FOOD SECURITY AND AGRICULTURAL DEVELOPMENT:

A CASE STUDY OF BOGETAORIO II SUB-LOCATION, KISII DISTRICT, KENYA.

BY

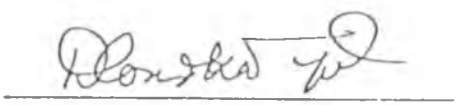
DISTERIUS ONDIEKI NYANDIKA

A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE OF MASTERS OF ARTS (AGRICULTURAL GEOGRAPHY), IN THE FACULTY OF ARTS, UNIVERSITY OF NAIROBI

AUGUST, 1994

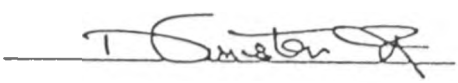
DECLARATION

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

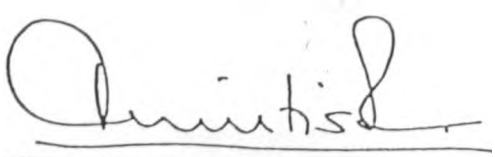


Disterius O. Nyandika
(Candidate)

This thesis has been submitted for examination with our approval as University Supervisors:



Prof. Dunstan A. Obara
(Supervisor)



Dr. Samuel K. Mutiso
(Supervisor)

DEDICATION

To the late Bishop of Kisii Diocese, Tiberius Charles Mugendi. He financed my Secondary school education when Dad died. To my brother Raymond Mokweri Nyandika.

TABLE OF CONTENTS

CHAPTER TWO: **BACKGROUND TO THE STUDY AREA**

CHAPTER THREE: **RESEARCH METHODOLOGY**

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

1.	FAO:	Food and Agricultural Organisation
2.	ASAL:	Arid and Semi-Arid Lands
3.	CBS:	Central Bureau of Statistics
4.	ACTS:	African Centre for Technology Studies
5.	DDC:	District Development Committee
6.	GAT:	Germany Agricultural Team
7.	GNP:	Gross National Product
8.	IRS:	Integrated Rural Survey
9.	IIASA:	International Institute of Applied Systems Analysis
10.	IDS:	Institute of Development Studies of the University of Nairobi.
11.	LBDA:	Lake Basin Development Authority
12.	LDCs:	Less Developed Countries
13.	NCPB:	National Cereals and Produce Board
14.	UNICEF:	United Nations International Childrens' Education Fund
15.	UN:	United Nations
16.	USDA:	United States Department of Agriculture
17.	WHO:	World Health Organisation

ACKNOWLEDGEMENTS

I would like to thank the following personalities and institutions for their assistance. I sincerely express my gratitudes to my University supervisors, namely Prof. Dunstan A. Obara and Dr. Samuel K. Mutiso, their inspirations made me excel in my first year examinations. Their continued support during the stages of preparing my proposal and their views during the writing of my Thesis were summarily enriching.

I thank Mr. James Osore (Kisii District Agricultural Marketing Officer) and Mr. Gideon Mwangi (Kisii District Crop Officer) for assisting me during the collection of my secondary data. Not to forget Mr. Joseph Kangwana the Bogetaorio II chief for his help while in the field.

I thank the Department of Geography of University of Nairobi for its computer facilities that enabled me to analyse my data. I also thank the Central Bureau of Statistics of Kisii District for their relevant secondary data.

My sincere compliments also go to all my fellow postgraduate students in the 1991/92 Academic year. I also have in mind my elder sister, Mrs. Agnes Angwenyi (Operations Manager PostBank) for editing part of my work. My gratitudes also go to Mr. Daniel Angwenyi (Account Manager, Commercial Bank of Africa).

Daniel's imagination and modelling about what he wanted me to become, increased my academic ambition. I appreciate the generous support from my brother, Mr. Richard Nyandika to me and to our family as I struggled with this scholarship. Not to forget my cousin, Mr. Edward Nyabayo for his homage.

However, errors in this work are my responsibility.

ABSTRACT

This research is about the relationship between food security levels and agricultural development. It examines the existing food policies, the extent to which household attitudes and social behaviour, savings and investments on inputs for agricultural development.

Stepwise regression analysis is used to derive models or equations for predictive purposes. On testing the hypotheses set for the study, it is established that there exists a significant correlation between household food security levels and factors of production; household savings, household labour and household levels of farm technology. It is also ascertained that variations in household's food security levels are reflected in agricultural diversification, and the levels of farm technology at each household. Graphs were generated to portray the variations of independent variables with dependent. This research was limited to a sub-location level because of the financial limitations. However, this facilitated greater accuracy in data collection and analysis. It has also made it possible to compare findings at micro-level with those at micro-level. For instance, this research has established that there is about 21.497% food deficit in the study area, whereas the Kisii District Development plan indicates that the region is self-sufficient in food production.

It is concluded that for general agricultural development, food security should be a major policy issue. This is because though Kisii district is a high potential agricultural region, it depicts pockets of food insecurity, which aggregates into a slow pace of agricultural development.

Other researchers may further explore to find out why those households recording low levels of food security own big tracts of arable land that remain uncultivated. It will also be worthwhile to investigate through a scientific inquiry why maize yields per bag also continue to decline since 1988/89. Summarily, a policy framework aimed at improving food security is a sure way of increasing agricultural labour productivity and the pace of agricultural growth. And incentives towards agricultural development remain basically the alleviation of hunger and malnutrition. Food insecurity is a major problem that some farmers in high potential areas face in agricultural development. This proviso justify the need to review the existing agricultural development policies for the referred zone.

CHAPTER ONE: INTRODUCTION

1.0 Statement of the Problem:

This study is a geographical investigation of household food security levels and agricultural development in Bogetaorio II sub location, Kisii District. Patterns of agricultural performance in Sub-Saharan Africa and particularly in areas of food production cause great concern among planners, donors and politicians. Empirical studies continue to predict a widening gap between projected trends in food production and consumption among developing countries. In 1984 FAO World Report included Africa's food crisis as that year's topic of interest in food and agricultural development. The UN has had the alleviation of hunger on its agenda for the last 20 years.

There is no more important task before the world than the elimination of hunger and malnutrition in all countries. But since 1960s in practically all tropical African countries food production has failed to match population growth. The average rate of growth in average food production per head of population was negative at about 0.7% in 1960s and worsened during the 1970s to about 1.6% (FAO 1974). Kenya is among the 29 Sub-Saharan countries out of 40 low income countries world wide that failed to produce enough food for their people towards the end of 1980s. The share of Sub-Saharan Africans living in abject

poverty as a percentage of all the poor in the third world is estimated to have grown to 24% from 19% in 1985.

Increased food production has become a major goal of the Kenyan government as stated in the 1981 sessional paper No.4 on Food Policy, which set forth a comprehensive food policy with the following objectives: maintain a position of broad self sufficiency in the main food stuffs, to achieve a specified degree of food security in food supply to each region of the country and thirdly to ensure that those food stuffs are distributed in such a manner that every member of the population has nutritionally adequate diet.

However, even with the foregoing policy framework the food deficits continue unabated. According to the recent economic survey (Republic of Kenya 1992), there was a 13.3% drop in maize production from 25.4 million bags in 1991, production of beans, potatoes, and sorghum also declined by 10.3%, 8.6% and 1.7% respectively. Given this background it is important to investigate the implications of such negative trends in food production on agricultural development.

In terms of the requirements for sustainable development, agriculture must continue to grow at a sufficient rate to do the following by the year 2000; Provide food security for the estimated population of 35 million, generate farm

family incomes that grow at least 5% a year for the next 15 years; absorb new farm workers at the rate of over 3% a year with rising productivity: supply export crops sufficiency for a 15% increase in agricultural export earnings and stimulate the growth of production off farm activities in jobs that can grow at 3.5% to 5.0% a year (Odingo, R.S. 1990).

Three issues raised in this study are:

a): What is the significance of examining the existing food policies and agricultural development?

b): To what extent does food security influence labour productivity, attitudes, social behaviour, savings and other agricultural development inputs?

C): To what extent should food security form the basis of agricultural development strategy in Kenya?

1.2 Literature Review:

Food problems are probably as old as human history. Throughout the ages there have often been famines in various parts of the world. The situation of hunger and malnutrition arises from historical circumstances, including social inequalities, in many cases including alien and colonial domination, foreign occupation, racial discrimination apartheid and neo-colonialism in all its forms (World Food Conference 1974).

Drought has been a major cause of food shortage. It occurred in Eastern Africa in 1980-81, in Southern Africa in 1978-79 and in the Sahel in 1968-74 (Anyane 1985). In Kenya following the drought of 1984, maize production fell by 35%, wheat by 43% and both dairy and beef herds were drastically reduced (Republic of Kenya 1989). In Kenya, of the 44.6 million hectares of land, only about 8.6 million hectares are medium to high potential agricultural land and over half of the country receives less than 500mm of rainfall annually. But estimates by Haggins and Kassam (1989) have shown that the soils of Tropical Africa, if used properly could at low levels of input produce food sufficient for three times the 1975 population and for one and half times the projected population of Africa in the year 2000. Researchers Mutiso (1977) and Wisner (1977) suggest that drought vulnerability resulting in food shortages in many parts of Eastern Africa must be considered as a function of unequal regional economic development and increasing income disparities among the areas populations rather than the physical factors alone. Researching on food problems in Kenya Kliest (1985) concludes that Kenya's short and long term food problems are closely related to specific ecological conditions prevailing in a large part of the country.

Six main household consumption surveys carried out in Kenya have been identified by Shah and Frohberg (1980).

a): 1963 survey of middle income earners in Nairobi.

b): WHO/FAO/UNICEF, Kenya food consumption and nutrition survey 1965/66.

c): Household budget surveys in Nairobi, Mombasa and Kisumu 1968/69.

d): Rural households surveys in Nyanza Province 1970/71.

e): Integrated Rural survey (IRS) 1974/75.

f): Urban survey, first phase Nairobi, Mombasa, Kisumu, Nakuru- food purchasing survey 1977.

g): Food consumption pattern in Rural and urban Kenya Shah and Frohberg (1980).

A comparison of data from the 1970/71 rural household survey of Nyanza province and the 1974/75 integrated rural survey data shows that food and nutrition problem in Kenya is not confined to arid and semi arid lands.

Thorbecke and Greer (1986) researched on food, poverty and consumption patterns in Kenya and reached at the following observations: Kenya small holders are not pure subsistence farmers; most settled areas of the country have extensive rural road networks linking households to markets; smallholders get a large proportion of their consumption needs from off-farm sources. On the probable consequences of a rise in maize prices on the incomes and food consumption levels of major socio-economic groups the two conclude that the poor in Kenya will not in general be adversely affected by maize price increase due to the fact

that the bulk of the Kenyan poor are small farmers who grow most of the maize. While Ateng (1986) undertook a study to determine net available food supplies for domestic consumption in Kenya by analysing the trends in production, exports and imports of major foods in the country during the period 1961-1983. In the search for possible answers for the compatibility of aggregate adequacy in food and nutrient supplies and malnutrition in some groups of the population in rural households, he found out that most of the rural households depend on purchased foods to a surprisingly high percentages and the poorest are particularly dependent on purchased foods.

There are two opposing schools of thought regarding the motivations, attitudes and values of traditional subsistence farmers. One school considers the peasant as `a miniature economic man' acting within the limits of economic rationality and aiming to improve his economic performance (Shultz 1964).

According to this school, socio-cultural factors have a marginal role. Subsistence farmers live and work in a physical, economic and cultural environment that is relatively static. Consequently they go through a process of trial and error gradually arrive at an optimal solution to the allocation of limited resources available to them (Mellor 1969). According to this view traditional farmers

will respond quickly and effectively to economic incentives in adapting new techniques of production. The second school of thought considers that in subsistence agriculture non-economic forces generally outweigh purely economic forces leading to the behaviour that is not within the bounds of economic rationality (Myrdah 1968).

Many societies in developing countries have rigid classes of society which constitute barriers to socio-economic and agricultural development (Alan 1973). In most under-developed and developed countries women are an essential part of the farm labour force but the vocational training of women is virtually neglected as a result of established social patterns and prejudice. Where wives do not share either directly or indirectly in cash crop profits they may resent increased workloads. This will inevitably lead to household tensions and hinder farm development (Eicher 1964). Food situations of poor families in Kenya is made more serious by the fact that while much else has changed, sexual divisions of labour has lagged behind.

There are six distinct basic approaches to the study of food deficits and hunger. (Hayami 1971). These approaches have a convergency between the traditional social science disciplines of economics, sociology and traditional food and health related disciplines. Firstly, we have the epidomological approach, in which separate factors defined

with nutritional diseases. Such studies are highly statistical and appear objective and unbiased. Large scale surveys are often mounted using this approach and aggregate findings to suggest national food and nutritional policies. Those trained in medical or health establishments such as WHO tend to use this methodology. All causes of hunger are viewed as spokes, and the importance of each spoke is determined by empirical study. This approach has not led to a general solution of hunger problem because the analysis stops short of identifying root causes and their implications. Few in using or applying this approach seek to understand the wider social context in which the hunger problem is embedded. True, efforts to understand the hunger problem through research, planning and programmes restricted to this approach holds little promise. Secondly, there is the ecological approach, which has gained popularity since 1960s. The main thesis here is on land productivity and sustainability which recognises the fact that in specific ecosystems the carrying capacity of the environment is exceeded leading to food scarcity. Ecological destruction and famine are considered to be manmade, resulting from the misuse of technology and the population pressure.

The econometric approach is the third and it is applied by trained economists, food and nutritional planners.

Methodologically this approach provides rigorous research in the form of systems, models, large scale surveys and national nutritional monitoring. More often it focuses on target groups and makes recommendations on cost benefit analysis on methods of intervention. While it is superior to the epidomological approach because of its broad analytical scope, with few exceptions the methods and conclusions of econometric approach largely do not incorporate the social contexts where they are applied.

The fourth is the technological approach which lays emphasis on improved methods of food production and subsequent preservation. In a nutshell, the main focus is on the green revolution as the main avenue towards sufficient food production in the world. The advocacy approach is the fifth and often adapted by all organisations active in food, hunger and development issues. This approach is associated with relief operations hence it is an ad hoc approach to solutions of food deficits and hunger.

The sixth is the structural approach: application of this approach to world food and hunger problem has become increasingly more important than other approaches. This is concerned with the causes for the conditions under which hunger is likely to occur. The premise of the structural approach regarding societal persistence and change is that they are rooted in the basic social structures of

societies. The characteristics of social structures is not the same from the highest level to the lowest level at the household (FAO 1974). This approach is found appropriate in order to understand the social economic structures that result into food deficits and its impact on agricultural development.

Researching on selected social-economic factors on food production in Kisii district Kumba (1990) used principal component analysis to generate a reduced set of factors that account for most variability of the original data. She concentrated on the influence of social-economic aspects of food production. The study was also intended to throw light on the levels of food production, levels of food security and other related aspects of food production in general. While not much is mentioned about the food security levels in the study area it is concluded that agricultural input variables are the major determinants of food yields. This provision will be verified in this research.

Studies conducted during the world war II at German coal mines found out that production varied directly with calories fed (Dore 1967). Experiments by WHO (1974) have found out that near starvation levels of food consumption cause irritability, general apathy, weakness and lack of energy. Ill health and low agricultural productivity are well documented. Inadequate food intake results in

malnutrition and death if food is critically low. But even moderate degree of malnutrition as documented in Kenya (CBS 1979) leads to ill health, lack of resistance to disease and impaired work capacity. It is agreed that malnutrition in Kenya today is mostly as a result of inadequate quantity of food and that the critical factor is the level of energy intake (Development Plan 1978-83).

The magnitude of the problem of landlessness and near landlessness is a factor in food insecure rural households (Rukandema, 1975). Amin (1966) in his work entitled food supply and economic development with special reference to Egypt identified five possible ways in which food supply may contribute to economic development.

a): Food production sometimes in certain circumstances constitute the leading sector which spreads expansion to other sectors of the economy.

b): Food exports may be a source of foreign exchange needed to finance development activities.

c): Through raising the level of food consumption, an increase in food supply may contribute to a rise in labour productivity and may even increase the supply of labour through an increase in population.

d): An increase in food supply may permit more labour to be employed.

e): An increasing food supply creates income which provides a market for an increased supply of manufactured goods.

Adequate nutrition is essential for maintenance of good health and for increasing the productivity of individuals and for raising overall national productivity needed for successful implementation of policies (Obara 1982).

For some decades a debate raged in the economic profession as to whether to promote industry or agriculture in overall development programme in developing countries. One school of thought whose prominent adherents included shultz, Johnston and Mellor argued that the primary source of growth lay in the transformation of their traditional agricultural sector (Amann, 1973). They noted that expanded production and export of primary products in countries displayed comparative advantage would earn them valuable foreign exchange. Another school saw a historically adverse terms of trade against primary products. The arguments are relevant because industrial development is complementary to agricultural development. The outcome of this debate is that several theories have been advanced to explain the process of agricultural and economic development in Africa and in developing countries

in general. Most of these theories have been grafted on experience outside Africa and do not provide the model required to explain the situation obtaining in Africa (La-Anyane 1986). Firstly, experience has disapproved the view that economic behaviour among African farmers does not differ essentially from that of farmers in the most of the world. It is indicated that the gap between theory and practice stems from the environment, in particular from the state of development of the infrastructure and institutions. Secondly, in other theories traditional African institutions and the existence of large traditional subsistence sectors of the economies have been cited as barriers to development. While it may be true that many of the problems of agricultural development are caused by the nature of traditional institutions however the view that African societies show far greater resistance to change than other societies of the world because their traditional practices resist change remain at the threshold. It has been argued by scholars from Africa that unnecessary emphasis has too often been placed on changing the motives of peasant producers as a pre-requisite to progress in agricultural production. African farmers have adopted modern farming methods;, use hybrid seeds, fertilcer and pesticides. It is also a fact that indegenous agroforestry systems are more productive and traditional farmers should be given credit.

Theories of agricultural development: literature review on this subject indicate that these theories are based on economic thought. Southworth (1976) argues that, Economic theories of Agricultural development consider the role of agriculture in economic development, the economic nature of traditional agriculture and the economic nature of modernization of agriculture. On the role of agriculture in economic development, emphasis include the description of agricultural potential to economic development. These ideals have been propagated by Johnston and Mellor (1961) and expounded by Nicholas (1963). Second emphasis is on the growth stage theories of Rostow (1960) which underline the significant role of agriculture in early stages of economic development. Third are the simplified Mathematical Models of development process advanced by Fei Ranis (1964) and Jorgenson (1961). Fei and Ranis assume that there is substantial stock of labour which may be withdrawn from agriculture without causing a decline in agricultural production. While Jorgenson assumes that the transfer of labour from agriculture will result in a decline in agricultural production. Efforts to build a theory of modernization of agriculture have proceeded little beyond cataloguing of relevant inputs, a recognition of important complementarities and diagnostic studies. Whereas it has been recognized that agricultural productivity influence the overall economic development process as well as the strategy for development of agriculture.

Models of agricultural development: Most developing countries face a basic issue of agricultural development strategy of making a choice between the `Japanese Model' and `Mexican Model' (Monk and Scott 1989). The contrast between the Japanese and Mexican approaches to agricultural development lies in the fact that the increase in farm output and productivity in Japan was the result of widespread adaption of improved techniques by a great majority of the farmers whereas in Mexico a major part of the impressive increases in agricultural output was the result of extremely large increase in production by a very small number of large scale highly commercial farm operators. There is also the `Israel Model' and the `Stalinist Model'. The former lays emphasis on government financed settlement schemes. The stalinist model also encourages pre-occupation with large scale units that are capital intensive. This reflects in part the tradition in Marxist thought of glorifying and exaggerating economies of scale in agriculture. However, Johnston (1970) concludes that the application of the `Japanese Model' by contemporary underdeveloped countries takes a number of problems. This is because their unique problems in agricultural development differ in four ways from those that confronted Japan. Much higher rates of growth of total population and labour force. Secondly, pressure both economic and non-economic give rise to a rather capital intensive pattern of investments dispite the scarcity of

capital and relative abundance of labour. The possibility of supplementing domestic resources by foreign aid. And lastly the current "climate" of opinion and other factors that complicate agricultural taxation. Developing countries must therefore device their regional and unique models of agricultural development.

John Tarrant (1990) wrote a paper entitled: "Food Conflicts in Food Deficit LDCs", this paper concentrates on answering food policy questions for food deficit LDCs, while taking examples from Bangladesh but noting similarities and differences elsewhere in the developing world. The conflicts are generally seen to be between policies which benefit producers and policies directed at consumers . In very general terms the stimulation of increased production in such countries requires higher prices and/or higher returns to agricultural production, while increased consumption necessary to reduce malnutrition requires lower prices, at least to some consumers. However, Tarrant fails to outline a policy that makes a distinction between consumers and producers, since large numbers of small producers may not produce sufficient food to feed their own families throughout the year they may then be net consumers.

Most of the incidence of hunger in the world has little to do with the availability of food but rather with the inability of sections of the population to afford what is

or could be available. Food could be sufficient in a country but some households lack purchasing power.

During the proceedings of 1989 Workshop organised by Global 2000 at Accra Ghana, it was noted that LDCs experience food deficit when so many of them are well endowed with natural resources, with a major portion of their population engaged in agricultural production, Dowswell, (1989). The seminar concluded that LDCs significantly under invest in human capital needed to modernise their agriculture, that their economic policies discriminate against the agricultural sector, while little research money is allocated to food research activities and that these countries also under invest in the provision of health care services for their rural population. This leaves their agricultural population weakened and less productive as workers. The seminar noted that unless changes occur in recent trends the alarming prediction by FAO that Sub-Saharan Africa will only produce 75% of the food production needed by the year 2000 will become a tragic reality.

Kahangi (1993) notes that Bio-technology and Computer technology had enabled Asian and Latin American producers of agricultural commodities such as cocoa, bananas and rubber to meet the quality requirement by importers and various consumers. He states that unless Africa's general growth was based on its own, indigenous technological capabilities there is little prospect in agricultural

developments. Kahangi further contends that Africa must first develop indigenous capacity to evaluate the available technology and those that were appropriate to its needs and situations.

Maize production is expected to be affected by anticipated climatic change (Ottichilo 1991). It is expected that increases in temperatures will increase plant pests and diseases. High temperatures will also accelerate mineralisation of organic matter in the soils. This problem is already significant in tropical humid regions leading to reduced soil fertility and soil structure. Very humid conditions are not suitable for maize production and instead tend to encourage diseases. Although the magnitude of temperature increase is not known, its increase is likely to limit areas for maize production.

Surplus commercial food production under subsidies is not distributed through normal market channels but rather through food aid programmes in distorted world market Franklin C.(1993). Franklin states that food relief from the developed countries have not helped the estimated 40 million people suffering from malnutrition in the arid and semi-arid lands of Africa alone.

Khusro, A. M. (1968) underlines the fact that agricultural stagnation helps to explain why French manufacturing

industries made so little progress before 1944 when compared to the rest of Western Europe in the same period.

The term food policy refers to those guidelines for decision making on all issues related to food production, processing, marketing, distribution and consumption in society. Historically most food policy have been actually agricultural policy and often has focused on ways to increase farm output frequently just for a single commodity such as wheat or rice. Such a partial or narrow approaches have failed to improve significantly the nutritional status of the large number of people in developing countries because they have failed to forge a strong link between the expansion of agricultural output and the reduction of hunger: (Shah 1980).

