FACTORS AFFECTING MAIZE PRODUCTION IN MALINDI DIVISION, MALINDI DISTRICT

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BY

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RECCOMENDATION

This Thesis has been submitted with our recommendation as University Supervisors

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DEDICATION

This Thesis is dedicated to the following:

My loving wife Esther and my son Gweth whose understanding and support enabled me to accomplish this work.

My Dear parents, Herenia and the late Norbertus for their instumental role in my upbringing.

My Dear brother Nicholas Ogwel who laid the foundations for my study

My Dear brothers Cyril and Abonyo without whose financial sacrifice, I would have not reached this far.

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To God, the Almighty King and the Father of our Lord Jesus Christ be all the glory and honour for His favour upon me that enabled me to start and accomplish this work.

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May the Lord God Almighty release on all of you his blessings in abundance.

ABSTRACT

Maize is the staple food for the Giriama community living in Malindi Division yet this Division depends on other areas of Kenya for its maize supply. About 25% of its land is considered to be an agricultural land which is adequate for growing enough maize for consumption by the local population which was estimated at 169764 (Central Bureau of Statistics, 1999 census report) and generate some surpluses for sale (or export) to other arid areas of Kenya. Maize production however, appears to have been low averaging 12.5 bags per hectare instead of the expected 37.5 bags per hectare yet the population of Malindi division has continued to grow, a fact of significant concern. This study examined the factors that affect maize production in the Division. A simple random sampling technique was used to select 120 (household heads) farmers that were included in the study. Ex-post facto research design (with survey methodology) was used in this study and data collected using a structured questionnaire. Both descriptive and inferential statistics were used to analyse the data. The study revealed that time of planting, use of ox-plough or tractor, timely weed control and lease type of land ownership contributed to significant higher maize yields. Contact with Extension service, gender of the household head, access to credit, off-farm income, level of education of the household head, use of certified seeds, use of manures and fertilizers and number of weeding operation conducted had no significant effect on maize yields in Malindi Division (α=0.05).

This study recommends that the Government extension staff should advise farmers that they should only grow certified seeds if they will be able to provide all the necessary agronomic conditions required by these type of maize variety. At the same time, the Government and other stakeholders should support interventions that will enable the farmers to access the use of ox plough since, its use was found to have a significant increase in maize yields.

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CHAPTER ONE

INTRODUCTION

1.1 Background information of the study

Maize is the staple food crop for the Giriama community, which is the predominant community in Malindi Division. Even though Maize is the staple food crop in Malindi Division, the Division is not self sufficient in its production. The estimated production trends of maize are shown in Table 1:

Table 1: Estimated Production trends of maize in Malindi Division

Year	Ha. Planted	Yields obtained in bags	Divisional population	Divisional annual requirements in bags
1997	5876	66889	163677	199140
1998	3300	31111	166274	202300
1999	5186	50131	169764	206546

Source: **Malindi District Agricultural annual reports for the years 1997, 1998 and 1999.**

The production of Maize in all the three years reported was far much below the District requirements. This might partially explain why the Division is in a constant state of food insecurity. For example, in April 1998, more than two thirds of the total population had no food in their store and were therefore relying on the market and government relief food programmes for survival (Ministry of Agriculture Livestock Development Annual Report 1998). According to this Ministry report, the Division received 12000 bags of maize from the government as famine relief in 1998.

This study was therefore designed to identify the factors related to maize production that contribute to this frequent food shortage in Malindi Division.

1.2 Statement of the Problem

According to the Ministry of Agriculture, Livestock Development and Marketing (1998), many households in Malindi Division have continued to experience food shortage since 1997. Despite the extension services provided by the Government and the fact that this crop is grown twice a year, the Ministry of Agriculture statistics show that there has always been an annual deficit in the production of this crop. Maize production in Malindi Division was 66,889 bags in 1997, 31,111 bags in 1998 and 50,131 bags in 1999 respectively. This gives an average yield of about 10, 15 and 12.5 bags per hectare respectively for the years 1997, 1998 and 1999. According to the Kenya seed company (1997), the potential on farm yields of PH1, PH4 and Coast composite for the Lower Coast Region (where Malindi Division falls) is 37.5 to 50 bags per hectare.

This therefore indicates that there is a big difference between the actual yields realised by the farmers and the potential production. This points out that there is low maize production among the farmers.

1.3 Purpose of the study

The purpose of the study was to investigate selected agronomic and socio-economic factors that are responsible for the low maize yields achieved by the farmers in the Division.

1.4 Objectives of the Study

The following objectives were used to guide the study.

1. To determine the effects of adoption of the recommended agronomic practices on the production (yields) of maize in Malindi Division
1 To determine the effects of the socio-economic factors on maize production (yields) in the Division.
2 To determine the effects of extension services provided by the government extension staff on the production (yields) of maize in the Division.

1.5 Hypotheses of the study

The following null hypotheses were tested in the study.

Ho_1. The adoption of the recommended agronomic practices has no effect on maize yields in the Division.

Ho_2. The socio-economic factors have no effect on maize yields in the Division.

Ho_3. Extension services provided by the government extension staff have no effects on maize yields in the Division.

1.6 Significance of the study

The information generated from this study was expected to become useful as it was expected to reveal the agronomic and socio-economic factors that are responsible for the low maize production in Malindi Division. Since the problem has been identified (the cause of low maize yields), it is now possible for the extension providers together with the farmers (beneficiaries) to design extension programmes that will help to increase the level of maize production

1.7 Assumptions of the study

The following assumptions were made for the study:

1.7.1 That all the households in all the seven locations of Malindi Division were homogenous.

1.7.2 That the farmers were able to clearly remember the amount of maize they harvested the previous year.

1.7.3 That the farmers were honest in their responses.

1.8 Limitation of the study

The respondents' anticipation of the objectives of the research may have influenced their responses

1.9 Definition of Terms

The following terms were operationally defined for the purpose of this study

1. Anti-stalk borer:

An agrochemical (insecticide) that is used to control maize stalk borer in cereals production

2. Farm mechanisation:

The use of either tractor or ox plough in carrying out some of the field operations like ploughing and weeding

3. Household:

A social unit of closely related family members who work, eat and or sleep together. This can be nuclear family (husband, wife and children) or an extended family.

5. Improved seeds/certified seeds

Seeds of crop varieties that have been developed through a series of research and trials and are recommended for specific areas. They are also produced by reputable organisations.

6. Local seeds

Seeds selected by the farmers from their previous harvest.

7. Time of planting.

The period or time before or after the onset of rains when planting is done.

8. Production

The amount of maize in bags per unit area of land realised by the farmers.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

1.0 Introduction

This chapter reviews the factors that affect the farm productivity of maize. These factors can be divided into three categories; agronomic, socio-economic and the ecological. This study limited itself to the agronomic and socio-economic factors only.

1.1 Agronomic factors

1.1.1 Planting method

It is important that the optimum number of maize plant be grown per given piece of land. Above the optimum number, there will be competition between plants resulting in decrease in yields while below the optimum there will be wasted space and heavy weed population. Kakamega Experimental station (1961) conducted a series of experiments in Nyanza in 1958 to compare the yields of maize under different spacings. The results of these experiments can be summarised as follows:

- High plant populations had lower proportions of plants reaching harvest.
- High plant populations had a high percentage of lodged plants giving a high proportion of spoiled and germinated grains.

According to Ministry of Agriculture Livestock Development and Marketing (1998) the majority of farmers in Malindi District have adopted row planting of maize but they still plant many seeds per hole than is recommended. The recommended spacing for maize in Malindi District is 90 x 30cm one seed per hole or 90cm x 60cm two seeds per hole.

1.1.2 Time of planting

According to Ministry of Agriculture 1976, planting of maize should be done early at the start of the rains. Time of planting has been shown to be the most important factor influencing maize yields in Kenya. Losses in the range of 70-80Kg of shelled grain per hectare have been recorded for each day delay in planting after the onset of the rains. The Ministry of Agriculture and Rural Development recommends dry planting of maize in areas which experience short rains.

Ministry of Agriculture experiments in 1965, on time of planting in Embu of Eastern Province revealed that late planting reduced yields by 2.4, 6.2 and 19.6 bags per hectare by planting one, two and three weeks late respectively. At Katumani where normal rainfall season extends for only 60-70 days, trial results show 5% reduction on yields for every one day delay in planting (Ministry of Agriculture 1976).

In 1961, Kakamega Experimental Station carried out trials in investigating different times of maize planting in Nyanza province. The results from a number of experimental sites can be summarised as follows:

- Planting as soon as possible after the beginning of the long rains is definitely advantageous resulting in a higher yield of grain;
- Late planting results in a progressively higher percentage of discoloured and diseased cobs i.e. results in less edible grain;

- Late planting results in progressively smaller percentage of large cobs; and
- If planting is late then the yields can be maintained to some extent by use of manure and fertilisers. In other words, late planting with fertilisers is infinitely better than late planting without fertilisers and may be equal to early planting without fertilisers. But this only refers to maize planted up to one month after the beginning of the rains.

1.1.3 Pest Control

The ecology of Coast Province especially the lower coast is conducive to the multiplication of insect pests and diseases (Mwakubo, 1993). For this reason, diseases and insect pests constitute a major constraint in maize production.

Some of the major insect pests for maize in Malindi District are stem borers and the army worms (Ministry of Agriculture Livestock Development and Marketing, 1998).

Stem borers are considered as major pests of many gramineae all over the world (Jepson 1954; Metcalf and Flint, 1967; Hill 1975). All important graminaceous crops such as maize, millet, rice and sorghum which are often the subsistence food crop in developing countries may seriously be affected (Scheltes, 1978). In subtropics and the tropics, stem borers are much more abundant. Well known destructive examples are the maize stalk borer, *Busseola fusca* which attacks maize and sorghum and the Coastal stalkborer, `*Chilo orichalcociliella*' which attacks maize, sorghum, millet, and sugarcane (Hill, 1975).

The life cycle and damage of all borers are very similar. Normally eggs are laid on the under surface of young leaves or between leaf sheaths and stems. After hatching, the young larvae feed actively on the tender leaves but as soon as their size increases, they bore into the stems. In young plants, larvae attack the growing point and cause the so-called `dead hearts'.

In older plants, the caterpillars bore into the main stem, which subsequently is hollowed out over a considerable length. The plants affected experience poor growth, reduced yield and are more susceptible to wind damage and secondary infections. Small and weak plants usually suffer more from borer attack than healthy plants. In tropical East Africa where crops are regularly grown under adverse conditions plants suffer more from borer attack (Hill, 1975). In such cases, stem borer damage may be disastrous (Scheltes, 1978).

Mwakubo (1994) found that only 9% of farmers in Kwale District used insecticides in controlling insect pests in maize yet this is a District where heavy infestation of maize stalk borer had been reported.

1.1.4 Weed control

Weeds grow very fast in lower parts of Coast Province due to the hot and humid climate. As a result the Ministry of Agriculture recommends two weedings.

According to Mwakubo (1994), the densities, persistence and fast growth of weeds lead to substantial increase in production cost because weeding is labour demanding. As a result, farmers limit the area under cultivation to manageable levels. The problem of weeds is that they compete for nutrients with crops thereby causing a substantial loss in grain yield if weeding is performed late.

The major problematic weeds in Malindi District as reported by Ministry of Agriculture are sedge weeds (nut grass), the wandering Jew and star grass (Ministry of Agriculture Livestock Development and Marketing, 1998). These are controlled majorly by hand cultivation. There are also some cultural practices of handling the weed problem. For example use of pulses (cowpeas) to suppress nutgrass in maize intercrop. Of the three weeds, the most widespread and problematic one in Malindi is sedge weed.

