4.3.1 Measure of Relationships

Measures of relationships involve determination of how a dependent variable could be predicted from an independent variable or a set of independent variables. In this study, simple and multiple regression and chi-square analyses were used to test how maize production is influenced by the different variables under investigation.

4.3.1.1 Regression Analysis

Regression analysis generally provides estimates of values of the dependent variable. It also measures the degree of association or correlation that exists between the dependent and independent variables. The coefficient of variation measures the strength of relationships between these variables. The regression analysis also assesses the proportion

of variance in the dependent variable that has been accounted for by the regression equation.

Multiple regression analysis represents a logical extension of a two-variable regression analysis. It was used in this study to predict the best linear yield equation. The Equation of the line was used to provide estimates of the dependent variables when values of the Independent variables are included in the equation. The multiple regression model is expressed in the following form:

$$\mathbf{Y_c = b^1x^1 + b^2x^2 + b^3x^3 + b^nx^n}$$

where;

$\mathbf{Y_c}$ = observation of the dependent variable (i.e. crop yields)

$\mathbf{b^1}$, $\mathbf{b^2}$ etc = coefficient of independence

$\mathbf{x^1}$,$\mathbf{x^2}$, $\mathbf{x^3}$= observation of independent variables (e.g. land size)

$\mathbf{n}$ = random error

Multiple regression model was used in this study since it satisfies the underlying assumptions that the variables should be randomly selected from a normally distributed population, that variables should be statistically independent of one another, and the variance of y (dependent variable) is uniform for any group of x^2 (Owen, 1982).

Multiple regression was also used because it takes account of more than one independent variable. It therefore made it possible to include more than one variable in the multiple regression analysis simultaneously, for two reasons. It eliminates the bias of extraneous variables by including them as repressors, and the introduction of additional variables

reduces variance (*r2*), hence improves confidence intervals and tests. Thus, besides being useful in testing the hypotheses, the model was able to include all the possible independent variables for the analysis at once. Multiple regression equation further allowed for the examination of the contribution of each predictor/independent variable, thereby providing a good approach to selecting good predictors of the equation.

4.3.1.2 Chi-Square

Chi-Square was used to test the hypothesis concerning the significance of differences in maize yield and the managerial and socio-economic of the farmers. The test was done using the general formula for chi-square normally given as :

$$X^2 = \sum O\text{-}E/E$$

Where,
X^2 =chi square, $\sum$ =summation, O= Observed frequencies, E= Expected frequencies

4.3.1.3 Coefficient of Variation

Rainfall variability was measured using coefficient of variation, a method used by several researchers. Coefficient of variation is defined as the standard deviation divided by the mean multiplied by 100. An equation can be written as:

$$CV = 100S/x$$

Where:

CV= Coefficient of variation, *S*= standard deviation, **x** =mean.

To measure the effect of variability in rainfall on maize production, the mean yields from the regions in Nyando Division were compared with their respective coefficients of variations.

4.4 Limitations of the Study

A number of limitations that could have imparted negatively on the work were encountered. However despite these limitations, the study was successfully undertaken. Among the salient ones are:

4.4.1 Misunderstandings of Questions

The questionnaire was in English while the interview was conducted in Dholuo. Direct translation exerted a constraint to getting the right answers. This meant that a lot of translations had to be done before recording the respondents' results. This proved tedious in cases where the researcher did not understand well the meaning of certain words, thereby calling for further probing for a better word for replacement. However, the field assistants were very resourceful in ensuring the acquiring of the right answers for all the questions.

4.4.2 Use of estimates on Inputs, Yields and Farm Sizes

There were no accurate figures for data on yields and farm sizes. Majorities of the farmers were not certain of the exact sizes of their farms, the amounts of inputs used and the yields obtained. This is because most them do not keep farm records. The researcher had to rely on estimates given by the farmers.

4.4.3 Suspicion of the Farmers on the Survey

Most farmers were suspicious of the study and on the likely use of the information that was obtained from them. This forced the researcher to depend on village elders who at times could not be readily traced. As a result, the work took a longer time than was expected.

4.4.4 Poor Infrastructure

The research was carried out during the short rains. Due to the nature of black cotton soil prevalent in the area, most roads were muddy. This hindered movement in the process of data collection.

4.4.5 Regression Analysis

Stepwise regression model assumes that the relationship between dependent and independent variables is linear and normally distributed. Some relationships however are in fact non-linear and non-normal in distribution. The relationship between the independent variable and dependent variable may not be easily identified because of higher level interaction i.e., the effect of closely related dependent variables on the independent variable can not be accurately separated.

Also a low correlation coefficient does not preclude the existence of a close non-linear relationship. Correlation does not necessarily establish causation. Moreover the

computation is cumbersome, tedious and requires advanced computer knowledge. It should also be noted that the results of regression computations are just average and are not exact.

4.4.6 Computer use

Difficulties on the use of a computer in a geographic study also exerted some constraints. For a model to be operational it is translated into a computer language (program). The computer program may not faithfully represent the model because something is lost during translation from model to program. Such limitations may be due to limitation in the program language and other practical considerations such as cost of program, which limited the research in all programs preferred. However multiple linear regressions was used successfully with the assistance of secondary data and information from key informers.

CHAPTER 5

RESULTS AND DISCUSSION

5.0 Introduction

This chapter presents the results of the data acquired from the field by use of a questionnaire. An analysis of various factors identified as affecting maize production has been presented. The aim is to get the most significant factors with greatest impact on maize production.

5.1 Rainfall and Socio-economic aspects of Maize Production

5.1.1 Rainfall and its Variation

In order to determine the extent of spatial rainfall variations, the study considered data on monthly, seasonal and annual rainfall for the period between 1982-1997. The results are summarized in the Tables and Figures below.

5.1.1.1 Mean Monthly Rainfall Variation

The mean monthly variation of rainfall at the two stations of Ahero in Southern region and West Kano in Northern region is shown in Table 5.1 and Figure 5.1.

Table 5.1 Mean Monthly Rainfall in Nyando Division

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
A- West Kano	56	9	40	162	79	100	11	100	80	162	40	9
B- Ahero	134	1.8	6	84.3	44.6	124	71.8	124	44.6	84.3	16.1	1.8
A-B	78.2	7.9	30.8	77.8	34.6	24.6	60.4	24.6	35.2	77.8	20.8	7.2

Source: Field survey Data, 1999

Table 5.2 below indicates the statistics on the mean monthly rainfall variation for the two rainfall stations situated in Nyando Division.