In Kenya there was widespread drought in 1960 and devastating floods in 1960-62. During 1980, Kenya was confronted with food shortages and forced to import maize, wheat and milk. Except one factor; namely the adverse growing conditions in 1979/80 crop year, all other factors that combined to cause food shortage then, could have been averted if Kenya had a sound food policy in operation.

During the heavy crops in 1976 and 1977 delay in the purchase and export of surpluses left the National Cereal and Produce Board with full stores unable to purchase all

the farmers supplied. Private trade was unable to absorb fully the surpluses due to restrictions on private movement of maize. In response, farmers reduced the acreage of production. This was reflected in the decline in productivity in 1980 reinforced by the shortage of fertilizer, the discontinuation of the seasonal credit scheme in early 1978 together with the lowering of the National Cereal and Produce Board (NCPB) purchase prices. At this point Kenya's policy makers saw the need for formulating a National Food Policy (NFP).

Kenya's comprehensive National Food Policy is documented in the sessional paper No.4 of 1981. This policy complemented a detailed National Livestock Policy which had come into effect earlier in 1980. The overall objectives of the NFP are to maintain a position of broad self-sufficiency in the main foodstuffs in order to enable the country to feed without using the scarce foreign exchange currency in food imports. Secondly to achieve a calculated degree of security of food supply for each area of the country. Thirdly to ensure that these foodstuffs are distributed in such a manner that every member of the population has nutritionally adequate diet. The NFP fully recognizes that increased food production in Kenya will depend on the production strategies and policy measures which enhances increases in yields. The policy components here include; price adjustments, provision of credit, research and field

extension, food processing and marketing, trade in agricultural commodities, food security and nutrition. The policy document also identifies the potentials for increasing production. Firstly, the excess of additional hectares of land would need to be planted. Secondly, any major increases in food production from areas of medium potential like in Central or Eastern provinces will come from the adaption of more intensive techniques of crop and animal husbandry. In the same policy it is underlined that the government would seek to increase production and consumption of more nutritious food, improving the distribution of purchasing power and the implemention of specific market intervention programmes. On the agricultural trade policy, the objective is to be self sufficiency in maize. In addition, there will be careful control of all food exports so as to allow shipment when domestic supplies are assured.

All factors considered, Kenya's Food Policy of 1981 is consistent both internally and with the broad objectives of National Development. It recognizes that increased food production will depend on the production strategies and policy measures which enhances increases in yields. However Kenya's food security situation has not improved. This could be attributed to that fact that, the NFP lays less emphasis on food security research. It also fails to forecast the future food production trends. The policy

also fails to incorporate any comparative studies from other countries. The NFP pays little attention to some of the social cultural constraints that reduce agricultural productivity, whereas the conflicting pricing policies for the consumer and the producer complicates Kenya's National Food policy formulation even further.

Food is both a major source of employment and a key incidence of poverty. Food is especially vital because it is, that element that ensures survival and provides energy for all human activities. Consequently, research on food being at the heart of survival, health and human energy should receive more attention than it has in the past. Literature abounds that Kenya is a poor country with many apparently undernourished people especially in rural areas. A significant number of Kenyan small farm households is estimated to consume fewer calories than the recommended daily allowance. The impact of these negative trends form a good strategy for agricultural development in rural Kenya. Not to forget that over 75% of nutritionally vulnerable people live in rural areas and depend on agriculture. (Shah and Frohberg, 1980).

A review of Kenya's development plans and food security statements indicates that the main policy of the government is to increase staples, cash crops and agricultural raw materials, in the medium and high potential areas. The

government strategies include; scientific and technological methods, agricultural diversification, development and expansion of land under crop cultivation, development and expansion of storage facilities, improvement of control of pests and other environmental contaminants to reduce pre and post harvest food losses and application of appropriate processing and packing technologies to enhance material food policy. All these, not a single policy has tried to link food security and agricultural development.

1.3 Justification of the Study

It is evident from the reviewed literature that research has tended to concentrate on the causes of food insecurity in general. Little progress has been made on the interrelationship between food security and agricultural development. Food problems cannot be solved unless all aspects of food received deserved attention. In this regard a multi-disciplinary approach in research is required for careful planning and concerted action by scientists, nutritionists, agriculturalists, policy makers, economists and technologists. Research already undertaken focuses mainly on weather, ecology, economics and agronomic aspects of food production.

One major feature of the post Kenya agricultural development policy has been the great emphasis placed on

cash crops relative to that placed on food production. But with frequent price fluctuations of cash crops in the world market and increased imports of food, it will be worthwhile to assess the impact of food security on agricultural development. The 1966-70 development plan laid emphasis on rapid economic growth. The 1970-74 underlined the significant role of rural development. That of 1974-78 also considered rural development while its agenda was on employment creation and improvement of income distribution. In the 1979-83 plan attention shifted to the alleviation of poverty. While in the 1984-88 plan emphasis was on the mobilisation of domestic resources for equitable development. In all these development plans, only the 1979-83 one recognised food policy issues. Although the development plans identify the significant role played by the agricultural sector, they do not set the data base to show the extent food security supports agricultural development. Food insecurity and nutritional status cannot be considered only as it influences health as has been the case in the past, but also as it relates to the human well being and to social economic and cultural development.

Because of the interdependence which exists between food demand and overall income on the one hand and between agricultural (food) output and total output (GNP) on the other, the country's demand and supply of food stuffs cannot be considered independently from economic growth or

agricultural development. The heavier the pressure exerted by food insecurity whether nationally or at household level, the more will resources tend to be deflected from investment. It is therefore important to research on the magnitude of food insecurity at household level.

Data on food production in the country is aggregated into trends in per capita food production. This is not a good measure of food security. Studies are required even at sub-locational level so as to identify the nature of food security situation. This is because food deficits exist at many different levels of a society, from household to international levels. The extent it affects the rate of agricultural development also varies. Household survey data are often too aggregated, such an average fail to indicate which sections of the population may have inadequate intake or a serious deficiency. It is imperative therefore that research be conducted at a local level.

A developing nation like Kenya, needs to be informed on food and nutrition status of its people so that it can anticipate problems in both production and marketing and can take steps to ensure adequate supplies, equitable distribution and efficient utilisation of food. **The following factors justify the choice of the study area;**

Most of the potential for maize production or generally in food production in Kenya is in the high and medium

potential areas, especially in Nyanza and Western provinces. But rural poverty is also concentrated in these regions Thorbecke (1978). This is a significant phenomena in agricultural development that deserves research attention.

A sound knowledge of site specific conditions of food security and agricultural development is the basis for agricultural growth and precondition for successful farming. Therefore any research and planning in agriculture requires clearly defined boundaries.

This research is relevant in regional planning. The strategy of the Lake Basin Development Authority is to increase food production in the basin in general, aiming at making the region a granary of Kenya or even in East Africa as a whole. Findings from this work will also be vital for the district development committee now that district focus strategy is the theme in planning.

The researcher is a native of the very district and the specified sub-location of the case study. Hence the researcher is better placed to make a breakthrough to all cultural problems emanating from the field. There is also the advantage of the first hand information of the area, which is of major significance in any accurate research project.

This study is of both practical and academic significance. It offers an empirical investigation on food security in agricultural development. This analysis is crucial in a developing economy like Kenya where agriculture is the backbone of the economy. And although the study area is limited to a locational level, findings will be applicable in broad policy framework.

1.4 Objectives:

a): To investigate the household food security levels and hectares of land under cultivation.

b): To establish the relationship between income expenditure on the purchase of food and amount of income spent on agricultural inputs.

c): To identify the relationship between levels of household food insecurity and the total value of farming equipments.

d): To investigate the total household labour and the total agricultural output.

e): To determine the extent household savings are influenced by expenditure on food purchases.

1.5 Hypotheses:

a): There is no correlation between the households' food security levels and the households' annual savings.

b): Levels of household food security do not influence the total value of farming equipments.

c): Food scarcity conflicts at household level do not lead to absenteeism from agricultural activities.

d): There is no relationship between the scale of agricultural output and available household labour.

1.6 Theoretical Framework and Scope of Study:

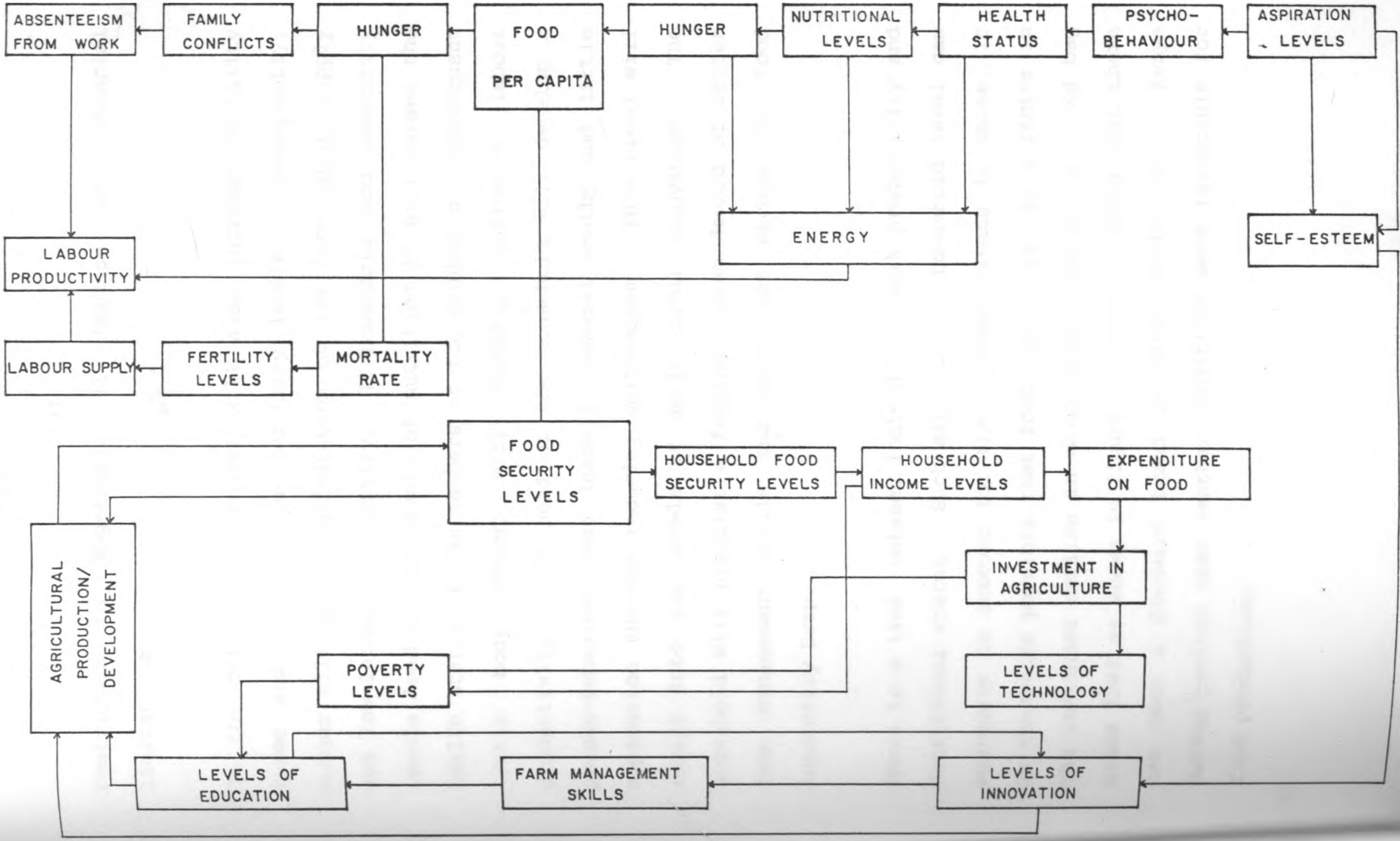
Holding other factors constant, food security will determine the existence of hunger. Malnutrition derived from hunger is a factor in the health status of the households' labour force available for agricultural activities. With subsequent little energy, labour productivity is consequently reduced. Alternatively hunger may generate family conflicts, leading into absenteeism from work and hence reducing agricultural productivity. Malnutrition will influence fertility levels and mortality rate, this may in turn reduce labour supply. In situations of food insecurity more of the household's expenditure is allocated to the purchase of food, thus reducing the household's disposable income which would have

been targeted into agricultural inputs. Likewise this trend will be reflected in low levels of technology and innovations in agricultural production. Reduced household's income will determine whether the household breaks through the poverty cycle, by channelling more income into agricultural sophistication and diversification. Levels of poverty determine the acquisition of education, directly influencing thereafter levels of farm management skills among the farm managers. All these factors combined retard the pace of agricultural development and the food security situation never improves. This is because food production is a major unit in agricultural systems.

It is theoretically conceptualized that as long as food insecurity prevails, thus influencing household incomes, savings and investments, agricultural productivity will never improve significantly and hence the process of agricultural development will be slow until the food security situation improves (Ref. Fig.1).

Research on food security and agricultural development is broad indeed . It would obviously include both physical and social economic factors. This piece of work attempts to establish the significance of existing food policies in Kenya, the extent to which food security influences labour productivity, farm technology , savings and investments and land under food crop production. This research is

Figure 1 FOOD SECURITY AND AGRICULTURAL PRODUCTION/DEVELOPMENT : A CONCEPTUAL FRAMEWORK



Source : Researcher

restricted to Bogetaorio II because of financial limitations.

On the other hand, hunger will also increase mortality rates and reduce human fertility levels. Consequently, hunger will be a manifestation of low farm labour supply and low labour productivity. If household food insecurity levels lead to low levels of nutrition it will worsen the health status of the members of the household. Subsequent little body energy will directly influence labour productivity. The head of the household will develop a psycho-behaviour that leads to general apathy and little aspiration thereby reducing self-esteem. This trend will result into low levels of agricultural innovation. The household will practise a farming system devoid of better farm management skills and would not escape the food insecurity trap.

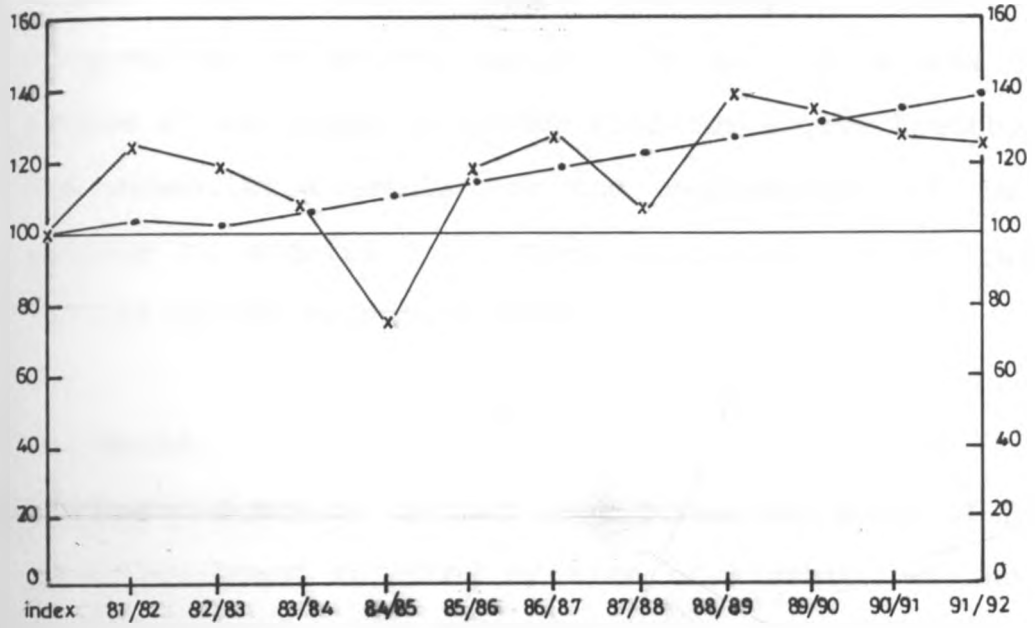
There is a link between individuals' work productivity and nutritional status . Such situation at household level can aggregate to account for the national trends in maize. It is therefore possible that food insecurity is a factor in the continued decline in maize production per a 90 kg bag since 1988 as shown in figure 2. Figure 2 Shows that there has been a downward trend in maize production in Kenya during periods when weather conditions were favourable for food production.

The amount of maize cultivated in Kenya has declined from 1.44 million hectares in 1988/89 crop year to below 1.30 million hectares during 1991/92 crop year. The 1994 economic survey indicates that maize production declined from 23 million 90 kg bags in 1992/93 crop year to 18 million 90 kg bags in 1993/94 crop year. During this period food demand exceeded food supply as evidenced by food imports. It is with this background that the implications of food security on agricultural development at household level are sought.

It is conceptualised that food insecurity would lead to increased household budget allocation to acquisition of food and for medical treatment resulting from malnutrition. With the foregoing, little income will be available for agricultural development.

It can therefore be concluded that food security is a major determinant in agricultural production and development. Lack of adequate food lowers both land productivity and labour productivity. This is because it will reduce funds available to purchase farm inputs and reduce body energy thus affecting labour productivity.

Figure 2 Growth Trends
Maize Production and Population



Indices: Population = 1980/81 actual: production = 1970/71 = 1980/81 average

Source: Secondary data from all economic surveys between 1981 and 1992

1:7 Operational Definitions:

Food Security:

Food security may be defined as the ability of countries or households of a region to meet the adequate levels of food consumption on annual basis. It is the access by all people at all times to enough food for active healthy life. Its essential elements are the availability of food and ability to acquire it. Food insecurity, is in turn the lack of access to enough food.

Household:

A household may be defined as a person or group of persons generally bound together by ties of kinship, who normally reside together. In this context it refers to individuals who share food from a common food granary. A household is also the basic unit of production in the rural areas.

Small Holdings:

Holdings are defined as organised economic units in which plant and animal products are produced for purposes of gain. In Kenya small holdings are farms with field sizes ranging from 0.2 to 12.00 ha.

Sustainable Development:

Refers to development that meets the needs of present population without compromising the ability of future generations to meet their own needs.

Rural Development:

This is a multi-sectoral activity which includes agricultural development, rural industry and the establishment of infrastructure.

Households Income:

Refers to Gross household income (Kshs) obtained by the sum of the value of marketed output, wage (off farm)and from any employment.

Nutrition/Malnutrition:

A process of food utilization by the body which comprises the breaking down of food eaten to simple constituents (catabolism) and rebuilding them (anabolism) into more complex tissues of the body, Dema (1965).

Food Crops:

Refers to those crops that are grown primarily to meet nutritional requirements of the household although some proportions may be offered for sale.

1.8 Organisation of the study.

This study is organised in five chapters. Chapter one outlines the statement of the problem of the study, and the relevant literature review. It spells out the justification of the study and states the objectives and hypotheses. Finally it describes the theoretical framework based on the basis of the scope of the study and it provides the

operational definitions. Chapter two is devoted to the background information to the study area giving a detailed account of both the physical and social economic profiles.

In chapter three the research methodology used is described and its limitations discussed. Chapter four is the core chapter in which the link between food security and agricultural development is established and its implications analysed. Finally chapter five contains a summary of research findings and recommendations to both researchers and policy makers.

CHAPTER TWO: BACKGROUND TO THE STUDY AREA

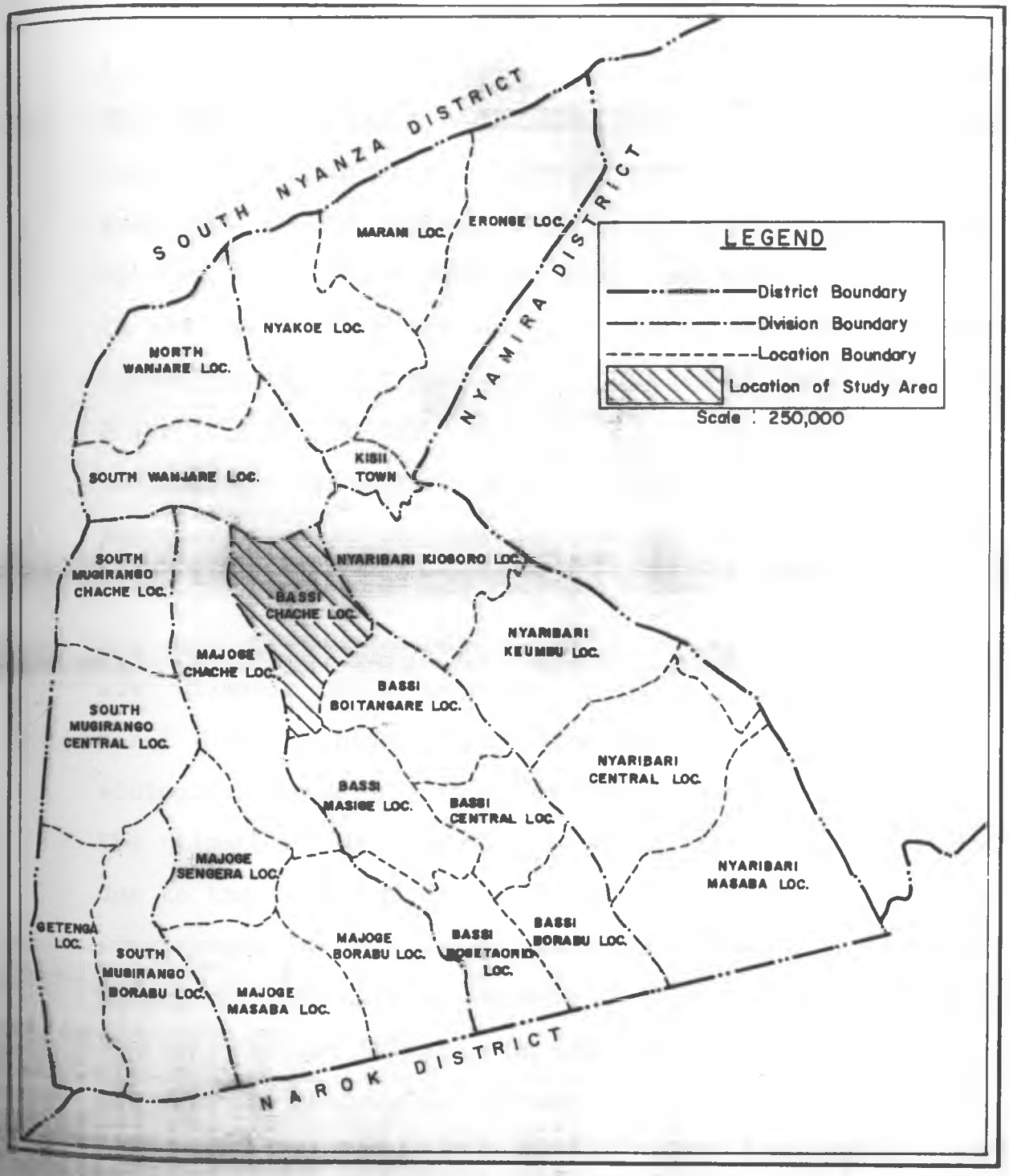
2.1 Location and Size:

Kisii district is one of the districts in Nyanza province. The district area comes under the lake basin development authority. It covers an area of about 2191 km². Bogetaorio II Sub-location is an administrative unit of the district and is an area of about 14 sq. km.