One of the sedge family, the purple nut sedge has been listed as the worst weed in the world (Holman, Pluckneth, Pancho, and Herberger, 1977.) as it has been reported to be a weed in 52 crops in 92 countries. Farmers in Kenya are aware of and concerned about sedge weeds because their control, especially selective control is difficult and its eradication is almost impossible once the sedge infestation is established

1.1.5 Use of certified Seeds

Mwakubo (1994) established that about 70% of farmers in Kwale District use local seeds and only 18% use improved seeds. There are three types of improved maize seeds that are recommended for lower parts of Coast Province. These are Pwani hybrid 1 and 4, Dryland hybrid 1 and 2 and the Coast Composite. Mwakubo attributes low use of improved seeds to reasons such as high costs of these seeds and the fact that there is usually no significant difference in yields between the improved seeds and local seeds. He found that the differences were not statistically significant even at 80% level of confidence. Muturi (1981) also found that the yields of the composites are not significantly higher than those of local maize and also require heavy input use.

The other reason attributed to the low use of certified seeds is the fact that local seed types are resistant to diseases. For hybrid maize seeds, however, fertilizer application is very critical. Low use of certified seeds may also be attributed to non-availability of the seeds at the right time. Mwakubo (1994) found that the certified maize seeds were not available in the Kenya Grain Growers Union (KGGCU) now known as Kenya Farmers Association (KFA) stores at the time they were required by farmers in Kwale District. Aboyade (1987) argued that farmers purchased few inputs in the early stages of development partly because of their simple production technology and partly because they lack access to input and materials.

1.1.6 Use of fertilizer and manures

High population growth rate has increased the population pressure exerted on land and as a result farmers in many parts of Kenya have responded to this high population pressure by carrying out intensive farming. The soils are therefore generally susceptible to degradation and nutrient exhaustion due to this intensive farming coupled with repeated cultivation. It is therefore apparent that fertilizer or manure application and other soil management practices are necessary for both maintaining and increasing yield.

Mwakubo (1994) found that only 4% of farmers in Kwale District applied fertilisers on their farms. Mwakubo found the reasons for non-application of fertiliser to be lack of finance, lack of knowledge about the appropriate fertilizer and the unavailability of the fertilizer themselves.

The fertilisers recommended by Ministry of Agriculture for use in maize production in Malindi District include Diamonium Phosphate (DAP) at planting and Calcium Ammonium Nitrate (CAN) for top dressing.

2.3 Socio-economic factors

2.3.1 Gender and household Leadership

Quisumbing, Brown, Felstein, Haddad, L. and Pena (1995) argue that women's role in the economy has often been under estimated, and their work in agriculture has long been invisible While policy makers have targeted population, health, and nutrition programmes to women in their reproduction roles, they have neglected women as productive agents. Growing evidence shows that income in the hands of women contributes more to household food security and child nutrition than income controlled by men (Quisumbing et al 1995). While agricultural research continues to develop new varieties with higher yields and

increased tolerance to unfavourable environmental conditions, an untapped source of agricultural growth could lie in reducing the bias against women in agriculture.

The three central ingredients, or pillars of food security are food availability or adequate food production; economic access to available food; and nutritional security, which often depends on the availability of non food resources such as child care, health care, clean water, and sanitation. Women play significant, if not dominant roles in supplying all three ingredients necessary to achieve food security in developing countries. But women play those roles in the face of enormous social, cultural and economic constraints.

It is therefore believed that policies and programs that will alleviate these constraints and level the agricultural playing field will substantially contribute to meeting household food security and world food needs and will sharply reduce the numbers of malnourished and food insecure people in developing countries.

(Quisumbing et al 1995) found out that resources are allocated inefficiently across plots controlled by different members of the household. Plots controlled by women are farmed less intensively than similar plots controlled by men in the same household and simultaneously planted with the same crop. Much less male labour per hectare is devoted to plots controlled by women than to similar plots controlled by men. Virtually all fertilizer is concentrated in plots controlled by men.

The less intensive application of resources on women's plots coupled with the low level of education leads to lower yields from the women controlled plots.

It is estimated that the value of household output could be increased by 10-20 percent by reallocating currently used inputs across plots and if women had the same experience and education as men (Alderman, Hoddino, Haddad and Udrye 1995)

A number of studies conducted during the 1980s suggest that men and women spend income under their control in systematically different ways (Guyer, 1980). Women typically spend a high proportion of their income on food and health care for children, as well as other goods for general household consumption. In contrast men retain discretionary control over a higher proportion of their own incomes for personal expenditure. Evidence from Africa, Asia and Latin America shows that women's income has a greater effect on household food security than men's income. In South Western Kenya for example, for a given household income level, female controlled income share had a positive and significant effect on household caloric consumption while men's income had a negative effect (Kennedy, 1991).

2.3.2 Mechanisation of Land Preparation

Mechanisation in land preparation is frequently hailed in the literature for increased agricultural production. A study by Oluoch-Kosura (1983), which evaluated alternative methods of land preparation on small farms in Western Kenya. He sampled farmers he had interviewed according to the type of farm implements used such as the hoe, hired oxen, own oxen, hired tractor and own tractor; and then ran separate production functions for each group. He found that oxen ploughing provided the most viable method of increasing crop yields, improving timeliness, and income in the region of study. As a result, he recommended that farmers should invest in improved draught equipment and should receive government assistance if they could not afford. Due to high maintenance costs, Oluoch-Kosura recommended that public support for tractor hire service be discouraged.

The underlying issues in Oluoch Kosura's study are to reduce drudgery in farming operations. Farmers who use the hoe can rarely push production beyond subsistence requirements. The use of hand tools for land preparation puts a limit on how much land can

be prepared for planting (Acqua and Mwabaya 1989). Land sizes involved clearly determine the kind of implements most appropriate.

Donovan (1987), however, warns that the move from hoe to oxen plough is not merely a substitution of one input for another, but rather a change in the entire farming system. Oxen ploughing imply that the farmer requires specialised animal husbandry practices. Mwakubo (1994), argues that for areas infested with tsetsefly the viability of oxen ploughing is doubtful and that in areas which are densely populated and grazing fields are a problem, the maintenance cost of the oxen may be a hindering factor to the viability of the oxen. In such situations there may even be need to encourage public support for tractor hiring service contrary to Oluoch Kosura's recommendations in 1983.

2.3.3 Source of household labour

Ndiaye and Sofranko (1988) emphasise that existing social and cultural facets within a household are important determinants of labour availability and thus technology adoption. They also argue that ascribed roles and expectations within a family unit tend to constrain labour mobility and the development of a labour pool.

Undry (1994) identified two sources of resource missallocation within households. These are individuals greater incentive to achieve higher output on their own plots than on others and imperfection in the intrahousehold labour allocation process.

The second source of resource miss-allocation; imperfection in the intra-household labour allocation process, is consistent with the argument previously made in the anthropological and feminist economics literature that gender differences lead to allocative inefficiencies within the household. Waainjenberg (1993) found that of all men of 15 years and over in Kilifi District, only about 47% work full-time or nearly full-time on

the farm. Waainjenberg found that off-farm work gives a more regular and reliable income than most farm activities, and this is more personal than the income obtained from working in a father's field or tending his tree crops. However only a small portion of the salary is brought home, the rest being spent on travel, housing, drinking and women in nearby urban centres. He reports that during the interviews, men often said they were looking for work; given the opportunity the number of men working on the farm would reduce. For the women, the situation was found to be completely different; about 92% work on the farm, 5% attend school and only 2% work off farm. The dependence of farm work on women is further demonstrated by the fact that the area planted with maize was positively correlated with the number of women on the farm. According to Waainjenberg, the absence of girls from schools and women from off farm work is very conspicuous.

2.3.4 Contact with the Extension Service

In traditional agriculture, farming skills and knowledge were passed from one generation to the next through on the job training, that is from the old to the young and from parents to children (Mwakubo, 1994). This transfer pattern however is inappropriate for agriculture undergoing transformation, hence the need for a modern extension service.

In a study carried out by Ascroft and Kariuki (1973) in Tetu Division of Nyeri District, information on spacing in maize production was distorted in 25 percent of the cases of second hand information. This implies that those who depend on the 'trickle' down of information are less likely to benefit fully from new technology if some information about it is lost.

Extension programme is basically designed to provide the farmers with the full knowledge about an innovation so as to enhance the adoption of the innovation by the farmers. The

adoption process is a mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject and to confirmation of this decision (Rogers and Shoemaker, 1971).

According to Rogers and Shoemaker (1971), a committee of Rural Sociologists postulated the traditional view of the adoption process in 1955 as consisting of five stages:

1. **Awareness stage:** The individual learns of the existence of the new idea but lacks the information about it.
2. **Interest stage:** The individual develops an interest in the innovation and seeks additional information about it.
3. **Evaluation stage:** The individual makes a mental application of the new idea to his present and anticipated future situation and decides whether or not to try it.
4. **Trial stage:** The individual actually applies the new idea on a small scale in order to determine its utility in his own situation.
5. **Adoption stage:** The individual uses the new idea continuously on a full scale.

According to this model of Rogers and Shoemaker (1971), extension is very vital at the first, second and the fourth stage. In the first stage, the extension (change) agent makes the farmers aware about the existence of a new technology (innovation). In the second stage, the extension agent provides the full details (advantages and disadvantages) of the innovation and this enhances the farmers' adoption of the innovation. In the fourth stage, the extension agent conducts on farm demonstrations on the farmers' fields to enable the farmer determine the utility of the innovation in his own situation.

It therefore implies that extension service speeds up the adoption of the innovations by the farmers hence the absence of the extension programme will slow down the rate of adoption.

Amudavi (1993) found that maize growing farmers in Vihiga Division who were in contact with the extension service had a high level of adoption of the recommended agronomic practices. Similarly, Mwakubo (1994) found that maize growing farmers in Kwale District who were in contact with the extension service achieved higher yields than those farmers who were not in contact with the extension service. The higher yields may be attributed to high level of adoption of the agronomic practices influenced by the extension agents. Mwakubo's results are consistent with the work of Bindlish, Vishra and Evenson (1993). Bindlish, Vishra and Evenson (1993), conducted an evaluation of the effects of the training and visit (T & V) extension system in Kenya. The study found that extension, measured by the ratio of field extension workers to farm households, had a positive effect on output and total factor productivity in both female managed and male managed farms. Garforth (1982) considers extension as the transmission of technical advice to farmers to assist them to improve their productivity and incomes. Dexter (1986), however argues that to perform this function of facilitating technology transfer, extension agents have to ensure that an adequate amount of high quality knowledge about the technology is present in the farming community. Bhandari (1972), argued that low numbers, poor education and insufficiently trained extension workers are the major problems that hinder farmers from adopting technologies disseminated through extension.

Extension service in Malindi Division is provided by both public and private sector.

Depending on the particular economic and political situation, the private sector may consist of individual farmers, agricultural input firms, agro-service marketing firms, processing industries, and multinational firms and or their subsidiaries. It may also include a wide range of agricultural production and marketing co-operatives, farmer associations, and private and

voluntary organisations (Rivera and Schram 1957)

The main private extension providers in Malindi Division are the agrovet stockists within the town, Heifer International, (an NGO promoting dairy farming in Coast province) and ActionAid, (an NGO which promotes the use of ox plough in LangoBaya location of Malindi Division).

Until July 1999, public extension in Malindi Division had been under the National Extension Program (NEP). The NEP was designed in line with the Training and Visit (T&V). Under the T&V, the Divisional Extension Co-ordinator (DEC) supervises the frontline extension staffs that are in charge of the extension units or sub-locations. Farm families within the extension units are organised into small groups of 10-20 farm families referred to as contact groups. Frontline extension staff visits these contact groups on specified dates and sites agreed upon by the group members and the extension staff. The DEC has a team of subject matter specialists in his office. The DEC reports to the District Agriculture and Livestock Extension Officer (DALEO). The subject matter specialists in the DALEO'S office in collaboration with research officers from Kenya Agricultural Research Institute (KARI) conduct monthly trainings to the Divisional subject mater specialists and the frontline extension staff. The frontline extension staffs then visit the contact groups to pass over the message gained during the training. During the visit, the extension staff seeks to find out any problem that the farmers are experiencing that pertains to the recommended agricultural technologies or any other problem being experienced by the farmers. The farmers' problems noted by the front line extension staff are presented to the District SMS who in collaboration with KARI seeks solutions to these problems through research. The research findings on these problems (solutions) are presented to the front line extension staff

through a training organised for them. The front line extension staff in turn organise on farm trainings/demonstrations to the farmers on these research findings (solutions/recommendations).