Table 5.2 Statistics on Mean Monthly Rainfall variation in Nyando Division

STATION	MEAN (mm)	CORRELATION
W/KANO	70.2	0.5
AHERO	61.5	

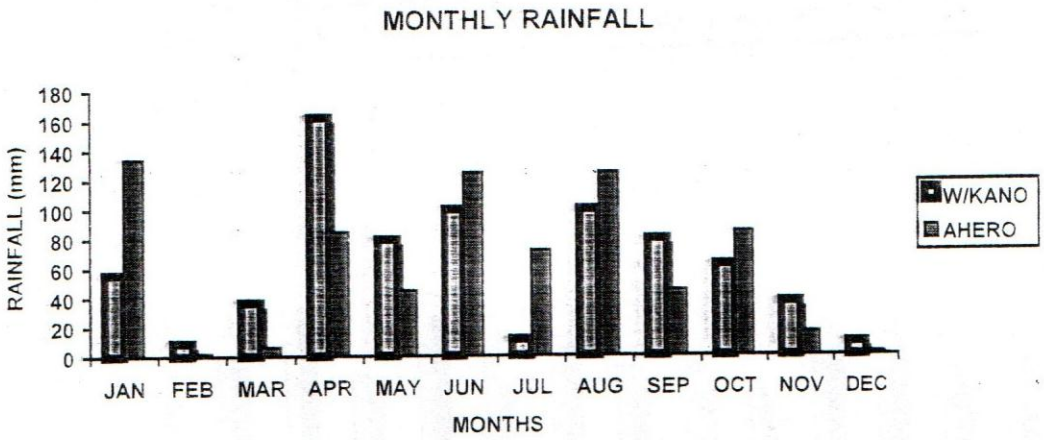


Fig. 5.1 Mean monthly rainfall for 1982-1997 in Nyando Division

As shown in Tables 5.1 and 5.2 and Figure 5.1 above, the two regions received different amounts of rainfall over the period between 1982-1997. It can therefore be said that the two stations were independent as far as the mean monthly rainfall received was concerned. From Table 5.2, West Kano received a mean monthly rainfall of 70.2mm, while Ahero rainfall station received a mean of 61.5mm. The coefficient of variation between the two stations was 0. 5, which is far from, perfect relationship.

5.1.1.2 Mean Seasonal Rainfall in Nyando Division

Seasonal rainfall variation between two stations Ahero in the Southern region and West Kano in the Northern region is shown in Figure 5.2 and Table 5.3. The figures represent the mean seasonal (March to May) rainfall amounts for 16 years.

Table 5.3 Mean Seasonal Rainfall in Nyando Division (1982-1997)

	1982	1983	1984	1985	1985	1986	1987	1989	1990	1991	1992	1993	1994	1995	1996	1997
	684.	634	457	758	835	665	798	978	812	655	639	523	824	766	590	594
	651	395	561	725	931	104	929	566	771	546	560	445	816	986	532	612
	33.2	244	103	33.4	96	379	30	412	41.3	109	79.6	77.8	8.2	221	58	17.4

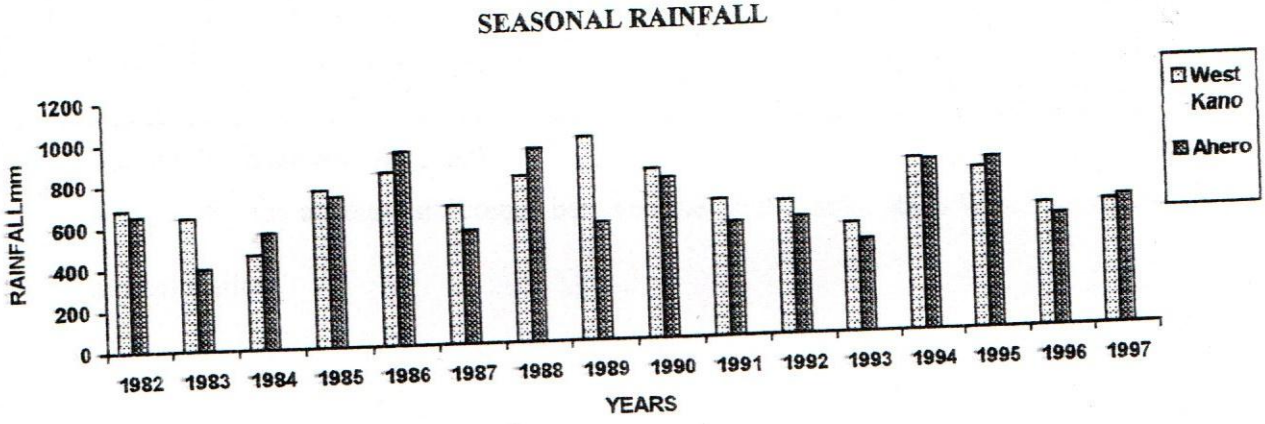


Fig. 5.2 Seasonal rainfall variation in Nyando Division 1982-1997

The average amount of long seasonal rainfall for Northern region was 691 mm while for Southern region was 653 mm. (Table 5.4). The coefficient for seasonal rainfall variation (CV) for Northern region was 19% while for Southern region was 30%. This shows that seasonal yearly rainfall was more variable in Southern region than in Northern region.

Table 5.4 Statistics on Mean Seasonal Rainfall

STATION	MEAN	CV	CORRELATION
W/KANO	691	19	0.2
AHERO	653	30	

5.1.1.3 Mean Annual Rainfall variation

The annual rainfall variations between the two stations in Nyando Division are shown in Table 5.5 and Figure 5.3.

Table 5.5 Mean Annual Rainfall in Nyando Division (1982-1997)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
A-West Kano-	1326	1051	1002	1149	1309	1180	1310	1507	1185	1075	1016	1091	1341	1136	1296	1367
B-Ahero	1222	1007	1003	1153	1412	1412	1489	1291	1194	964	1088	776	1323	1356	1291	1378
A-B	105	4.3	0.7	4.2	103	232	179	216	9.4	111	71	316	18	221	5	11

Source: Field survey Data, 1999

Key : A-B –the absolute difference between the rainfall amounts in West Kano and Ahero rainfall stations

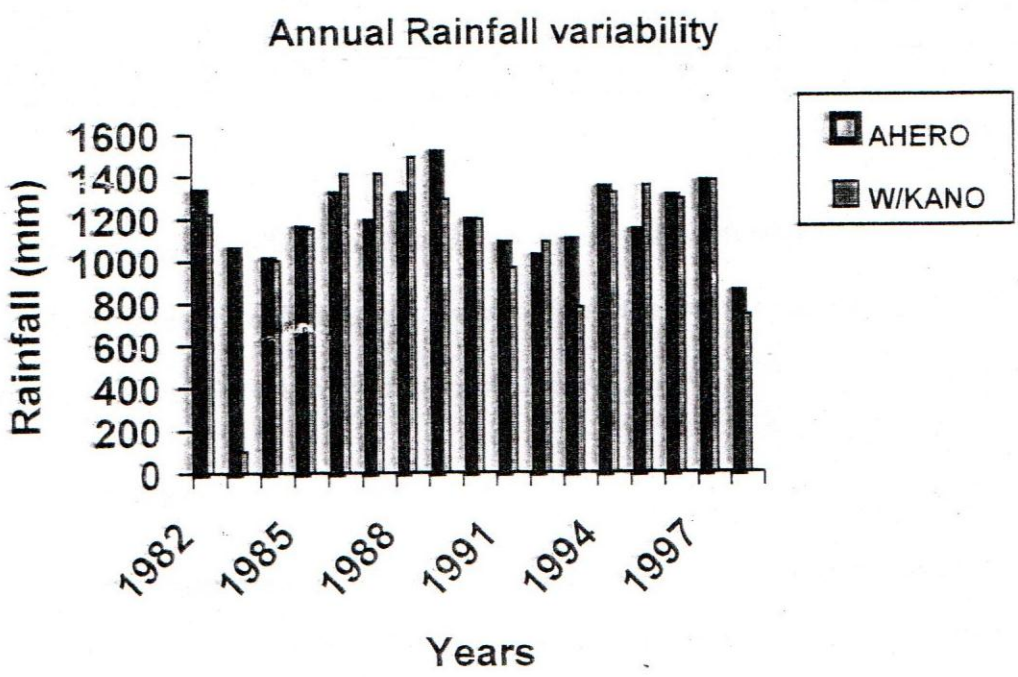


Fig. 5.3 Mean Annual rainfall variation in Nyando Division 1982-1997

The average yearly rainfall amounts were almost the same (1181 mm. for Northern region and 1187 mm for Southern region), but there was a difference in rainfall received in individual years. For instance in 1993, Northern region received 1091.4 mm while Southern region received 775 mm (Table 5.5). This shows a difference of 315 mm, which may not be important as far as water supply to plants is concerned.