2.2 Topography and Drainage:

Kisii highlands cover the greatest part of the district. On the eastern part of Bogetaorio II sub-location the relief ranges between 5300-8500 ft. While on the western sides stretches the level area, Sameta hill marking the peak at about 4660 ft. The drainage system of this case study area is eastwards. The major river Kuja (Gucha) meanders across the southern part of the location. The other water resource rivers include Iyabe and Etora respectively. These rivers are perennial. The nature of the topography intensify the run-off velocity thus resulting into all forms of soil erosion, and sometimes it destroys crops. Mass wasting is also common on steep slopes. Swamps characterize lower riverine courses. Flooding which occurs during rainy seasons is not of significant consequence.

Figure 3:Location of Study Area:



2.3 Geology and Soils:

The general picture about the types of soils in the district is practically clear, however the literature available on the geological structure gives a generalised picture. The parent rock is mainly volcanic . The soils in the district in the whole are quite fertile and hence agriculturally very productive. The rocks underlying the district include:the Nyanzian (pre-cambrian system), Kavirondian system,the Granitic rock,the Bukoban, the Tertiary volcanic and the pleistocene and recent deposits of soils,gravels and laterite iron stones.

2.4 Climatic Characteristics:

Kisii district highlands may be divided into a few agro-ecological zones only, most of which are high potential. The climate of the district is one of the wettest in Kenya due to the fact that it is situated in the centre of local convergence of the daily lakewinds with the easterlies during the generally dry seasons in Kenya. Annual rainfall averages 1200 to 2100mm. The rainy seasons of the year are not easy to distinguish because there are normally no dry seasons in between. The minimum night temperatures are about 50.26°F while the maximum day temperatures average about 83.6°F around the year. At the same time the average normal temperature is about 66.9°F with relative humidity of 50-60%.(Source: Kisii Development Plan 1989/93).

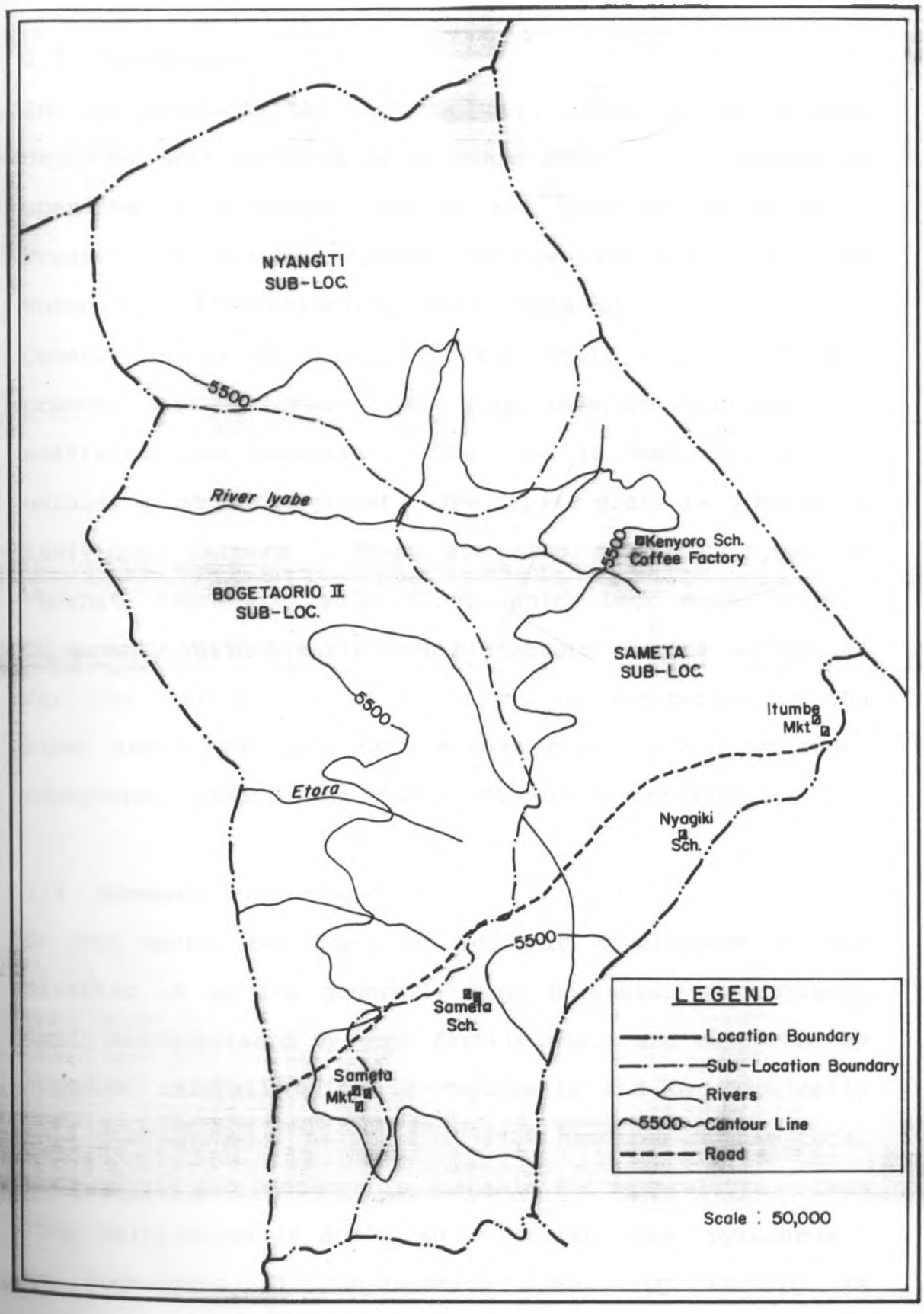
Generally rainfall is high with 2000 mm in the highlands and a probability of over 90%. On the whole it is fairly evenly distributed and only January and August receive less than 100mm. The month of April with over 300 mm has the highest precipitation. Below is the rainfall data from a station at the area of study.

Table 1: Rainfall Distribution, Station Nyakegogi, Kisii District (1985)

Month	Nyakegogi (Ogembo) Amount (mm)	No. of Wet Days	Temperatures (°F)
January	71	7	77
February	80	-	66
March	187	11	68
April	287	14	66
May	221	15	66
June	161	15	67
July	90	10	65
August	134	5	66
September	146	7	66
October	143	9	68
November	170	-	66
December	130	5	68
Total Average	1826		Average 63°F

Source: Ministry of Agriculture and Livestock Development Department of Agriculture: Kisii District (Annual Report1985)

Figure 4: Bassi Chache Location: Sameta Division



2.5 Vegetation:

In the highlands the high rainfall combined with a good depth of soil sustains heavy grass cover. The vegetation consists of highland forests and highland grassland. Present also are communities like low tree high grass type which is characterised by tall grass of 5 to 8 feet. Densely scattered within it are small trees and also present are grouped tree grasslands,the sub-type of scattered tree grassland. The area is dominated by the natural grass (star-grass). The napier grass is planted by individual farmers. There are also different types of "herbs": these are tender plants which lack woody stems. In summary various environmental factors combine to account for the distribution of the types of vegetation in the study area. The main factors are: climatic and latitude, topography, edaphic and abiotic factors respectively.

2.6 Economic Resources:

In the whole, the basis of economic development in the district is in its generally high potential agricultural land, characterised by good fertile soils and supported by abundant rainfall which is regionally and geographically well distributed. At least 175,584 hectares of the total area of 219,600 hectares is suitable for agriculture. Cash crop cultivation is dominated by coffee, tea, pyrethrum. In Bogetaorio II Sub-location cash crop farming is dominated by the cultivation of coffee and tea. The cultivation of tea in hectares has overtaken coffee in the

recent past. The cultivation of maize is mainly for subsistence, so is dairy farming.

2.7 Food Security in Kisii District:

"Ugali" made from maize and "wimbi" from finger millet has been the staple food of the majority of the adult population in the district at large. Other major food crops cultivated in the district include: beans, English potatoes, sweet potatoes, cabbage, tomatoes, pineapples, bananas and groundnuts. The Abagusii also keep cattle mainly for milk. They also keep sheep and goats. Chicken is also important for meat and eggs.

According to the Kisii Development Plan 1989/93, food security remains a major objective as spelt out in the sessional paper No.4 of 1981. The report concludes that the district is self sufficient in food production. The plan notes that the main problem is working out the balance between the traditional cash crop and the intensification of maize and milk production to provide food for the growing population.

2.8 Nutrition Levels in the District:

Maize meal is the main staple food for the majority of the people in the district. Most mothers breast feed their children up to the age of about one. There after they put them on porridge made from maize meal as the main supplementary food. Further reflection of the nutritional status in the district is given by the CBS Nutrition Survey

undertaken in 1982 which reveals that the percentage of stunted children was 33%.

Table: 2 Nutrition Targets 1989/93 (In 90kg bags)

YEAR	POPULATION	MAIZE	BEANS
1989	1,371,102	3,153,346	1,850,988
1990	1,416,515	3,257,985	1,912,295
1991	1,463,011	3,640,925	1,705,065
1992	1,510,590	3,474,357	2,139,996
1993	1,559,253	3,586,282	2,104,992

Source: Kisii Development Plan 1989-1993 (page 62)

Assumptions:

a): Per capita calories requirement is 2011 per day.

b): Adult protein requirement is 90 grams per day for beans.

c): Child protein requirement is 90 grams per day for beans.

d): One kilogram of maize gives 92.2 grams of protein and 3,510 calories.

e): One kilogram of beans gives 245 grams of protein and 3,220 calories.

f): 50% of the population are adults (15 years and over) of average weight of 70 kilogram.

g): 50% of the population are children under the age of 15, an average weight of 28 kilograms.

h): For children, the protein requirement is assumed to be 3.2 grams per kilogram of body weight (depending on the workload and especially on reproduction), hence giving an average of 1 gram per kilogram of body weight or 70 grams per adult (average).

2.9 Transport and Communication:

The transport network within the study area and its linkage to Kisii town is fair. This premise is supported by the fact that there is only a single tarmac road (all weather road) that crosses the study area from Kisii town to Kilgoris. Several feeder roads characterise the study area, as they are linked to agricultural co-operative societies and to almost all market centres. Nevertheless during heavy rains especially in the month of April, some of these feeder roads then are almost impassable. In relation to the general communication, postal services are available in two market centres in the study area, namely Itumbe and Sameta. The area is poorly linked by telephone services; the only market centre with telephone services is Sameta.

2.10 Demographic Characteristics:

In general, the district is almost exclusively populated by one tribe, namely the Abagusii people, the Luhyia and the Luo peoples who numbered 7870 and 2887 respectively during the 1979 population census (Nyamira district included) still occupy second and third places. Population projection and population densities in Kisii district and Nyamache division, are presented below. When it comes to sharing of workload between men and women at the household level, the general pattern in Kenya and at the study area in particular has been that females do a lot of work.

In Bogetario II Sub-location the researcher makes the following observations: that food production is essentially the work of women: the work of women include cultivation, fetching water, collection of firewood and marketing. Hence the household division of labour remain to a large extent the work of women, to a large extent the work of men evolves around alcoholism, construction and somehow in cattle farming.

Table 3: Population projection: for Nyamache Division

1988	1989	1990	1991	1992	1993
146,443	151,400	156,499	161,499	166,030	171,011

Table 4: Populations: for Kisii District

1988	1989	1990	1991	1992	1993
886,193.06	916,249	847,106	975,519	1,004,785	1,034,928

Table 5: Population Density: for Kisii District

1988	1989	1990	1991	1992	1993	Area in km^2
608	628	649	669	689	710	241
607	607	627	648	668	709	2191

Source: Kisii District Development Plan 1989-1993 Ministry of Planning Kisii.

Table 6: NO. Of Households (TOTAL) 8726 + 6822 Bobasi Constituency:

Adults	Children	Other relatives	No relatives	Persons per households (total)
> 15 years	< 15 years			
Bassi Chache: Bassi Borabu				
3:14	1.69	0.66	0.34	5.82
3:28	2.05	0.81	0.40	6.55

Source: Kisii Development Plan 1989-1993

Table 7: Area available per Division and per Household and Person.

Agricultural Land (Hactares)		household and per person	
		Household	person
Bassi Chache	101	1.39	0.22
Bassi Borabu	92	1.60	0.23

Source: 1979 Census- 127 (Area - 114) Farm Management handbook page 99.

2.11 Summary:

Kenya demonstrates extremely well the operation of ecological principles which summarizes the work of climate and soils and the potential land uses that can be matched with agro-ecological zones. Kisii district is classified within the category of high agricultural

potential zones. The foregoing chapter indicate that Kisii district experiences annual precipation that averages between 1200-2100m. Coupled with well drained and deep fertile soils (Jaetzold 1990). The district has a high agro-ecological potential with low risk of about (1-3%) of failure for adapted maize crop. With this background it can be concluded that the district is self-sufficient in food production. For instance the Kisii development plan 1989-1993 concludes that the district is self sufficient in food production. But is this representative of the situation on the ground, precisely at household levels in the district?

This chapter also underlines the fact that the district has an established agricultural economic base. It also indicates that the household family size is one of the highest in Kenya's population density thus reducing agricultural land. There are problems of transport, especially the impassable feeder roads during wet months which affect agricultural marketing. This chapter therefore provides the necessary background into other possible factors that are related to food security and agricultural development in the area of study.

CHAPTER THREE : RESEARCH METHODOLOGY

3:0 Introduction

This part is an identification of the sources of data collection, an illustration of the methods of data analysis and presentation and an outline of the actual research limitations and solutions.

3:1 Sources of Collection

Data collection was from both primary and secondary sources, reconnaissance and personal observations of the households in the study area. Personal questionnaires (recording schedule) and interviewing of the relevant informants (members of the households). Secondary information sources comprised of the collection of relevant published material from various institutions.

3:2 Sample Design

Before drawing a sample, an adequate sampling frame must be in place. If it is deficient, in that a number of units are not included, obviously those units have no chance whatsoever of being selected. For purposes of this research there was no appropriate sampling frame to be utilised. Stratified sampling could have been preferred by using a list of all land parcels in the sub-location obtained from the District Registry. But given the specific objectives of the study and the fact that households with more than one parcel of land could be included and those on inheritance without notification of the District Land Registry could be left, this approach was consequently dropped. To overcome these problems random sampling method was chosen. The study area was divided into small administrative units.

Table 8: Random Sample

Administrative Units	Number of Households Interviewed	Actual Useful Respondents	Estimated Number of Households
Bomesichi	31	16	81
Boigesa	21	08	68
Bosingi	40	15	140
Bokinami	35	18	60
Kenyerere	27	06	48
Total	**154**	**63**	**397**

However, all data collection in social Science is liable to error and no method is free from error. In order to minimize the error, the method to be illustrated below was determined by its appropriateness of research objectives, reliability, validity, representativeness, explanatory power and administrative convenience. Actual useful respondents refers to those households questionnaires that were, comprehensively filled.

Random sampling was conducted on the basis of the following categories:

(a) Grass thatched houses

(b) Iron sheet houses

(c) Semi-permanent houses

(d) Permanent houses

The rationale of the above method was on the basis of one main assumption:

Assumption:

Holding all other factors constant, the type of houses owned by each household reflects the scale or level of food security. For instance, grass thatched households would have would have low level of food security, whereas owners of permanent houses would have high level of food security.

The actual useful respondents shown in table 8 above is represented in table 9 , thus showing the categories of houses and the actual respondents

Table 9 : Sample data per house category

Administrative Units	a	b	c	d	Total
Bomesichi	05	04	03	04	16
Boigesa	02	03	02	01	08
Bosingi	03	05	04	03	15
Bokinami	06	05	03	04	18
Kenyerere	02	02	01	01	06

3:3 Data Analysis and Presentation

Multivariate techniques that are to be used in data analysis include: multiple regression analysis, stepwise regression procedure and partial correlation analysis.

Expected data in the original form will be as below.

Y = dependent variable

X_1-X_n = independent variables

Where

Y = Food security levels

X_1 = Income spent on the purchase of maize

X_2 = Income spent on agricultural production

X_3 = Hectares of land under food production

X_4 = Hectares of land under cash crop production

X_5 =Total value of farm inputs

X_6 = Total household labour

X_7 =Household's savings last year

X_n = Others.

3.3.1 Partial Correlation

Partial correlation is a method of dealing with three variables, in which the correlation coefficient of two of them can be measured unaffected by the influence of the third, which is controlled.

Formula:

$$\sqrt{xy,z} = \frac{\sqrt{xy,z} - (\sqrt{xz}.\sqrt{yz})}{\sqrt{(1-\sqrt{xz})(\sqrt{1-\sqrt{yz}})}}$$

Where

x,y,z = Different variables

$\sqrt{xy,z}$ = The correlation coefficients between variables x and y while the third influence of variable z is controlled.

Partial correlation analysis is of great significance in geography and in agricultural geography in particular. This is because of the need of having to assess the influence of

each of a number of factors in a particular situation. Correlation is one of the ways of deciding the relationship between two factors but in many situations the interest of the researcher lies with more than two as evidenced in agricultural geography. It simplifies the difficulties of knowing the extent to which the correlation (and apparent causal relationship) between two variables is influenced by the third.

However the coefficient derived remains descriptive statistic and therefore the interpretation of statistical test remain a very important function of the researcher. For purposes of this research Partial Correlation Analysis is computed within Stepwise Regression Analysis.

3.3.2 Regression Analysis

Simple Linear Regression Analysis

This is a descriptive tool which is used to determine the best linear prediction equation and evaluate its prediction accuracy, secondly to control the other confounding factors so as to evaluate the contribution of a specific variable or a set of variables. And it is also used to find structural relations and provide explanations for the obvious complex multivariate relationships.

Linear model :

$$Yi = \beta o + \beta i Xi + \epsilon i$$

where Yi = the i^{th} observation of the dependent variable Y

βo = the Y intercept (regression constant)

βi = the partial regression coefficient (slope of regression line)

Xi = the i^{th} observation of the independent variable X

ϵi = the value of the random error ϵ.

Regression Assumptions:

No specification error:

a): the relationship between Xi and Yi is linear.

b): no relevant data or independent variables have been excluded.

c): no irrelevant independent variables have been formatted

There is no measurement error. It is assumed that the variables Xi and Yi are accurately determined.

The following assumptions are made on the error term; ϵi

a): a zero mean $\sum (\epsilon i) = 0$, that is for each observation the expected value of the error term is zero.

b): homoscedasticity $\sum (\epsilon i^2) = \Theta^2$ the variance of the error term is constant for all values of Xi.

c): no auto-correlation $\sum (\epsilon i.\epsilon j) = 0$ $(i \pm j)$ the error terms must be uncorrelated.

d): the independent variable is uncorrelated with the error term $(\epsilon i.Xi) = 0$.

e): normality: it is assumed that the error term denoted by ϵi is normally distributed.

Multiple Regression Analysis

Sometimes dependent variables are estimated not from one but from, three or more independent variables. Normally a geographer is concerned with determining the

relationship between several independent variables with one dependent variable.

Regression Model

$Yi = \beta o + \beta i\ X_1 i + \beta i\ X_2 i$ ..... $\beta p\ \lambda pi + \epsilon i$

Yi = i^{th} observation of the response variable

βo = Regression constant

$\beta i\ \forall j$ = i.....p regression parameters referred to as the partial regression parameters coefficient.

ϵi = is the i^{th} value of the random error, sometimes it is called the random disturbance.

Anova Table

SS_{REG} - tells us how much of the variations in the independent variables is attributed to the dependent variable.

$$MS_{REG} = \frac{SS_{REG}}{Df}$$

The corrected total degrees of freedom is always one less than the total sample size since one degree of freedom is used to estimate the grand mean.

R-SQUARE - Is the square of the multiple correlation. It is the proportion of variance in loss explained by independent variables.

ADJ R-SQ - The adjusted R-square takes into account how many variables were used in the equation and slightly lowers the estimates of explained variance.

When the independent variables in a regression are uncorrelated the estimates of the regression coefficients are unchanged by adding or dropping independent variables.

When independent variables are correlated dropping and adding variables very much affects the regression estimates.

3.3.3 Problems of Regression Analysis

Multi-collinearity

This problem results when one of the independent variables is a linear combination of others, consequently we have few independent normal equations and hence can not derive estimates for our coefficients. The way the equation is formulated, may result into "perfect" multicollinearity. This is when one (or more) independent variable is in exact linear combination of others. A research detects a case of perfect multicollinearity given the following symptoms.

a): a large R^2 (coefficient of determination)

b): statistically insignificant estimates of the coefficients of independent variables

c): high degree of multicollinearity results in a large variance of estimators coefficients. The end result is that the t ratio tends to be very low. Which means that even if the corresponding independent variable has an important effect on the dependent variable, the multicollinearity problem may lead us to believe that its effect is insignificant. In conclusion therefore what multicollinearity does cause is imprecision in our estimators, they have a large variance and are not very reliable. Multicollinearity is not an easy problem to resolve. However where possible the researcher can always try to increase the precision of his estimators (that is the same as reducing their variance) by increasing the number of observations.

Problem of Auto-correlation

Auto-correlation refers to a purely arithmetical relationship between variates in one or more data sets. For instance the percentage of population in one age group will "Ceterius Peribus assumption" directly affect the percentage in other age groups (whereas the number, in each age group are not related in this purely arithmetical way).

One of the basic assumptions in regression model is that the value of the disturbance assumptions in regression model is that the value of the disturbance term in one period is independent of its value in any other period.

Mathematical expression COV (Ut Us) = 0 for (Ut. Us) = 0 for t ± s the problem that auto-correlation introduces concerns the variance of our estimators specifically the formulas we have derived for the variance do not hold. When the formula is applied in cases of auto-correlation, erroneous ratios are generated rendering our tests of hypotheses about the parameters of our model invalid. In auto-correlation our variance formula below is invalid, as a correct expression of variance b1. As

$$\text{Var } (b1) = \frac{\Theta u^2}{\sum (Xt - X)^2}$$

as a result the tests of hypotheses using our standard formulas are no longer valid.

Regression models are widely used in geography and independence of errors is a condition that a regression model must fulfil before it is reliable for purposes of testing

hypotheses. Auto-correlation is the greatest concern in geography because of its effects of auto-correlation in regression models that are fitted to data. The following points should be noted in auto-correlation:

a): Auto-correlation in the residuals would indicate that some sources of variation has been omitted from the model or that the function of the model is not correct.

b): Estimates of the standard errors of regression coefficients will be biased if the errors are auto-correlated and where the auto-correlation is positive, these standard errors will be underestimated. This will inflate the calculated values of test statistics for the significance of regression coefficient and may lead to the mistaken conclusion that variables are related when they are not.

c): Spatial auto-correlation in the residuals indicates that the model is incomplete. A complete and correct model would explain all the systematic spatial organisation in the data and leave residuals that displayed no spatial organisation at all.

d): Any inferences based on the model are likely to be mistaken, hence the model needs to be corrected before it can be a reliable basis for testing hypothesis.

e): The problems do not arise primary from unsuitable data, however, but from unsuitable models. The simplest kinds of regression models were not developed to accommodate the needs of spatial analysis and simple regression models must be enlarged in order to accommodate on analysis of spatial phenomena.

