CONTRIBUTION OF FERTILIZER MANAGEMENT PRACTICES TO POVERTY REDUCTION: THE CASE OF KILINDI DISTRICT

BY

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ABSTRACT

A study was conducted to assess the contribution of fertilizer management practices to poverty reduction in eight villages of Kilindi District, Tanzania. The objective of the study was to assess the contribution of fertilizer management practices in enhancing food security and household income. Data were collected using both structured and non-structured interviews. Field observations and secondary data supplemented the data collected using questionnaires. Purposive sampling procedures were used to obtain eight representative villages. At a village level, 30 respondents each from different households were picked at random for the study leading to a sample size of 240 respondents. The collected data were analysed using SPSS software. Results of the study indicated that only 1.3% of the farmers use inorganic fertilizers whereas 3% use organic fertilizers. Fertilizers are mainly used for maize and vegetable production. These are applied at very low application rates which can not suffice meaningful crop production. Results also indicated that the organic fertilizers used are not properly managed. Manure accumulates in open kraals and frequency of manure removal is quite low pointing to likelihood of nutrient losses. Results further indicated that crop yields are quite low as a consequence of use of poor husbandry practices notably appropriate fertilizer use leading to food insecurity and low household income. It is therefore recommended that farmers should be trained and/or sensitized on proper use and management of fertilizers. The district is endowed with plenty of animal manure of which if judiciously used can increase crop production hence reduce food insecurity and increase household income. Different training methods such as Farmers Field Schools, demonstrations, tours, workshops and seminars should be employed. Extension services should also be improved if meaningful dissemination of agricultural technologies is to be attained.

DECLARATION

I, **Joachim Martin Shekiangio,** hereby declare to the senate of Sokoine University of Agriculture that this dissertation is my own original work and it has not been submitted for a degree in any other University.

..... 30th/09/2008

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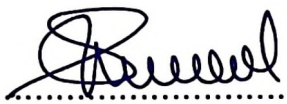
The above declaration is confirmed



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Prof. Kimbi, G.G. — Date

(Supervisor)

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DEDICATION

I dedicate this work to Almighty God, Holy Mary, my parents, Martin Shekiangio and Anna Shekiangio who laid the foundation for my education.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
DALDO	District Agricultural and Livestock Development Officer
FAO	Food and Agricultural Organization
FEWS NET	Food Early Warning System Network
FFS	Farmers Field Schools
Ha	Hectare
HESLB	Higher Education Students Loan Board
HIV	Human Immune deficiency Virus
ICRAF	International Research Centre for Agro-forest
IFDC	International Food Development Corporation
K	Potassium
Kg	Kilogram
Km	Kilometer
M	Meter
Mm	Millimeter
N	Nitrogen
NBS	National Budget Survey
NGO	Non Government Organization
NPES	National Poverty Eradication Strategy
NSGRP	National Strategy for Growth and Reduction of Poverty
P	Phosphorus
PRS	Poverty Reduction Strategy
REPOA	Research on Poverty Alleviation
SPSS	Statistical Package for Social Science

SSA	Sub Saharan Africa
SUA	Sokoine University of Agriculture
TAS	Tanzania Assistance Strategy
Tshs	Tanzanian shillings
UNDP	United National Development Programme
UNFPA	United Nations Population Fund
URT	United Republic of Tanzania
USD	United States of American Dollar

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Agriculture plays an important role in the economies of the East African countries. In Tanzania it employs about 80% of the entire population. The main agricultural contributors of these economies are small-scale farmers who use limited resources and simple farm inputs for crop production (Keenja, 2001). Over the years crop production in Tanzania has not been promising. According to URT (2003) major factors that have contributed to low crop production include heavy dependence on rain with little emphasis on irrigation, poor access to market outlets and market information, poor crop management practices, inferior farm implements, poor physical infrastructure, land degradation, decline in quality and quantity of support services, lack of improved seeds, poor plant protection services and low soil fertility.

Continuous production without external nutrient inputs decreases fertility status of soils. Efficient crop and sustained production calls for the use of fertilizers (organic and inorganic sources) in order to replenish the nutrients taken from the soil by plants and those lost through other soil degradation processes. Recently, there has been renewed effort in the use of organic fertilizer amendments throughout the world because of the escalating fertilizer prices, pollution hazards and poor quality of the crops (Springer, 2005).

The most effective strategy for poverty reduction and economic growth in Africa is to ensure that the agricultural sector is itself growing rapidly (Joubert *et al.*, 1999). Agricultural productivity in Sub-Saharan Africa (SSA) must improve in order to increase

rural incomes and meet the demand for food in both rural and urban areas. Available evidence lends strong support to the close relationship between agricultural development and economic growth. This puts promotion of appropriate technology in agriculture at the center of the challenge facing African countries (Buresh and Tian, 1998).

According to the agriculture sector vision "the Government and stakeholders in agriculture envisage an agricultural sector that by the year 2025 is modernized, commercial, highly productive and profitable, utilizes natural resources in an overall sustainable manner and acts as an effective basis for inter-sectoral linkages" (URT, 2001). Based on Tanzania's Development vision 2025, the Government of Tanzania has established national organizing framework for putting the focus on poverty reduction. One of the identified areas is to increase productivity of peasant farmers and the urban informal sector and secure markets for their products (REPOA, 2002).