The coefficient of variation for Northern region was 14% while for Southern region was 19% (Table 5.6). This further indicates a marked difference in rainfall pattern in the two adjacent areas. The coefficient of variation figures showed that rainfall was more variable in Southern region than in Northern region.

Table 5.6 Statistics on Mean Annual Rainfall

STATION	MEAN	CV	CORRELATION
W/KANO	1181	14	0.7
AHERO	1187	19	

In general, it was found that rainfall was more variable in Southern region than in Northern region. There was not only marked variation from the average individual years, seasons and months, but rainfall also varied from area to area.

5.1.2 Draft Power

It was observed that farmers in Nyando Division depend partly on draft power for their farm operations. However the draft power was not readily available to 75% of the farmers (Figure 5.4). This is because they could not afford to keep them.

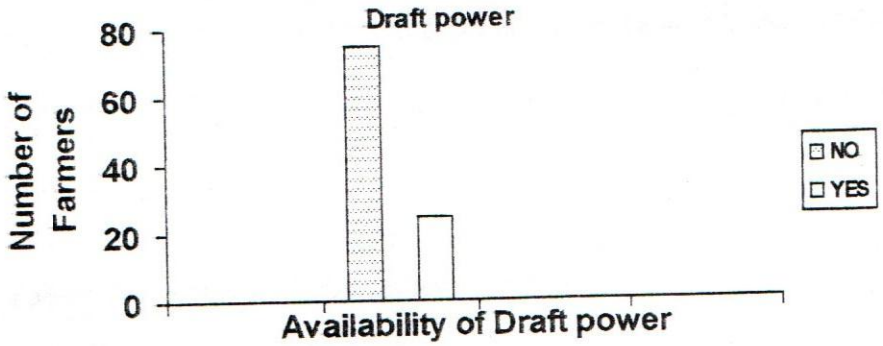


Figure 5.4 Draft Power Ownership in Nyando Division.

The draft power available was of poor quality and at the time of survey, most were suffering from foot and mouth disease. Most farmers could not prepare their farms due to poor animal health.

5.1.3 Formal Education

On the question of education, the survey showed that over 60% of the farmers in Nyando Division had at least some level of formal education as shown (Figure 5.6).

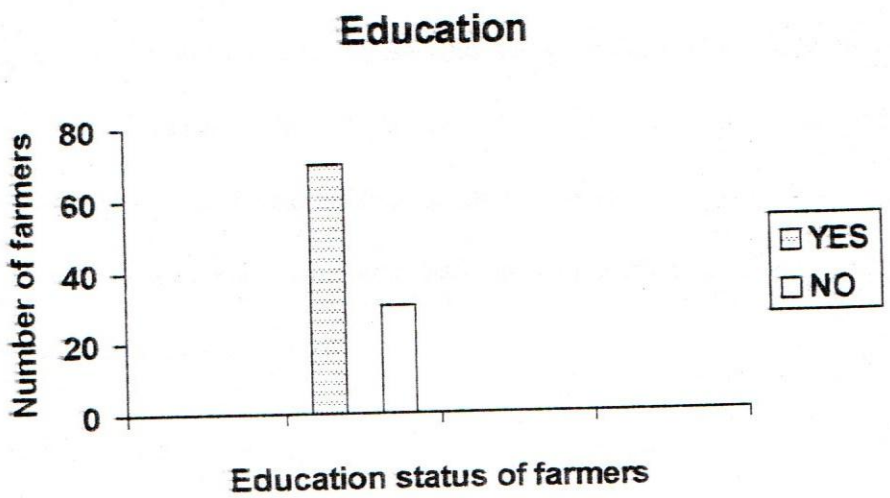


Figure 5.5 The Education status of Farmers in Nyando Division

Only 30% of the farmers had no formal education. The above information can be supplemented by the information contained in Table 5.7, which shows the numbers and percentages of farmers who have attained various categories of education in Nyando Division.

Table 5.7 Farmers education levels in Nyando Division

Education level	%	Cum. Percent
Illiterate	5	5
Primary	50	55
Secondary	30	85
Post secondary	15	100
Total	100	

Source: Field survey data (1999)

The education levels were classified as illiterate, primary, secondary and post secondary. Illiterate category consisted of those people who have had no formal education. Under Primary category the levels considered were primary school from standard 1-8. The levels considered under Secondary category were from form one to form six. Post secondary category was meant to be for those who had gone beyond secondary school, into colleges or to formal training. However, very many different groups fell under this category. There were those who had finished secondary school then gone to college, those who had finished form four and those who had finished form two. Training after standard eight was considered post secondary.

5.1.4 Sources of Information on farming practices

When asked about their sources of information on farming practices, the farmers identified four main sources as which are summarized in Table 5.8 below.

Table 5.8 Farmers sources of information in Nyando Division

Information source	No.	%
AES	49	49
Family members	43	43
Friends	46	46
Media	29	29
Others	24	24

Source: Field survey Data, 1999

From the table it is evident that almost all farmers in Nyando Division had knowledge on farming techniques. Agricultural extension workers (AES), family members and friends formed the major source of information. Apart from the three being the major sources of information, the respondents also indicated other sources as observation, mass media and

barazas, in that order of importance. It can therefore be said that the farmers in the area are quite enlightened.

5.1.5 Farm size

The distribution of the respondents across various farm size categories is summarized in Table 5.9.

Table 5.9 Farm sizes in Nyando Division

Farm size (ha)	Percent	Cum. Percent
.0-1.00	7	7
1.1-3.00	71	78
>3.10	22	100
Total	100	

Source: Field survey Data, 1999

It is noted that a majority of households (71%) had small farm sizes of between 1 to 3 acres. Only 22% of the households had farm sizes of 3 ha and above. The average farm size in the division estimated at 3ha comprises 1.1 ha of cultivated land, 1.5 ha of pasture and 0.4 ha of homestead.

5.1.6 Land Tenure

The farmers were asked to state the type of their land ownership. The result, as summarized in Table 5.10 and Figure 5.6 shows the main types of Land ownership system in Nyando Division as communal, household and leasehold.

Table 5.10 Land Tenure System in Nyando Division

Land Tenure	Percent	Cum. Percent
Communal	12	12
Leasehold	3	15
Household	85	100
Total	**100**	

Source: Field survey Data, 1999

However, most farms are household owned with 85% of the total agricultural land followed by communal at 12%. The share of the remaining category leasehold is only 3% (Fig. 5.6).