Solutions:

Durbin-Watson test is used to detect autocorrelation.

The test uses what is usually referred to as the Durbin Watson "d" statistic, which is based on the sum of the squared differences in successive values of estimated disturbance terms: If we wish to test the null hypothesis of no autocorrelation, Ho: $Y = 0$, against the alternative that we do have autocorrelation, Hi: $Y \neq 0$, we would accept Ho if "d" has a value that is sufficiently close to 2, and would accept Hi otherwise. Alternatively, values of "d" that are close to zero or to 4 would lead to the acceptance of Hi:$Y \neq 0$.

Problem of heteroscedasticity

In regression analysis, another assumption is that the disturbance terms have the same variance $\text{Var}(\epsilon i) = \Theta^2$

This condition of constant variance is known as homoscedasticity. In the case of violation it is heteroscedasticity. Under this circumstance there is nothing wrong with our normal equations basically though, like in auto-correlation there will be different expressions of variances for our parameter estimators. Consequently if we proceed to use our usual formula to estimate these variances our resulting tests of hypotheses and confidence intervals would not be accurate. Therefore the researcher must examine the relationship under study and see if there is any reason to believe that the disturbance terms will not be homoscedastic. The researcher should try to reformulate the relationship in such a way so as to remove the presumption of heteroscedasticity viewing heteroscedasticity as being the result of a poorly formulated model.

3.3.4 Computer Application:

Computers are important as they are often used in solving geographical problems. Using quantitative methods in research is tedious and time consuming. Computers minimise the labour involved in handling large quantities of data whether for a statistical calculation or some form of model. Computer programmes have made it possible to test social theory with data files containing large number of cases and variables which could be impossible to handle. For purposes of this research stepwise regression analysis was made easier. In the regression sub-program, the computer would enter variables in single steps from best to worst provided they meet the statistical criteria established. The variable that explain the greatest amount of variance in the dependent variable will enter first; the variable that explains the greatest amount of variance in conjunction with the first will enter second and so on. This means the variable that explains the greatest amount of variance unexplained by the variable already in the equation enters the equation at each step. Significantly however, variables with higher inclusion number which did not meet the statistical criteria during the steps for which only they were eligible will continue to be considered at each step even when those with the lower inclusion level are eligible.

3.3.5 Graphical Representation

Graphs shall be used to portray relationships between variables. Data from the table will be illustrated graphically to show food security levels and other independent variables. Multiple line graphs would enable the comparison of trends of household food security levels against independent variables, and especially those not found to be quite significant in multiple regression analysis. Graphs are important in giving a quick visual

impression of the variations. They do show us such variations much more clearly than tables.

3.4 Research Limitations and Solutions:

In concluding this chapter it is important to make the following remarks:

Quantitative techniques are purposeful "simplification" of reality. Regression analysis being in this group its success as a tool of prediction depends not only upon an accurate quantitative assessment of present causes of phenomena studied but also on the judgement as how these change in the future or when completely new factors emerge. Hence a quantitative model is thus a technique to simplify reality because no predictive model can include every factor present in real situation. Reality is immensely complex and the dangers of oversimplification are therefore great. Whereas a model can be a very useful technique but it must be assessed with caution and care must be taken not to place too much reliance on the result without rational reasoning simply because it is arrived at by a precise mathematical formula.

In stepwise regression the procedure starts with the simple correlation matrix and enters into regression the variable most highly correlated with the response. The variable that will explain the greatest amount of variance in the dependent variable will enter first, the variable that explains the greatest variance in conjunction with the first will enter second and so on. This is the best of the variable selection procedure.

Agricultural geographers often encounter difficulties of having to access the influence of each of a number of factors in a given situation. Partial correlation will be used to

overcome this problem. This is a technique of dealing with three variables in which the correlation coefficient of the two of them can be measured unaffected by the third which is controlled.

In presentation of data both qualitative and quantitative maps serve to illustrate and distinguish different categories of phenomena. The use of statistical Package for Social Scientists (SPSS) by aid of computer a number of statistics commonly used in social research will offer a great deal of flexibility in the format of data.

In designing and formulating the research proposal for this thesis the following problems were identified and various steps both methodological and analytical were incorporated to check their negative effects on research conclusions.

a.): Data on food production in Kenya is aggregated into trends in per capita food production. This is not a good measure on the food security situation because it does not reflect the actual food distribution within each household. This analysis concentrates on maize production, this is because maize is the most important staple food among the Kenyan population. It thus gives the best approximation of assessing household food security levels. Important also is the fact that alot of secondary data on maize production is available.

b.): Data on nutritional status is not accurate. This is because of the sparsity of such data and at the same time the said data varies from region to region at any one time. Household food security levels are assumed to reflect nutrition status.

c): There is the possibility of violating the assumptions of the regression model. When this occurs then the accuracy of testing the set hypotheses is questionable. Durbin Watson test was used to test for autocorrelation.

d.): Technical problems: included inaccuracy in data collection, due to lack of relevant records and poor memory among members of the household. Administratively it would be difficult to define precisely where the boundaries begin and end. This always causes problems in sampling.

I did not raise adequate funds to finance the writing and the collection of data for this Thesis. Given this fact and coupled with the rate of inflation in the country by the time undertaking this research it was expensive indeed. Personal first hand information about the study area assisted to overcome this problem.

The advent of multiparty politics and general elections led to the re-scheduling of my field trips to early January 1993. There were obvious contradictions in cases where some households were purchasing maize for commercial purchases and not for domestic consumption. To overcome this problem a sieve was provided in the questionnaire.

CHAPTER FOUR: ANALYSIS ON FOOD SECURITY AND AGRICULTURAL DEVELOPMENT

4.0 Introduction

This is the main chapter in this piece of work. It is in this section where the validity of raw field data is tested by the set laws of multiple regression analysis before it is used for further analysis and interpretation. Stepwise regression analysis is used to select the most significant factors which enables the testing of our hypotheses. Attempts have also been made to graphically represent the research findings. Data output in itself does not explain much or have no meaning, it is therefore within this chapter that rational explanations are advanced, conclusions and recommedations are derived from this chapter too.

4.1 Stepwise Regression Analysis

Partial correlation provides us with an index of association referred to as coefficient of partial determination; which measures the correlation between say Y and X_1 while other independent variables X_2 to X_{13} are held constant. It helps to represent the reduction in unexplained variations in Y (Household food security levels) that was left unexplained by a simple regression using only one independent variable by including more independent variables as predictors.

Step-wise regression analysis in evaluating potential merits of predictor variables (X_1 to X_{13}) step by step has used the coefficient of partial determination to select which independent variables to include.

Table 10: Step-wise Regression Analysis

No.	Variables	Mult-iple R	R^2	%Rise	Fcalcu-lated	D.F	Fcriti-cal
1	X_7	0.65	0.42	-	44	1,60	4.00
2	X_7 X_6	0.75	0.56	25	38	2,59	
3	X_7 X_6 X_5	0.82	0.67	19.6	39	3,38	
4	$X_7X_6X_5$ X_{13}	0.85	0.72	7.5	37	4,57	
5	X_7X_6 $X_5X_{13}X_{11}$	0.86	0.74	2.8	32	5,56	4.08

Source: Ondieki Nyandika (1994)

From the stepwise regression analysis the following models or equations are derived and can be used for prediction purposes. (see table 10).

1. $Y = 7.31387 + 1.12162X_7$
2. $Y = -6.02909 + 3.12614X_6 + 1.060602X_7$
3. $Y = -8.57975 + 0.58523X_5 + 3.15143X_6 + 0.82030X_7$
4. $Y = -7.85799 + 0.63536X_5 + 2.8037X_6 + 0.63800X_7 + 1.42206X_{13}$
5. $Y = -3.53780 + 0.60498X_5 + 2.65904X_6 + 0.68314_7 - 2.15156X_{11} + 1.36585X_{13}$

From the regression models above one can suggest that equation number (3) is the best possible predictor since the inclusion of variable X_5 and X_6 in the regression model gave the higher percentage increment in R^2. Whereas on the other hand the inclusion of variable X_{11} and X_{13} in the regression model only gave a small increase in R^2 i.e 7.5% and 2.8% respectively.

But in stepwise regression analysis, a variable that has met the entry criteria in the model has a significant contribution. From the above table therefore, equation 5 is the best predictor of the regression model since the inclusive of any of these variables X_5 X_6 X_7 X_{11} and X_{13} results in a substantial percentage increase in R^2. This can also be supported by the partial correlation of the individual independent variables against Y (the dependent variable). The variables included in the equation 5 have their partial correlation as shown below.

Table 11: Partial Correlation

Variable	X_5	X_6	X_7	X_{11}	X_{13}
Partial	0.43	0.49	0.42	-0.31	0.32

The rest of the variables X_1, X_2, X_3, X_4, X_8, X_9, X_{10}, and X_{12}, as shown in the print out (see appendix D) correlate weakly with the dependent variable (Y). As a result, their significance as predictor models has not been supported by the sample data and scientifically therefore it can be concluded that these variables have little effect.

How good is the model

a) **Coefficient of determination (R^2)**

This is the proportion of the total sums of square of the dependent variable explained by the independent variables.

Y dependent = Household food security levels.

X_1 independent = Households savings previous year.

Table 12. Analysisi of Variance:

	DF	Sum of Sqares	Mean Sqares
Regression	1	13759.71757	13759.71757
Residual	60	18569.29237	309.48821
F= 11.15959 Signf F = .0000			

With the entry of X7 in the model R^2 = 42.562

This means 42% of the households food security levels (y) is determined by the farmers annual savings X_7. Non determination is about 57.4%.

Table 13. Analysis of Variance:

	DF	Sum of Sqares	Mean Sqares
Regression	2	18240.95990	9120.47995
Residual	59	14088.05004	238.78051
F = 11.15959 Signif F = .0000			

With the entry of X_6 independent = Total household labour engaged in agricultural production against Y= dependent; coefficient of determination (R^2) = 56.423%. Meaning about 56% of the total household labour can be explained by the variations in household food security levels. Non determination is about 43.5%.

Table 14. Analysis of Variance:

	DF	Sum of Sqares	Mean Sqares
Regression	3	21791.40609	7263.80203
Residual	58	10537.60385	181.68283
F = 39.98068		Signif F = .0000	

The third variable in stepwise regression analysis is X_5 independent = value of farm technology. Its R^2 = 67.405 which implies that 67% of the variation in the dependent variable is "explained" by the linear relationship with X_5 (independent). Non determination is about 32.59%.

Table 15. Analysis of Variance:

	DF	Sum of Sqares	Mean Sqares
Regression	4	23489.74735	5872.43684
Residual	57	8839.26259	155.07478
F = 37.86842		Signif F = .0000	

In step four, X_{11} dependent = land not under cultivation, gives R^2 of 74.543 which means 74% of the variation in Y is explained by X_{11}. Non determination is about 27.34%

Table 16. Analysis of Variance:

	DF	Sum of Sqares	Mean Sqares
Regression	5	24098.96728	4819.79346
Residual	56	8230.04266	146.96505
F = 32.79551 Signif F = .0000			

The last variable in the equation is X_{13} independent = number of grade cows. It gives an R^2 value of 72.658. Meaning 72.658% of the variation in the dependent variable (Y) is accountable by X_{13}. Non determination is about 25.45%

(b) **An adjusted coefficient of determination.**

From (a) above, R^2 statistic continue to increase as variables are added to the model (whether or not they are very significant), I could produce a superior model by adding more regressors. Hence the problem with R^2 statistic is that there is no penalty for increasing the number of independent variables. Using computer application an adjusted R^2 value has been calculated. Many researchers feel that R^2 Adj will increase if "significant" variables are added to the model but will decrease if "unimportant" variables are added to the model. The goodness of the model can therefore be illustrated by a decreasing R^2 adj as seen below (Table 17).

Table 17: Coefficients of Determination

Variables	R^2	R^2 adj
X_7	0.42562	0.41604
X_6	0.56423	0.54946
X_5	0.67405	0.65719
X_{13}	0.72658	0.70740
X_{11}	0.74543	0.72270

Source: Ondieki (1994)

The significance of the coefficients of determination given in table 17 is shown by the testing of hypotheses.

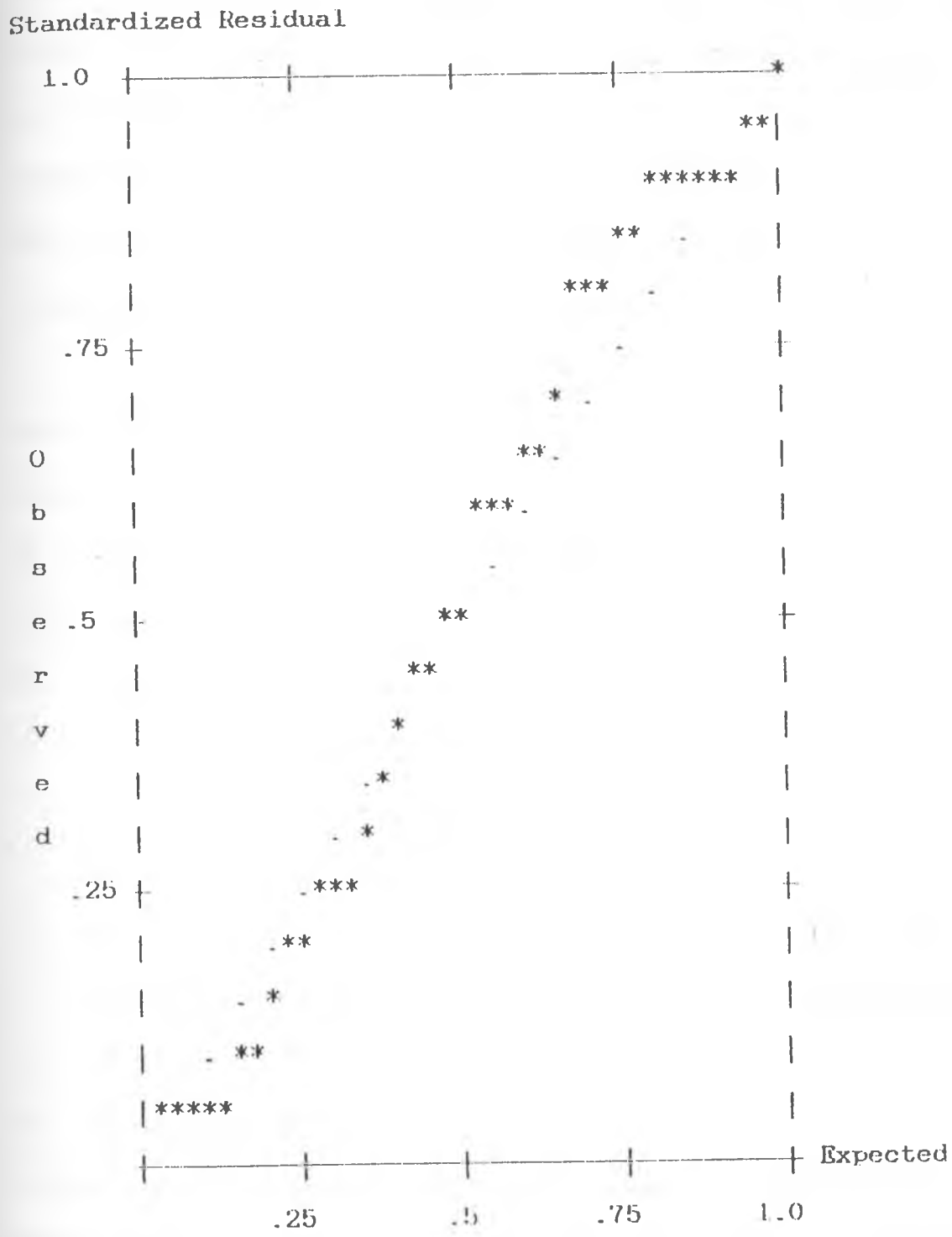
(c) **Examination of the Residuals**

A residual is a deviation of an observed (Y) from an estimated (Y) value. The observation of the residuals indicate that theoretical assumption have not been violated, because the error components are independent and have a zero mean. On examining the scatterplot the residuals appear as a random variation about zero. This is the expected graphical behaviour of residuals and it supports the thesis that the model is correct and the assumptions are satisfied (see figure 5: Histogram- standardised residual).

Figure 5: Outliers Histogram - Standardised Residuals

```
NExp N      (* = 1 Cases,     . : = Normal Curve)
0  .05   Out
1  .10  3.00 *
0  .24  2.67
2  .55  2.33 :*
0 1.13  2.00 .
1 2.07  1.67 *.
1 3.40  1.33 * .
2 5.00  1.00 **  .
6 6.58   .67 ******.
* 7.77   .33 *******:***
* 8.21   .00 *******:***
* 7.77  -.33 *******:***
8 6.58  -.67 ******:*
6 5.00 -1.00 ****:*
0 3.40 -1.33   .
0 2.07 -1.67  .
0 1.13 -2.00 .
0  .55 -2.33 .
1  .24 -2.67 *
1  .10 -3.00 *
0  .05   Out
```

Figure 6: Normal Probability Plot (Standardized Residuals)



The normal probability plot is designed to detect normality. It is the plot of the ordered residuals against the normal order statistics for our sample size. The normal order statistics are the expected values of ordered observations from the normal distribution with zero mean and unit variance. The expected result from a normal plot when the residuals are a sample from normal distribution is a straight line passing through zero with the slope of the line determined by the standard deviation of the residuals. Figure 6 shows "a well-behaved" normal plot of the residuals from an analysis of variance.

Interpretation of normal plots is based on the pattern of departure from the expected straight line in a normal plot. Our skewed distribution shows a curved normal plot with the directions of the curve determined by the direction of the skewness.

(d) **Testing for Autocorrelation.**

The computer Durbin - Watson test "d" = 2.00541. Therefore we accept the null hypothesis of no autocorrelation eg. H_O:Y = O, because the computed "d" value is close to 2. If our data had generated a Durbin Watson 'd' value close to zero or to 4 thus upholding the hypothesis of existence of autocorrelation e.g H_I:Y#O would have scientifically rendered our field data invalid for further analysis and interpretation.

4.2 Testing Hypotheses

In order to test our hypotheses our objective is to establish that the computed i.e `F' calculated is greater than "F" critical with "F" tables. Therefore if the computed value of (F) is significant we conclude that the regression account for a significant amount of variation in the sample data.

Refer to table 10 stepwise regression analysis which indicates that "F" critical for all the regression models is between 4.00 and 4.08 when the "F"-computed is accepted or rejected at probability levels of α 0.05.

a): H_O There is no significant relationship between households' food security levels and the households annual savings.

Where (F calculated > F critical)

Accept H_1 alternative hypothesis at α 0.05 probability.

b): H_O Levels of household's food security do not influence the levels of farm technology. (F calculated > F critical), therefore take H_1 alternative hypothesis with α 0.05 probability.

c): H_O Food scarcity conflicts do not lead to absenteeism from agricultural activities. Variable X_{12} food scarcity conflicts has not been entered in the stepwise regression analysis. We can not reject H_O.

d): H_O There is no relationship between the scale of agricultural output and available household labour (F calculated > F critical).

H_1 is accepted at α 0.05 probability.

Up to this stage it has been established that there is a very high relationship between household food security levels and

(i) Household savings

(ii) Household labour

(iii) Level of farm technology

(iv) Number of grade cows owned by each household.

Interpretation here after is based on these relationships. That there exists a significant correlation between household food security on one hand and factors of production (i ii iii) on the other hand. There is the established fact that variations in household food security levels are reflected in agricultural development when seen in the light of the number of grade cows owned by each household.

4.3 Land Under Food Production

It is true that the agricultural sector in Kenya has witnessed the modernisation of the small farm sector through land tenure changes involving the introduction of adjudication, consolidation and registration, followed by the introduction of cash crops.

In addition, the restriction of land potential is concentrated in the highlands. Rural population densities have resulted into land fragmentation. There is less than 10 hectares per head of population in the study area (Republic of Kenya, 1989). Because of high population growth the farm holdings are small. In some instance more arable land is being put under cash crop production mainly tea in relation to food production.

Table 18 Land not under Cultivation

Land (Ha)	Frequency	%
0 - 2.9	50	80.6
3.0 - 5.9	10	16.13
6.0 - 10.9	2	3.25
11.0 - 15.9	-	-
16.0 - 20.9	-	-
21.0 - 25.9	-	-
+26	-	-

There seems to be a clear cut distinguishing feature of the total households studied.

a): Large (5-15 ha) and medium (16-30 ha) scale farm households who own big tracts of land and have both cash crops and food crops. These households are food secure.

b): Small-holder farm households (0.2-14 ha)

Because of high population farm holdings are small. In some cases more land is under food crop production. In some households food insecurity is institutionalised, these are households that have not broken the poverty cycle. Some households had outstanding notable cases of malnutrition and large families (average 10 persons). However about 50% of these small holders meet their food requirement needs.

c): The landles, households.

These are classes of people who are alien and keep working on other peoples farm for wages. Others are victims of landless because they have sold all their farms.

d): Estimates about the extent of landlessness vary widely in Kenya; Kliest (1985). In 1978 reportedly 21.6% of rural households covered by the fourth integrated rural survey (IRS) appeared to be landless. In central, Nyanza and Eastern province respectively 21.8%, 15.8% and 19.7% of the rural households covered by IRS did not own nor rent any land. During the consecutive IRS the number of "zero holding households" seem to be increasing. In the study area the number of the landless is 1% of those interviewed.

Land holdings are not a significant determinant of household food security levels because the employed purchase food whereas those in small farms are able to produce enough, whereby some with large farms are food insecure. In the foregoing analysis, there are no significant differences amongst the individual households' land holdings in hectares on one hand and their food security levels on the other hand.