Low soil fertility of the cultivated lands is one of the major problems currently facing most parts of Tanzania. This culminates into inadequate food production for the rapidly growing population. In order to achieve sufficiency in food production there is a need to accelerate efforts to halt the decline in soil productivity and restore the productivity of the degraded soils (Kimaro, 2003).

The use of fertilizers has been declining over the years due to removal of fertilizer subsidies, low purchasing power of resource poor farmers, high cost and the uncertain accessibility of fertilizers (Swinner *et al.*, 2005) There is a need to promote possible alternatives, for example use of organic materials such as animal manure, compost and crop residues as fertilizer sources (Lekasi *et al.*, 2003).

Sustainable crop production requires judicious use of inputs such as fertilizers. Fertilizers are no substitute for poor husbandry and farmers should not be lead to believe that fertilizers are the only answer to crop yield problems, therefore a more rigorously insistence on optimal management practices should always precede any advice on the use of fertilizers (Samki *et al.*, 1982). Efficient use of fertilizers means the supply of the proper amount of plant nutrients at the correct time in a plant available form, while at the same time avoiding losses as much as possible.

Management is a key factor which to a large extent determines the extent to which nutrients contained in fertilizers can effectively be used for crop production. Improper storage, application methods and handling conditions of fertilizers contribute to nutrient losses resulting in low nutritive values. (Kimbi and Semoka, 2004).

1.2 Problem statement and justification

Sustainable and effective management of natural resources for enhanced food security call for integrated policy initiatives. The issue of sustainability in food security within acceptable limits is complex. In Tanzania, crop yields are quite low due to various factors. Low soil fertility is one of the major problems that affect yields of most field crops leading to low income of the resource poor farmers and subsequently food insecurity.

In order to effectively address low income and food insecurity which are generally due to low yields of most crops, deliberate efforts must be directed to the improvement of agronomic practices. Use of fertilizers (both inorganic and organic) is one of the important factors that can increase production which is a pre-requisite for improvement in household food security and income, hence, poverty reduction. This study mainly focused on

fertilizer management practices aimed at coming up with recommendations for increased yields. The results of this study are expected to provide essential information to policy makers, Non Government Organizations (NGOs) and other rural practitioners in setting strategies that aim at use and management of fertilizers in order to increase food production and household income.

1.3 Objectives

1.3.1 General objective

To assess the contribution of fertilizer management practices in enhancing food security and household income.

1.3.2 Specific objectives

i. Determine the extent of fertilizers use and major crops fertilized.
ii. Identify management practices related to fertilizer use.
iii. Identify and analyze constraints to fertilizer use.
iv. Identify and analyse the role of fertilizer use in production level, food security and income.
v. Come up with the recommendations aimed at enhancing crop production hence food security.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The concept of food security

The concept of food security is complex; it covers a wide range of aspects from global food balance to nutritional adequacy of an individual. According to FAO (2004), there is no one universal concept of food security. Maxwell (1996) reports that, Food security concepts have developed considerably since it emerged in the 1970's.The concept would have shifted from high economic and quantitative considerations to a more humanistic and qualitative direction, it may be looked from macro level to micro level. FAO (2004) has defined food security as physical and economic access by all people at all times to sufficient safe and nutritious food to meet their dietary requirement for productive and healthy life. This definition has highlighted four major conditions; first food must be available through domestic production or importation. Secondly, the available food must be accessible by the people; this implies that people must have adequate resource to access the available food for consumption. Thirdly, the available food must be safe with adequate nutrient for a healthy and active life; finally, the accessed food must be sufficient to meet the dietary requirement of the population.

2.1.1 Dimensions of food security

There are three dimensions of food security which are food availability, food accessibility and food stability. According to URT (2003) food availability is determined by the level of food supplies, composed of subsistence production and market supplies stemming from domestic production, food stocks and food imports. In subsistence societies, food availability would be equal to food in stock plus what can be directly obtained from the fields and gardens as well as from collection of wild foods (Msola, 2007).

Food accessibility refers to people's ability to get social and economic access to food, and it is typically constrained by income (Ethui *et al.*, 2002). Also assess to food is related both to the adequacy of supply and to the efficiency of the distribution system involving storage, processing, preservation, transport and marketing

Food stability is referred to variations and the risk of shortfalls in food production, supplies and/or demand over time. In food stability concerns are income distributions, effective markets and various public and informal support and safety nets.

2.1.2 Food security situation

Food security is a major concern of most developing countries, especially those of the Sub-Saharan Africa (SSA). FAO (2001a) reported that about 40% of total African population, mostly children and women, face mounting problems of poverty and malnutrition. According to recent projections from the FAO, World Food Summit goal of halving the number of food-insecure people from 800 million in 1995 to 400 million by 2015 will not be achieved until 2030 (Pinstrup-Andersen *et al.*, 2001). Moreover, food insecurity is expected to accelerate in SSA.

In Tanzania, study of 2001-02 Household Budget Survey indicates that 18.7% of the Tanzania population lives below the food poverty line (NBS, 2002). In the country, food insecurity in urban areas is the function of income or purchasing power and food prices; while in rural areas it is a function of production and consumption (Diller and Boudreau, 2005). However, in Tanzania, the growth rate of food production is unsatisfactory. Worse still there is usually a great geographical variation in the production of food in the country depending on rainfall distribution in the year, such that is some years there may be

surpluses of food in some regions while there may be serious shortages in other regions (Makundi *et al.*, 2001; Keenja, 2001). In Tanzania, smallholder farmers in 2001/02 contributed to the country attaining food self-sufficient estimated to be 95% and in 2002/03 the self sufficiency levels of about 102% was attained. In spite of the high attainment in food self-sufficiency, due to geographical differences, in the season there were local food deficits particularly in the central part of the country. Recurrent droughts or floods often result in food shortages at national scale forcing the nation to import substantial amounts of food. URT (2003) reported that most households in rural Tanzania usually deplete their food stocks by December just before the next growing season.