Currently, the extension program in place is the National Agriculture and Livestock Extension Program (NALEP). The organisation of NALEP is still uncertain, as this is the time that the program is being introduced.

2.3.5 Access to credit

Credit availability is factor that affects farm output. Ongaro's study (1990) in Western Kenya found that farmers who receive credit had higher farm output compared to those who did not. Thiensenhusen (1978) attributes this increased farm output with credit to the fact that credit enables the farmer to buy the essential farm inputs for production. Hayami and Rutan (1970), also argue that credit to farmers promoted the purchase of improved seeds, pesticides, fertilisers and implements. They also contend that credit could provide little leverage in the absence of profiTable investment opportunities

Acquah and Mwabaya (1989) in a study in Msambweni Division of Kwale District observed that low use of credit was mainly due to fear of being unable to repay and hence the possible sale of their farms used as collateral to recover the loans.

2.3.6 Off farm income

Credit is not the only source of income to agriculture. An important source may be off-farm employment or trade incomes Mwakubo, (1994). Swinton (1983), examined the interaction between peasant farming practices and off-farm work in Mexico. Using a higher programming model, Swinton (1983), found that the availability of off farm jobs was crucial in determining the technology used and the mix of enterprises for the medium sized farms.

2.3.7 Level of Education

Bembridge (1987) reported that education level of the farmer increased the farmer's knowledge about crops and this knowledge increased the adoption of the recommended crop production technologies. The adoption of these recommended technologies is generally attributed to increased (higher) crop yields. Chitere (1985) also attributed the higher yields of maize achieved by the educated farmers to the high adoption level of the recommended agronomic technologies like timely planting, use of certified seeds and timely weed control.

Molnar (1985) on the other hand attributed the higher yields achieved by the educated farmers to the increased managerial, diagnostic and comprehension ability of the educated farmers to respond to financial and production problems.

2.3.8 Conceptual Frame Work

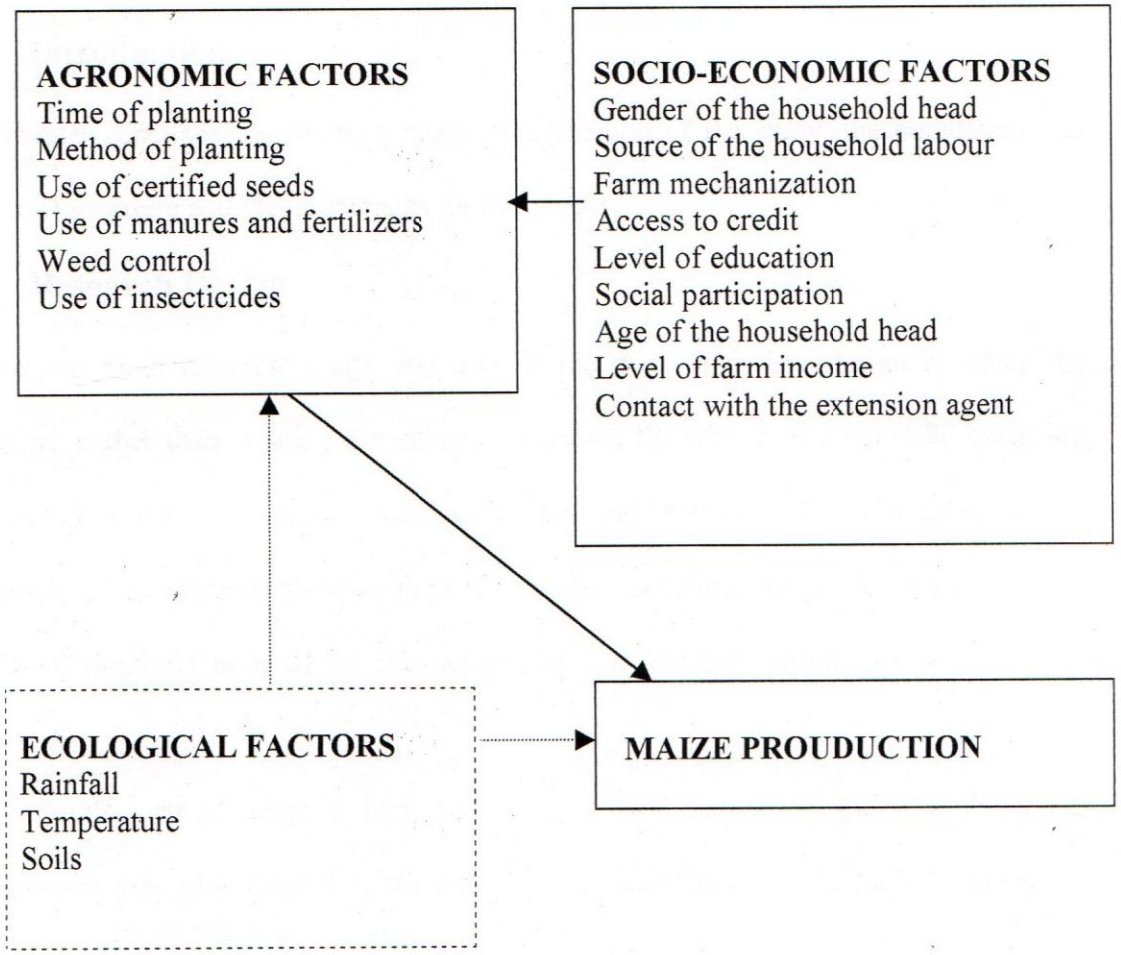
The conceptual frame work described here is based on the adoption model. According to this model, the adoption of recommended agricultural technologies by the farmer is influenced by the socio-economic factors of the farmer or household head. The adoption of these technologies lead to increased farm output (yields).

In this study, the recommended agricultural technologies were taken to be the recommended agronomic factors in maize production. These agronomic factors include: timely planting, timely weed control, use of certified seeds, row planting and use of manure and fertilizers The adoption of these agronomic factors is however influenced by the socio-economic factors of the household. The socio-economic factors considered in this study are; Extension contact, access to credit, access to off-farm income, education level, sex of the household head and Land tenure system. The adoption of these recommended agronomic factors increases the maize yields achieved by the farmers. Even though the adoption of the agronomic factors increases maize production, this increased production is not automatic; it is dependent upon the prevailing ecological factors (soils, rainfall and temperature), which must be favourable for this increased maize production to be realised.

The variables for this study can be grouped into three:

- the independent variables that include the agronomic and the socio-economic factors
- the dependent variable that is the maize output per hectare
- the intervening variable which includes the prevailing ecological conditions.

Figure 1: Conceptual Frame Work



CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter describes the research design, the location of the study, the population, the sampling procedure and the instruments for this study.

3.1 Research Design

The ex post facto research design was used in the study. This is a design in which the researcher, rather than creating a treatment, examines the effects of a naturally occurring treatment after that treatment has occurred (Krejcie and Morgan, 1970).The design allows the researcher to examine the effects of a naturally occurring independent variables (the agronomic practices adopted by the households and the socio-economic status of the household).

The research method adopted here was a household survey in which a structured questionnaire was administered to the sampled household heads in the three Locations of Malindi Division.

3.2 Location of the study

The location of the study was Malindi Division in Malindi District, Coast Province of Kenya. The Division has eight Locations namely; Goshi, Ganda, Malindi, Watamu, Gede, Jilore, Langobaya and Chakama. Out of these eight Locations, the study was conducted in three Locations; Goshi, Langobaya and Jilore.

3.3. Population

All the heads of households, which grow maize in Malindi Division, were targeted. The total number of households in this Division as per 1999 census was 26,082. The proportion of households that grow maize in Malindi Division was estimated at 92%. This implies that 92% of the households in Malindi Division were targeted for this study.

3.4 Sample and sampling procedure.

Three locations (Goshi, Jilore and Langobaya) out of the eight in Malindi Division were purposively selected and included in the study. This is because they are the ones in which maize is mainly grown within the Division due to their conducive ecological conditions for maize growing relative to the other Locations. The other five Locations are active in Tree crop (Mangoes, Cashewnuts, Coconut and Citrus) growing although they also grow some maize.

The total number of households in the three selected Locations was 8865 with 3200 for Goshi, 2080 for Langobaya and 3585 for Jilore. By using Krejcie and Morgan's (1970) formula, the minimum sample size should be 112 households. This study therefore adopted a sample size of 120 households. The Krejcie and Morgan's formula is shown below:

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$ in which

S = required sample size

N = population size

P = population proportion which is estimated as 0.92

d = Degree of accuracy as reflected by the amount of error that can be tolerated in the fluctuation of p. The value of d taken as 0.05

X^2 = Table value of chi-square for one degree of freedom relative to the α value (0.05) which is equal to 3.841.

The 120 sample size was proportionately distributed among the three locations as follows:

Goshi ----------43

Langobaya ------28

Jilore ----------49

A comprehensive list of households in the selected three locations was constructed using data from Malindi District Agricultural office and Central Bureau of Statistics. A Table of random numbers was then used to select the stipulated number of households from each location. Since the Agriculture Extension Staff are only 9, in the selected three locations, no sampling was done. All of them were included in the study.

3.5 Instrumentation

An interview schedule used for collecting information from the selected households. The questionnaire items were developed on the basis of the scope of the study, theoretical concepts, experience of the study adviser and the related literature. The questions addressed the main variables of concern which were:

3.5.1 Independent variables

a) Agronomic factors

- Time of planting with respect to the onset of rainfall
- Application of insecticides against stalk borer.
- Type of seed (certified or local seeds).
- Method of planting (row or broadcasting)
- Weed control

- Use of manure/ fertilizer

b) Socio-economic factors

- Type of farm tool (use of ox plough/ tractor in land preparation).
- Sex of the household head.
- Contact with extension service.
- Level of Education.
- Access to credit.
- Access to off-farm income.

3.5.2 Dependent variables

Maize production (yields) per hectare

3.5.3 Validity and reliability of the instrument

Content validity was ensured by developing the items (questions) that are related to the objectives of the study. A presentation was made before the members of the academic staff and students from the Department of Agricultural Education and Extension.

Cronbach's alpha coefficient was used to estimate the reliability of the questionnaire. Bryman and Gramer (1997) indicated that the level of acceptance of an instrument for social research is set at 0.7 coefficient alpha. The alpha coefficient of the questionnaires as calculated from the 120 questionnaires was 0.6537. This is approximately 0.7 to one decimal place.

3.6 Data Collection Procedures

The researcher interviewed the selected households following an established schedule. Each question was read to the respondent and the interviewer recorded the responses on the questionnaire. Follow-ups were done in cases where respondents were not available in order to minimise non-responses. Confidentiality of the information collected was assured to each respondent.

3.7 Data Analysis

The data collected was coded and analysed using Statistical Package for Social Scientists (SPSS). The purpose of coding is to classify responses into meaningful categories, so as to bring out their essential pattern (Moser and Kalton 1972).

Both descriptive and inferential statistics were used to analyse the data. The descriptive statistics used were; frequency distributions and percentages while the inferential statistics used were t-test, Analysis of Variance (ANOVA), Duncan's Multiple Range Test (DMRT) and Chi-square test.

The tests were used as follows; t-test for testing the inequality of means between two variables, t-test for testing of the inequality of means between more than two variables, DMRT for mean separation in cases where there was significant difference between more than two means while Chi-square test was used in testing the association between the variables.