Table 19: Land Under Food Production (Intercopped and single)

Land Ha	Frequency	%
0 - 2.9	39	62.9
3.0 - 5.9	17	27.4
6.0 - 10.9	05	8.06
11.0 - 15.9	0	0
16.0 - 20.9	0	0
21.0 - 25.9	01	1.6
+26	0	0

Source: Ondieki, (1994)

Table 20 Land Under Cash Crop Production

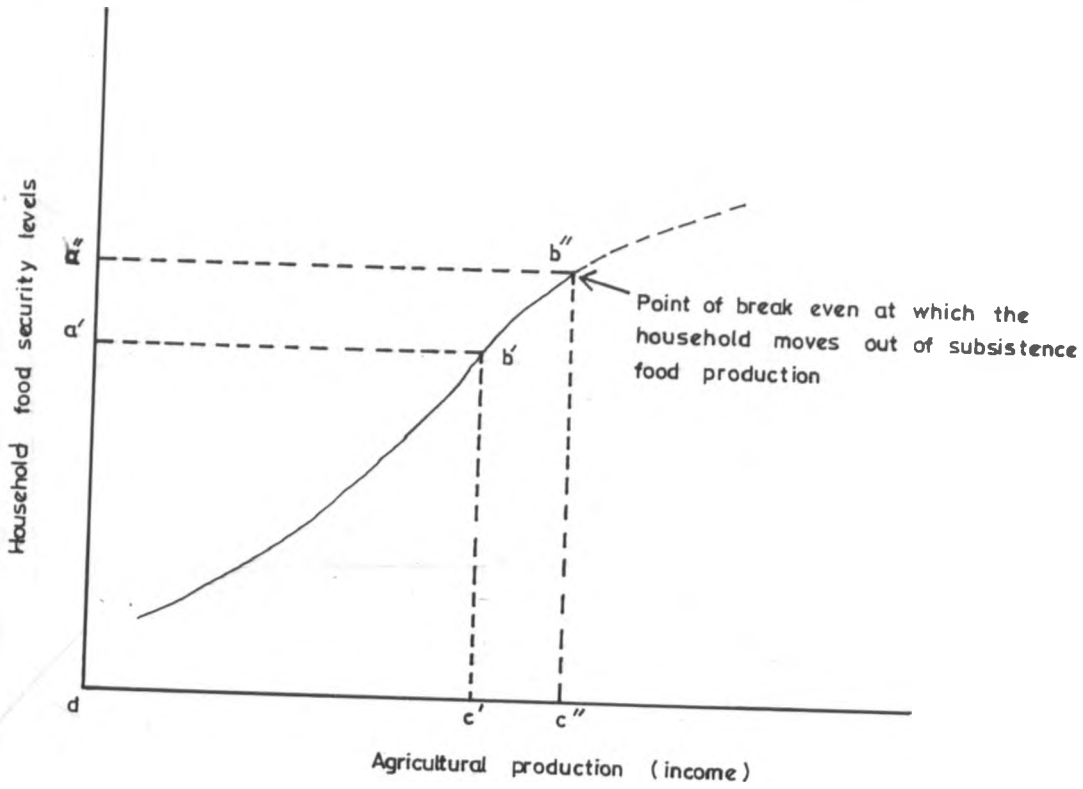
Land Ha	Frequency	%
0 - 2.9	40	64.5
3.0 - 5.9	13	20.97
6.0 - 10.9	8	12.9
11.0 - 15.9	0	0
16.0 - 20.9	1	1.6
21.0 - 25.9	0	-
+26	0	-

Source: Ondieki, (1994)

At this stage one may concure with Esther Boserup (1965) that population growth is an independent variable which in turn is a major factor determining agricultural development. A portion of uncultivated land can also be attributed to levels of agricultural innovations. This is because sometimes population pressure is insignificant compared to the scarcity of capital base for the purchase of inputs. Paradoxically there is prestige associated with the ownership of land but the cultivation of the same piece of land is a degrading affair to some people. Evidence from the study area indicates that hired land is better cultivated. This is because of the capability and profit drive. In history, individual owenership of land as opposed to communal ownership has always led to increased agricultural production. This is because of refusal by farmers to accept

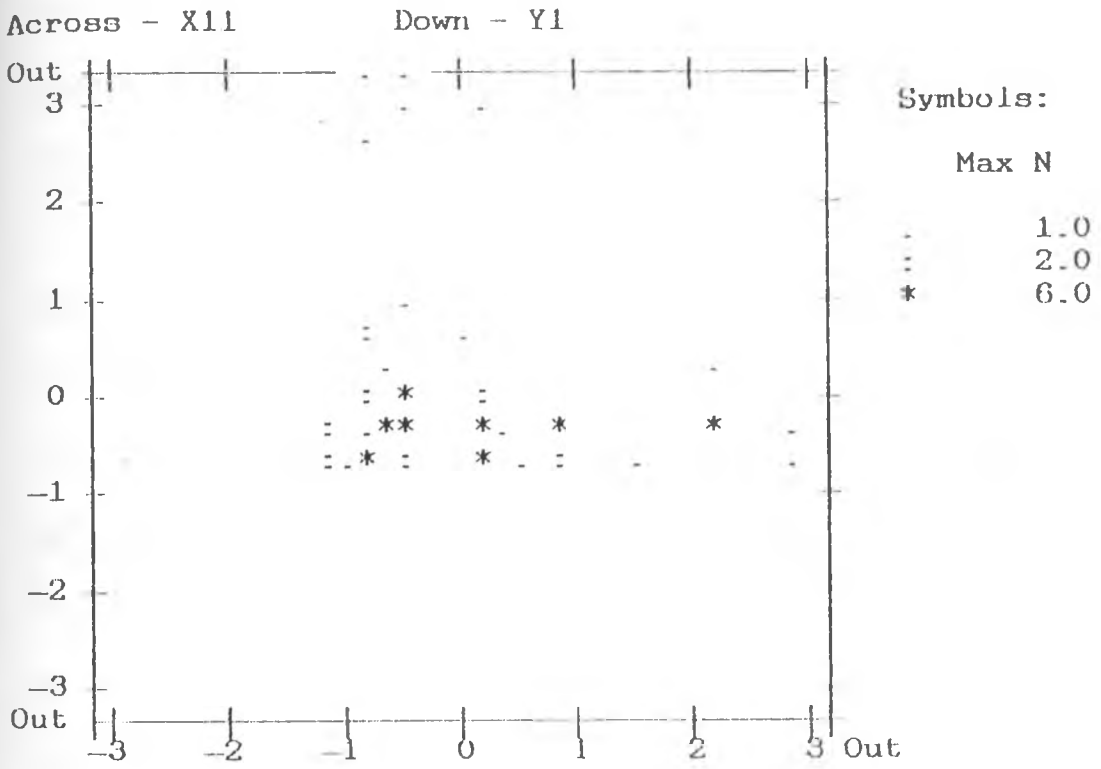
responsibility for facilities and services shared by others. In this research polygamy has intensified cultivation in some farms. Most of the households with small portion of uncultivated land belong to polygamous families. It is estimated that given the climatic and soil conditions in Kisii District, the minimum area of agricultural crop land that would sustain an individual at subsistence level would be 0.3 ha. On the other hand 40 heads of cattle (50% of milk type) would be required to sustain at most 10 people at subsistence level. Therefore either 30 ha of crops or 40 heads of cattle would be required to sustain lives of a single family of six to ten people in a household (District Development Plan, 1989/93). Such family size is common in the study area. Most of the households with between 0 - 2.9 ha of land uncultivated incidentally leave a lot of their arable land uncultivated. Food security and uncultivated land were found to be significant, one can say that the inability to bring idle land under cultivation is influenced by food security levels.

Figure 7: Food Security and Agricultural Production



In Figure 7, a' b' c' and d' represent a state of `survival' for the household, when optimum levels of food are produced. And a" b" c" and d" represent a situation whereby the household produces excess food for the members. It is conceptualized that agriculture diversification will begin at this stage. Before then the nature of farming will be essentially subsistence, savings, and capital formation will also be low. The converse is true.

Figure 8: Standarized Scatterplot



Illustration

A weak positive linear relationship between household food security levels (Y) and land not under cultivation (Xii)

4.4 Labour Productivity

From the literature review it has been shown that adequate nutrition is essential for the maintenance of good health and for increasing the productivity of individuals and for raising overall national productivity. Those households with food insecurity consume less, contract more diseases, have higher mortality rate and can easily be physically stunted and they consequently exert less energy in their daily tasks than those less affected with food insecurity.

Effects of food security on the physical capacity to have children is more direct since it works through the mothers nutritional and health status. There is no doubt that adequate food supply and working conditions in agricultural field affect the activity of the mother to bear and raise children. For our economy in general, capital is scarce but labour is abundant. This is true in rural areas where we have disguished employment in the agricultural sector. This class of unskilled labour is not purely a function of technology and skill but also a function of body energy. Inadequate food curtails the benefit from schooling and training programmes. And it leads into general lack of vigour, alertness and vitality among the labour force. These outcomes reduce the productivity of the households in short and long terms, reduce output and income and make it more difficult for families and even for the nation to escape the poverty cycle.

Labour supply and demand are a function of household food security levels, economic status and gender composition of the family given the prevailing social conventions. Labour availability sets a limit on the amount of land a household can farm. It has been shown that men are exploiting the input of women in cash crops, while still they leave

the basic costs of reproduction of labour through food production and other farming activities to women. Abilities of labour in agricultural production can also be associated with malnutrition:

Malnutrition can be detected by:

a) those households that cannot produce or procure adequate food.

b) those households that live in marginal or harsh environment.

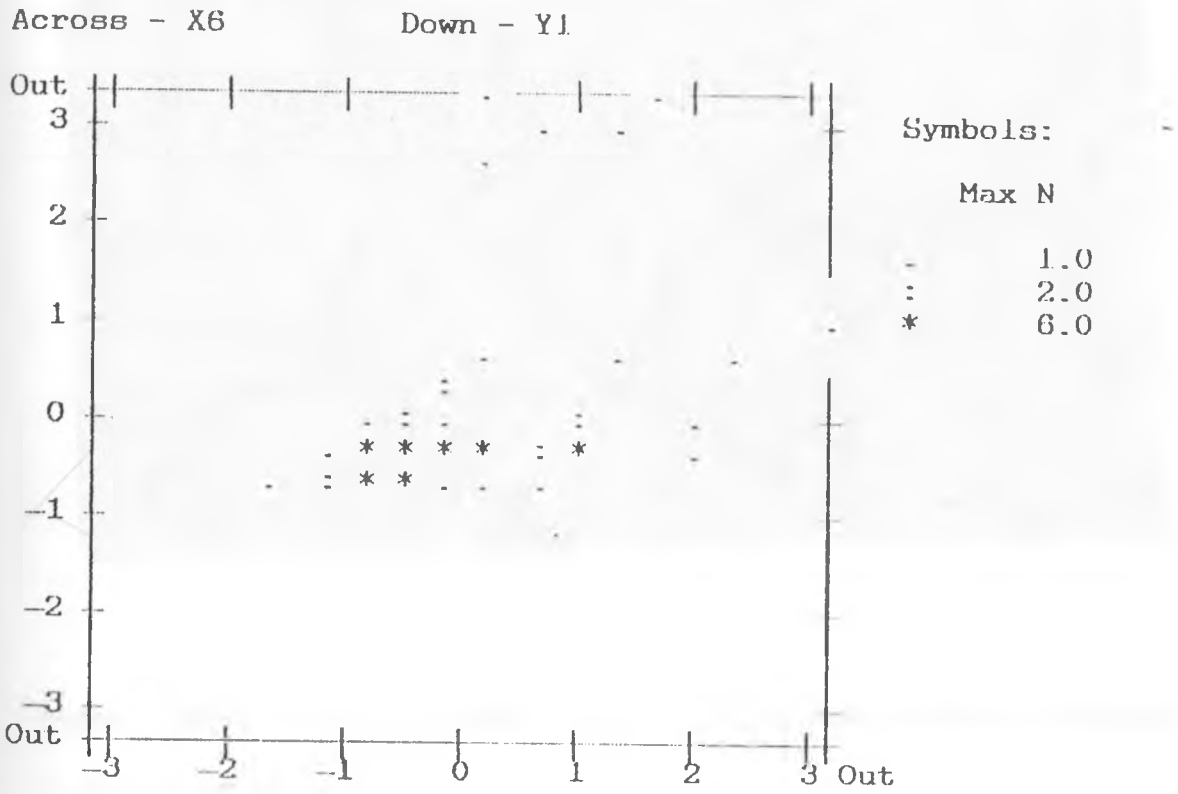
c) those households that are socio-economically disadvantaged.

This research has used (a) and it has been shown that households with food security have high labour productivity. However agricultural production is very different from industrial production. Agricultural production is sequential in nature, subdivided temporally and operationally. The production cycle in agriculture is consequently prolonged and varies greatly between crops. Hence measuring labour productivity in agriculture is difficult. No straight forward marginal productivity rates can be applied here as productivity of household labour will be influenced by appropriate application of other necessary inputs in agricultural production. Therefore concluding that low levels of food at the household is indicative of low labour productivity is rational indeed. However the number of children and elderly in rural households continue to increase because of improving medical services which have reduced child mortality and increased life expectancy. This therefore increases the dependence ratio.

Figure 9: Elderly grandmother representing unproductive labour force

It is a plausible arguement that a higher dependence ratio reduces labour productivity on one hand and increases the demand for food. However, this study did not establish the effect of household dependence ratio on household food security levels because some relatively younger and elderly populations are actively involved in food production during cultivation, planting, weeding, guarding the crop from animal destruction, harvesting and preservation.

Figure 10: Standardized Scatterplot



Illustration

A strong positive linear relationship between household food security levels (X_1) and the total household labour engaged in agricultural production (X_6).

Figure 11: Farm under maize production

Figure 11 shows a farm under maize production on the foreground and idle arable land on the background.

Some scholars have argued that some communities require persuasion to adopt technology because they uphold traditions and customs that hinder production of more food. Why would a household refuse to increase its production and incomes if opportunities are available? The reality is that, the ability to use the available technology is influenced by food security levels in a given household.

4.5 Savings and Investments in Agricultural Production

The invention of agriculture was the single accomplishment which permitted man to establish sedentary communities, create social structure and bring about division of labour for economic development.

The day when a choice between industrialisation and agriculture formed debates are gone. Farm progress is a requirement for rapid industrialisation. Agricultural sector must produce enough food and surplus for exchange with capital goods.

Agriculture is the main occupation in the study area and indeed in many rural areas of Kenya. Sometimes it is the main source of income in some households. It is also important to note that the households' income levels influence nutritional levels, savings and investments. Holding other factors constant, household incomes are mainly influenced by:

a). Size of the household

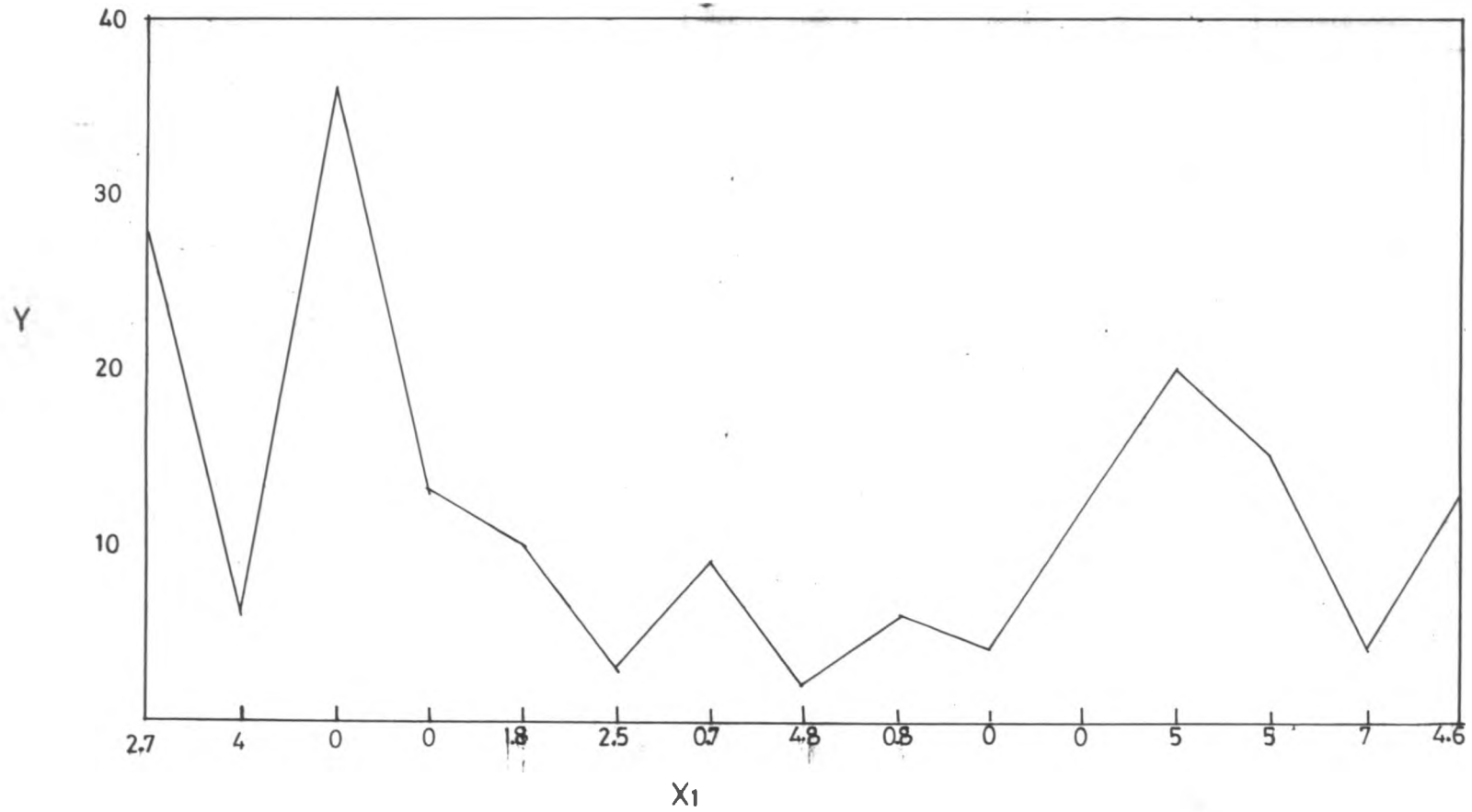
b). Size of the farms

c). Consumption patterns peculiar to the household

d). Other sources of income

Food security is influenced by both macro and micro-factors ranging from technology, supporting institutions, marketing to monetary and other fiscal exchange rate situations that affect the overall rate of growth and distribution of income.

Figure 12: Food Security And Income Spent On Maize

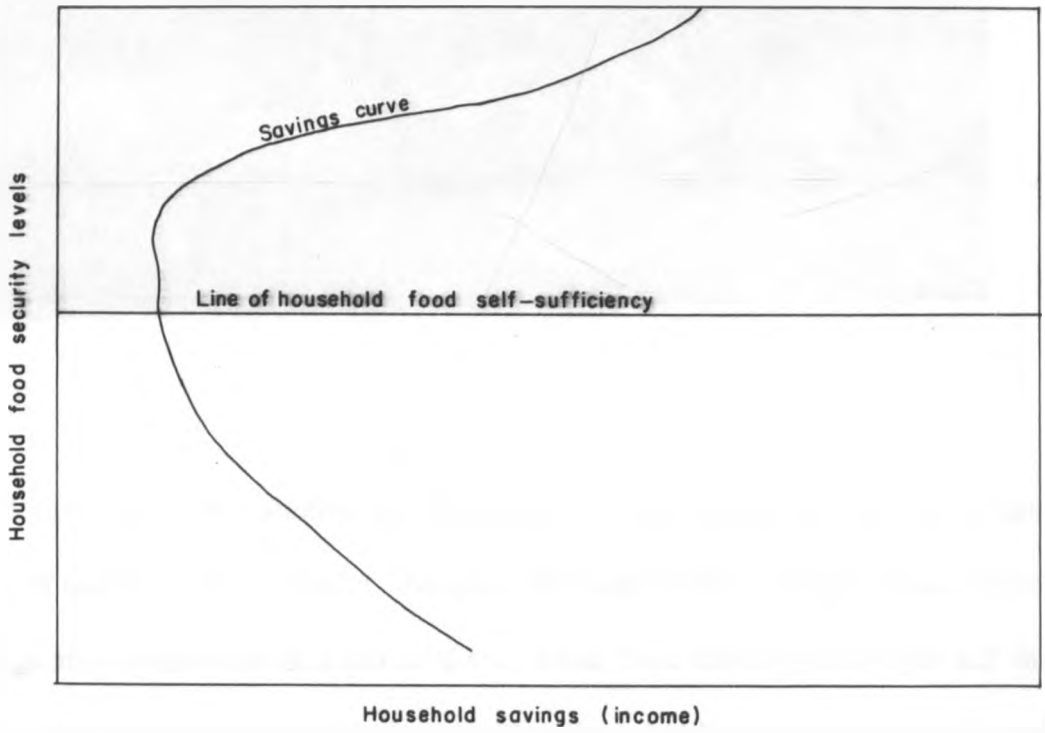


SOURCE: Ondieki 1991

(KSH '000)

As illustrated above, households that have high food security levels have low expenditure on maize before the next harvest season.

Figure 13 Food Security and Household Savings



Holding other factors constant, household Savings will continue to decrease until the household attains status of food self-sufficiency.

Figure 14: Maize Agribusiness

Most food deficit households studied are dependent on agricultural production as their main source of income and livelihood. Because their agricultural output is low, incidents of low savings and investments is a kin to them. Most food deficit households sell their maize produce, not because they have harvested enough but because they have buy other basics. Households that supplement their food budget by buying extra food, reduce the total income that could have been channelled into investments in the agricultural sector. Figure 12 demonstrates that those households with low food security levels spent more of their household incomes on the purchase of maize while those with high food security levels spent zero income on the purchase of maize. From this research the incomes of latter households spent on maize was on buying maize hyprid seeds for planting.

It has been shown that the aggregate picture of how adequately the current food balance sheet at household level can provide energy and protein requirements for agricultural productivity in some households, in this agriculturally high potential area it is low indeed. Attempting to ensure food security should therefore be seen as an investment in agricultural production. The plausible argument is that food insecure households are less able to bear risks in agricultural production. A target of investment in food security will accelerate diversification of household economies.

Figure 15: Traditional Granary

4.6 Agricultural Development

In this research agricultural development is seen in the light of improved agricultural productivity and diversification of agricultural production. Food security determines the economic structure of a family. Consequently the production, distribution and consumption of agricultural produce in a society may be influenced by levels of food security. Development and intensification of agriculture in high potential regions if well managed can lower grain prices in a liberalized market. The spill over effect will in the final analysis benefit households in low potential areas. The latter will consequently save and invest in agricultural production in purchasing farm equipment, pesticides and fertilizer among other inputs. However in analysing the role of food security levels in agricultural development the basic assumption is that improvement in households' food security levels will automatically results in an increase in food intake for each household member thus improving labour productivity. From this research households engaged in crop diversification are also self-sufficient in food production. This is because the surplus income from say cash crops are reinvested in agricultural production by purchasing fertilizers and better farming tools that improve labour productivity.

Table 21: Administrative Units and Means of X_2 X_8 and Y_1

Administrative Unit	Y_1 Mean	X_2 Mean	X_8 Mean
Bomesichi	11.94	2.66	15.95
Boigesa	58.73	4.137	22.18
Bosingi	61.9	0.8	2.7
Bokinami	5.54	1.24	8.17
Kenyerere	4.4	1.2	2.26

X_2: Households' income spent on agricultural development the previous year.

X_8: Total income from cash crop production

Y: Household Food Security levels.

Table 21 shows that households with a higher food security mean (Y_1 mean) generated more income from cash crop production (X_3 mean). Consequently the same households spend more income on agricultural development the previous year (meanX_2) the converse is true.

Figure 16: Food security and income spent on agricultural development.