2.2 Concept of poverty

Although poverty involves very real and material deprivation, no universally accepted definition of it exists. Understanding varies widely from culture to culture, and may embrace a range of variables, which are not always correlated (Ellis, 2000). According to Jazairy (1992) and Chambers (1992), poverty is defined as a state of deprivation, prohibitive of a decent human life. In other words poverty is a state that prevents people form living in acceptable standards of life. Reinforcing factors being; lack of productive resources to generate material wealth, illiteracy, prevalence of disease, discriminative socio-economic, political system, and natural calamities such as drought, floods, HIV/AIDS and man made calamities such as war. These socio-economic features which are reflection of poverty are high rates of morbidity (unhealthy) and mortality, prevalence of malnutrition, illiteracy, high infant and maternal mortality rates, low life expectancy, poor quality housing, low per capita income and expenditure, poor infrastructure and filthy environment. Thus, poverty is fundamentally to do with lack of well- being (URT, 1999). A positive state of well- being can be an expression of human capabilities of doing and

being. The proportion of rural people in poverty rises markedly in locations that are marginal in terms of agricultural productivity, remote form services, and prone to natural disasters.

There are two types of poverty, first the *absolute poverty* that corresponds to people who fall below some fixed measure that represents the minimum material necessities for health survival. It reflects the absolute economic well being of the relevant part of a given society (i.e. the poor) in isolation form the welfare distribution of the entire society. Second, the *Relative poverty* which means that people whose income may be significantly below the average incomes of the country, and who are, therefore, excluded from participating in the customary activities of the majority of citizens. This reflects the relative living standards of the poor in relation to the entire society. Nevertheless, people can be in relative poverty, yet their consumption levels may be well above the minimum physiological needs of survival (Ellis, 2000; Omari, 1994; World Bank, 2000-02). This study defines poverty as a state that prevent people from living in acceptable standards of life, reinforcing factors being; lack of productive resources to generate material wealth and discriminative socio-economic system; feature reflective of poverty are low per capita income and expenditure.

2.3 Tanzania's efforts to poverty reduction

Poverty reduction can be defined as lifting the poor out of poverty (Makombe *et al.*, 1999). Reducing poverty is a major objective of economic development. Since independence in 1961, the Government of Tanzania has had poverty eradication as its main goal. The early 1970s were characterized by heavy Government expenditure in social services (primary schools, health centres and water schemes). In 1974 masses of rural population had been relocated to village (villagization campaign) (Collier *et al.*, 1990). The main objective was to adequately provide social services. Bagachwa *et al.* (1995)

reported that from the mid 1970 to the early 1980s the country was faced by serious economic instability.

In 1986 the Government signed an agreement with World Bank and IMF on policy reforms. The first reform was Economic policy which emphasized on free market economy. URT (2003) noted that immediately after signing the agreement, it was discovered that there is a problem of relying only on productive sectors and for getting infrastructure sectors. In 1990/91 – 1992/93 EASAP programme which concentrated on both, production and social infrastructure was introduced.

Currently, there is the National Strategy for Growth and Reduction of Poverty (NSGRP) which builds on the Poverty Reduction Strategy (PRS) of 2000/01 – 2002 / 03 and National Poverty Eradication Strategy (NPES) of 1998. The NSGRP keeps in focus the aspirations of Tanzania Development Vision 2025 for high and shared growth, high quality livelihood, peace, stability and unity, good governance, quality education and international competitiveness. Supportive to this strategy are Tanzania Assistance Strategy (TAS), Agricultural Sector Development Strategy (ASDS), and public sector reform, local government sector reforms and Legal sector reforms. All these intend to improve quality of life and social well –being, good governance, accountability, growth and reduction of income poverty, hence, reduction of poverty (Abdoulaye and Sandes, 2005).

2.4 An overview of soil fertility

Soil fertility is the capacity of soil to support growth of plants on a sustainable basis under given condition of climate and relevant properties of land (Young, 1989). High soil fertility is characterized by among others; high water holding capacity, good aeration,

moderate temperature, high water infiltration capacity, high organic matter content, and balanced levels of both macronutrients and micronutrients (Balagoplans and Jose, 1995).

Soil fertility depletion in smallholder farms is the fundamental biophysical cause of declining food production in sub-Saharan Africa (Ley *et al.*, 2000). Most soils in Tanzania are highly weathered and generally deficient in most nutrients, particularly nitrogen and phosphorus (Mnkeni, 1989). The problem is also aggravated by inadequate use of fertilizers, low use of soil enriching crops by farmers, use of low yielding crop varieties and poor crop management.

2.5 Soil fertility improvement strategies

Low soil fertility is a major constraint to crop production in most parts of Tanzania (Kimbi and Semoka, 2004). Nutrient deficiencies and imbalances in soils can be adjusted and corrected through the following soil fertility improvement strategies:

2.5.1 Application of fertilizers

The use of mineral fertilizers provides essential nutrients for crop growth and hence improved food yields (IFDC, 1986; Kumpawat and Ranthore, 1995).