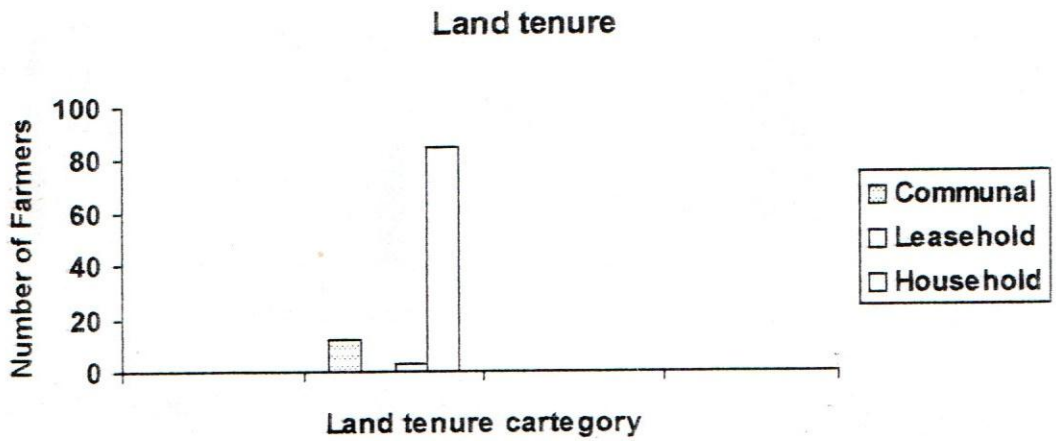


Figure 5.6 Land Tenure Systems in Nyando Division

5.1.7 Income

The farmers were also asked to state the amount of money they get from maize production and from off-farm annually. The results summarized in Table 5.11 and Figure 5.7.

Table 5.11 Annual farm income in Nyando Division

Income Ksh. 000	Income Category	Percent	Cum. Percent
1-6	1	24	24
6-10	2	39	63
11-15	3	12	75
>16	4	25	100
Total		100	

Source: Field survey Data, 1999

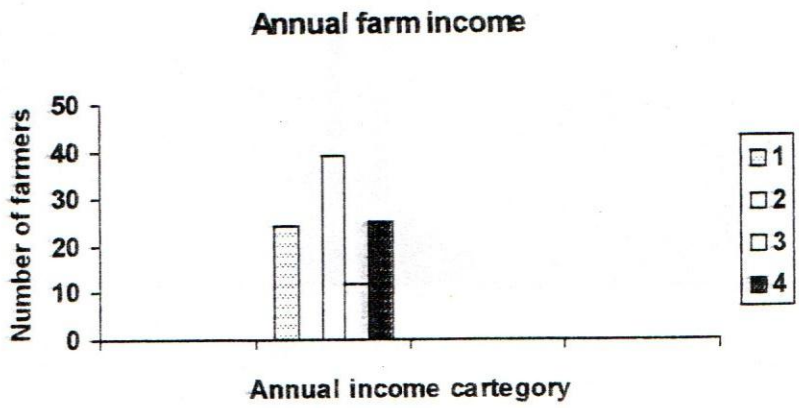


Figure 5.7 Annual incomes in Nyando Division

It was found that the farmers in Nyando Division rely primarily on farming and partly on off farm employment as a source of income. However the farm income was generally very low. Most of the farmers (63%) were getting less than ten thousand shillings annually (Figure 5.8), only 25% were getting sixteen thousand shillings and above from the farms (Table 5.11). The farmers' engagement in off farm employment is summarized in Table 5.12. Almost half of the farmers (48%) in Nyando are engaged in off farm employment.

Table 5.12 Farmers engagement in off farm employment in Nyando Division

Response	Percent	Cum. Percent
Yes	48	48
No	52	100
Total	100	

Source: Field survey Data, 1999

5.1.8 Labour

Family size was used as the main determinant of labor supply (Figure 5.8).

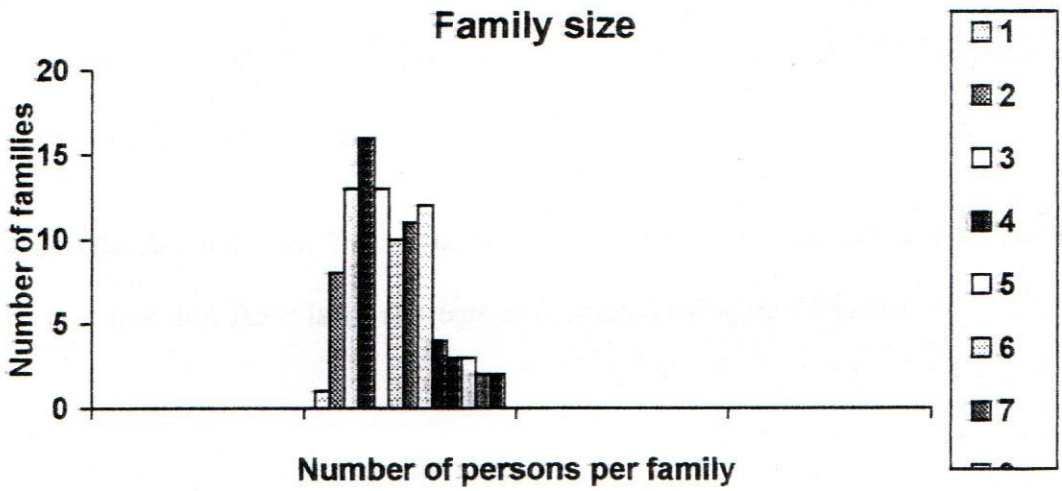


Figure 5.8 Family sizes in Nyando Division

The average family size was 6 members while only 5% of the families had above 10 members per household (Figure 5.8). However not all family members were engaged on full time farming. Non-farm workers were mostly children below 6 years (pre-school children), children attending school, and family members working in urban areas.

Table 5.13 shows the amount of labor available per household in hours in Nyando Division.

Table 5.13 Labour hours per household in Nyando Division

Labor hours per household	Percent	Cum. Percent
<300	13	13
301-600	41	54
601-900	39	93
>900	7	100
Total	100	

Source: Field survey Data, 1999

It was observed that most households (41%) had labor supply of between 301 to 600 hours. However, only 7% had labor supply above 900 hours. 13% of households had less than 300 hours (Table 5.13).

Despite the fact that over 70% of households had 5 members and above, many farmers indicated that they faced labor shortage as illustrated in Figure 5.9 below.

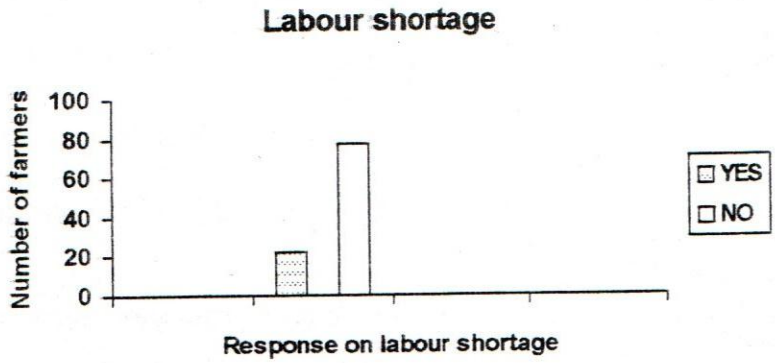


Figure 5.9 labor shortages in Nyando Division

As can be seen from Figure 5.9, 78% of the farmers in the division faced labor shortage during critical farm operation periods of planting and weeding. Only 22% of the farmers had no labor shortage.