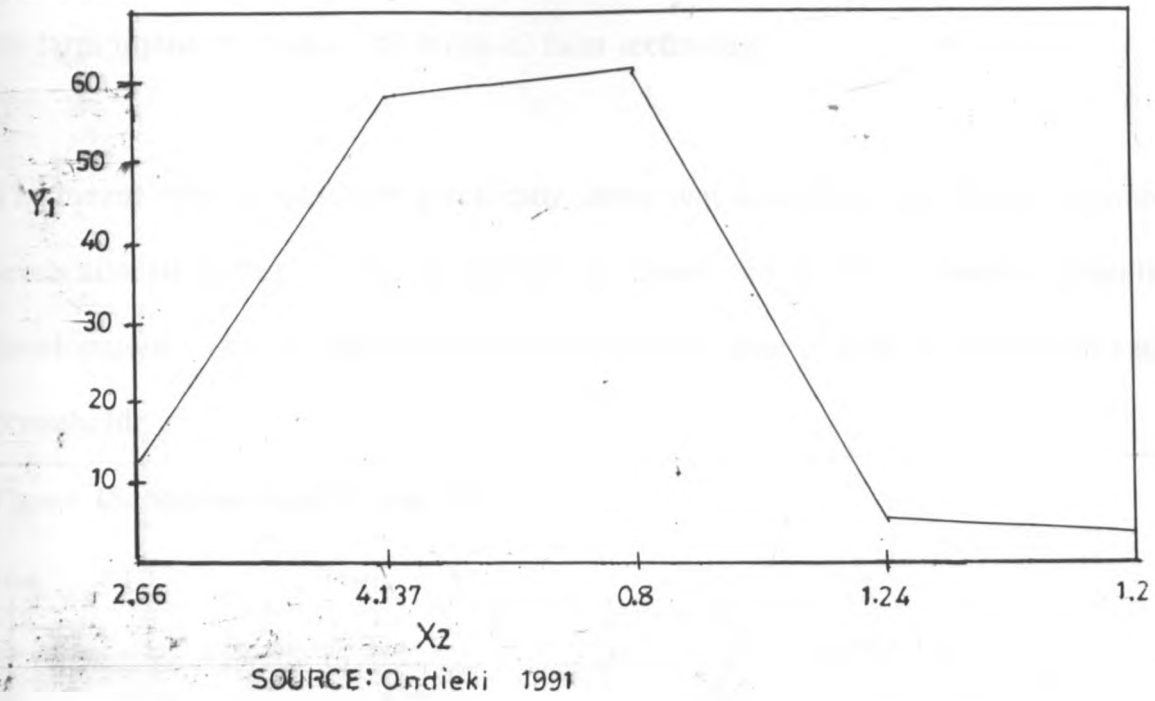
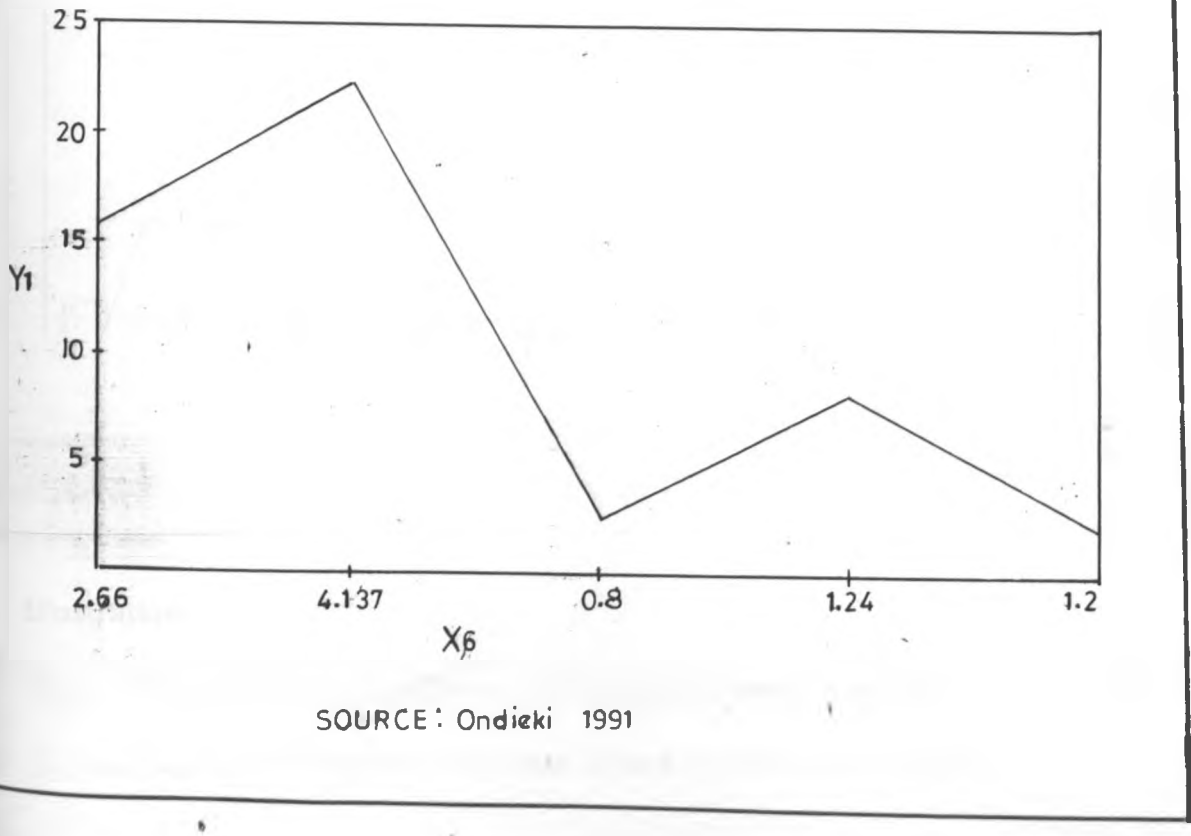


Figure 17: Food security and income from cash crop production.



Farm technology is estimated by the values of farm inputs. The higher the expenditure on farm inputs the higher the levels of farm technology.

The means when represented graphically shows that household with higher food security levels allocate higher incomes to agricultural inputs and therefore towards agricultural development. This is determined by the estimated value of farm technology at each household.

Figure 18: Standardized Scatter Plot

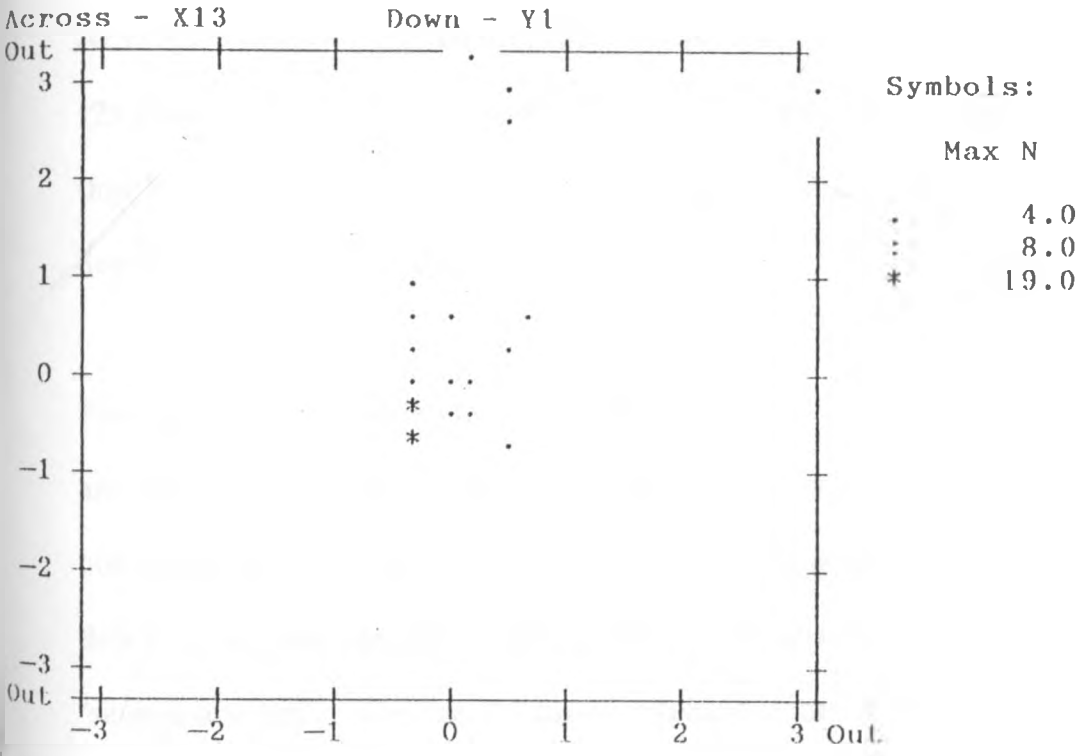


Illustration:

Figure 18 shows a weak currilinear relationship between household food security levels (Y_1) and the nuber of grade dairy cows owned by the household (X_{13})

Table 22: (Income spent on agricultural production)

	SUM OF SQUARES	DEGREE OF FREEDOM	VARIANCE MEAN SQUARES	
TOTAL	SS = D^2 4683.456	N-1 = 4		
EXPLAINED BY TREATMENT	SST = r^2 4795.5638	1.0	MST = 4795.568	F = MST / MSE
UNEXPLAINED	SSE = $(1-r^2)$ D^2	N-2	MSE $\frac{(1-R^2)\ D^2}{N-2}$ -37.035933	129.48408

Source: Ondieki (1994)

At Ó 0.05, with 95% confidence, the "F" expected is 10.128. While the F calculated is -129.48408. `F' calculated is small compared to F expected. Thus it can be concluded that X_2 does not influence variations in Y, this fact is also supported by our coefficient of determination which is also too small (2.37%)

Food is basic, and well nourished people probably never "think" about food and hence are able to concentrate on other areas of economic development. Whereas food deficit households direct all their efforts towards satisfying this basic need. In this study food deficit households operate "a current account" while the secure households operate a "savings account". How can the former account meant to purchase food, improve agricultural productivity?. Current account holders have to engage in the sale of vegetables, fruits (guavas, passion, oranges) and other households trade in kerosene, second hand clothes and the local brew in order that they meet the basic requirements. Conversely those better off in food security in food transact potatoes, beans and milk agribusiness. About 22% of these secure households recorded nil income from the sale

of food crops, during the month of interview. While 15% of the insecure ones registered nil income from the sale of food crops. 72.65% of the variation in food security can be explained by the independent variable, namely the number of grade cows owned by the each household (see appendix B). A general observation is that food secure households concentrate on cash crop production. Incidentally the same households employ modern technology in maize production (ox-plough, tractor, fertilizers, modern granary). This is because they are able to save and can afford to buy a dairy cow among other things. However a nation's land, labour, capital (including external capital), management and administration are the basic factors which contribute to agricultural development. But the effectiveness of these contributions may only be enhanced by proper organisation of its agricultural institutions, in particular marketing, agricultural education, research extension and by development of its physical infrastructure, especially its road network.

A clasification of factors affecting Agricultural Development

a) Physical Input Factors

(I) Non-human physical inputs

a)	Land	g)	Structures
b)	Climate	h)	Work animals
c)	Seeds	i)	Other animals
d)	Water	j)	Tools and machinery
e)	Fertiliser	k)	Fuel and power
f)	Pesticides		

(II) Labour

b) Economic Factors

(I) Transport, storage, processing and marketing facilities

(II) Facilities for supply and distribution of inputs including credit.

(III) Input prices, including interest rate

(IV) Product prices and prices of consumers

(V) Taxes, subsidies and quotas

c) Organisation Factors

(I) Land Tenure

(II) Farm size and legal farm

(III) General government services and policies

(IV) Voluntary and statutory farmers organisations for:

a) Co-ordinating physical input use, eg. irrigation and co-operatives

b) Economic services eg. purchase, sale credit associations and co-operatives

c) Social services e.g. health centres, schools

d) Local government

e) Diffusion of knowledge e.g. adult education extension services and youth clubs.

d) Social-Psycho-cultural Factors

(I) Integration of agricultural institutions practices and values within the technosocial matrix of a nation.

(II) Public administration factors, structures, values, mode of co-operatives, bureaucracy.

(III) Social structures, cultural values and dynamics of peasant communities.

(IV) Processes of socio-cultural change, barrier and motivations in innovative sequence functional harmony and disharmony in society.

e) Knowledge Factor

(I) Organisation of basic and applied research.

(II) Diffucion of knowledge related to:

a) Technical knowledge e.g. agronomy, plant genetics social science, water management, agricultural engineering and pest control.

b) Economic knowledge e.g. land economics, general economics and farm management.

c) Policy e.g. politics, public administration planning.

Source: Rural Africa "Research Notes on local politics and political anthropology". African centre-political science department Michigan State University Issue 3 1967 pp 20.Agricultural development should not be seen as a way of opening-up virgin land only but also as a trend of improving, increasing and the rehabilitation of the existing less productive agricultural systems.

Figure 19: Dairy grade cows

A grade cow is an indicator of agricultural diversification and advancement.

Household with high food security levels also have high prosperity to save and invest. Some of this households have managed to purchase dairy grade cows. This also an indicator of Agricultural diversification and progress.

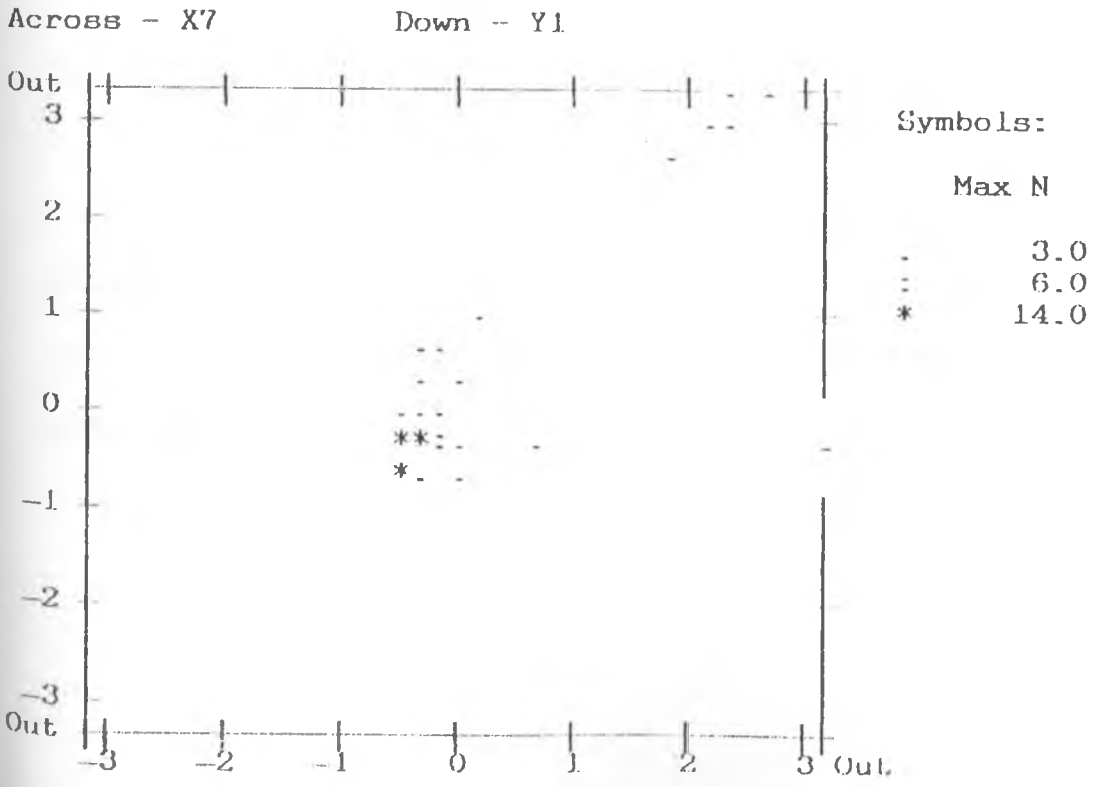
4.7 Farm Technology

Most rural households are endowed with labour and land. These factors of production are not fully exploited because of lack of appropriate technology and other limitations that constrain them.

The main inputs have been found to be land and labour. Other complementary inputs such as seeds, manure, tools and draught animals are to a large extent farm produced.

In improving agricultural yields farmers must buy: fertilizers, chemicals for the control of pests, disease and weeds, equipments and other inputs. About 67% of the variations in household food security is "explained" by the linear relationship with the independent variable namely farm technology (see appendix D).

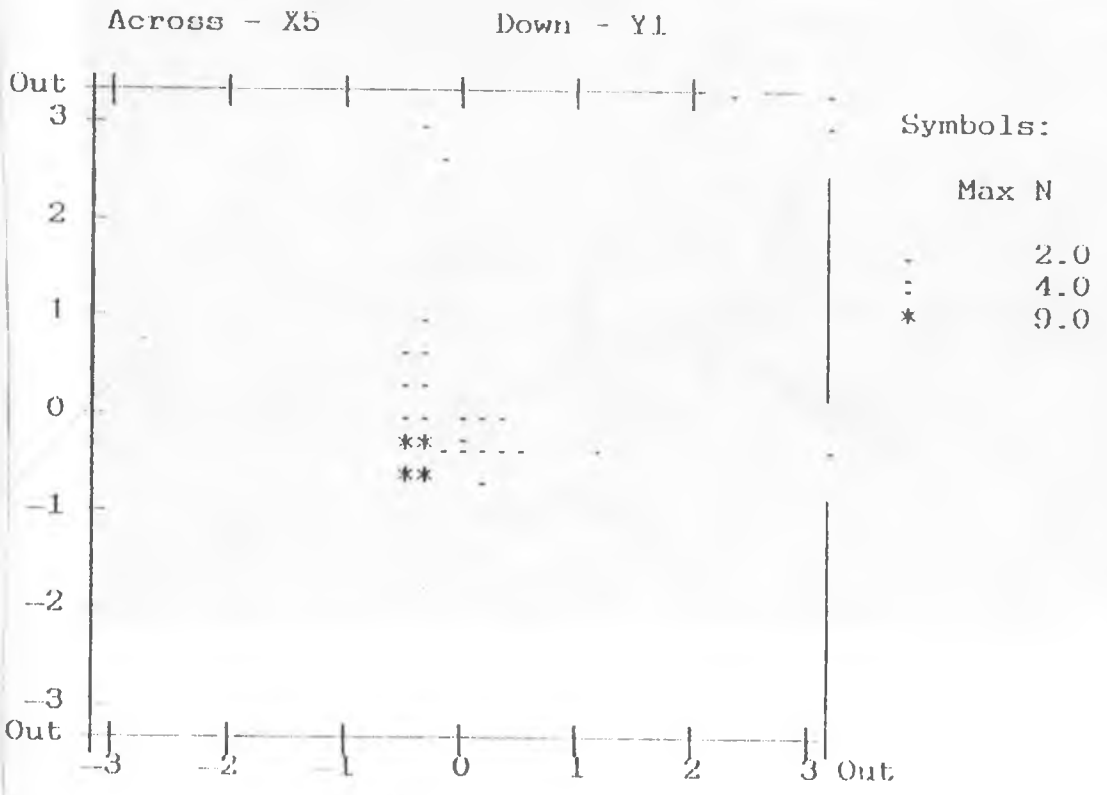
Figure 20: Standardized scatterplot



Illustration

A weak positive linear relationship between household food security levels (Y_1) and household savings (X_7).

Figure: 21: Standardized scatterplot



Illustration

Acuvilinear relationship between household food security levels (Y) and levels of farm technology.

Figure 22: Farming tools

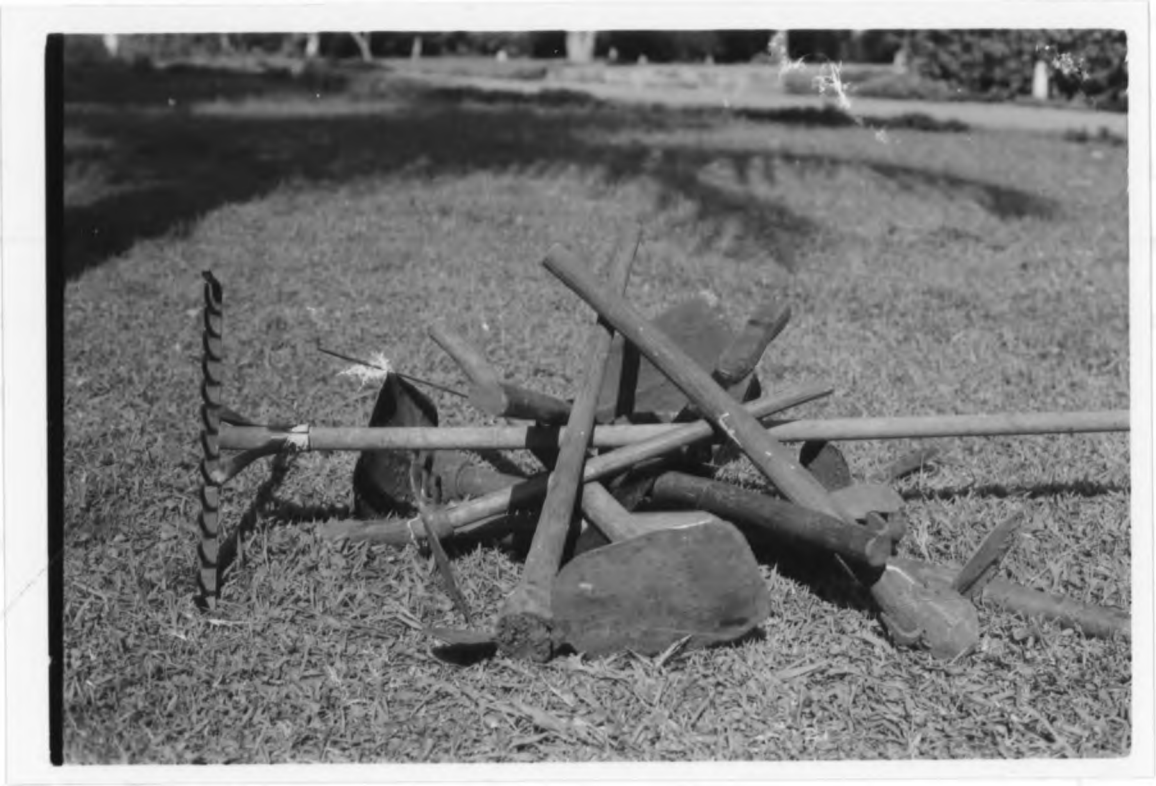


Figure 22 above shows some of the farming tools found in the study. Farming tools found in each household relates to the level of food security in each household. Modern farming tools were found in food secure household. Food insecure households registered traditional and primitive farming tools. The tools shown above were found in food secure households.

These variations are expected because what would have gone towards purchasing some farm inputs is spent on the purchase of food. A pre-requisite for improved agricultural productivity is the adoption of a wide range of new techniques such as more efficient implements and frequency of application of fertilizers. This is envisaged in food secure households where an ox-plough, tractors, fertilizers and modern granary are recorded. All food insecure households have rudimentary traditional equipments able only to cultivate only as much land as they can clear and all these in turn are determined by the energy of the labour of the labour force. These households are caught up in the viscious cycle of farm technology. Figure 23 demonstrates that primitive technology leads to low incomes and food deficit.