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Table 2. Summary of statistical tests

HYPOTHESIS	INDEPENDENT VARIABLES	DEPENDENT VARIABLES	STATISTICAL TEST
There is no difference in maize yields between farmers who have adopted recommended agronomic practices and those who have not.	➢ Time of planting ➢ Use of manure / fertilisers ➢ Method of planting ➢ Time of weed control ➢ Plant population ➢ Type of seed ➢ Stalk borer control	Maize output per Hectare of land	➢ t-test ➢ Duncan's Multiple Range Test (DMRT) ➢ Chi-square test
Socio-economic factors have no effect on the yields of Maize achieved by the households in Malindi Division	➢ Sex of the household head ➢ The level of education of the household head ➢ Credit facilities ➢ Type of farm tool ➢ Off farm income ➢ Extension service	Maize output per Hectare of land	➢ t-test ➢ t-test ➢ Chi-square test

CHAPTER FOUR

RESULTS AND DISSCUSSION

4.0 Introduction

The purpose of this study was to examine the factors that affect maize production in Malindi Division. A simple random sampling technique was used to select 120 household heads (farmers) who were included in the study. Ex post facto research design was used and data collected using a structured questionnaire. Both Inferential (t-test, Chi-square test and Duncan's Multiple Range Test) and descriptive (Frequency distributions) statistics were used to analyse the data. The inferential statistics were used at (α=0.05)

4.1. Effects of adoption of the agronomic factors on maize production

The agronomic factors that were considered in this study are: time of planting, method of planting, use of certified seeds, use of anti-stalk borer insecticide, weed control and use of manure and fertilizers.

4.1.1 Time of planting

Time of planting here is based on rainfall and it refers to the number of days before or after the onset of rainfall when the farmer carried out the planting of maize. The objective here was to find out the effects these different times of planting have on the yields of maize achieved by the farmers. Early planting is taken to be any planting done a few days before or one to seven days after the onset of rainfall. Planting done seven days after the onset of rainfall is considered late since the plants will not benefit from the Nitrogen flush that is available in the soil within the first two weeks after the onset of rainfall. The average maize yields for these two groups of farmers are shown in Table 3

Table 3 indicates that about 60% of the farmers in Malindi Division have adopted the recommended early planting of maize. 40% of the farmers still plant late.

The farmers who planted early obtained an average maize yield of 16.3 bags per hectare while those who planted late obtained an average yield of 12.8 bags per hectare.

The difference in maize production between the early planting and late planting was tested by t-test. The t-test analysis revealed significant difference between these two yields (16.3 and 12.8 bags per hectare), ($T_{(1,113)} = 2.5483$, $p=0.01$). This implies that even at 99% confidence level, the early planting will still result to higher maize yield than late planting.

These results are in line with the findings of the investigations carried out by Ministry of Agriculture in Embu District and Nyanza Province in 1976 and 1961 respectively.

The Embu trials (Ministry of Agriculture 1976) revealed that late planting reduced yields by 2.4, 6.2 and 19.6 bags per hectare by planting one, two and three weeks late respectively.

Table 3: Difference in Maize yields under different planting times

Response	Frequency	Percent	Aver yields of maize bags/hectare
Early planting	68	59.13	16.3
Late planting	47	40.97	12.8
Total	115	100	-

$T_{(1, 113)} = 2.5483$, $p=0.01$

When time of planting was looked at across locations, Ganda recorded 100% timely planting, Langobaya 73.5% while Jilore 5% timely planting.

The timely planting practiced by the households in Ganda location resulted into higher maize yields in Ganda than Jilore and Langobaya locations. The average maize yields for

Ganda, Jilore and Langobaya Locations were 22.1, 14.5 and 6.6 bags per hectare respectively. The three average maize yields were significantly different, $F_{(2, 112)} = 134.1967$, $p=0.00$

4.1.2 Use of certified seeds

Certified seeds are in this case taken to be the hybrids (PH1/PH4) and Coast Composite purchased from stockists who are believed to have obtained their supplies from acknowledged/recognized sources. For the case of Coast Composite, the farmer could as well choose from his previous harvest as recycling is allowed but not for the hybrids, the PH1 and PH4 in which the recommendations are that they should not be recycled. Local seeds are taken to be the seeds that the farmer chose from his previous harvest or has purchased from the neighbours or open market and are not the composites.

Table 4: Difference in maize yields for different types of seeds.

Type of seed	Frequency	Percent	Average yields in bags/hectare
Certified	30	26.09	12.8
Local	85	63.91	15.5
Total	115	100	

$T_{(1, 113)} = 1.7107$, $p=0.09$

As shown in Table 4, only 26% of the farmers interviewed in Malindi Division have adopted planting of the recommended certified seeds. The majority, 64% plant local seeds.

The farmers who planted certified seeds obtained an average maize yield of 12.8 bags per hectare while those who planted local seeds obtained an average yield of 15.5 bags per

hectare.

The difference in maize production between the certified seeds and the local seeds was tested by t-test. The t-test analysis revealed no significant difference between these two yields (5.2 and 6.2 bags per hectare), ($T_{(1,113)} = 1.7107$, $p=0.09$). This implies that at 95% confidence level, the set alpha level, there is no significant difference between the performance of certified and local seeds.

This lead to the acceptance of the hypothesis that the adoption of recommended agronomic practices (planting of certified seeds) has no effect on maize production in Malindi Division.

The results of this study are similar to those of Mwakubo (1994) who also found certified seeds not to be doing better than the local seeds in Kwale District in the same Coast Province of Kenya. He found that even at 80% level of confidence there was no significant difference between the farmers who use certified seeds and those who use the local seeds.

A chi-square test revealed no significant association between use of certified seeds and early planting, early weed control and use of tractor/ox-plough. certified seeds being hybrids require certain optimal conditions that are provided by timely weeding, early planting, and proper land preparation. The absence of association of use of Certified seeds and these factors may explain why the certified seeds did not outperform the local seeds in terms of yield.

During the interview, the farmers gave different reasons for not using the certified seeds and instead prefer to use the local seeds. These reasons are tabulated in Table 5

Table 5: Reasons for type of seeds planted

Reason given	Frequency	Percent frequency
Local performs better	2	2.5
Local does not require fertilizer	1	1.2
Local matures early	8	9.9
Lack of money to buy improved	67	82.7
The unavailability of the improved at the right time	3	3.7
TOTAL	81	100

Even though certified seeds do not perform better than the local seeds when all the optimal conditions are not provided, only 1% of farmers have recognized this fact. The majorities of farmers still prefer the certified seeds but are constrained by the cost.

Interlocation comparison showed no significant difference between the locations with respect to the use of certified seeds ($X^2_{(df=2),} = 2.7758$, $P = 0.2496$)

4.1.3 Use of anti-stalk borer insecticides

Use of insecticides refers to the application of the antistalk borer granules on the funnel of a growing Maize plant in order to control Maize stalk borer. This is a dangerous pest that enters into the young maize plant through the funnel destroying the young leaves of maize and eventually boring into the stem of a relatively old plant causing a severe damage. The objective was to find out the level of use of this anti-stalk borer insecticide and the effects of using this insecticide on the yields of maize achieved by the farmers. The survey revealed that only 7% of the farmers interviewed had adopted the use of insecticides in controlling Maize stalk borer. 93% of the farmers had not adopted this

practice. These results are in agreement with Mwakubo (1994) who while investigating the factors affecting food production in Kwale District in the same Coast Province of Kenya found that only 9% of farmers in Kwale District use insecticides in controlling insect pest in maize yet that is a District where heavy infestation of maize stalk-borer has been reported. In the same way, this study has revealed that only 7% of the farming community in Malindi Division use insecticides in controlling maize stalk borer yet the Ministry of Agriculture reports (Ministry of Agriculture Livestock Development and Marketing, 1998) indicate that maize stalk-borer is a major insect pest in Malindi Division.

Table 6: Difference in maize yields with control of maize stalk borer

Response	Frequency	Percent	Average yields of maize in bags/hectare
Yes	8	7.0	8.5
No	107	93	15.3
TOTAL	115	100	-

$T_{(1, 113)} = 2.3650$, $p=0.02$

The farmers who used insecticides obtained an average maize yield of 8.5 bags per hectare while those who did not use the insecticides obtained an average yield of 15.3 bags per hectare. The difference in maize production between the use of insecticides and non-use of insecticides was tested by t-test. The t-test analysis revealed a significant difference between these two yields (8.5 and 15.3 bags per hectare), ($T_{(1,113)} = 2.3650$, $p=0.02$). This implies that even at 98% confidence level, non-use of insecticides gives better yields than the use of insecticides.

This lead to the acceptance of the null hypothesis that the adoption of recommended agronomic practices (use of insecticides to control stalk borer) has no effect on Maize production in Malindi Division.

These results are in conflict with other research findings; Hill (1975) and Scheltes (1978) who found out that in East Africa, where crops are regularly grown under adverse conditions, there is high crop loss due to borer attack. Further analysis revealed that all the eight farmers who used pesticides against the stem borer were from Lango Baya Location. Ministry of Agriculture 1999 Annual report for Malindi District indicate that Langobaya recorded low Maize yields in 1999 due to an outbreak of armyworms in the area. Though this was not followed up, the eight farmers who reported the use of pesticides might have suffered from the armyworm outbreak. This might have been the cause of the low maize yields realized by these farmers.

The chi-square tests between the use of the insecticides and time of weeding as well as the type of farm tool used revealed that majority (6 out of 8) of the farmers who reported the use of pesticides carried out late weeding and all of them used traditional hoe in land preparation. The late weeding and the use of traditional hoe might have also contributed to the low yields reported by these farmers who used the pesticides.

It also important to note that the number of the farmers who used pesticides was too small (8) in relation to the number of farmers who did not use the pesticides (107). This low number might make the inferential results to be unreliable. This means that with more farmers using the pesticides, it is possible their performance could either be higher than or equal to those who did not use the pesticides.

Chi-square tests between the use of insecticides and other independent variables were carried out and the results are shown in Tables 7 and 8.

Table 7 Associations between use of pesticides and Type of farm tool

Use of Pesticide	Type of farm tool		Total
	Traditional hoe	Tractor/Ox-plough	
Did not use pesticides	71	36	107
Used pesticides	8	0	8
Total	79	36	115

$X^2_{(df=1),} = 3.91, P = 0.044$

Table 8 Associations between use of pesticides and Time of weeding.

Use of Pesticide	Time of weeding		Total
	Timely	Late	
Did not use pesticides	22	85	107
Used pesticides	2	6	8
Total	24	91	115

$X^2_{(df=1),} = 0.089, P = 0.528$

Table 7 indicates that there is a significant association between the use of pesticides and the type of farm tool used by the farmer. The association is such that farmers who use pesticides are likely to use traditional hoe. Even though Table 8 shows no significant association between the use of pesticides and time of weeding, the majority of the farmers who used pesticides carried out late weeding.

During the interview, the farmers gave different reasons why they did not use the insecticides to control maize stalk-borer. These reasons are tabulated in Table 9

Table 9: Farmers' reasons for not using insecticides

Response	Frequency	Percent frequency
There are no serious insect pest problems.	43	40.2
Insect pest problem noticed but did not know how to control.	3	2.8
Insect pest problem noticed but lacked the money to buy the insecticide.	57	53.3
Other reasons.	5	4.7
TOTAL	107	100

Results from table 9, reveal that 40% of the farmers did not believe that there is a serious insect problem in Malindi Division. This is quite questionable since Ministry of Agriculture reports (Ministry of Agriculture Livestock Development and Marketing, 1988) indicate that maize stalk-borer is a major insect pest in Malindi Division. It might be that some of these farmers do not know the symptoms of the stalk borer attack since these are hidden insects, which cannot easily be seen. Half (53%) of the farmers acknowledged the stalk borer problem but did not have funds to purchase the insecticide.

4.1.4 Method of planting.

The method of planting refers to either planting in rows or broadcasting. The objective was to find out the level of adoption of row planting by the farmers and the effects of row planting on the yields of maize achieved by these farmers. Table 10 shows the average maize yields for row planted and broadcasted maize.

Table 10: Difference in Maize yields for different methods of planting.

Response	Frequency	Percent	Average yield of maize bags/hectare
Row planting	82	71.3	15.8
Broad casting	33	28.7	12.5
TOTAL	115	100	-

$T_{(1,113)} = 2.21$, $p=0.03$

The results show that the majority (71.3%) of the farmers in Malindi Division have adopted the recommended row planting and only 28.7% of the farmers still practice broadcasting. Row planting is preferred by the farmers since it makes it easy for them to practice inter-cropping especially with legumes such as cowpeas and green grams.