In addition the survey found that that 56% of the sampled households were headed by women while only 44% had male heads (Table 5.14). Given that women had normally had many other households, they could not fully participate in farm duties as is expected.

Table 5.14 Household heads in Nyando Division

Response	%
Male	44
Female	56
Total	100

Source: Field survey Data, 1999

5.1.9 Constraints to Maize Production

Apart from the actual investigations, it was necessary to get the general opinion on the constraints to maize production from the stakeholders in the division. Most of the farmers and key informers interviewed were not satisfied with the levels of maize production they were getting. They identified a number of constraints affecting the production process as shown in Table 5.15.

The main constraints identified by a majority of the farmers were capital and rainfall. Other constraints as mentioned by the farmers in order of importance include, farm size, soil, capita/credit, technical information, uncertified seed, infestation by striger weed and maize streak virus.

Table 5.15 Constraints to maize production in Northern and Southern regions of Nyando Division

	Number of respondents		
	Northern	Southern	Total
Rainfall	43	46	89
Farm size	15	11	26
Soils	13	8	21
Capital/credit	44	48	92
Technical information	4	4	8

Source: Field survey Data, 1999

5.2 Factors affecting maize production in Nyando Division

5.2.1 Introduction

All the factors which include, income, labor, rainfall, technical knowledge, education, draft power and farm size were correlated and regressed against the maize yield in order to find the most significant factors which could be used in developing a model for increased maize production in Nyando Division. The correlation and multiple regression results are shown in Tables 5.16, 5.17 and 5.18. The results of chi-square test concerning the significance of differences in maize yields and the socio-economics of the farmers are shown in Tables 5.19 and 5.20.

Table 5.16 Correlation Coefficients

	Rainfall	Yield	Farm size	Education	Crop input	Tech. awareness	Annual income	Labour
Rainfall	1.0000	0.4047	0.3287	0.0000	0 .5210	0 .1225	0.5293	0.0090
		0.000	0.000	0.500	0.000	0.112	0.000	0.465
Yield	0.4047	1.000	0.0642	0.0357	0.6307	0.4642	0.5457	0.0702
	0.0000		0.263	0.362	0.000	0.000	0.000	0.244
Farm size	0.3287	0.0642	1.000	0.0344	0.0374	0.0395	0.0853	0.0259
	0.000	0.263		0.367	0.357	0.348	0.199	0.399
Educatio n	0.000	0.0357	0.0344	1.000	0.0326	0.0091	0.0042	0.0670
	0.500	0.362	0.367		0.375	0.464	0.483	0.254
Crop input	.5210	.6307	0.0374	0.0326	1.0000	0.2493	0.4993	0.0118
	0 .000	0.000	0 .357	0.375		0 .007	0.000	0.454
Tech. Awarene ss	0.1225	0.4642	0.0395	0 .0091	0.2493	1.0000	0.3777	0.2008
	0.112	0 .000	0.348	0.464	0.007		0.000	0.023
Annual income	0 .5293	0.5457	0.0853	0.0042	0 .4993	0 .3777	1.000	0.0031
	0.000	0.000	0.199	0.483	0 .000	0.000		0.488
Labour	0 .0090	0.0702	0.0259	0.0670	0 .0118	0.2008	0.0031	1.000
	0.465	0.244	0.399	0 .254	0.454	0.023	0.488	

(Coefficient / (Cases) / 1-tailed Significance)

Table 5.17 Multiple regression

Dependent Variable. Ykgs- maize yield

Multiple R - 0.75699 R Square- 0.57303 Adjusted R Square- 0 .53982 Standard Error- 1.25256

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	7	189.50283	27.07183
Residual	90	141.20125	1.56890

F = 17.25526 Significant F = .0000

Variable	B	SE B	Beta	T	Sig T
Rainfall	0 .096162	0.363524	0.026168	0.265	0.7920
Input purchased	0.732393	0.173987	0.368242	4.209	0.0001
Annual income	0.499421	0.175633	0.300189	2.844	0.0055
Farm size	0.453564	0.264529	0.125670	1.715	0.0899
Education	0.215231	0.281963	0.052930	0.763	0.4473
Tech. Awareness	0.849795	0.288204	0.225397	2.949	0.0041
Labor	0.445207	0.220668	0.143862	2.018	0.0466
(Constant)	3.686714	1.068522		3.450	0.0009

Table 5.18 R e g r e s s i o n: Rainfall Variability and Maize Yield

Dependent Variable. Y maize yield.

R rainfall levels

Multiple R - 0.42674 R Square- 0.18211 Adjusted R Square- 0.17359

Standard Error 374.98041

Analysis of Variance

DF	Sum of Squares	Mean Square
Regression 1	3005574.01531	3005574. 01531
Residual 96	13498589.25000	140610.30469

F = 21.37520 Signif F = 0 .0000

Variables in the Equation

Variable	*B*	*SE B*	*Beta*	*T*	*Sig T*
R	350.325000	75.773263	.426744	4.623	.0000
(Constant)	317.475000	119.072271		2.666	0090

Table 5.19 Farming Practices of low and high maize yield in Southern region

	Low vields	High vields	Chi. Sa. sig. level
Average vield (Kg/acre)	330.9	930.5	0.000
Practice			
Hybrid seed %	62	75	0.28
Weeding (hrs /acre)	198.3	170	0.085
Draft power % own	76.1	87.5	0.479
Labor (hrs/acre)	671.4	787.5	0.143
Early planting Feb	73.8	50	0.178
Technical awareness %	52.3	62.5	0.599
Crop input (Ksh/acre)	100	2000	0.011
Land holding (acres)	15.16	21.45	0.026
Crop income (Ksh.000)	7.97	10.6	0.48
Off farm income (Ksh. 000)	3.1	4	0.500

Source: Field survey Data, 1999

Table 5.20 Farming practices of low and high maize yields in Northern region

	Low yields	High yields	Chi. Sq. Sig. level
Average yield (Kg/acres)	720	2020.5	0.000
Practice			
Draft power %	50	87	0.005
Labor (hrs/acre)	729.2	687.5	0.929
Weeding (hrs/acres)	184.6	233.3	0.025
Early planting	88.5	95.8	0.337
Hybrid seed	46	83	0.006
Technical awareness %	38	92	0.000
Land holding (acres)	2.7	3.1	0.245
Crop income (Ksh 00)	11.5	14.4	0.007
Off farm income (Sh00)	76	110	0.001
Crop input (Sh.00)	3.35	4.8	0.000
Education %	69	71	0.539

Source: Field survey Data, 1999

5.2.2 The effect of variations of Rainfall amounts on Maize Yields in Nyando Division

From the multiple regression result, variability in rainfall amounts had a significance of 0.792 at 0.05 significant levels and accounted for 2% of the total variation in maize yield (Table 5.17 on page 76). There was however a closer correlation of 0.407 between rainfall variability and maize yield (Table 5.16 on page 75). The variation in rainfall levels between the two regions of Nyando Division did not contribute much to yield differences between them. Those farms situated in areas of high variability in rainfall amounts such as Southern region experienced almost the same output as their counterparts in low rainfall variable areas such as Northern region. As is illustrated in Tables 5.19 and 5.20 on page 78 above, the differences in yields in the Northern and Southern regions of the division were mainly attributed to differences in socio-economic characteristic of the farmers. That is increase in

maize yields in Nyando Division depends more on adjustment of the socio-economic characteristics of the farmers. Such adjustments as proper timing of rainfall *onsets* and *ends* with regard to farming operations such as land preparation and planting dates could increase maize yield.