Figure 23 Viscious Circle of Farm Technology

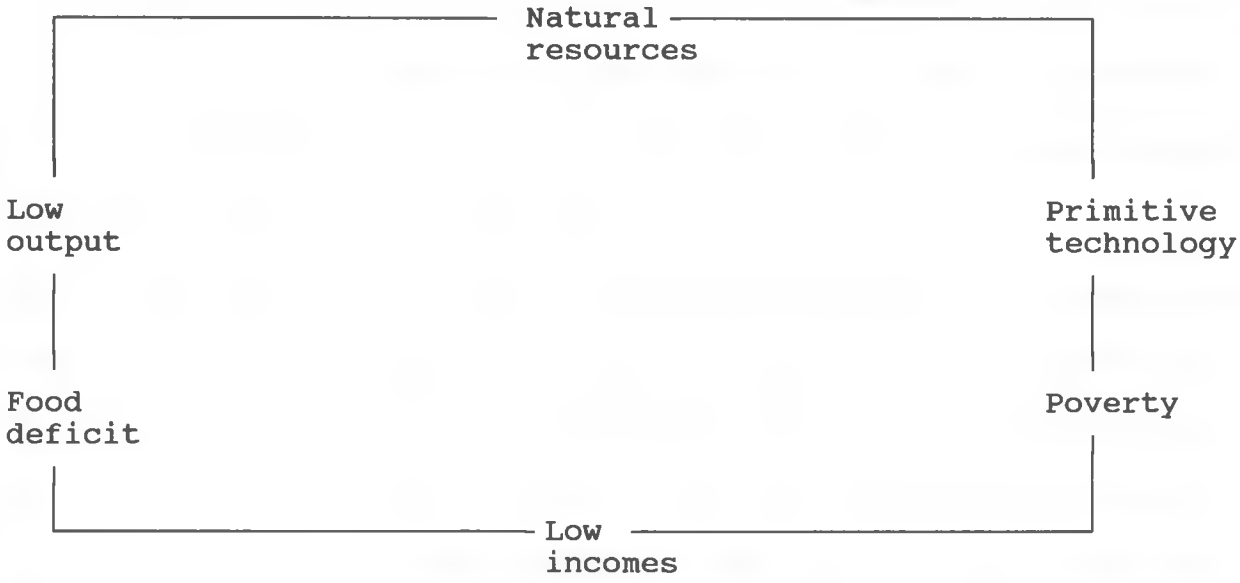


Figure 23 demonstrates that primitive techonology leads to low incomes and food deficit.

4.8 Other Factors

Family conflicts related to food can lower the morale of the household work force, even though this factor was not been found to be significant in agricultural production. Information to this effect could have been withheld by the respondents, because asking such question can be unethical and family interests must be safeguarded. However of the total household about 27% of them recorded cases of family conflicts related to food insecurity. All cases fall under the food insecure households.

Food secure households are expected to be making a substantial income from the cash crop economy, whereas those insecure rely on food crop production and marketing. Much of the land of food secure households is devoted to cash crop production. This is the arable land that is uncultivated by insecure households and in some cases this land is leased to other farmers. Such phenomena is a result of low attitude and morale plus low energy of the labour force resulting from low food intake. Food insecure households have 100% participation in the sale of food crops, whereas 38% of the secure households recorded no income from such agribusiness.

Figure 8 depicts the variation of food security and income accruing from the sale of food crops. It is indicative that the pattern of variation in food security is not explained by the said income. This provision is supported by the fact that the independent variable X_{10} is insignificant by regression analysis. This is because food crops vary from household to household and sometimes even the poor make some income from food crops. Likewise the secure households could be undertaking both income generating activities.

Uneven distribution of income and other resources can also explain the persistant food and nutrition problems in the rural sector. The World Bank (1986) supports this contention when it argues that though the world has ample food supply, in sub-saharan African, hundred of millions of people do not share in this abundance. Accordingly they do not have food security since they have inadequate purchasing power.

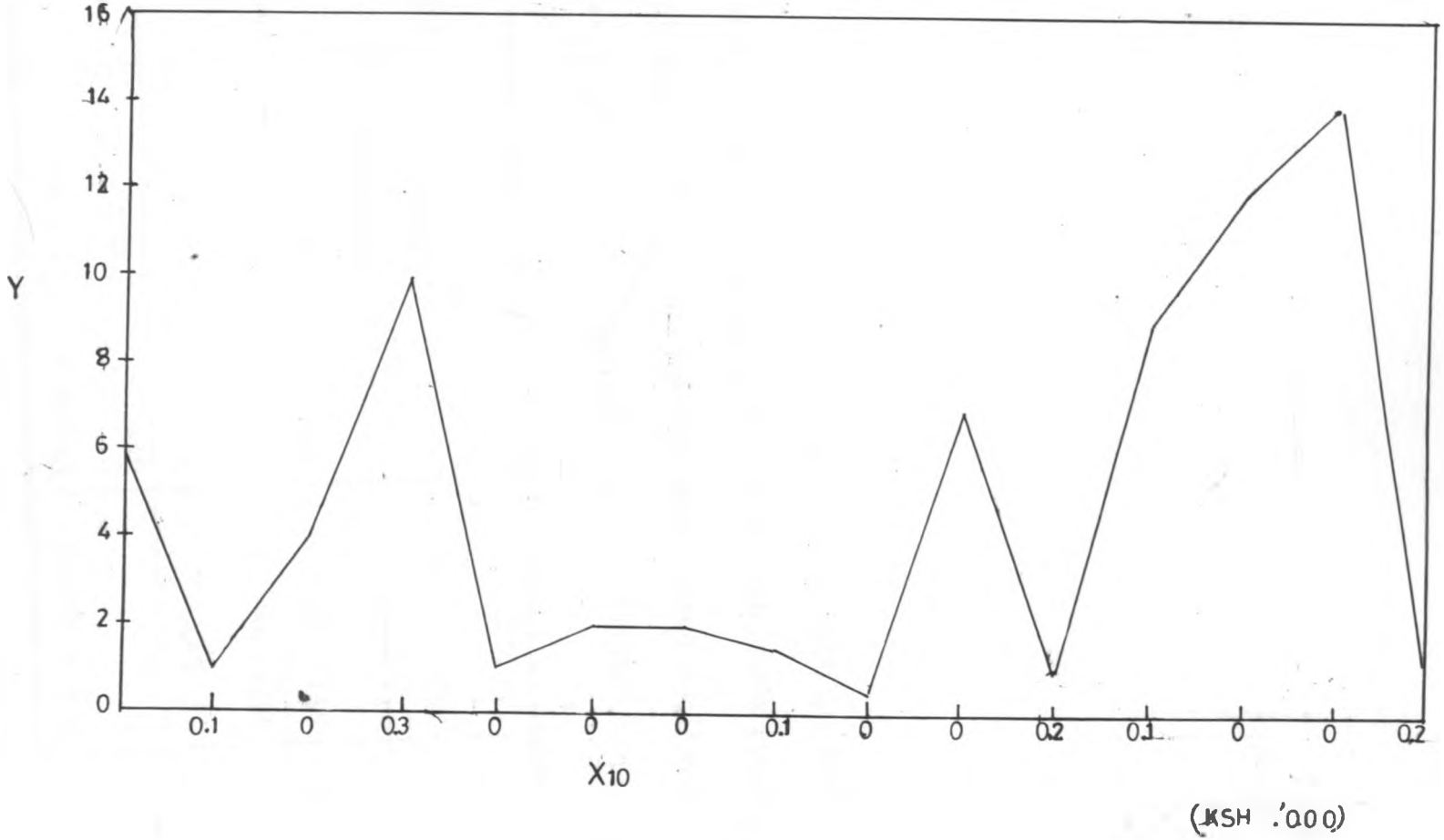
The scatter plots of the dependent (Y) on the independent variables X_5, X_6, X_7, X_{11} and X_{13} were found to be significant by stepwise regression analysis, in the following percentages 67%, 56%, 42%, 72% and 74% respectively. The resulting standardized scatter plots for the same depicts predictable trends of variations. It has been shown that households with low levels of food security register some income from the sale of food crops. Though food secure households recorded higher incomes from the same, many recorded none.

To establish the correlation between household food security levels (X) and household cash crop incomes (X8) means and this result to:

$r^2 = 0.0696422$ which means that only 6.96% of the variations in household food security levels is explained by cash crop incomes.

Rationally households with substantial income from cash crop farming should have higher levels of food security. However, this has not come out significantly as shown above. This outcome could have been determined by the fact that some of the referred households had their workers on the farm. In addition, there is the preference of cash crop farming to food crop farming, meaning that there is decline of land under food production.

Figure 24: Food Security And Income Spent On Food Crops



SOURCE: Ondieki 1991

Table 23: Anova Table (Income from cash crop production)

	Sum of squares	Degree of freedom	Variance Mean	
Total	SS= ΣD^2 1625.1706	N-1 4		
Explained by treatment	SST= $r^2\Sigma D^2$ 113.18046	1.0	MST 113.18046	$F_c \frac{MST}{MSE}$ 0.0294945
Unexplained	SSE= $(1-r^2)\Sigma D2$- 111.1078	N-2=3	MSE 3837.33	

At α 0.05 with 95% confidence, the (F) expected is 10.128 while the (F) calculated is 0.0294945. Since (F^c) is smaller when compared with (F) expected, it is concluded that X^8 does not influence significantly variations in Y, this is also reinforced by the coefficient of determination (r^2) which is 6.96%

Table 24: Individual influence on decision making in agricultural production

	Wife %	Household %	Others
Food crops	83	0.7	10
Cash crops	6	54	-
Income/investment	90	10	-
Buying of farm inputs	30	65	0.5

Women have a lot of say in food production, whereas men also control the cash crop economy. This is because of the capital motive; this is supported by the high percentage say the same men have on income and investment.

Some cultural activities may also affect agricultural productivity and consequently food production. The Kisii cultural activities such as initiation ceremonies, social rituals and long burial ceremonies may take too much time at the expense of other productive activities like planting, weeding and harvesting.

Social structures may also influence agricultural production. Those households that are food secure had higher inspirations; about 100% towards savings and investments in agriculture. Conversely the food insecure households had low morale, low imagination, low willpower and low innovations in their farms, all these factors are conditioned by the degree of hunger at the household level. One can therefore contend that when farmers are confronted with new technologies and new scientific opportunities for improving their farms, psychological factors conditioned by hunger and culture, social and economic factors influence their productivity.

Upholding assumptions made in reference to table 2, it is possible to quantify food security levels in the study area. Assume the household size of seven persons. From our sample there are about 197 households thus giving a total population of 1372 people. From the questionnaires there is a total of 796.2 kg bags of maize from 63 households. This gives an average of about 12.6 bags per year. However, the available supply is 2477.067 bags. This gives a deficit of about 678.3 bags. Therefore there is 21.497% food deficit in the study area. Both physical and social economic factors contribute to this deficit.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of Findings and Conclusions:

There is a significant relationship between household food security levels and the households annual savings. The higher the levels of food security, the higher the income levels in terms of annual Savings. Thus there is a structural correlation between household food security and annual savings, This is because a portion of household income that would have been saved is spent on the purchase of food given that food is basic need.

Levels of households' food security have a direct effect on household farm technology levels. The households with higher levels of food security also recorded advanced levels of farm technology. The criteria was affordability of fertilizer, hybrid maize seeds, a modern granary and better farming tools. Food insecure households had the following inputs; a traditional granary, traditional farming tools, used farm manure and ordinary maize seeds.

Food security conflicts do not significantly lead to absenteeism from agricultural activities. Household conflicts were found not to influence significantly the participation of household labour engaged in agricultural production. However, there were cases of absenteeism related to food scarcity conflicts. Some respondents attributed food insecurity to poor management of incomes accruing from cash crops by the head of the household.

Food insecure households also incidentally have alot of arable land not under cultivation. This can be attributed to inadequate/insufficient body energy to do work and general apathy to do work because of hunger and poverty. Inadequate household income lead to inability to engage workers to cultivate arable land.

Food secure households have a diversified agricultural farm and high agricultural yields. The referred households grew a variety of horticultural and cash crops. Many had a number of dairy cattle, goats and sheep. Others in the same category engaged in poultry farming.

There is a significant relationship between the scale of agricultural output and available household labour. However, agricultural productivity at each household varied greatly with levels of technology available.

It is evident that more aggregate food out put in Bogetaoria II Sub-location, Kisii District; a higher agricultural production area does not feed more people or even does not help in filling crucial household food deficits, since, some households in the study area experience impacts of food insecurity.

5.2. Discussion of the Findings:

Lack of awareness about both the natural and the magnitude of food crisis in Kenya's high potential agricultural areas has been brought to the fore. Benefits of increased productivity in agriculture should be shared between different types and sizes of households who are producers and consumers. Discrimination against women in

terms of the income from agricultural produce, may reduce agricultural performance. Food insecure households experience conflicts that are related to scarcity of food.

Food problems in the world and Kenya in particular has gained great prominence. But its nature and answers attract diverse opinions. Discussions range from population growth, affluence, availability of fertilizers and pesticides, the cost of energy to environmental concerns and weather conditions.

A major barrier to agricultural development is poverty itself. During the study it was found out that in some households poverty had become institutionalised. What is needed - in my view - are a variety of incentives that will induce people to grow crops. In addition incentives in my opinion are the alleviation of hunger and malnutrition. Agricultural productivity will only increase if the households living levels are above hunger and poverty. This is because hunger and poverty are interdependent. The entire problem is food insecurity, it is the major risk most households face in modernising their agricultural productivity and this risk must be minimised if agricultural development will be realised, this is my thesis.

Food insecurity is not confined to low agricultural ecological regions only. Kisii district is a high potential area and it is believed to enjoy excellent levels of food security. From this research, it is true that there are several pockets of food insecurity, which aggregate and result into subsequent agricultural underdevelopment.

Ironically, from the foregoing analysis those households with low levels of food security, own big tracts of land (arable land) remains uncultivated. They simply cannot bring the land under cultivation because of hunger and malnutrition. This is because the labourers lack of adequate energy to do work, are lazy and weak, they work for less hours in their farms and above all, it reduces purchasing power for agricultural inputs, because, more incomes is directed towards the purchase of food. Whereas, those households that produce enough food also do well in non food crops and especially so in cash crops. This is because food security gives a provision for agricultural investment. More emphasis should be placed on those measures that increase agricultural labour productivity. Food security is therefore a matter of high priority. The components of the Green revolution should only complement the gear in agricultural production.

Food situation in the research area are made more serious by the fact that sexual division of labour has lagged behind. Domestic quarrels emanate from discrimination against leads to negative attitude towards work. Men and their alcoholic habits have contributed significantly to low levels of food production.

I would prefer selective food aid (food for work) for food insecure households instead of prioritisation of technological and economic aid. It is the jembes and hoes that "know how to cultivate" the monotonously rugged Kenyan topography, but this must be complimented by the body energy; that human muscle energy that will climb and dig these hills. Food aid may encourage overdependence but not when this aid is linked to actual cultivation in the field.

In the light of these research findings, one can conceive of a case where progress in agriculture development begins with increased productivity in food, and is sustained because farmers move rapidly out of subsistence farming into other occupations as productivity rises.

In the past the nature of agricultural development has been seen within the context of rural development programmes as a prerequisite to progress in agricultural production.

Internal problems of agricultural production are compounded by the external limitations on economic development. There is a great reliance on overseas sources of investment funds on Kenya's agricultural development. The strategy of measuring or ensuring food security in deficit households is a secure way of reducing this overdependence. With current liberalisation of prices for agricultural produce and inputs, while rural Kenya is largely an exchange economy, adverse shift in households income due to the price of food is most likely going to affect the households food intake adversely and consequently lead to starvation. Some rural households in Kisii district continue to depend on purchased food yet their region is classified as a high potential area. Economic issues and elements of weather are not the only components in food security. The problem is that pronouncements per se urging farmers to increase food production without research on the structural matrix under which the factors of food production are apportioned must continue to yield insignificant results.

5.3. Recommendations to Planners and Policy makers:

Future development plans need to underline the importance of food security by channelling additional investments in the agricultural sector towards food production. The poor households should be targeted. This is because optimum food security endures rapid agricultural development. Methods must also be devised to identify the poor.

This research concludes that adequate food production is the sure way of increasing agricultural production. Hence the ministry of agriculture, livestock development and marketing must adopt those polices which will give farmers an incentive to increase food production and to adopt measures to mobilise their own resources to ensure progress in agricultural development. Other immediate measures are, farm gate price incentive, specific extension services to change the eating habits in preference of maize (zea mays); particularly in employment as rural agricultural extension officers.

The government should incorporate agri-business sector in its food policy plan. This will entail research on new and better ways to produce and market food, dissemination of new technology, developing and enforcing laws, consumers and producers must be partners in agribusiness. Most farmers do not consider themselves as part of agribusiness system. Instead they see themselves in competition with agribusiness for consumer money and as a source of their production activities. Marketing is therefore a very important component in food security.

Excluding food production into less favourable ecological setting requires heavy capital investments and careful planning in the presence of several uncertainties.

The impact of climatic change and its influence on agricultural productivity must be investigated. Firstly, there is anticipated increase in precipitation in humid regions leading to increase in agricultural and forest production but would aggravate problems of nutrient leaching, soil erosion, weeds, flooding and pre-harvest and post harvest crops. Secondly, dry areas are expected to become drier according to climatic change models, with evaporation rates increasing. This would have far reaching implications on the government plans to expand crop and livestock production in arid and semi arid lands in Kenya. On the adoptive responses, the five year plans are too short to capture the long term impacts if climate change. The time has come for the Kenyan government to device a long range strategic plan that incorporates issues such as assistance to farmers, environment, technological innovation and climate change. It has been noted that the expected increases in temperature and humidity will favour the reproduction of pests and growth of disease causing organisms. Agricultural pests and crop diseases are already a major problem in Kenya. Pests like army worms, caterpillars, weevils and beetles cause heavy pre-harvest and post-harvest losses annually whereas crop diseases reduce productivity of a wide range of crops. However, the magnitude of crop losses likely to rise from climate change is not yet known. This is a great challenge to researchers and planners.

The Ministry of Agriculture should aim to establish regional food security database. Conduct surveys and analyses for purposes of preparing a plan of action. This is because local nutritional inadequacies can be minimised through regional food systems planning.

While Kisii district is regionally considered to be self sufficient in food, pockets of households have been found with cases of seasonal food deficits. Before the government moves to utilise resources of ASAL, of course the capital to embark on such rehabilitation is enormous, our productivity potential in high potential areas is not fully exploited.

5.4. Recommendations for future researchers:

Research should be undertaken to determine the impact of food aid to food insecure households. Whether this will be a positive or negative measure towards agricultural productivity. Will this be a motivation towards agricultural production in general or it will instead encourage laziness in the form of overdependence?

Research is needed on the inherent conflicts between the consumers and producers. The task of increasing food production to meet the needs of a growing population and pockets of poverty and to provide food for extra consumption by the poorest is daunting.

More research is needed to resolve the conflict that exist between producers and consumers. The distinction as Tarant, R., (1990) puts it between the consumer and the producers is not always clearcut. A large number of small producers may not produce sufficient food to feed their own families throughout the year. They hence become consumers. To what extent does this trend contribute to the position of food insecure househlod?

Researchers must account why there is more arable land that remains uncultivated amongst food insecure households; if the primary reason is not food insecurity!.

Quantity and distribution of rainfall would continue to account for seasonal and regional fluctuations in maize production in Kenya. Maize production fell sharply in the drought years of 1987/88. However since 1988/89 there is a downward trend that cannot be largely attributed to weather vagaries. Other researchers may investigate why;

(a): The amount of maize being cultivated in this country has declined from its peak of 1.44 million hectares in 1988/89 to below 1.30 million by 1992.

(b): Yields per bag also continue to decline since 1988/89. Refer to figure 2.

BIBLIOGRAPHY

1. Abbort, J.C. (1979) Agricultural Economic and Marketing in the Tropics. Longman Groups Limited.

2. Achanya, K.T.(1984) Interfaces between Agricultural Nutrition and Food Science. United Nations University.

3. ADB (1993) A review of African Development Report.1993

4. Agbjourn, E. Ed (1984) Food as a Human Right. United Nations University.

5. Akech, S.O (1990) Small-holder Food Production in Rongo Division; South Nyanza district. University of Nairobi (M.A. Thesis)

6. Alan B.O (1973) The Nutrition Factor; Its role in National Development. Brooking Institution.

7. Amin, G.A. (1966) Food Supply and Economic Development with Special Reference to Egypt. Frank Cass and Co.Ltd.

8. Amann, V.F.(1973) Agricultural Policy Issues in East Africa. Makerere University.

9. Ateng, B.A. (1980) Inadequate food Intake and Exchange Entitlement in Kenya's Rural Areas. University of Nairobi.

10. Ateng, B.A., Senga W.M, Farugee, R. (1981) Population Growth and Agricultural Development in Kenya. University of Nairobi.

11. Ateng, B.A. (1986) Food Policy Analysis in Kenya. University of Nairobi Ph.D thesis.

12. Ayako, B.A (1985) Kenya Small Scale Farmhold. Consumption and production Behavior. A policy simulation model. University of Nairobi thesis.

13. Berg, D.A (1973) Nutrition Factor: its Role in National Development. Bookings Institution.

14. Borserup E. (1965) The conditions of Agricultural growth; Economics of Agrarian change under population pressure. Pub. Aldine Co. New York.

15. Clayton, K.,Lipton,K., Hildren, R. O'conner ed. (1988) Agriculture and Rural Areas; Approaching the Twenty First Century. Iowa State University Press.

16. Dema,I.S.(1965) Nutrition in relation to Agricultural Production. F.A.O. Rome.

17. Dowswell, C.R. ed(1989) Proceedings of a workshop. Feeding the future: Agricultural Development Strategies for Africa. CA SIN/SAA/GLOBAL 2000 August 1-3 Accra Ghana.

18. Dore R.S (1967) Factors that influence coal mining. Pub. Warwik Berlin.

19. Drapper, N.R.(1966) Applied Regression Analysis. John Wiley and Sons Inc.

20. Ehrlich, P.R. and Ehrlich, H.A.(1970) "Population Resources", Environmental Issues in Human Ecology

21. Eicher Carl (1964) Agriculture in Economic Development. Macgraw - Hill BK Co.

22. FAO: (1976) Indicative World plan for Agricultural Development.
FAO, ROME.

23. FAO/WHO (1974) Food and Nutrition strategies in National Development.
Ninth Session of joint FAO/WHO Expert.
Committee in nutrition,
Rome 1974.

24. Franklin Cardy (1993) Desertification and Global Food Supply.
UNEP, Nairobi.

25. Gasper Diogo de, Caesar Espiritu Reginald Green (1981) World Hunger; A Christian Reappraisal, World Council of Churches.
Geneva, October 1981.

26. Goldberger, A.S. (1968) Topics in Regression Analysis.
Macmillan Company.

27. Haggins, C (1989) Kassam, P Soil productivity in the tropics.
Pub. Longman.

28. Harle, Vilho ed (1974) Political Economy of Food
Saxon House Publishers.

29. Hayami, Yajiro (1971) Agricultural Development, An International Perspective. Johns Hopkins University Press.

30. Harrat, Jacob G. (1967) Strategy Towards the Conquest of Hunger. Rockfeller Foundation.

31. Harman, H.H (1976) Modern Factor Analysis. University of Chicago.

32. Hunt Diana (1976) Poverty and Agricultural Development Policy in Semi-arid areas of Eastern Kenya. International African Institute.

33. ISSJ (1989) "Economic Analysis and Inter-displinarity " A Journal August.

34. Jaetzold, R. (1990) Farm Management Handbook of Kenya. Vol.11 Part A. Nyanza and Western Province G.A.T.

35. Jones, William (1972) Kenya's Maize Hybrids: effects of their introduction. IDS Paper No.39.

36. Johnston, D (1970) Agricultural Development in a developing world. Pub. Houghton Co.

37. Keefe Phil O., Ben W. Ed.(1976) Landuse and Development. African Environment special report. International African Institute.