Most resource poor farmers in SSA cannot have easy access to inorganic fertilizers because they are expensive. However, continued use of inorganic fertilizers without sound organic matter management strategies will lead to soil degradation and hence low yields (Kimbi *et al.*, 2001). There is a need to promote the use of organic materials such as animal manure, compost, crop residues and mulch if meaningful agricultural sustainability is to be attained.

Use of organic materials in farming system increases microbial activity and moisture retention capacity. Also they reduce soil bulk density following formation of polysaccharides, polyuranoides, cellulose and humus which are responsible for firm binding between soil particles resulting in more stable aggregates (Sharma and Mittra, 1991). Apart from all those benefits manure is an alternative source of fertilizers particularly to resource poor farmers.

2.5.2 Biological processes and transformation in the soil

The microbial population and species in the soil influence soil fertility and productivity. Soil microorganisms are involved in many biological processes and transformation in the soils (Semoka, 2006). Biological processes that influence soil fertility include nitrogen fixation and biological decomposition of organic matter.

Through the process of biological decomposition, soil microorganisms contribute to the soil organic matter content and are involved in the release of plant nutrients from soil organic matter. Further more, microorganism *(Rhizobium)* either free living or living symbiotically in root nodules convert free nitrogen into organic form. Sanginga *et al.* (1995) observed that the proportion of the amount of N fixed is influenced by the effectiveness of the *Rhizobium* strains and prevalent environmental conditions. Biological nitrogen fixation plays a crucial role in sustaining soil fertility and productivity.

2.5.3 Proper management of crop residues

One of the key strategies in designing sustainable agricultural systems is the management of crop residues. It has been observed that if crop residues are well incorporated in the soil they decompose and contribute to soil organic matter (Brady and Weil, 2001). Proper

management of crop residues influences soil physical conditions. It is usually desirable to incorporate residues soon after harvesting to start the decomposition process early if the field is to be planted the following year (Mrema, 2005). This helps to ensure that a good seed bed can be prepared and that the soil is free of excessive residues for planting if a crop is not going to be planted the following year. The residues can also be left on the soil surface to act as a cover. This would greatly reduce erosion by both wind and water.

2.5.4 Soil erosion control

Soil erosion control and soil conservation measures and practices aim at reducing soil losses and sustaining soil fertility and productivity (Kimaro, 2003). On the other hand, soil water conservation and management aims at increasing the moisture retention capacity of the soil and the improvement of the hydraulic properties of soils. Major soil erosion control and soil conservation practices include contour tillage, strip cropping, terracing and mulching. A trash or stubble mulch, when used with field crops would not only check erosion but also increase infiltration, reduce evaporation and preserve granulation (Brady and Weil, 2001).

2.5.5 Crop rotation and intercropping

Growing different types of crops on the same piece of land in successive seasons or at the same time not only give maximum ground cover to control soil erosion but, at the same time improve soil structure and texture (Tisdale *et al.*, 1993). If leguminous crop is included in the mixture of crops which are grown on the field, it improves the nitrate content of the soil. Nitrogen fixing bacteria which live in the root nodules of legumes can fix atmospheric nitrogen and change it into nitrates. The nitrates are then absorbed by roots of the non – leguminous crops.

2.6 An overview of fertilizer use

Evidence from recent research work indicates that the impact of fertilizers in improving crop yield and hence agricultural production is generally the highest followed by improved seeds and agricultural practices in soils of moderate fertility (Dapaah and Ontikorang, 1990). Pinstrup –Anderson (1982) observed that an increase in fertilizer use was responsible for about 30% of the total increase in grain production and about one-third of the total increase in grain production in Asia and one-fifth in Africa. He further observed that the low contribution of fertilizers in increasing grain production in case of Africa is largely due to the low levels of fertilizer consumption.

Sustainable crop production requires judicious use of inputs such as fertilizers (Kimbi *et al.*, 2001). Inorganic fertilizers have over the last four decades dominated in agricultural production in most parts of the world (Ofori, 1993). The use of such fertilizers has however, drastically declined following the energy crisis which has immensely affected most of the developing countries (Hauck, 1982). Consequently, inorganic fertilizers are increasingly becoming unaffordable by most small-scale farmers. In Tanzania, the use of inorganic fertilizers for crop production has moreover been affected by the removal of fertilizer subsidies by the Government (Giller *et al.*, 1998). This has resulted in low yields of most crops due to deteriorating land productivity.

According to Schuuman (1994) and Fontaine and Sindzingre (1991), fertilizer subsidy policies have been adopted to reduce farmers costs, to encourage adoption of fertilizers and to increase usage. It is also believed that one of the major reasons in implementing fertilizer subsidy initiative was to transfer income to the small marginal farmers. A longer catalogue of the major reasons for government intervention in the fertilizer markets partly

because the private sector was unable to deliver the inputs with sufficient competitiveness, timeliness, quality, accuracy of information, and geographical coverage.

Soil fertility improvement can also be achieved through the use of organic amendments, such as animal manure, crop residues, green manure, agricultural and industrial wastes, sewage sludge, compost and possibly off-season weeds.