The difference in maize production between row planting and broadcasting was tested by t-test. The t-test analysis revealed significant difference between these two yields (15.8 and 12.5 bags per hectare), ($T_{(1,113)} = 2.21$, $p=0.03$). This implies that even at 97% confidence level, the row planting will still result to higher maize yield than broadcasting. This leads to the rejection of the null hypothesis that the adoption of recommended agronomic practices (row planting) has no effect on maize production in Malindi Division.

90.2% of all the households interviewed from Ganda Location planted in row, this was 57.5% for all the households from Jilore and 64.7% of the households from Langobaya Locations.

Chi-square tests between method of planting and other independent variables were carried out and the results are shown in Tables 11 to 14.

Table 11: Association between method of planting and time of planting

Planting Method	Time of planting		Total
	Timely planting	Late planting	
Broadcasting	13	20	33
Row planting	55	27	82
Total	68	47	115

$X^2_{(df=1),} = 7.460$, $P = 0.006$

Table 11 shows that 60% (n=20/33) of the farmers who broadcasted, planted late while on the other hand 67% (n=55/82) of the farmers who planted in row planted on time. The above association was found to be significant p-value of 0.006 at an α level of 0.05. This means that farmers who plant in rows also prefer planting on time. This timely planting might be one of the contributing factors to the high yields achieved by the farmers who planted in rows.

Table 12: Association between method of planting and time of weeding

Planting Method	Time of weeding		Total
	Timely weeding	Late weeding	
Broadcasting	2	31	33
Row planting	22	60	82
Total	24	91	115

$X^2_{(df=1),} = 6.146$, $P = 0.009$

Table 12 shows that only 6% (n=2/33) of the farmers who broadcasted carried out timely weeding. Similarly 27% (n=22/82) of the farmers who planted in row weeded on time. The above association was found to be significant at p-value of 0.009 at an α level of 0.05. This means that farmers who plant in rows seem to carry out weeding on time while

those who broadcast seem to carry out late weeding. This timely weeding might be one of the contributing factors to the high yields achieved by the farmers who planted in row.

4.1.5 Mannure and fertilizers

The survey revealed low level of manure use in Malindi Division with only 0.9% of the farmers interviewed indicating to have used manure. The average maize yields for these groups of farmers are shown in Table 13 below

Table 13: Difference in maize yields with use of mannure

Response	Frequency	Percent	Average yield of maize bags/hectare
Manure use	1	0.9	15.5
No manure use	113	99.1	14.8
TOTAL	115	100	-

The one farmer who used manure obtained an average maize yield of 15.5 bags per hectare while those who did not use manure obtained an average yield of 14.8 bags per hectare. The difference in maize production between the use of manure and non-use of manure was not tested since there was only one farmer who used manure.

Similarly, low level of fertilizer use was reported among the farmers interviewed with only 1.7% of the farmers reporting to have used fertilizer. The average maize yields for these two groups of farmers are shown in Table 14.

Table 14: Difference in maize yields with use of fertilizer.

Response	Frequency	Percent	Average yield of maize bags/hectare
Fertilizer use	2	1.7	15.3
No fertilizer use	113	98.3	14.8
TOTAL	115	100	-

The farmers who used fertilizer obtained an average maize yield of 15.3 bags per hectare while those who did not use fertilizer obtained an average yield of 14.8 bags per hectare. The difference in maize production between the use of Fertilizers and non-use of fertilizers was not tested because of the number of farmers who used fertilizer.

The results of this study show that very few farmers, 0.9% and 1.7% used manure and fertilizers respectively. These results are in agreement with those of Mwakubo (1994) who found that in the neighboring Kwale District only 4% of farmers use manures and fertilizers.

Previous studies in the same area by the Ministry of Agriculture (1994) under the FEP (Fertilizer Extension Project) showed that when other factors are held constant, the use of the right fertilizers at the right rates increased the yields by 40%.

This (FEP) study recommended the use of DAP or SSP or DSP fertilizers at planting and CAN fertilizer at top dressing when the plants are at knee height.

During the interview, the farmers gave different reasons why they don't use manure and fertilizers. These are tabulated in Table 15 and 16

Table 15: Farmers' reasons for not using fertilizer

Response	Frequency	Percent frequency
Does not make any difference	41	36.6
Lack of money to buy fertilizer	63	56.3
Fear of negative effects on the soil	0	0
Not available with the local stockists	5	4.5
Lack of technical knowledge on the use	3	2.7
TOTAL	112	100

The results indicate that 37% of the farmers did not use the fertilizers because of their belief that fertilizers will not give better yields, while 56% of them did not do so because of lack of money to buy the fertilizer even though they acknowledged that fertilizer is necessary.

Table 16: Farmers' reasons for not using mannure

Response	Frequency	Percent frequency
Does not know how to prepare	13	12.7
Require a lot of labor in using	30	28.8
Does not make any difference in yields.	61	58.5
TOTAL	114	100

Table 16 shows that there is low manure use in Malindi Division because of the farmers belief that there will be no improvement in the yields. This is a true reflection of the local belief by the majority of the farmers in the Division that their soils are fertile and do not require the use of manure or fertilizer. 28.8% of the farmers did not use manure because of the intensity of labour that is required. With women providing the bulk of household

farm labour, it might be indeed a hindrance to the use of manure, which is bulky, and require labour in transporting to the farm and in the actual application.

4.1.6 Time of Weeding

Time of weed control refers to the stage of plant growth when the first weeding operation is completed. It is referred to as timely if it is completed before the plants reach knee height and late if the plants are either at or past knee height. The objective was to find out the level of adoption of timely weed control by the farmers in Malindi Division and the effects of the weeding time on the yields of maize. The average maize yields for different weeding times are shown in Table 17 below

Table 17: Average maize yields for different weeding times.

Response	Frequency	Percent	Average yield in bags per hectare
Completed 1st weeding before knee height	24	20.9	19.3
Completed 1st weeding at knee height	56	48.7	15
Completed 1st weeding after knee height	35	30.4	11.5
Total	115	100	-

The results indicate that only 20.9% of the farmers in Malindi Division carry out timely weed control, while the majority of the farmers 79.1% practice late weeding.

The farmers who weeded on time obtained an average maize yield of 19.3 bags per hectare. Those who completed first weeding when the plants were at knee height obtained an average maize yield of 15 bags per hectare while those who completed the first weeding when the plants were past knee height obtained an average maize yield of 11.5 bags per hectare.

The difference in maize production between the different weeding times was tested by ANOVA. The ANOVA revealed significant difference between these three yields (19.3, 15 and 11.5 bags per hectare), ($F_{(2,112)} = 8.7983$, $p = 0.00$).

The Duncan Multiple Range Test (DMRT) for mean separation was further used to determine where the difference exists between these three yields.

Table 18: Duncan Multiple Range Test (DMRT) for average Maize yields under different weeding times

Time of weeding	Number of observation	Subset for alpha = .05		
		1	2	3
1st weeding completed before	35	7.7308		
1st weeding completed at knee height	56		6.0021	
1st weeding completed after knee height	24			4.6363

The DMRT showed significant difference in yields (α=0.05) between all the three different weeding times. This means that 1st weeding done before the Maize plants reach knee height results in better performance than that done either at knee height or past knee height. On the other hand, 1st weeding completed at knee height also gives better performance than that done when the plants are past knee height.

This leads to the rejection of the null hypothesis that the adoption of recommended agronomic practices (timely weed control) has no effect on Maize production in Malindi Division.

Table 19: Cross tabulation between time of weeding and time of planting.

Time of weeding	Time of planting		Total
	Early	Late	
Before Knee height	20	4	24
At knee height	28	28	56
After knee height	20	15	35
Total	68	47	115

$X^2_{(df=2),} = 7.806$, $P = 0.02$

With a chi-square value of 7.806 and p-value of 0.02 it indicates that there is significant association between time of weeding and time of planting. The association is such that the households who plant on time prefer weeding on time. This implies that timely weed control is associated with timely planting. This timely weed control might be one of the factors that contributed to the high maize yields that were realized by the farmers who planted on time. Carrying out weed control in early-planted crop field is easier than that in a late-planted crop field. This is because early-planted crops suppress weed growth making the crop field not to be heavily infested by weeds. This might be one of the reasons why timely weed control was significantly associated with timely planting.

Table 20: Cross tabulation between time of weeding and method of planting.

Time of weeding	Method of planting		Total
	Broadcasting	Row planting	
Before Knee height	2	22	24
At knee height	20	36	56
After knee height	11	24	35
Total	33	82	115

$X^2_{(df=2),} = 6.339$, P = 0.042

The chi-square value of 6.339 and p-value of 0.042 shows that there is significant association between time of weeding and method of planting. The association is such that the households who plant in row also prefer to carry out timely weed control. This implies that timely weed control is associated with row planting. The timely weed control adopted by the households who plant in row might be one of the factors that lead to significant high maize yields realized in row planted maize fields.

Crops that are planted in row are usually easier to weed compared to those broadcasted. This ease of weeding row planted crops might be one of the factors that contributed to timely weed control that was achieved by the farmers who planted in row.

Chi-square test showed that households from Ganda Location reported a significant high level of timely weed control than the other two locations $X^2_{(df=4),} = 23.2911$, P = 0.0001. Ganda, Jilore and Langobaya Locations reported timely planting levels of 70.8%, 12.5% and 16.7% respectively.

4.1.7 Number of weeding operations

Further analysis on weed control was based on how many times the farmers carry out the weeding and whether there is any significant difference in maize yields between farmers

who only carry out one weeding and those who carry out two weeding operations.

The average maize yields for these two different number of weeding operations are shown in Table 21

Table 21: Average maize yields for different number of weeding operations.

Response	Frequency	Percent	Average maize yields in bags per hectare
One weeding	32	27.8	13.3
Two weeding	83	72.2	15.5
More than two weeding	0	0	-
TOTAL	115	100	-

($T_{(1,113)} = 1.5185$, $p = 0.1$).

The results show that majority of farmers (72.2%) in Malindi Division carry out two weeding operations. This is because the environment in Coast Province is quite favorable for the rapid growth of weeds (Mwakubo 1994, MOALD 1998). This explains why the majority of farmers carry out two weeding operations.

The difference in maize production between one weeding and two weeding operations was tested by t-test. The t-test analysis revealed no significant difference between these two yields (13.3 and 15.5 bags per hectare), ($T_{(1,113)} = 1.5185$, $p = 0.1$).

This implies that the number of weeding operations has no influence on the yields of maize obtained by the farmers in Malindi Division.

4.1.8 Type of weed

The type of weed that is predominant in the study area was also investigated. Two types of weeds were considered in this case; the sedges (nut grass) on one hand and all the other available weeds on the other hand.

t-test on type of weed showed no significant difference in maize yields between nut grass infested fields and the maize fields infested by other weeds, ($T_{(1, 113)} = 0.8324$, $p = 0.4$). The average maize yields for these two different categories of maize fields are shown in Table 22

Table 22: Average maize yields with reference to the type of weed

Response	Frequency	Percent	Average yields in bags per hectare
Nut grass (sedges) predominant field	18	15.7	6.4833
Other weeds (star grass, wandering Jew etc) predominant	97	84.3	5.8477
TOTAL	115	100.0	-

($T_{(1, 113)} = 0.8324$, $p = 0.4$).

The absence of significant difference between these two means implies that the effect of Sedges weed on maize production is the same as that of other weeds in Malindi Division even though Sedge (nut grass) is described as the worst weed in the World (Holman, Pluckneth, Pancho and Herberger 1977)

4.2 Effects of Socio-economic factors on maize production

120 farmers were interviewed and the analysis of their responses pertaining to various socio economic factors is discussed in the following sections.

4.2.1 Gender and household head

The objective was to find out the difference in maize yields between the male headed and female-headed households.

The average maize yields for these two groups of farmers are shown in Table 23.

Table 23: Average maize yields for male and female managed farms.

Response	Frequency	Percent	Average yield in bags per hectare
Female headed household	16	13.9	15
Male headed household	99	86.1	14.8
TOTAL	120	100	-

($T_{(1,113)} = 0.0844$, p=0.9).