38. Kahangi, F (1993) Bio-technology and Agricultural Production. UNEP Publication.

39. Kenya National Assembly (1981) Sessional Paper No.1 on National Food Policy. Government Printers.

40. Kenya National Assembly (1986) Sessional Paper No.1 on economic Management for Renewal Growth. Government Printers.

41. Khusro, A.M ed (1968) Reading on Agricultural Development. Allied publishers.

42. Kirit, P. and Ference, R (1981) Food for All in a Substainable World. Institute for Applied System Analysis.

43. Kliest, T. (1985) Regional and Seasonal Food Problems in Kenya.

Foods and Nutrition Studies Programme.

44. Kodhek, G.(1992) Private Sector Maize Marketing in Kenya. Proceedings of Conference on maize supply and marketing under market liberalization. Egerton University.

45. Kumba J.K. (1990) Influence of selected socio-economic factors on Food Production in Kisii District: A case study of Irianyi Division M.A. Thesis . Nairobi University.

46. La-Anyame, S. (1985) Economic of Agricultural Development in Tropical Africa. John Wiley and Sons.

47. Lathan, M. (1979) Human Nutrition in Tropical Africa. F.A.O. Rome.

48. Leonard, D.K. (1972) The social structure of Agricultural Extension services in Western Province of Kenya. IDS PaperNo.126.

49. Lipton, M. Heald (1984) African Food Strategies and EEC Role. An Interim Review. Public Centre for European Policy Studies.

50. Masaya, T.R. (1975) Spectral Analysis of Coffee, maize and wheat in Kenya. IDS Paper No.218.

51. Myrdal, G (1968) Asian Drama. An inquiry into the poverty of Nations.
Pub. Pantheons, New York.

52. Mathews, H (1989) Geographical Data. Oxford University.
Press..

53. Mbatia, P.N.(1990) Socio-economic Factors Affecting Food Nutrition and Health in Rural Sector in Kenya.
University of Nairobi.

54. Mboya T.J. (1967) Solving the Food Problem, between Demand and Need.
International Features Services.

55. Mutiso, G.C. (1977) Kitui: The Ecosystem Intergration and Exchange on overall Framework Working Paper No.303.
IDS University of Nairobi.

56. Mosteller, F. (1977) Data Analysis and Regression.
Addison Wesley Co.

57. Obara, D.A. (1987) Forces of Changes; "Analysis of Factors shaping food security and Agricultural Development among Resources Poor Farmers in Western Kenya".ICIPE.

58. Odada, J. (1988) The Impact of structual adjustment. Policy in Well being of vulnerable groups in Kenya. A report of proceedings of a workshop held 3rd - 5th November. English Press Ltd.

59. Odingo R.A (1977) Decision making in Food Marketing in Kenya with special Reference to maize and sugar. M.A thesis. University of Nairobi.

60. Ohkowa K. Bruce F.J. Bruce F.J. (1970) ed. Agricultural and Economic Development. Pub. Princeton University Press.

61. Oloya, J.J.(1968) Some aspects of Economic Development Special Reference to East Africa. Kenya Literature Bureau.

62. Omuse J. (1982) Proceding of the workshop on Food Policy Research priorities, 14-17th June. Kenya Council for Science and Technology.

63. Ottichilo W.K., Kinuthia J.H., Ragego P.O. and Nasubo, G. (1991) Weathering the storm. Climate change and investment in Kenya. ACTS Press Stockholm Sweden.

64. Raikes, P. (1988) Modernising Hunger. Heinemann Education Books Inc.

65. Rostow, W.W. (1960) Economic Development. Pub. American Acadamy of Historians.

66. Ralph, J et-al (1982) Farm Management Handbook. Vol.11. Ministry of Agriculture, Kenya.

67. Ramphel, H. (1984) Food Security option for sub-saharan African. IDS Paper No.467.

68. Rukandema, F.M. (1975) Socio-Economic Arithmetic of Poverty. Preliminary data from Bukura and Shitoli sub-location of Kakamega District. IDS Paper No.253.

69. Republic of Kenya — Development Plan (1979-1983)

70. ---------- — Development Plan (1984-1988)

71. ---------- — Development Plan (1987-1978)

72. ---------- — Development Plan (1989-19983) Government Printers.

73. Sa' donoer, A. (1974) — Socio-cultural problems of Agricultural Development in West Sumatra. Regional Institute of Higher Education and Development. Singapore.

74. Shutz, T.W.(1964) — The way a head for Agricultural Development. Pub. Cornell University Press.

75. Senga, W.M et. at (1976) — Agricultural Development in Kenya. Oxford University Press.

76. Shah, M.M. (1980) and Frohberg, G. — Food consumption pattern rural urban Kenya. International Institute for Applied System Analysis.

77. Southworth, W.M (1967) Agricultural Development and Development. Macgraw Hill Series.

78. Thorbecke, E. (1969) Greer, K. The Role of Agriculture in Economic Development.Columbia University Press.

79. ----------(1986) Food Poverty and Consumption patterns in Kenya. ILO

80. Todaro, M.P.(1982) Economic of a Developing World. Longman Inc.

81. Warwick, D.P. (1973) Comparative Research Methods. Prentice Hill Series.

82. World Bank (1980) Kenya Population and Development.

83. ----------(1986) Poverty and Hunger for food Security in LDCs. Washington D.C. USA.

CONFIDENTIAL

PERSONAL QUESTIONNAIRE FOR HOUSEHOLDS IN BOGETARIO II SUB-LOCATION: KISII DISTRICT.

1.0 GENERAL INFORMATION:

1.1 Sample Number .....

1.2 Date of Interview .....

1.3 Sub-location .....

1.2 PERSONAL DATA:

2.1 Name .....

2.2 Age .....

2.3 Sex .....

2.4 Relationship with the head of the household[xx] .....

.....

2.5 Educational Level [y] .....

.....

2.6 Religion .....

.....

2.7 Agricultural Training[s] .....

.....

2.8 Occupation other than Farming .....

2.9 Number in the Household .....

.....

3.0 FARM TECHNOLOGY/INPUTS

ITEM	QUANTITY	VALUE (KSHS)
Draught		
Animals		
Wheelbarrow		
Tractor		
Spade		
Jembes		
Pangas		
Fertilizer		
Grain Store		
Others Specify 1.		
2.		
3.		
4.		
TOTAL VALUE (Kshs)		

4.0 LABOUR USE IN FOOD PRODUCTION

TASK	TYPE OF LABOUR	NO. OF WORKED DAYS
Draught		
Animals		
Wheelbarrow		
Tractor		
Spade		
Jembes		
Pangas		
Fertilizer		
Grain Store		
Others Specify 1.		
2.		
3.		
4.		
Total Value (Kshs)		

5.0 LABOUR USE IN FOOD PRODUCTION

(Members of the household that participate in food production)

NUMBER	MALE	FEMALE	AGE	EDUCATION	MAN-HOURS
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

6.0 FOOD SECURITY LEVELS

6.1 Hectares of land under cultivation

Food production _____

Cash crop production _____

Other farming activities _____

	(HA)	VALUE (KG)
Onion		
Potato		
Poultry		
Beans		
Sorgum		
Millet		
Soya Beans		
Fishing		
Sugar Cane		

6.2 What are the farmers' estimates of annual food yields

CROPS	YIELDS (KG)	VALUE (KSH)
1. Maize		
2. Beans		

6.3 How much do you spend annually on the purchase of,

CROP / YEAR	1988	1989	1990	1991	1992
1. Maize					
2. Beans					

6.4 What in your view accounts for the levels of food in the household. (List according to importance).

1. .....

2. .....

3. .....

4. .....

5. .....

6. .....

7. .....

8. .....

9. .....

10. .....

6.5 How many dairy cows do you have _____

Indigenous _____

Grade _____

7.0 SAVINGS AND INVESTMENTS IN AGRICULTURAL PRODUCTION

7.1 How much do you spend annually on agricultural inputs?

ITEM / YEAR	1988	1989	1990	1991	1992
Fertilizer					
Jembes					
Tickborn disease					
Spraying Equipment					
Labour					
Land rent					
Fencing					
Purchasing of seeds					
Pesticides					
Others (Specify)					
Total Value (Kshs.)					

7.2 What are the sources of household income (Ksh)?

Cash crop _____

Sale of Food crops _____

Salaries _____

Rental houses _____

Grants _____

Loans/Credit _____

7.3 What is your annual budget like (Ksh)?

School fees _____

Agricultural activities _____

Loan repayment _____

7.4 Any assistance given in agricultural activities last year.

PROVISION	VALUE
Animals	
Land	
Fertilizer	
Food Aid	
Training	
Ox-Plough	
Oxen	

7.5 What are your annual savings (Ksh)? _____

7.6 What are the main factors that influence your household savings?

a) .....

b) .....

c) .....

d) .....

e) .....

7.7 Income from cash crop production last year Kshs....

8.0 FAMILY CONFLICTS

8.1 What form of family conflicts have you experienced in the recent past?

Failure to pay school fees _____

Failure of household members _____

To work in the shamba _____

Land lease conflicts _____

Others (Specify) 1} _____

2} _____

3} _____

8.2 Has the inability to work in the farm been caused by lack of food related conflict?

Yes _____

No _____

9.0 MISCELLANEOUS

9.1 Number of animals in the farm

Dairy Cattle _____

Bulls (oxen) _____

Donkeys _____

Goats _____

Sheep _____

9.2 What is your monthly income from the sale of food production in Kshs .....

9.3 To what use do you put the income accruing from the sale of food produce? .....

9.4 How do you supplement your food deficits?

	Purchase	Food Aid
Yes		
No		

9.5 (a) Hectares of land not under cultivation _____

(b) Reasons

(1) .....

(2) .....

(3) .....

(4) .....

(5) .....

9.6 Type of land ownership

Land Tenure _____

Tenancy _____

Title deed _____

Other specify _____

9.7 Assessment of the quality of grain granary

Modern _____

Traditional _____

9.8 Is there any cases of malnutrition observed within the household?

Yes _____

No _____

9.9 What is your great aspiration?

Food production _____

Cash crop production _____

10.0 Who makes the main decisions in agricultural development?

	Level of Education	Age (Years)
Man		
Woman		

10.1 Who makes decisions on the following:

(Indicate with a yes/no answer in the appropriate box)

	Wife	Household	Others
Income / Investment			
Buying of Farm Inputs			

10.2 Has the household experienced any land dispute?

Yes _____

No _____

10.3 If yes in 10.2, how did it affect farm cultivation?

.....

.....

.....

.....

.....

.....

APPENDIX B RAW FIELD DATA

Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
28.0	2.7	7.8	2.9	0.6	0.0	11.0	0.6	16.0	22.0	2.5	0.4	0.0	4.0
6.0	4.0	1.5	0.3	0.1	10.5	2.0	0.7	0.5	38.0	0.2	2.0	0.0	2.0
36.0	0.0	4.0	5.0	2.0	2.4	15.0	9.0	6.5	26.0	0.0	1.0	0.0	0.0
13.0	0.0	2.3	4.0	0.5	7.2	10.0	4.8	15.6	23.0	0.0	2.0	0.0	0.0
10.0	1.8	0.5	0.8	1.2	4.8	5.0	0.4	4.0	21.0	4.0	0.8	3.0	0.0
3.0	2.5	0.6	0.5	0.0	14.8	3.0	4.5	0.0	2.0	0.0	2.0	0.0	0.0
9.0	0.7	4.3	6.7	6.0	11.5	2.0	1.8	41.0	22.0	0.0	0.8	3.0	0.0
2.0	48.0	0.4	0.5	1.5	1.5	3.0	1.2	3.8	21.0	1.5	1.0	4.0	0.0
6.0	0.8	0.4	0.5	2.0	0.6	1.0	75.0	39.0	45.0	3.0	6.0	0.0	2.0
4.0	0.0	6.2	6.0	9.1	6.7	2.0	16.0	12.0	22.0	0.0	0.0	7.0	0.0
12.0	0.0	3.6	2.0	3.0	9.3	4.0	0.2	1.5	34.0	13.0	0.5	0.0	0.0
20.0	5.0	1.2	2.0	3.0	1.5	4.0	6.6	60.0	22.0	0.0	0.8	0.0	3.0
15.0	5.0	4.4	21.2	20.0	10.7	2.0	4.0	50.0	21.0	2.0	0.6	0.0	2.0
4.0	7.7	0.3	1.6	2.0	1.2	3.0	15.5	1.4	25.0	3.8	0.6	0.0	1.0
13.0	4.6	0.2	1.0	0.0	0.2	3.0	2.5	0.0	22.0	0.0	1.0	0.0	0.0
10.0	9.0	4.7	5.0	0.0	24.3	3.0	0.3	4.5	21.0	5.0	0.9	0.0	1.0
30.0	0.0	0.2	0.7	1.8	1.7	5.0	2.4	4.0	53.0	0.5	1.6	0.0	0.0
9.0	0.0	15.8	5.0	10.0	68.0	2.0	3.0	20.0	22.0	0.0	3.0	0.0	1.0
0.8	2.5	0.3	0.6	0.0	0.2	1.0	0.0	0.0	21.0	0.0	0.1	27.0	0.0
90.0	0.0	4.2	3.0	4.0	58.0	5.0	37.6	30.4	28.0	0.6	0.4	0.0	2.0
100.0	0.0	4.3	4.0	5.0	40.0	9.0	41.8	32.4	29.0	0.8	1.0	0.0	2.0
85.0	0.0	2.8	2.0	3.0	60.0	6.0	36.7	30.0	30.0	0.5	2.0	0.0	3.0
80.0	0.0	2.9	4.0	2.0	2.3	8.0	35.6	33.0	26.0	0.2	1.0	0.0	32.0
75.0	0.0	2.6	3.0	3.0	4.2	5.0	31.3	27.7	27.0	0.3	0.4	0.0	3.0
1.0	5.0	0.1	2.0	0.0	0.0	3.0	0.0	0.0	43.0	0.0	6.0	30.0	3.0
8.0	0.9	1.0	4.1	9.2	5.5	7.0	0.5	3.0	24.0	0.0	2.9	0.0	0.0
2.0	5.9	0.9	0.9	3.1	2.5	3.0	0.9	1.2	30.0	0.0	0.5	5.0	0.0
5.5	11.2	0.0	2.3	6.0	4.6	5.0	0.4	2.7	26.0	0.2	0.9	1.0	0.0
3.0	2.3	0.5	1.0	3.5	0.9	2.0	0.0	2.1	21.0	0.4	2.0	4.0	0.0
9.4	0.0	2.2	5.2	10.5	0.9	10.0	0.9	2.5	30.0	0.0	2.1	0.0	0.0
2.0	8.0	1.2	0.5	5.0	1.2	3.0	0.2	4.0	36.0	0.1	4.0	0.0	0.0
1.0	5.0	0.1	0.5	0.0	0.9	2.0	0.0	0.0	38.0	0.2	2.0	6.0	0.0
5.0	2.4	2.3	1.0	2.0	2.6	4.0	1.5	2.5	28.0	0.3	1.0	0.0	0.0
1.0	2.6	0.3	0.8	0.5	0.5	2.0	0.3	1.2	42.0	0.3	3.0	2.0	0.0
3.0	3.6	0.4	0.2	2.0	1.2	3.0	2.0	2.0	37.0	0.4	1.0	1.0	0.0
4.0	0.0	2.8	2.0	1.5	1.1	6.0	0.3	4.0	26.0	0.3	0.8	0.0	0.0
32.0	2.0	0.3	4.0	2.0	2.1	8.0	3.4	7.3	29.0	0.4	0.6	0.0	1.0
11.0	2.6	2.1	3.5	0.8	1.5	7.0	2.1	8.0	31.0	0.0	1.0	0.0	0.0
5.0	0.0	2.5	0.0	3.0	2.7	7.0	3.0	7.0	29.0	21.0	2.0	0.0	0.0
0.5	15.0	0.4	1.5	0.5	0.3	5.0	0.1	1.0	26.0	0.1	1.0	10.0	0.0
3.0	0.0	0.3	6.0	9.0	6.0	6.0	1.9	10.0	34.0	1.2	5.0	0.0	2.0
8.0	0.0	0.6	2.0	3.0	8.0	4.0	2.1	7.0	21.0	0.3	1.0	0.0	0.0
1.0	4.0	0.3	0.9	0.3	0.3	6.0	0.0	0.1	21.0	0.2	0.5	0.0	0.0
5.0	0.0	0.4	3.0	2.0	2.4	4.0	1.0	2.1	19.0	0.1	2.0	0.0	0.0
25.0	10.0	5.0	3.0	5.0	0.4	4.0	2.5	10.0	28.0	0.0	5.0	0.0	0.0

EXPLANATION OF THE VARIABLES

Y= Household Food Security levels (measured by no.of 90 kg bags).

X1= Income spent on the purchase of maize before the next harvest season (ksh'000)

X2= Total Household's income spent on agricultural production the previous year (ksh'000)

X3 = Hectares of land under food production by the Household.

X4= Hactares of land under cash crop production per household.

X5= Total value of inputs/ technology in maize production last season (ksh.'000)

X6 = Total Household labour engaged in agricultural production.

X7= Household's Savings last year (ksh.'000)

X8= Total household income from cash crop production the previous year (ksh.'000).

x9= Average age of the total labour force engaged in agricultural production.

X10= Total amount of income from the sale of food crops the previous month (ksh'000).

X11= Land not under cultivaton.

X12= Number of occassions when members of the household could not work due to food related conflicts.

X13= Number of grade dairy Cows owned by the Household

APPENDIX D STEPWISE REGRESSION ANALYSIS

Variable(s) Entered on Step Number

1.. X7 annual savings

Multiple R	.65239
R Square	.42562
Adjusted R Square	.41604
Standard Error	17.59228

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	13759.71757	13759.71757
Residual	60	18569.29237	309.48821

F = 44.45959 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
X7	1.12162	.16821	.65239	6.668	.0000
(Constant)	7.31387	2.45817		2.975	.0042

Variable	Beta In	Partial	Min Toler	T	Sig T
X1	-.07032	-.09128	.96765	-.704	.4842
X2	.20315	.26659	.98915	2.125	.0378
X3	.13365	.17632	.99970	1.376	.1741
X4	.05420	.07138	.99628	.550	.5846

X5	.35587	.43278	.84949	3.687	.0005
X6	.37400	.49125	.99100	4.332	.0001
X8	.18572	.21675	.78241	1.705	.0934
X9	-.09800	-.12813	.98197	-.992	.3251
X10	-.05484	-.07233	.99921	-.557	.5796
X11	-.23864	-.31341	.99075	-2.535	.0139
X12	-.12973	-.16959	.98157	-1.322	.1913
X13	.27089	.32982	.85143	2.684	.0094

Variable(s) Entered on Step Number

2.. X6 labour

Multiple R	.75115
R Square	.56423
Adjusted R Square	.54946
Standard Error	15.45252

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	18240.95990	9120.47995
Residual	59	14088.05004	238.78051

F = 38.19608 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
X7	1.06062	.14842	.61691	7.146	.0000
X6	3.12614	.72162	.37400	4.332	.0001
(Constant)	-6.02909	3.76145		-1.603	.1143

Variable	Beta In	Partial	Min Toler	T	Sig T
X1	.01256	.01827	.92190	.139	.8898
X2	.13764	.20367	.95419	1.584	.1186
X3	.09004	.13538	.97658	1.041	.3024
X4	.04450	.06726	.98764	.513	.6096
X5	.35957	.50201	.84246	4.421	.0000
X8	.16406	.21952	.77962	1.714	.0919
X9	-.05008	-.07455	.96543	-.569	.5713
X10	-.08515	-.12853	.98467	-.987	.3277
X11	-.19213	-.28710	.97309	-2.283	.0261
X12	-.03471	-.05031	.91570	-.384	.7026
X13	.20565	.28287	.82450	2.246	.0285

Variable(s) Entered on Step Number

3.. X5 farm tech.

Multiple R	.82101
R Square	.67405
Adjusted R Square	.65719
Standard Error	13.47898

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	21791.40609	7263.80203
Residual	58	10537.60385	181.68283

F = 39.98068 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
X7	.82030	.14042	.47713	5.842	.0000
X6	3.15143	.62948	.37702	5.006	.0000
X5	.58523	.13239	.35957	4.421	.0000
(Constant)	-8.57975	3.33140		-2.575	.0126

variable	Beta In	Partial	Min Toler	T	Sig T
X1	.04721	.07901	.83152	.598	.5519
X2	-.10192	-.13970	.54514	-1.065	.2913
X3	.03820	.06557	.82818	.496	.6217
X4	-.04119	-.06970	.79622	-.528	.5999
X8	.11787	.18086	.70892	1.388	.1704
X9	.01719	.02900	.80436	.219	.8274
X10	-.08608	-.15024	.84219	-1.147	.2560
X11	-.15521	-.26636	.82458	-2.086	.0414
X12	-1.498E-03	-.00250	.83836	-.019	.9850
X13	.25435	.40146	.71376	3.309	.0016

Variable(s) Entered on Step Number

4.. X13 grade cows

Multiple R	.85240
R Square	.72658
Adjusted R Square	.70740
Standard Error	12.45290

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	23489.74735	5872.43684
Residual	57	8839.26259	155.07478

F = 37.86842 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
X7	.63800	.14094	.37109	4.527	.0000
X6	2.80317	.59101	.33536	4.743	.0000
X5	.63536	.12324	.39037	5.155	.0000
X13	1.42206	.42971	.25435	3.309	.0016
(Constant)	-7.85799	3.08552		-2.547	.0136

Variable	Beta In	Partial	Min Toler	T	Sig T
X1	.04414	.08065	.70514	.606	.5473
X2	-.14793	-.21901	.52637	-1.680	.0986
X3	8.5714E-03	.01593	.70633	.119	.9055

X4	-.04145	-.07657	.71254	-.575	.5678
X8	.07069	.11628	.64319	.876	.3847
X9	.03761	.06903	.57663	.518	.6066
X10	-.07148	-.13593	.71252	-1.027	.3089
X11	-.14041	-.26253	.69559	-2.036	.0465
X12	-.01317	-.02397	.70883	-.179	.8583

Variable(s) Entered on Step Number

5.. X11 free land

Multiple R	.86338
R Square	.74543
Adjusted R Square	.72270
Standar Error	12.12291

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	5	24098.96728	4819.79346
Residual	56	8230.04266	146.96505

F = 32.79551 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
X7	.68314	.13899	.39735	4.915	.0000
X6	2.65904	.57969	.31811	4.587	.0000
X5	.60498	.12090	.37170	5.004	.0000
X13	1.36585	.41923	.24429	3.258	.0019
X11	-2.15156	1.05675	-.14041	-2.036	.0465
(Constant)	-3.53780	3.67763		-.962	.3402

Variable	Beta In	Partial	Min Toler	T	Sig T
X1	.02831	.05327	.68978	.396	.6939
X2	-.13298	-.20319	.51412	-1.539	.1295
X3	.01032	.01988	.68826	.147	.8833
X4	-.02759	-.05257	.69334	-.390	.6977
X8	.07308	.12456	.62926	.931	.3559
X9	.09070	.16401	.67106	1.233	.2228
X10	-.07836	-.15425	.69393	-1.158	.2520
X12	-5.469E-03	-.01030	.68988	-.076	.9394

Total Cases = 63

Durbin-Watson Test = 2.00541