Tanzania is endowed with a large number of livestock such as cattle, goats, sheep, pigs, donkeys and poultry. Efficient use of manure from these animals could substantially alleviate the problems of declining land productivity in most parts of the country. Kyomo and Chagula (1983) reported that animal manure output in Tanzania to be about 11 million tons per year. Irrespective of such enormous potential, very little amount of animal manure is being utilized for crop production in most parts of the country. This is mainly due to lack of technical know- how by most farmers which largely emanates from inadequate scientific basis for advising farmers on aspects such as application rates, storage techniques and appropriate manure application methods.

Generally, fragility of the soil and inappropriate soil fertility management strategies are the main limiting factors constraining agricultural production. Increase in agricultural production requires an expansion of a rational consumption of fertilizers by farmers.

2.7 Fertilizer management practices

Management is a key factor which to a large extent determines the extent to which nutrients contained in fertilizers can effectively be used for crop production. Fertilizers are no substitute for poor husbandry and farmers should not be lead to believe that fertilizers

are the only answer to crop yield problems, therefore a more rigorously insistence on optimal management practices should always preceed any advice on the use of fertilizers (Samki *et al.*, 1982).

Efficient use of fertilizers means the supply of the proper amount of plant nutrients at the correct time in a plant available form while at the same time avoiding losses as much as possible. Kimbi and Semoka (2004) observed that proper storage and handling of animal manure before application minimize nutrient losses. Low soil fertility of the cultivated land is one of the major problems to enhanced crop production. In order to achieve sufficiency in food production, Tanzania needs to accelerate efforts to halt the decline in soil productivity and restore the productivity of the degraded soils. Information from various parts of the tropics indicates that combination of organic and inorganic fertilization results in great improvement in food crop yields (Egbe *et al.*, 1998). Furthermore, fertilizer application rates, application methods, time of application, storage and handling conditions are important factors which are likely to affect the quality of fertilizers, hence agricultural productivity.

2.7.1 Fertilizer application rates

Proper fertilizer application rates increases crop yields by correcting nutrient deficiencies. The optimum rate of fertilizer application to a crop is the rate that produces maximum economic return. However, it is smaller than the amount required produce undesirable effects on the environment (Colwell, 1994). Fertilizer response is a function of a number of environmental factors which include availability in the soil of plant nutrients and available moisture within the rooting depth of the particular crops (Abdoulaye and Sanders, 2005).

Fertilizer application rates vary depending on various factors such as economic value of the crop, price of the fertilizer, nutrients available in the soil, ability of the crop to absorb nutrients, moisture content of the soil, and nutrient removal by a crop and soil aeration (Love *et al.*, 2005).

With crops having high economic value, high rates of fertilizer application are generally advisable than crops of low economic value. For example, the recommended rate for tomatoes is 150 – 70 - 70 NPK, respectively while the recommended rate for wheat is 60 – 40 – 0 NPK respectively (Samki *et al.*, 1982). Tremendous differences exist in the ability of plant to absorb nutrients from a given soil. For example, peanut and lespedeza readily absorb adequate potassium under much lower soil potash levels than can alfalfa or soy beans. If nutrient removal by a given crop is high, fertilizer application should be increased to compensate for the loss.

2.7.2 Time and methods of fertilizer application

Time and methods of application are important aspects of fertilizer management practices as they affect fertilizer use efficiency. Response to fertilizers by crops can be affected by time of application in relation to stage of the crop growth and form of fertilizer applied (Abdoulaye and Sandes, 2005). Maximum use efficiency of fertilizer nitrogen is obtained during vegetative phase to grain filling stage, the stage that permit maximum utilization of fertilizer N (Tisdale *et al.*, 1993). Early applications, especially for fertilizers containing for example the nitrate form of nitrogen should be avoided so as to minimize loses through leaching (Prasad, 1996). Generally, P is applied prior to planting since growing crops need P for growth and development (Jain and Shara, 1993). Since P and K have low mobility in the soil, they are always applied before or at planting (Hadwani and Gundalia, 2005). The

best time for application of organic fertilizers like animal manure, is before planting season. Manure should be ploughed into the soil so as to allow the materials to decompose before planting operation begins and also to avoid nutrient losses through processes such as ammonia volatization and leaching (Brady, 1984).

Right choice of method of application will increase fertilizer use efficiency. There are several methods for fertilizer application such as broadcasting, banding and foliar application.

The choice of application method will depend on various factors such as type of fertilizer, form of fertilizer, amount to apply, mobility, type of crop and economic factors associated with the fertilizer (Home and Panda, 2005). For inorganic fertilizers this will depend on the nutrients contained in relation to mobility solubility, adsorption capacities and fixation in the soil.

Fertilizers with low mobility like phosphate fertilizers and fertilizers which are easily volatized like urea, banding method is recommended (Semoka, 2006). Banding is more advantageous when P fertilizer is more water soluble than insoluble P fertilizer. Application of P fertilizer through broadcasting leads to low nutrients concentration in the soil solution due to the fact that the applied nutrient is mixed with large volume of soils (Forth, 1990). However, application of phosphate fertilizer by broadcasting has been recommended in soils with low adsorption capacities (Sanches, 1976). Banding method of application reduces soil phosphate contact, resulting in less phosphate fixation in the soil than what would occur with broadcasting (Sleight *et al.*, 1984). Organic fertilizers should be well distributed over the field and incorporated in the soil. Manure should be ploughed

in the soil so as to allow the materials to rot and avoiding losses through processes such as ammonia volatilization and leaching (Lekasi *et al.*, 2003).