Table 23 shows the majority (86%) of households in Malindi Division to be male headed. The female-headed households obtained an average maize yield of 15 bags per hectare while the male-headed households obtained an average maize yield of 14.8

The difference in maize production between the male headed and female-headed households was tested by t-test. The t-test analysis revealed no significant difference between these three yields (15 and 14.8 bags per hectare), ($T_{(1,113)} = 0.0844$, p=0.9).

With no significant difference, it means that the sex of the household head has no effect on maize production in Malindi Division.

Chi-square tests between sex of the household head and other independent variables were carried out and the results are shown in Tables 24 to 27.

Table 24: Cross tabulation between Sex of the household head and time of planting

Sex of the household head	Time of planting		Total
	Late planting	Timely planting	
Female	6	10	16
Male	41	58	99
Total	47	68	115

$X^2_{(df=1),} = 0.087$, P = 0.496

The Chi-square value of 0.087 and a p-value of 0.496 show that there is no significant association between sex of the household head and time of planting maize in Malindi Division ($\alpha = 0.05$.). Amudavi (1993) found a significant association between sex of the household head and the adoption of timely planting of maize in Western Kenya with male-headed households practicing timely planting compared to their female counterparts. The results of this study therefore contradict those of Amudavi.

Table 25: Cross tabulation between Sex of the household head and method of planting

Sex of the household head	Method of planting		Total
	Row planting	Broadcasting	
Female	12	4	16
Male	70	29	99
Total	82	33	115

$X^2_{(df=1),} = 0.124$, $P = 0.491$

The Chi-square value of 0.124 and a p-value of 0.491 show that there is no significant association between sex of the household head and method of planting maize in Malindi Division ($\alpha = 0.05$.). This is in contrast to the findings of Amudavi (1993) which showed significant association between the sex of the household head and the adoption of row planting with male headed households tending to practice row planting compared to their female counterparts.

Table 26: Cross tabulation between Sex of the household head and Type of farm tool used in land preparation.

Sex of the household head	Type of farm tool used		Total
	Traditional hoe	Ox-plough	
Female	9	7	16
Male	70	29	99
Total	79	36	115

$X^2_{(df=1),} = 1.339$, P = 0.191

The Chi-square value of 1.339 and a p-value of 0.191 show that there is no significant association between sex of the household head and type of farm tool used in Land preparation. ($\alpha = 0.05$.). This is in contrast to the findings of Amudavi (1993) and Oluoch Kosura (1983) which showed significant association between the sex of the household head and the use of ox-plough in Land preparation with male headed households tending to use ox-plough in land preparation compared to their female counterparts.

Table 27: Cross tabulation between Sex of the household head and Time of weeding.

Sex of the household head	Time of weeding		Total
	Timely weed control	Late weed control	
Female	11	5	16
Male	69	30	99
Total	80	35	115

$X^2_{(df=1),} = 0.006$, P = 0.575

The Chi-square value of 0.006 and a p-value of 0.575 show that there is no significant association between sex of the household head and time of weed control in Maize growing in Malindi Division ($\alpha = 0.05$.). The absence of association between the sex of the household head and the time of weeding can partially explain why there was no

significant difference in maize yields between the female headed and male-headed households. This is because both male and female headed households seem to be operating under similar conditions. The absence of association between the sex of the household head and these other factors of maize production (time of planting, method of planting, time of weed control and type of farm tool used) can be explained from the cultural perspective. According to the Giriama community who live in Malindi Division, subsistence farming of annual crops is left in the hands of women. This implies that even in the male-headed households, women are still the people who make the main decisions that relate to the growing of maize. This is in line with the findings of Waainjenberg (1993), who found that most farm work in Kilifi District was performed by women. Kilifi district is also predominantly occupied by the Giriama community.

4.2.2: Type of farm implements

The main types of farm implements studied here were traditional hoe (popularly known as Kaserema) and the ox-plough/tractor drawn implement. The objective was to find out the level of adoption of ox-plough use and whether any difference exists in maize yields between the farmers who use ox-plough and those who use traditional hoe.

The average maize yields for these two groups of farmers are shown in Table 28.

Table 28: Average maize yields for different types of farm implements used.

Response	Frequency	Percent	Average yields of maize in bags/hectare
Use of traditional hoe	79	68.7	11.3
Use of tractor/ox-plough	36	31.3	22.8
TOTAL	115	100	-

($T_{(1,113)} = 10.96$, $p=0.00$).

Table 28 shows that only 31% of the households in Malindi Division have adopted the use of ox-plough in land preparation. The average maize yields for the farmers who used ox-plough and those who used traditional hoe were 22.8 bags and 11.3 bags per hectare respectively.

The difference in maize production between the use of different types of farm tools in land preparation was tested by t-test. The t-test analysis revealed significant difference between these two yields (22.8 and 11.3 bags per hectare), ($T_{(1,113)} = 10.96$, $p=0.00$).

The significant difference between these two yields indicate that the type of farm tool used by the farmer has a significant effect on the yields of maize achieved with use of ox-plough/tractor increasing the yields and use of the traditional hoe reducing the yields in Malindi Division.

Interlocation comparisons showed that 97.2% of all the households who used ox-plough or tractor in land preparation were from Ganda Location, 2.8% were from Jilore while Langobaya Location reported 0% ox-plough/tractor use.

Chi-square tests between type of farm tool and other independent variables were carried out and the results are shown in Tables 29 to 30 below.

Table 29: Cross tabulation between type of farm tool and time of planting.

Type of farm tool	**Time of planting**		**Total**
	Timely Planting	Late Planting	
Traditional hoe	32	47	79
OX Plough	36	0	36
Total	68	47	115

$X^2_{(df=1),} = 36.221$, $P = 0.000$

The Chi-square value of 36.221 and a p-value of 0.000 show that there is significant

association between type of farm tool used and the time of planting maize in Malindi Division ($\alpha = 0.05$.). The significant association between the type of farm tool used and the time of planting may partially explain why there was a significant difference between the yields of maize attained by the farmers who used ox-plough and those who used traditional hoe. This is because those who used ox-plough planted on time while those who used traditional hoe planted late. The ox-plough use eases the work and therefore enables the farmers to prepare their land on time. The timely land preparation subsequently leads to timely planting.

Table 30: Cross tabulation between type of farm tool and Time of weeding.

Type of farm tool	**Time of weeding**		**Total**
	Timely weed control	Late weed control	
Traditional hoe	9	70	79
OX Plough	15	21	36
Total	24	91	115

$X^2_{(df=1),} = 13.725$, $P = 0.000$

Table 30 shows that 13% (n=9) and 41.6% (n=15) of the households respectively used traditional hoe and ox-plough in land preparation. This implies that there is an association between the type of farm tool used and the time of weeding with use of ox-plough tending to achieve timely weed control. This association is significant ($\alpha = 0.05$) implying that the use of ox plough achieves timely weed control than the use of the traditional hoe.

Table 31: Cross tabulation between type of farm tool and Method of planting.

Type of farm tool	Method of planting		Total
	Broadcasting	Row planting	
Traditional hoe	29	50	79
OX Plough	4	32	36
Total	33	82	115

$X^2_{(df=1),} = 7.920$, $P = 0.003$

The Chi-square value of 7.920 and a p-value of 0.003 show that there is significant association between type of farm tool used and the method of planting maize in Malindi Division ($\alpha = 0.05$.). It therefore implies that the use of ox plough enhances the adoption of row planting.

4.2.3 Level of Education

Five different levels of Education were considered in this study; never went to school, lower primary school level (1-4), upper primary school level (5-8), secondary school level and post secondary Education. The average maize yields for these groups of farmers are shown in Table 32.

Table 32: Average Maize yields for different Levels of Education

Response	Frequency	Frequency %	Average maize yields in bags/hectare
Never went to school	40	34.8	15.3
Lower primary (1-4)	25	21.7	14.3
Upper primary (5-8)	30	26.1	14.0
Secondary education	12	10.4	13.5
Post secondary education	8	7.0	16.9
TOTAL	115	100	-

($F_{(4,110)} = 0.8391$, $p=0.5$).

The results show that 34.8% of the household heads in Malindi Division are illiterate (never went to school), 21.7% are semi illiterate with lower primary (1-4) education level, 26.1% are literate with upper primary (5-8) education level, 10.4% are literate with secondary level of education while 7% are literate with post secondary level of education. The difference between the yields achieved by different farmers of different level of Education was tested by ANOVA. The ANOVA results showed no significant difference in maize yields between household heads with different levels of education ($F_{(4,110)} = 0.8391$, $p=0.5$). Literacy levels have been found to influence the farmers' adoption of agronomic technologies and the subsequent crop yields Amudavi (1994) and Mwakubo (1994). These results however contradict those of Amudavi and Mwakubo. The cross tabulation of the level of education and type of farm tool used revealed that 41.5% of the illiterate and semi illiterate farmers used ox plough in preparing their land while 24% of the literate (upper primary level and above) farmers used ox plough. The use of ox plough by a high (41.5%) of the illiterate farmers in relation to the literate ones (24%) is

the main factor that caused this contradiction. When all the farmers (both illiterate and literate) who had used ox plough were excluded from the analysis, the results were in agreement with those of Amudavi and Mwakubo with the maize yields significantly increasing with the increase in the level of education.

Table 33 shows the maize yields with the education level when the use of ox plough is excluded.

Table 33: Average maize yields for different levels of education with the exclusion of the ox plough use.

Education Level	Frequency	Frequency %	Average maize yields in bags/hectare
Illiterate (0-4)	41	51.9	10.4
Literate (5-post secondary)	38	48.1	11.7
TOTAL	79	100	-

($T_{(1,77)} = 1.0321$, $p=0.05$).

The use of the ox plough by a large number of the illiterate farmers gave them an advantage over the literate ones in terms of proper land preparation, timely planting and timely weed control and this made the illiterate farmers to perform more or less the same as the literate farmers. When this advantage was removed, by excluding all the farmers who used the ox plough, the literate farmers performed better than the illiterate ones. It can therefore be argued that the use of the ox plough has a significant effect on the yields of maize realized by the farmers in Malindi Division.

4.2.4 Contact with Extension service

The objective was to find out the difference in maize yields between the farmers who access Government extension services and those who do not access these services.

The average maize yields for these two groups of farmers are shown in Table 34.

Table 34: Average maize yields with reference to extension contact.

Response	Frequency	Frequency %	Average maize yields in bags per hectare
Had extension contact	47	40.9	13
No extension contact	68	59.1	16.3
	115	100	-

($T_{(1,113)} = 2.3429$, $p=0.02$).

Table 34 shows that 41% of the households were in contact with Government extension service while 59% were not in contact with extension service in regard to obtaining information about maize production. The farmers who were not in contact with extension service achieved an average maize yield of 16.3 bags per hectare while those in contact with extension service achieved maize yields of 13 bags per hectare. The difference between these two types of yields was tested using t-test. The t-test results revealed that the average yields of the households not in contact with extension service was significantly higher than that of the households in contact with extension service. ($T_{(1,113)} = 2.3429$, $p=0.02$).

The cross tabulation of extension contact and type of farm tool used revealed that 45.6% of the farmers who had no contact with the extension service used ox plough in preparing their land while 10.6% of the farmers who had contact with the extension service used ox plough. Just as was observed with the level of education, the use of ox plough by a high (45.6%) number of the farmers who had no extension contact in relation to those who had extension contact (10.6%) is what enabled these farmers (who had no extension contact) to outperform those farmers who had contact with extension service.

When all the farmers (both in contact and those not in contact with the extension service)

who had used ox plough were excluded from the analysis, the results changed with the farmers in contact with the extension service achieving higher maize yields than those farmers not in contact with the extension service. Table 35 shows the maize yields with the extension contact when the use of ox plough is excluded.

Table 35: Average Maize yields with extension contact when the use of ox plough is excluded.

Response	Frequency	Frequency %	Average maize yields in bags per hectare
Had extension contact	42	53.2	12
No extension contact	37	46.8	10.5
	79	100	-

($T_{(1,77)} = 1.2924$, $p=0.2$).

The use of the ox plough by a large number of the farmers not in contact with the extension service gave them an advantage over those in contact with the extension service in terms of proper land preparation, timely planting and timely weed control and this made the farmers not in contact with extension service to perform better than the farmers who had extension contact. When this advantage was removed, by excluding all the farmers who used the ox plough, the farmers not in contact with the extension service performed better than the farmers not in contact with the extension service.