The influence of arial variations in rainfall amounts on maize yield from simple regression when other factors are not considered was however very high. Variations in rainfall amounts had a significance of 0.000 at 0.05 Table 5.17 on page 76. The implication here is that rainfall amounts were more variable in the Southern than in Northern region, which had more rain. This could have negatively affected maize production in the southern region. This is further illustrated in Table 5.21 below, which shows the general statistics on the level of maize yields in Nyando Division. Most of the farmers comprising 72%, fall between category 1 and 3 where the yields per acre is below 1200Kgs.

Table 5.21 Distribution of farmers by yields levels and regions of Nyando Division

Yield Kg/acres	Category	Northern		Southern	
		Number	%	Number	%
Up to 600	1	9	18	22	44
601-800	2	7	14	12	24
801-1000	3	12	24	10	20
1001-1200	4	6	12	1	2
1201-1400	5	6	12	2	4
1401-1600	6	6	12	1	2
1601-1800	7	3	6	1	2
Above 1800	8	1	2	1	1
Total		50	50	100	100

Source: Field survey Data, 1999

On regional basis the Northern region received better yields than the Southern region as shown Table 5.22 below.

Table 5.22 The level of maize yields in Southern and Northern regions of Nyando Division

Location	Maize yield (bags/acre)		
	Mean	Minimum	Maximum
Northern	11	3	22
Southern	7.4	2	19

Source: Field survey Data, 1999

The average maize plot yield in Northern region of 11 bags/acre was almost double the yield in Southern region of 7.4 bags/acre. The maximum number of bags RECORDED was 22 bags/acre in Northern region while that for Southern region was only 19 bags/acre (Table 5.22). Moreover, 18% of the farmers in Northern region received yields below 600 kg/acres as compared to 44% in Southern region (Table 5.21 above). Further 44% of the farmers in Northern region were getting yields above 1 ton/acre compared to only 11% in Southern region.

The unreliable rainfall could have also discouraged the farmers from using farm inputs since rainfall was identified as the main constraint to maize production (Table 5.15; pg 74). Use of such inputs as hybrid seed have the advantage of early maturing and high yields. Moreover, biological evidence has proved the need for a minimum amount of moisture in the soil to allow survival of organisms responsible for making nutrients available from animal manure (LBDA, 1992; Russels, 1980). Indeed in some parts of Southern region, soil moisture levels were very low because of low rainfall and high evaporation rates (Adera, 1996). Thus, insufficient rainfall was cited by most farmers

(89%) as a major constraint in maize production. Nyando Division an average rainfall ranging between 950 mm to 1200 mm per annum, with a reliability of 40 to 60%. The short rains come between August and November, and are normally more reliable than the long rains, which come between February and May (LBDA, 1992). However there are times when rainfall is excessive and causes flooding in the area, which destroys crops.

5.2.3 Crop inputs and Maize yields

Investments on crop inputs such seed and fertilizer, among others, accounted for 37% of the total variation in the maize yield (Table 5.17; page 76). The value of annual crop input purchased by the farmer had a significance of 0.000 at 0.05 significant levels. Among the farmers in Nyando Division, total money spent on farm inputs accounted for 37% of the maize yield per acre that a farmer would harvest in a given season. Here Beta coefficient is 0.3682 means that if money spent on farming operations is increased by one unit the number of bags of maize harvested increase would be by 37%. There was also a very close correlation of 0.6307 between the value of crop input purchased and maize yields (Table 5.16; page 75). The total investment that a farmer puts in the farm is therefore very important in explaining maize production in Nyando Division. This is further supported in the chi-square in Table 5.19 and 5.20 on page 78. Investment on crop inputs had a significance of 0.000 and 0.011 in the Northern and Southern regions respectively.

5.2.4 Effects of Extension Service on Maize Yields

There was a close correlation of 0.4642 between the farmers Extension Service and maize yield (Table 5.16; 75). The influence of extension service was measured using the

number of contacts the farmer had with the extension staff. The survey revealed that the farmer's knowledge on maize production technologies such as use of inputs such as fertilizer and hybrid seeds, crop rotation and plant spacing was important in determining yields. Technical knowledge had a significance of 0.004 and accounted for 22% of the maize production in Nyando Division (Table 5.17; page 76). Farmers who had such knowledge obtained better yields than those who had not. This means that if the agricultural extension services were increased in the study, maize crop yields would increase by 22%. Currently there are only 12 agricultural extension officers serving over 10,000 farmers in the division. That is one extension officer to eight hundred farmers (1:800). Therefore to increase maize production in the division requires an increase in the number of agricultural extension officers.

In Kenya, Mbithi (1973) similarly found that poor maize production figures from peasant farmers was a direct result of weak extension service network, which effectively resulted in poor communication of the agricultural research.

Technical know-how was identified by four farmers as one of the constraints limiting maize production (Table 5.15; page 74). Farmers who followed recommended practice such as plant spacing obtained a healthy crop stand and recorded high yields. The major disadvantage the division is that it was difficult to accurately measure and maintain recommended spacing. Such was the situation in Northern region where most farmers relied on using their feet to maintain uniform spacing. In Southern region, farmers who had difficulty in maintaining the required spacing were to dribble seeds behind the plough

as an alternative strategy. Many also admitted that they lacked knowledge on how to rotate the multiple crops that they grow due to poor extension service.

As is evident from (Table 5.8; page 68) most of the farmers reported that friends and family members were their source of agricultural information. This means that there is a free flow of information from these groups, and extension workers to enable them to reach greater number of farmers can exploit this. By encouraging and strengthening these channels of communication, the extension workers can be more effective in their work.

5.2.5 Farm size and maize Yields

Farm size had a low correlation of 0.0642 with maize yield (Table 5.16; page 75). Farm size however had a significance of 0.050 at 0.05 significant levels and accounted for 12% of the maize yield per acre that a farmer will harvest in a given season (Table 5.17; page 76).

A unit increase in farm size would thus increase maize yield by 12%. Farm size thus is an important determinant of maize production in the division. The farmers with larger size of land could easily adopt crop rotation as compared to those with small farm sizes. This is further supported by the chi- square results in Table 5.19 and 5.20 on page 78. Farm size had significance of 0.245 for the Northern region and 0.026 for the Southern region.

In Argentina, Harper (1983) found that the returns from an owner-occupier farm declines with decrease in farm size. In a similar study carried out in Botswana, it was found that large farms often have higher returns than the small farms. This is because farmers with large farms can easily and economically use farm machinery and draft power.

Average farm size in the division is estimated at 3 acres comprised 1.1 acre of cultivated land, 1.5 acre of pasture and 0.4 acre of homestead (Table 5.9; page 68). It was found that 73% of the total land resource in the study area was cultivable. Out of these, only 17% is cultivated, the remainder is left as fallow, pasture and scrubs.