Broadcasting is commonly practiced in pastures and closely spaced crops such as small grains like millet and barley while banding is suitable for wide spaced crops like maize (Jansson and Persson, 1982). Cultivated crops that are grown in rows are usually fertilized by placing fertilizer as a narrow band on one or both sides or below the plant / seed (Engelstad and Terman, 1980).

Fertilizer is a costly input and therefore, its use efficiency has to be enhanced by a choice of more efficient placement method.

2.7.3 Fertilizer storage and handling

Storage and handling conditions of fertilizers are factors that determine the extent to which nutrients contained in fertilizers can effectively be used for crop production. Organic manure should properly be handled and stored before application in order to minimize nutrient losses. Kimbi and Semoka (2004) observed that animal manure from intensive livestock systems is of higher quality because of improved handling and storage practices whereas in most extensive livestock systems manure accumulate in open kraals for several years providing conditions for nutrient losses through processes such as leaching, ammonia volatization and run-off during rainy season. If left unprotected in kraals areas for substantial period of time, manurial quality is drastically reduced through processes such as ammonia volatization and leaching (Brady and Weil, 2001).

To maintain nutritive value of inorganic fertilizers Brady (1984) identified methods of insuring free flowage of inorganic fertilizers. The free flowing condition of fertilizer is

maintained by important procedures: moisture resistant bags are commonly used in distribution, certain moisture absorbing materials are usually included in the fertilizer mix and the fertilizer may be granulated. Granulation helps to prevent caking. Granulation also prevents the fertilizer from being carried by the wind, thus permitting more uniform spreading. Also granulation tends to reduce the rate of reaction with large volumes of soil.

2.8 Role of fertilizer use in crop production, food security and household income

Increase in production is a pre-requisite for improvement in household food security and income. Increased food availability is associated with soil fertility improvement through the use of fertilizers. Food security is attained through increased per capita production of food crops, having adequate income and ensuring that in times of shocks enough reserves are maintained to minimize vulnerability. The linkage between poverty and food security is a clear-cut with poverty considered the most widespread causes of food insecurity (World Bank, 2001). Since farming remains the source of food and the most important income generating activity in rural Africa, it should be linked with increased agricultural productivity, fertilizers use and environmental protection.

In some parts of Eastern Tanzania, maize yields are rapidly decreasing as a result of soil fertility decline. This trend can be reversed through appropriate tillage practices, organic matter and residue management in conjunction with modest application of inorganic fertilizers (Luambano, 2003).

Rweyemamu and Ndunguru (1984) observed that field bean grain yield and dry matter production were increased when cattle manure was applied. Results by Augustburger (1982) indicated that fresh chicken manure produced highest yield in the first crop of

potato but gave lowest in the second crop. It was concluded that this was due to fast release of N in poultry manure. Peat and Brown (1962) reported average cotton yields of about 550kg/ha per year from application of animal manure. Scaife (1968) observed a significant increase in seed cotton yield from application of 7.5tons/ha of cattle manure at Ukiriguru-Mwanza. Application of animal manure and other organic materials such as compost and mulch have been known to sustain good yields of banana and coffee in Kilimanjaro regions (Kasembe *et al.*, 1983). Generally, proper use of fertilizers insures increased agricultural productivity, hence food security and household income (sale of surplus produce).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

The research was conducted in Kilindi district, Tanga region. Kilindi district is located South West of Handeni district covering an area of 6129km^2. It has a potential arable land of about 216 240 hectares. Land under crop production is estimated to be 101 935 hectares, amounting to 35% of the district area. The district lies within an attitude of 500m to 1600m above sea level, with Nguu Mountains and plateaus covering the South West part of the district. The district experiences bimodal rainfall pattern. The short rains normally start from mid-October and ends in mid-January while the long rains season starts from mid-March and end in June. The annual rainfall ranges between 800mm to 1000mm. The population is 144 349 people with an average household size of 4.9 people. The population density is 32 people per square kilometers (Tanzania Census, 2002; Boi, 2004). The dominant ethnic groups are Zigua, Nguu and Maasai. Majority of the residents of Kilindi district live in rural areas and are engaged in crop production and livestock keeping as their major activities. The main food crops grown are maize, beans and cassava. Livestock species kept are cattle, sheep, goats and chickens.

3.2 Research design

The research design of the study was cross sectional survey. The design consisted of use of questionnaire to representative samples of the population at a single point in time. The design is useful for descriptive purposes as well as for determination of relationship between and among variables (Bailey, 1998; Cooksey and Lokuji, 1995).

3.3 Sampling techniques and procedures

Four divisions namely; Mswaki, Mgera, Kimbe and Kwekivu were purposively included in the study due to variability in climatic conditions. In each division, two villages were purposively selected on the basis of animal manure production potential. Sample size for each village was 30 respondents who were selected randomly. This was based on Bailey's (1994) observation, that regardless of the population size, a sample of 30 respondents is the bare minimum for studies in which statistical data analysis is to be done. A list of households in a village obtained from the village register was used as a sampling frame.

3.4 Data collection

3.4.1 Primary data

Several methods were used for primary data collection. These included household questionnaire survey, focused group discussion with the key informants using a checklist of questions and physical observation. The aim was to cross check and verify information obtained through these different methods based on the objective of the study.

3.4.1.1 Reconnaissance survey

A reconnaissance survey was conducted in order to get basic information related to the study objectives.