Chi-square tests between Contact with Extension service and the type of farm tool used as well as the planting time is shown in Tables 36 to 37.

Table 36: Cross tabulation between contact with extension service and type of farm tool used.

Extension contact	Type of farm tool		Total
	Traditional hoe	Ox-plough	
Not in contact with extension	37	31	68
In contact with extension	42	5	47
Total	79	36	115

$X^2_{(df=1),} = 15.786, P = 0.000$

The Chi-square value of 15.786 and a p-value of 0.000 show that there is significant association between contact with extension service and type of farm tool used in land preparation ($\alpha = 0.05$.). This shows that many of the farmers who used the ox plough were not in contact with extension service. The high maize yields achieved by the farmers who were not in contact with extension service can partially be attributed to the ox-plough use.

Table 37: Cross tabulation between Contact with Extension service and Time of planting.

Extension contact	Time of planting		Total
	Early	Late	
Not in contact with extension	49	19	68
In contact with extension	19	28	47
Total	68	47	115

$X^2_{(df=1),} = 11.508, P = 0.001$

The Chi-square value of 11.508 and a p-value of 0.001 show that there is significant association between contact with extension service and time of planting maize in Malindi Division ($\alpha = 0.05$.). This implies that households not in contact with extension service

tend to achieve timely planting than those in contact with extension service. The significant association between contact with Extension service and time of planting might partially explain why households not in contact with extension service achieved significant higher maize yields than the households in contact with extension service.

4.2.5 Access to credit

The objective was to find out the proportion of farmers who are able to access credit facilities for maize production and whether the use of credit in maize production has any significant effect on the maize yields achieved. Table 37 below shows the average yields with reference to credit use

Table 38: Average maize yields with reference to credit use.

Credit Accessibility	Frequency	% Frequency	Average maize yields in bags/hectare
Did not access credit	113	98.3	14.8
Accessed credit	2	1.7	16.8
TOTAL	115	100%	-

($T_{(1,113)} = 0.2643$, $p=0.8$).

Only 2 % of the households accessed and utilized credit in maize production in Malindi Division. The households who accessed credit obtained an average maize yield of 14.8 bags per hectare while those who did not access credit obtained 16.8 bags per hectare. A t-test on access to credit showed no significant difference in maize yields among the farmers who accessed credit and those who did not access credit ($F_{(1,113)} = 0.699$, $p=0.8$). Ongaro (1990) and Thiensenhusen (1978) in their studies found farmers who had accessed credit to have obtained higher significant Maize yields than those who had not accessed credit. The findings of this study are however different from those of Ongaro and

Thiensenhusen and this might be due to low level (2 %) of credit use in Malindi Division. The farmers interviewed gave various reasons for their inaccessibility to credit. These reasons are shown in Table 39

Table 39: Reasons for not using credit

Response	Frequency	% frequency
Not aware of any credit giving organization	50	44.3
Lack of security required by the credit giving organizations.	51	45.1
Fear of land being auctioned in failure of paying back the credit.	12	10.6
TOTAL	113	100

About 44% of the farmers did not get credit because of lack of knowledge/awareness of any credit giving organizations. Discussions with the Divisional Extension Coordinator however revealed that there are no organizations that target peasant farmers for credit within Malindi Division. Agricultural Finance Corporation (AFC) is the only organization that used to offer credit to farmers but due to financial problems, it no longer offers such services. The other credit giving organizations are mainly cooperatives and their services are restricted to certain groups of people who must be members e.g. Teachers Savings and Credit Organization and Malindi business Saving and Credit Organization.

4.2.6 Off farm income

The objective was to find out the proportion of farmers who have access to off-farm income and weather the accessibility of this off-farm income has any significant effect on

maize yields achieved. Table 40 shows the average yields with reference to off-farm income.

Table 40: Average maize yields with reference to off-farm income.

Off-farm income	Frequency	% Frequency	Average maize yields in bags/hectare
Received off-farm income	35	30.4	15.8
Did not receive off-farm income	80	69.6	14.3
Total	115	100	-

($T_{(1,113)} = 1.2296$, p=0.2).

34 % of the households interviewed received some off-farm income. The households who received off-farm income obtained an average maize yield of 15.8 bags per hectare while those who did not receive off-farm income obtained 14.3 bags per hectare. A t-test on access to off-farm income showed no significant difference in maize yields among the farmers who accessed off-farm income and those who did not ($T_{(1,113)} = 1.2296$, p=0.2). Chi-square tests between gender of the household head and other independent variables were carried out and the results are shown in Tables 41 to 43.

Table 41: Cross tabulation between access to off-farm-income and time of planting

Off-farm income	Time of planting		Total
	Timely planting	Late planting	
Did not receive off-farm income	44	36	80
Received off-farm income	24	11	35
Total	68	47	115

$X^2_{(df=1),} = 1.856$, P = 0.123

The X^2 value of 0.087 and the p-value of 0.123 imply that there is significant association between off-farm income and time of planting at 90% level of significance but there is no

significant association between the two variables at 95% significance level. It therefore means that at α level of 0.05 off-farm income does not influence the time of planting maize in Malindi Division. It seems as if the off-farm income received by the households is not spent on maize production related activities and this might partially explain why off-farm income did not influence the maize yields in Malindi Division.

Table 42: Cross tabulation between access to off-farm-income and type of farm tool used

Off-farm income	Type of farm tool used	
	Traditional hoe	Tractor/Ox-plough
Did not receive off-farm income	59	21
Received off-farm income	20	15
Total	79	36

$X^2_{(df=1),} = 3.123$, P = 0.062

The X^2 value of 3.123 and the p-value of 0.062 shows that there is significant association between off-farm income and type of farm tool used in land preparation at 94% level of significance but there is no significant association between the two variables at 95% significance level. It therefore means that at α level of 0.05 off-farm income does not influence the type of farm tool used by the farmer in land preparation. It therefore seems that the off-farm income received by the households is not spent on either hiring or purchase of ox-plough for maize production related activities and this might partially explain why off-farm income did not influence the maize yields in Malindi Division.

Table 43: Cross tabulation between access to off-farm-income and timely weed control

Off-farm income	Timely weed control		Total
	Early weeding	Late weeding	
Did not receive off-farm income	18	62	80
Received off-farm income	6	29	35
Total	24	91	115

$X^2_{(df=1),} = 0.351$, $P = 0.423$

The X^2 value of 0.351 and the p-value of 0.423 shows that there is significant association between off-farm income and the time of weed control at 40% level of significance but there is no significant association between the two variables at 95% significance level. It therefore means that at α level of 0.05 off-farm income does not influence the time of weeding maize in Malindi Division. It seems that the off-farm income received by the households is not spent on hiring labour for weed control and this might partially explain why off-farm income did not influence the maize yields in Malindi Division.

4.2.7 Land Tenure System

ANOVA test on type of land tenure system showed that there is significant difference in maize yields among the three different land tenure systems. ($F_{(2,112)} = 8.6516$, $p=0.00$). The average maize yields for these three different land tenure systems are shown in Table 44.

Table 44: Average maize yields for different land tenure systems

Response/Type of land tenure system	Frequency	% Frequency	Average maize yields in bags/hectare
Individual ownership	76	66.1	13.8
Lease	10	8.7	23.5
Family/communal ownership	29	25.2	14.8
TOTAL	115	100	-

($F_{(2,112)} = 8.6516$, $p=0.00$).

The lease type of land ownership gave the highest average maize yields than the individual and family/communal types of land ownership.

Table 45: Duncan's Multiple Range Test for Average maize yields under different Types of Land Ownership

Type of Land ownership	Observation	Subset for alpha = .05	
		1	2
Individual ownership	76	5.5014	
Communal ownership	29	5.9138	
Lease	10		9.4320
Sig.		.638	1.000

Duncan's Multiple Range Test ($\alpha= 0.05$) showed significant difference in average maize yields between the farmers who leased and all the other forms of land ownership (individual and family/communal ownership). There was however no significant difference between individual and family/communal types of ownership.

Chi-square tests between the type of land ownership and other factors of production were carried out and the results shown in Tables 46 and 47

Table 46: Cross tabulation between Type of Land ownership and time of planting

Type of Land ownership	Time of planting		Total
	Timely planting	Late planting	
Individual Land Ownership	45	31	76
Lease	10	0	10
Family/communal Land Ownership	13	16	29
Total	68	47	115

$X^2_{(df=2),} = 9.367$, P = 0.009

The X^2 value of 9.367 and the p-value of 0.009 shows that there is significant association between type of Land ownership and time of planting at 99% level of significance. It therefore means that at α level of 0.05 type of land ownership has an influence on the time of planting maize in Malindi Division. All the households who had planted maize on leased piece of land practiced timely planting. The farmers who lease the land usually pay some fee and they work very hard to ensure that they pay back the cost of leasing the land and in addition make some profit. In most cases these are people who work and live in Malindi town and they grow maize as a commercial crop.

Table 47: Cross tabulation between Type of Land ownership and type of farm tool.

Type of Land ownership	Type of farm tool		Total
	Traditional hand hoe	Tractor/Ox-plough	
Individual Land Ownership	57	19	76
Lease	1	9	10
Family/communal Land Ownership	21	8	29
Total	79	36	115

$X^2_{(df=2),} = 17.61$, P = 0.000

The X^2 value of 17.61 and the p-value of 0.000 imply that there is significant association between type of land ownership and type of farm tool used at 100% level of significance. It therefore means that at α level of 0.05 type of land ownership has an influence on the type of farm tool used by the households with farmers operating on leased land preferring to use tractor/ox-plough. The use of tractor/ox-plough by households who operated on lease type of land can partially explain why the lease type of land ownership gave significant higher maize yields than all the other types of land ownership.

Interlocation analysis showed that all the farmers who owned land by lease were from one location, Ganda Location.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This study examined the factors that affect maize production in Malindi Division. These factors were divided into two: agronomic practices and socioeconomic factors. The Agronomic factors considered were:

5.1.1 Time of planting:

This was studied at two levels, early planting and late planting. Early planting refers to any planting done a few days before the onset of the long rains or one to seven days after the onset of rainfall. Late planting refers to any planting done eight days and above after the onset of long rains. The average maize yields for the early planted and late planted maize were calculated and the difference in performance between these two planting times tested by t-test at α=0.05. The average yields for the early-planted maize was found to be significantly higher than the late planted maize.

5.1.2 Method of Planting:

Row planting refers to Maize plants planted in rows at recommended spacing of 90cm x 60cm two seeds per hole or 60cm x 30cm one seed per hole. The average maize yields for the row planted and broadcasted maize were calculated and the difference in performance between these two methods of planting tested by t-test at α=0.05. The average yields from row planted Maize was significantly higher than those from the broadcasted maize.

5.1.3 Time of weeding:

Timely weed control refers to the completion of the first weeding operation before the

plants reach knee height while late weeding refers to any weeding operation completed when the plants are at or are past knee height. The average yields from early-planted Maize were significantly higher than that from the late planted maize ($T_{(1,113)} = 2.5483$, $p=0.01$ and $\alpha=0.05$.)

5.1.4 Number of weeding operations:

This was studied at two levels, one weeding operation and two weeding operations. One weeding operation refers to the maize plants being weeded only once during the entire growing period while two weeding operations refers to the Maize plants being weeded twice during the growing period. No significant difference was found between the yields from the maize fields weeded once and those from the fields weeded twice ($T_{(1,113)} = 1.5185$, $p = 0.1$ and $\alpha=0.05$.)

5.1.5 Type of weed:

This was studied at two levels, Sedges (nut grass) weed and other types of weed. Sedges refer to maize fields infested mainly by Nut grass type of weeds while other weeds refer to the maize fields infested mainly by other weeds different from the nut grass. No significant difference in maize yields was found between the Sedges infested maize fields and the maize fields infested by other weeds $T_{(1, 113)} = 0.8324$, $p = 0.4$ and $\alpha=0.05$).