The fact that 85% of the land is family or household owned as is illustrated in Table 5.10 on page 69 above, is worth noting given that the nature of land ownership determines the intensity of land use and the improvements that can be done on land. Despite the low average farm size in the division (3-acre), it was found that newly married members of the family expect to get sub plots within the parent family plots. This reduces the acreage under farm production.

Most of the farms in the division are also scattered and are therefore not fully utilized. The scattering of the farms is associated with the frequent floods in the area. During the floods farmers move to the upland areas. They however retain the newly acquired land even when floods subside. Therefore the nature of land ownership in the division can be said to have impacted negatively on maize production. The survey revealed that the pattern of land allocation for different crops varies with the size of the farm. Although the proportion of maize area tended to decline as the farm size increases, households with smaller farms put a higher proportion of their land into maize production.

26% farmers cited inadequate land supply as a constraint to maize production (Table 5.17; page 76). According to the farmers, the farm sizes were too small for meaningful maize production. The small farm sizes hindered the use of improved farming practices such as crop rotation, which have the advantages of a healthy crop stand, high yields and

maintaining soil fertility. In additional advantages include reduction in the incidence of diseases and weed parasites. However, because of small farm sizes most farmers could not benefit from these advantages of crop rotation. Instead they were to inter-crop and allocate more land to cash crops. This led has to a reduction of acreage under maize production.

5.2.6 The effect of Farmers Income/Credit on Maize Yields

The annual income had a significance of 0.0055 at 0.05 significant levels and accounted for 30% of maize yield in the division (Table 5.17; page 76). This means that maize production in Nyando Division can be increased by increasing the farmer's income. There was high correlation of 0.5457 between the annual crop income and maize yield (Table 5.16; page 75). That is maize yield was closely influenced by the income of the farmers.

Similar results are recorded in the studies done in Tanzania, Kenya, South Africa and Zimbabwe (Govereh, 1990; Dillon, 1984). Both authors concur that low investment associated with low income reduces farm production.

In the division, the farmer's income was very critical in the use of techniques that required farmers to disburse some cash. Because of the limited access to credit facilities faced by small-scale farmers, use of improved techniques was potentially constrained. Even though 85% of the farms were household owned, it was noted that very few farmers had title deeds and none of them had used the titles to get loans for farm production.

Keeping in mind the high cost of agricultural inputs, it is no wonder that 92% of the farmers cited capital as a major constraint (Table 5.15; page 74). Indeed capital is always a major constraint for farmers, especially those who rely primarily on farming as a source of

income. Similar conclusions have been drawn in studies carried out by World Bank (1993) where capital was reported to be a major constraint among farmers.

Farmers agreed that using hybrid seed and applying fertilizers such as single phosphate, compound D and ammonium nitrate improves soil fertility and gives rise to high yields and healthy crop stand. However, due to lack of capital, many farmers did not try these inputs because they could not afford them. In 1998 the households who applied fertilizer obtained 80% more yield increase relative to those who did not apply any fertilizer at all. Agronomy theory suggests that the use of fertilizer particularly phosphates in this case improves the efficiency of water absorption by maize. This is because Phosphates promote vigorous root development and plants are therefore able to penetrate lower strata of the soil thus tapping extra water, which is otherwise unattainable to plants growing in soils with lower phosphate levels. The implication of this is that if farmers can use a simple technology like applying manure or phosphates they may achieve tremendous yield increase.

5.2.7 Labour supply and Maize Yields

The family size and the number of hired labor or manpower were used to calculate the amount of labor hours spent on the farm. It was established that the more hours a farmer spends on the farm especially during weeding, the higher the maize yields. Labor hours had a significant value of 0.046 at 0.05 significant level (Table 5.17; page 76). Thus among the farmers in Nyando Division, a unit increase in labor hours particularly during weeding period would increase maize yield by at least 14%. Labor accounted for 14% of

maize production in Nyando Division. However, there was a low correlation of 0.0702 between labor and maize yield (Table 5.16; page 75).

A similar study done in Mali noted that labor input in cereals during the harvest is the critical determinant of a good harvest (Kampen, 1980). Operations like planting and weeding require proper timing and inadequate labor can cause operational delays that inevitably reduce crop yields. This is particularly important in Nyando Division because of the common occurrence of striger weed infestation.

However, the seasonal nature of rain-fed agriculture in the division has made it difficult for farm household members to earn constant income throughout the year. This, together with low and uncertain rainfall has made farming a risky and low return venture in the division and has forced about half of the able bodied workers to seek employment outside farming where they can earn wages all the year round.

Most household heads were women. Since women have many other chores apart from farming, their position as heads of households could affect farm production. Thus family labour was found to be inadequate to meet seasonal demand in Nyando Division.

5.3 Validation of Hypotheses

The main purpose of statistical analysis was to determine whether there was any relationship between the socio-economic variables, rainfall and maize yields. The aim was to identify the factors that could be used to increase maize production and improve food security situation in Nyando Division. The results indicate that a significant relationship existed. This means that these factors affected the farming operations of the farmers in the division and hence maize yields.

Two null hypotheses were tested in this study. The first hypothesis stated that variability in annual rainfall amounts received during the growing season do not account for the variations in maize yields in Nyando Division. The results reveal that variability in rainfall amounts did not significantly affected maize yield. Rainfall variability had a significance of 0.790 at 0.05 significant levels. The null hypothesis is therefore accepted and the alternative rejected.

The second hypothesis stated that small-scale farmers in Nyando Division do not have adequate incomes, labor, and agricultural extension services, farm sizes and education for maize production. The study revealed that a number of these socio-economic factors significantly affected maize production. Multiple regression results reveal that most of these factors were significant at 0.05 significant level. Labour was 0.0466, extension service 0.0041, value of crop input purchased 0.001 and farm size had 0.0899. The null hypothesis is therefore rejected and the alternative accepted. Socio-economic factors significantly affect maize production in Nyando Division.

Since one of the alternative hypothesis was accepted, the study can be said to have succeeded in identifying the factors that influence maize production in Nyando Division. These factors are low incomes, lack of extension services, low labour supply and lack of adequate farm sizes for maize production.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary on Findings and Conclusions

In this section a number of factors found to be the major constraints that limit maize production in Nyando Division are presented. The evaluation also shows the relevance of this study based on the information gathered during the field exercise. Six factors established to affect maize production in Nyando Division include:

- Labour was established as an important factor contributing to maize production in Nyando Division. The supply of labour was limited by the high number of household members going to school and absent laborers. This was critical especially during weeding periods when there was inadequate labour. Farmers who obtained higher yields had more weeding hours than those who had lower yields. This shows that labour, especially for weeding was very important in determining yields in the division. Lack of enough labour thus exerted a limit to maize production in Nyando Division.
- The study found out that household income levels were relatively low and depended on crop production and off farm income. As a result, farmers did not invest much on farm inputs such as draft power and fertilizer. This affected maize production in the area negatively.
- There was a significant variation in seasonal, monthly, and yearly amount of rainfall received in Nyando Division. This difference did not contribute much to differences in

yields between the two regions considered. Therefore rainfall variability compared to other factors considered did not have much affect on maize production in the division.