3.4.1.2 Focused group discussions

The group discussions were carried out with key informants guided by a checklist of open ended questions. The key informants considered here were the village leaders in each of the eight villages namely; Songe, Tunguli, Negero, Kibirashi, Mswaki, Kwediboma, Mabalanga and Kilindi. Other group of key informants considered was from KILIMO

Office in the district (DALDO and Extension officers).A group of ten farmers was formed in each of the eight villages. Information sought in group discussion consisted of crop production trends, extent of fertilizer use and major crops fertilized constraints to fertilizer use, farmers' opinions on effective soil fertility management practices and possible repercussions for each practice.

3.4.1.3 Household questionnaire

Household questionnaire was pre-tested in Kileguru and Mafisa villages by interviewing five households in each village in November 2006. The selection of these villages based on similar situations to sampled villages. The purpose of pre–testing was to check the validity of the instrument. Based on the results of the pre-testing, the questionnaire was adjusted accordingly (appendix 1).

Open and closed – ended questions were included in the household questionnaire. Type of primary data collected using household questionnaire included household characteristics, farming activities and production, extent use of fertilizers and major crops fertilized, management practices applied in fertilization, constraints to fertilizer use, income generating activities and food supply.

3.4.2 Secondary data

Several publications and reports were reviewed to get secondary information such as crop yield/trends, extent use of fertilizers, major crops fertilized, constraints to fertilizer use and suggested solutions. Main sources of such data included; KILIMO offices in the district and Tanga region, Ministry Headquarters and SUA Library.

3.5 Data processing and analysis

Data from primary sources were coded and analyzed using Statistical Package for Social Science (SPSS) computer programme. Results were summarized and presented both qualitatively and quantitatively using frequency tables and cross tabulations.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

This chapter presents results and discussions of the findings under the following sub-sections; Household head characteristics, Farming activities and production, Extent of fertilizer use and major crops fertilized, Fertilizer management aspects, Constraints to fertilizer use and Role of fertilizer use in production level, food security and household income.

4.1 Household characteristics

The household head characteristics examined in this study were: sex, marital status, age, household composition, education level and the main occupation. The purpose of choosing these characteristics was to get the general overview of what the respondents are composed of and how that influence production could levels and fertilizer use management practices towards poverty reduction.

4.1.1 Sex and marital status

Table 1 shows sex and marital status of household heads in the study area. Of the 240 household heads interviewed the highest proportion (95.4%) was males and 4.6% females. This may suggest that males are responsible persons in most of the households' responsibilities and are the ones who make major decisions concerning the household, especially production decisions. According to UNFPA (2008), men's lives are usually characterized as heads of household or wage-earners and children and society benefit from men's active involvement with their families. Anand and Sen (1995) reported that women's position within the household is subordinate to that of men and hence, men have

more powers than women. As a result they make all major decisions in the household thus sidelining women in decision making even in matters that directly affect them.

Table 1: Sex and marital status of the respondents (n=240)

Variable	Characteristics	Number	Percent
Sex	Male	229	95.4
	Female	11	4.6
Marital status	Married	211	87.9
	Single	16	6.7
	Divorced	7	2.9
	Windowed	6	2.5

The findings also show that 87.9% of the respondents were married, 6.7% single, 2.9% divorced and 2.5% widowed. Married couples in the study area are likely to be more food secure than single persons because of high labour reinforcement (Synergy) in accomplishing farm operations. Mkunda (2007) noted that through history, large families have been considered as blessing interms of labour force. Nypan (1991) indicated that most people are married because of the belief that marriage can offer a solution to possible hardship in life especially for most women. Results also indicate that Very few are widowed and divorced probably suggesting few deaths and/or few marriage problems.

4.1.2 Age, household size and occupation

Results in Table 2 indicate that age distribution in the study area vary from 19 to 70 years with the average age of 45 years. Majority (50%) were in the age of between 38 and 59 years, whereas 29.6% were in the age group of 19 and 37 years. About 20% were above 60 years.

According to Basnayake and Gunaratne (2002), the age of a person is usually a factor that can explain the level of production efficiency. Age influences experience, wealth and decision-making, all of which have an effect on the working capability of an individual, hence productivity.

Table 2: Age group of the respondents (n=240)

Age group	Number	Percent
19-37 years	71	29.6
38-59 years	120	50.0
> 60 years	49	20.4
Total	**240**	**100.0**

This implies that most of the household heads were in the economically productive age group. According to Mandara (1998) and Mtenga (1999), household members are considered economically productive from the age of 16 to 64 years. The age group of below 16 years is children some of whom attend schools and others too young to participate in farming activities. The age group of above 64 years is considered less productive because members of this group are too old to supply labour for production of economic goods and services. Kalamata (2006) noted that advancement in age above 64 years reduces body strength to engage in farming activities, leading to retirement from active physical work.

Results in Table 3 indicate household size in the study area. The average household size was 5.3 persons. The smallest household had 1 person while the largest had 11.

Table 3: Distribution of sample households by household size

Item	N=240
Average	5.3
Standard deviation	2.5
Maximum	11.0
Minimum	1.0
% within household size category	
1-2 persons	39
3-5 persons	34
6 persons	15
> 7 persons	12

The number of people per household ranged from 1 to 11 persons with most families having 1 to 2 persons (39%), about 34% of families was having 3 to 5 persons. About 15% of the families had 6 persons while12% had above 7 persons. This implies that most families in the study area had household size which is below the sample average of 5.3 persons per household (Table 3) suggesting low provision of family labour to agricultural production.