5.1.6 Use of certified seeds:

Certified seeds refer to the planting of either Hybrids (PH1, PH2, PH3 and PH5.) obtained from a recognized stockists or composites (Coast composite variety) obtained from a recognized stockists or obtained from the farmer's previous harvest. Local seeds refers to any type of Maize seed obtained from the farmer's own farm, the neighbor's farm or open market and are not Coast Composites. The average maize yields for

certified seeds and local seeds were calculated and the difference in performance between these two types of maize seeds tested by t-test at α=0.05. No significant difference in maize yields was found between the use of certified seeds and use of local seeds.

5.1.7 Use of Manures:

This was studied at two levels, use of either compost manure or farmyard manure at planting and no use of manure at planting. Low 0.9% levels manure use was reported among the farmers interviewed. Because of the low proportion of the farmers who used manure, it was not reliably possible to compare the mean yields between the use and non-use of manures.

5.1.8 Use of Fertilizers:

This was studied at two levels, use of either DAP/TSP/SSP at planting and or use of CAN Fertilizers for topdressing. The second level is where there was no use of any kind of fertilizers throughout the entire growing period of maize. Just as was noted with the manure use, the low proportion (1.7%) of the farmers who used fertilizer made it not possible to reliably compare the yields between the use and non-use of fertilizers.

The Socioeconomic factors studied were;

5.1.9 Sex of the household head:

Majority (86%) of the households in Malindi Division are male headed. The average maize yields from male headed and female headed households were tested by t-test at α=0.05. No significant difference in maize yields was found between the female-headed and the male-headed households. The chi-square tests also revealed no significant difference between the male headed and the female-headed households in relation to ox-plough use, time of planting and method of planting.

5.1.10 Level of Education of the household head:

Five different levels of Education were considered in this study; never went to school, lower primary school level (1-4), upper primary school level (5-8), secondary school level and post secondary Education.

More (56.3%) than half of all the household heads in Malindi Division were found to be illiterate or semi-illiterate. One-way ANOVA revealed no significant difference in maize yields between these five levels of education. The use of ox-plough was found to be more among the illiterate household heads than the literate ones.

5.1.11 Access to credit:

This was studied at two levels, household heads that accessed credit and the household heads that did not access credit. The average maize yields for these two categories of household heads showed no significant difference between the households who accessed credit and those who did not access credit. The level of credit access was however low (1.7%).

5.1.12 Off farm income:

This was studied at two levels, household heads who accessed off farm income and those household heads that did not access off farm income. The average maize yields for these two categories of household heads were calculated and the difference (in performance) between these two average yields tested by t-test at $\alpha=0.05$. No significant difference in maize yields was found between the households who accessed off farm income and those who did not access off farm income.

5.1.13 Type of Land Ownership:

Three types of land ownership were studied; communal type of land ownership, lease

type of land ownership and Individual type of Land ownership. The lease type of land ownership gave significant higher maize yields than both the individual and communal type of land ownership. There was however no significant difference in maize yields between the communal and the individual type of land ownership.

5.1.14 Contact with Extension Service:

This was studied at two levels, household heads who received extension advice from the Government Extension staff and those who did not receive. The average maize yields for these two categories of household heads were calculated and the difference (in performance) between these two average yields tested by t-test at α=0.05. When the use of the ox plough was considered, the farmers who did not receive the extension advise achieved significant higher maize yields than those who received extension advise from the Government extension staff. When the use of the ox plough was not considered, the farmers who received extension advise received higher (though not significant) maize yields than farmers who did not receive extension advise.

5.1.15 Type of farm tool used:

This was studied at two levels, households who used ox plough or tractor in land preparation and those who used traditional hoes in land preparation. The average maize yields for these two categories of households were calculated and the difference (in performance) between these two average yields tested by t-test at α=0.05. Use of Ox plough/tractor resulted into significant higher maize yields than the use of traditional hoe. Chi-square tests revealed that the use of ox-plough was significantly associated with early land planting, early weed control and row planting.

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5.2 Conclusions

Based on the results of this study, the following conclusions were made:

5.2.1 Time of planting;

The time of planting has an effect on maize production in Malindi Division with early planting increasing yields and late planting reducing the yields.

5.2.2 Method of planting

The method of planting adopted by the household has an effect on the yields of maize in Malindi Division with row planting increasing the yields and broadcasting reducing the yields. The households who have adopted row planting have also adopted early planting and early weed control.

5.2.3 Time of weeding

The time of weeding has an effect on the yields of maize in Malindi Division with early weeding increasing yields and late weeding decreasing the yields.

5.2.4 The number of weeding operations

The number of weeding operations has no effect on the yields of maize in Malindi Division.

5.2.5 Use of certified seeds:

Use of certified seeds has no effect on the yields of maize in Malindi Division. The yields from certified seeds are not significantly different from those of local seeds.

5.2.6 Use of Manures and Fertilizers:

There is very low (1%) adoption of the use of manures and fertilizers in maize production in Malindi Division. Because of this low level of adoption of Manure/Fertilizer use, it is not possible to reliably determine the effect of manure/fertilizer in maize production

under this type of study. This can only be determined under experimental research design.

5.2.7 Type of land ownership

The type of land ownership has an effect on the yields of maize in Malindi Division with the lease type increasing the yields compared to the communal and Individual type of land ownership.

5.2.8 Type of farm tool used

The type of farm tool used has an effect on the yields of maize in Malindi Division with the use of ox-plough/tractor achieving significant higher maize yields than the use of the traditional hoe.

5.2.9 Contact with Extension service

The contact with extension service has some slight increment (which is not significant) in maize yields when the use of the ox plough is not considered. When the use of ox plough is considered, farmers not in contact with the extension service significantly achieve higher maize yields than those not in contacts.

5.2.10 Contribution of the study to the discipline of Agricultural Extension.

This study has generated useful information that can help improve the design for extension programme for the maize growing farmers in Malindi Division.

The over-reliance on traditional hoe was found to greatly lower the yields of Maize. For example, the farmers with formal education using traditional hoe produced lower maize yields than the illiterate farmers using ox-plough. Similar findings were found with extension service. The farmers who had extension contact but used traditional hoe achieved low maize yields than those who did not have extension contact but used ox-

plough. Use of certified seeds without the adoption of the recommended agronomic practices achieved lower maize yields than those who planted local seeds. Since these problems have been identified, the extension providers together with the farmers can design extension programs that will help increase the level of maize yields.

5.3 Recommendations

5.3.1 Use of Certified seeds

With the certified seeds not performing better than the local seeds, it is recommended the extension service should advise the farmers that planting the certified seeds without providing the necessary optimal conditions will lead to low yields. The farmers who cannot be able to provide such optimal conditions should be advised to plant the local seeds.

5.3.2 Timely Weed Control

The results of this study revealed that timely planting significantly improves the yields of maize and that timely planting is enhanced by the use of the ox plough. It is therefore recommended that the Government and other stakeholders should support interventions that will enable the farmers to access the services of the ox plough. The emphasis should be put on Bukura mark II ox plough which is a three in one plough; has three attachments; the cultivator for weed control in an already established crop field, the moldboard for preparing the land and the ridger for making ridges.

5.3.3 Level of Education/Contact with Extension Service

The results revealed no significant difference (α=0.05) in maize yields between sedges infested maize fields and the maize fields infested by other weeds.

This study recommends that there should be a further research using an experimental

research design on the difference in maize yields between plots treated with sedges weeds and those treated with other weeds.

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APPENDICES

Appendix 1: questionnaire design

Sub location of the respondent.....

1.Sex of Respondent

1. Male [ ]
2. Female [ ]

2. (a) What is the total size of your land in hectares?.....

b) how many hectares including the ones you have leased from others have you put under maize last year?

3. how many bags of maize did you harvest last year?.....

4.a) With references to the onset of last year's long rains when did you carry out major planting of maize.

1. Few days before the onset [ ]
2. One to three days after the onset [ ]
3. Four to seven days after the onset [ ]
4. Seven to fourteen days after the onset [ ]
5. More than two weeks after the onset [ ]

b) **In case of more than seven days after the onset,** why did you choose to plant at this time

1. Is the best planting time [ ]
2. Was still preparing the land [ ]
3. Seeds and other inputs not yet available with the local stockist [ ]
4. Still looking for money to buy seeds and other inputs [ ]
5. Other reasons (specify)

5.a) Did you apply any insecticide in the funnel of maize during the growing period as a control measure for any pests?

1. Yes [ ]
2. No [ ]

b) **If no,** why?

1. There were no serious pest problems [ ]
2. Pest problem noticed but did not know how to control [ ]
3. Pest problem noticed but lacked the money to buy the insecticide [ ]
4. Any other reason (specify)

6.a) Which type of maize did you plant majorly

1. Local (own seed) [ ]
2. Coast composite [ ]
3. Pwani hybrid [ ]
4. Katumani [ ]
5. Dry land Hybrid [ ]

b) **If local** why?

1. Performs better than the improved [ ]
2. Does not require fertilizer like the others [ ]
3. Matures early compared to the improved [ ]
4. Lack of money to buy the improved [ ]
5. The improved not available with the local stockist at planting time [ ]
6. Any other reason (specify)

7.a) How did you plant your maize?

1. In row [ ]
2. Broadcast [ ]

b) **If broadcasted** why

1. Shortage of labour needed in row planting [ ]
2. Is faster than row planting [ ]
3. Yields better than row planting [ ]
4. Any other (specify)

c) **If in row** how many plants did you leave per hole?

1. One [ ]
2. two [ ]
3. More than two [ ]

8.a) Which type of weed was predominant in your field?

1. Nut grass (sedges) [ ]
2. Others [ ]

b) How many times did you carry out the weeding

1. Once [ ]
2. twice [ ]
3. More than twice [ ]

c) At what stage of growth did you complete the first weeding?

1. Before knee high [ ]
2. At knee high [ ]
3. Past knee high [ ]

9.a) Did you use any manure in planting maize

1. Yes [ ]
2. No [ ]

b) **If no** can you please suggest why you were unable to use the manure

1. Don't know how to prepare [ ]
2. require a lot of labour in using [ ]
3. unnecessary [ ]
4. any other reason (specify)

10.a) Did you use any fertilizer in planting maize

1. Yes [ ]
2. No [ ]

b) **If yes** at what stage of growth did you use it

1. At planting only [ ]
2. At planting followed by topdressing [ ]

c) **If no** can you suggest some of the factors that made you not to use the fertilizer?

1. Does not make any difference in yield [ ]
2. Did not have money to buy the fertilizer [ ]
3. Spoils the soil [ ]
4. Not available with the local stockist [ ]
5. Did not know how to use [ ]
6. Any other reason (specify)

11.a) What type of farm tool did you use to cultivate your land

1. Traditional hoe [ ]
2. Ox plough [ ]
3. Tractor [ ]
4. Ox plough + traditional hoes [ ]
5. Tractor + traditional hoe [ ]

b) **To be answered by those who only used the traditional hoe.** What factors hindered you from the use of ox plough?

1. is costly to hire [ ]
2. not easily available for hire [ ]
3. any other reason (specify)

12. Did you receive any teaching or guidance from your local agricultural extension officer

1. Yes [ ]
2. No [ ]

13. a) Did you receive any credit for your farming activities ?

1. Yes [ ]

2 No [ ]

b) If **yes** from which organisation?

---

c) If **no** what were the hindrances?

1. Not aware of any credit giving organisation [ ]
2. Lack of security required by the credit giving organisations [ ]
3. Fear of land being auctioned in failure of paying [ ]
4. Any other reason [ ]

14 a) Other than credit, did you receive any income outside your farming activities?

1. Yes [ ]
2. No [ ]

b) If **yes** from what source?

1. Own salary from employment [ ]
2. Husband / wife's salary [ ]
3. Assistance from children [ ]

15 What right do you have to the use of your land or how do you own your land?

1. Individual ownership [ ]
2. Lease [ ]
3. Family / communal ownership [ ]

16. What is your level of education?

1. Never went to school [ ]
2. Up to class I-4 [ ]
3. Up to class 5-8 [ ]
4. Completed secondary education [ ]
5. Post secondary education [ ]