- Land for maize production was not readily available to most farmers in the division. It was noted that land size devoted to maize production differed significantly from one region to another. Access to maize cropland was a major problem because as young families came up, the land has to be subdivided. Other crops particularly cash crops tend to be allocated more land than maize crop. This has led to a decrease in maize production. Moreover the household land parcels were scattered making it difficult for them to work on all the pieces at once. It was therefore established that land size is an important determinant of maize production in Nyando Division. This implies that farm sizes exerted limit to maize production in the area.
- Crop management skills were found to be generally low among household heads. Skills were potentially limited by male absenteeism. Thus most men were engaged in employment in the nearby towns leaving the women alone to manage the farms.
- Like the low resource levels of most small-scale farmers, fewer technologies were adopted. The techniques were not new to farmers but only a few were using them. The majority did no know how to use them due to poor extension service. Farmers who had a closer link with the agricultural extension officers performed better than those who had never been visited by the officers.
- Finally, the study has assessed the use of farm inputs in Nyando Division. The results revealed very low use of agricultural inputs in maize production in the study area. The inputs considered in the study-included fertilizer and improved seeds. Most farmers in the area do not use fertilizer at all. The low use of agricultural inputs is attributed to

three constraints. The farmers' assumed that the soils in the division are fertile because of frequent flooding in the area. Secondly, the farmers had low incomes and did not have access to credit facilities. This exerted a constrain in the investment of farm inputs. Lastly, the agricultural extension services in the area were poor. Very few farmers knew of the input requirements. Thus non-use of farm inputs exerted a constraint to maize production in Nyando Division.

6.2 Recommendations

The findings of this research can be used to provide a basis on which a number of recommendations are drawn.

- Spatial rainfall variability to some extent affected maize production. Agricultural planners should make use of the local meteorological stations to formulate policies that are viable to the respective specific regions. The focus for research in Nyando Division need to be directed to the existing potential in this area so as to generate new techniques that extension workers can successfully extend to the farmers.
- Farm size was found to be a limiting factor for maize production. Most of the farmers had small farm sizes, which were far apart. Land consolidation should be done in the whole of Nyando Division to bring together pieces of land, which can be used for maize production.
- The cultural practice that encourages subdivision of land among family members should be discouraged. This would ensure availability of adequate and economically viable farm sizes for maize production. Instead the family members should be encouraged to purchase land in other parts of the district where land is available.

- Farmers' income was identified to limit use of farm inputs, which could increase maize production. Indeed farmers who achieved good yields spent money on inputs almost three times the value of those who got lower yields. Therefore ways of increasing farmers incomes should be sought to enable them use the appropriate maize production technologies. Since the main source of income for most farmers was from off-farm sources, there is need to determine ways of generating more off farm sources of income so that worthwhile progress in improving maize production can be achieved.
- The study found that 85% of the farms in the division were household owned. However, very few farmers had title deeds and none of them had used them to get loans for maize production. The research in the division needs to be directed towards determination of the factors hinder provision of title deeds and how the title deeds can be used to get credit for farm production.
- Finally, extension service was also identified as a major factor affecting maize production. It was noticed that those farmers with closer contact with the extension staff had better maize yields than those who did not. At the time of research there were only 12 agricultural extension officers serving the whole division in the ratio of one officer to eight hundred farmers. There is need therefore to deploy more extension officers in the division. Furthermore the officers should be local people who are familiar with the needs of the region. This would make the farmers more aware of the maize production techniques and thereby apply them for increased production.

It is hoped that the findings and the recommendations of this study would be useful to policy makers and those concerned with agricultural production in Nyando Division

and other parts of the country where similar conditions exist. By using appropriate farming technologies maize production in Nyando Division can be increased and monitored well above subsistence level.

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APPENDIX

QUESTIONNAIRE AND INTERVIEW SCHEDULE FOR THE FARMERS

Section I General Information

01 Name of the farmer _____(optional)

02 Sex: Male [A] Female [B]

03 Age of the holder _____years

04 Location_____

05 Sub location_____

06 Highest level of education attained_____

Section ii Farm Resource and Income

(a) Farm Resources

01 Family details

Personnel	No.
Total in family	
children <15years old	
Children> 15years	
off farm employed	

02 What is the total area of your farm? _____(acres)

03 State the ownership of this land [A] individual holding [B] leasehold [C] Customary.

04 if this land is hired , how much do you pay for it? Kshs _____

05 Do you have a title deed? [A] Yes [B] No

06 Have you used your title deed as a security for loan? [A] Yes [B] No

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05 Do you have a title deed? [A] Yes [B] No

06 Have you used your title deed as a security for loan? [A] Yes [B] No

07 If yes how much did you borrow? KSH _____

08 How much of the money borrowed was used in agricultural production? KSH _____

09 Farm assets

Asset	Type	Number
Cattle		
Tractor		
Others		

(b) Labour supply

10 What is the nature of your labour supply?

Source	No. engaged	Hours	Cost	Supervisors
Holder				
Family				
Casual				
Permanent				

11 Are you engaged in any formal employment to support the family? [A] Yes [B] No

12 If yes, fill the table below

Occupation	Location (rural or town)	Income

13 Is the labour available when you need it? [A] Yes [B] No . If no explain_____

Section iii Maize Production

(a) Cropping pattern

01 What crops do you grow?

Crop	Acres	Yield bags/acre	production Kg/acre
Maize			
Sorghum			
Millet			
Sugarcane			
Rice			
Others			

02 What has been the maize production trend in the last five years?

Year	Production bag/acre
1994	
1995	
1996	
1997	
1998	

(b) Information

03 Have you attended any farmers' training course? [A] Yes [B] No

If yes a) specify the type of course _____and b) where trained _____

04 In what way do you think the course has been useful to you?

05 How do obtain information on input of maize production [A] radio [B] extension officer [C] others (specify)

06 How often in a year do the extension officers visit you to advice on maize production?

[A] monthly [B] bimonthly [C] quarterly

07 Are you normally satisfied with the advice given by the extension officer? [A] yes [B] No

c) Farming practices and income

08 How much money did you use in the following activities in maize production last year?

Activity	Amount
Land preparation	
Seeds	
Fertiliser	
Weeding	
Others	

09 What was your last years total income from the farm? KSH_____

Crop	Amount
Maize	
Sugarcane	
Sorghum	
Others (specify)	

10 How many times did you weed maize crop last season? _____

11 Do you practice crop rotation? [A] Yes [B] No

If yes specify the crops _____

12 What kind of agricultural inputs do you use?

Input	Type
Fertiliser	
Hybrid seeds	
Others (specify)	

13 Can you show how you have been using the maize production technologies listed below?

Technology	Year	Trial	Adopted/Not	Alternative
Hybrid seeds				
Capital				
Others (specify)				

14 What do you see as the advantages, disadvantages and alternatives to the following improved inputs?

Input	Benefit	Disadvantage	Alternative
Fertiliser			
Hybrid seed			
Spacing			
others (specify)			

15 To what extent do the following factors hinder your production of maize? 1 for most significant, 2 for significant, 3 for not significant and 4 for no effect.

Factor	Rank (1-4)	Remarks
Farm sizes		
Capital		
Rainfall		
Labour		
Weeds		
Soil fertility		
Hybrid seed		

16 What do you suggest can be done to improve maize production in this location?

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