Results in Figure 1 also show that 38.3% of respondents were conducting farming activities, 36.3% were doing farming and livestock keeping whereas 13.3% were only keeping livestock suggesting that the majority of the population in the study area largely depend on agriculture (Crop and livestock) production. This is consistent with the URT report of 1997 which indicates that about 80% of the population in Tanzania is engaged in agriculture.

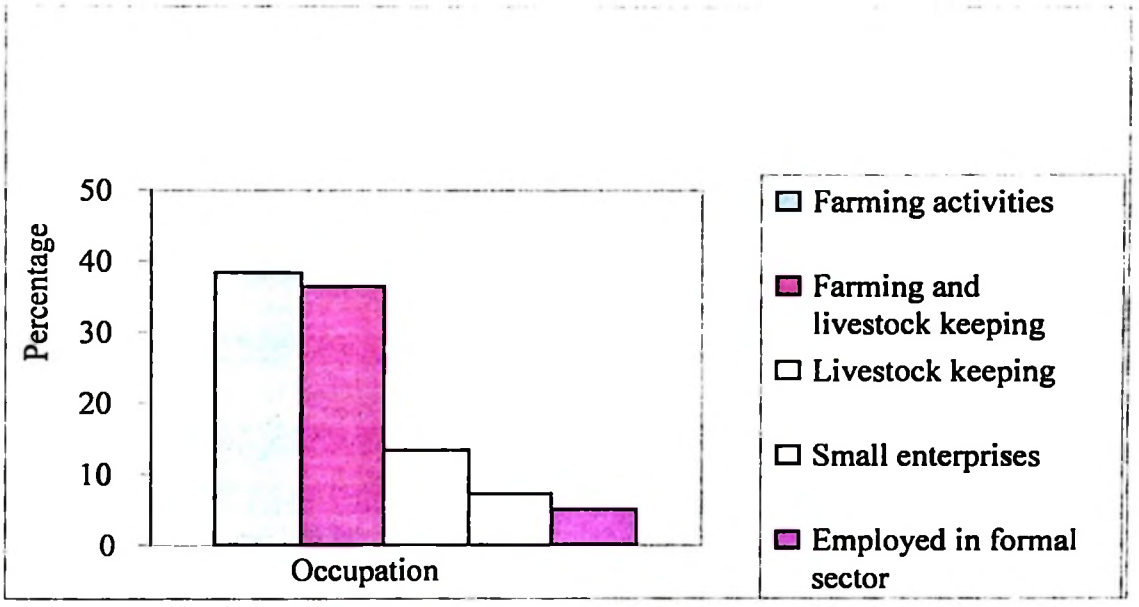


Figure 1: Distribution of respondents by occupation in the study area

About 7% of the respondents were engaged in small enterprises mostly in petty trading, masonry and lumbering whereas 5.0% were employed in formal sectors.

4.1.3 Education level

Results of the education level of respondents are shown in Table 4. Majority (55%) had standard VII level of education whereas 22.9% had no formal education, about 16% had standard I-IV education level and 5.4% had secondary school education level.

Table 4: Educational level of the respondents (n=240)

Education level	Number	Percent
No formal education	55	22.9
Standard I-IV	40	16.7
Standard VII	132	55.0
Secondary school (Form I-VI)	13	5.4
Others(Certificate, Diploma, Degree)	0	0.0
Total	**240**	**100.0**

These results suggest that most of the household members in the study area had modest education (Standard VII and above). With such education levels most of them are likely to adopt new technologies. According to Herath and Takeya (2003) education level is positively associated with the probability of adopting new technologies. Nkonya (1997) reported that farmer's education is a component in influencing technology and in accepting the concept of technology.

Education is also related to nutrition. It is argued that the pathway from education to improved health may work directly through improved allocation of resources to health as well as through changes in income (Sahn and Alderman, 1997).

4.2 Farming activities and production

Farming activities and production depend on production factors that have direct effects on what and how to produce at the household level. Such factors include land, farm implements, labour and capital. The ownership and access to these factors are very important attributes since those production assets assure the household increased agricultural productivity and production.

4.2.1 Land ownership and tenure systems

In order to determine land ownership and means of acquiring land respondents were asked whether they own land for crop production. Responses from the household heads are shown in Table 5. A substantial proportion (90%) of respondents in Kilindi district indicated that they own land. Results further indicate that 81.3% inherited land from their parents or grandparents. About 5% purchased land from friends and neighbours while,

3.7% rented land from neighbours or friends. Significant proportion of respondents (10%) indicated that they don't own land.

Table 5: Land ownership and tenure systems

Owns land	Number	Percent
Yes	216	90
No	24	10
Total	240	100
Land tenure systems		
Inheritance	195	81.3
Purchase	12	5.0
Rent	9	3.7
None	24	10
Total	240	100

Results from group discussions indicated that land size range from 0.5 to 10 ha. Most of the respondents had land size ranging from 0.5 to 3.5 ha suggesting low level of production as a result of small sizes of cultivated land coupled with inadequate crop management practices. Physical observation revealed that households with more than 3.5 hectares had plots of orchards, some planted with orange trees.

The quality and quantity of land determines to a large extent the amount and type of production that can be done in a particular place (Msola, 2007). This implies that those who inherited the land (own farms) are most likely to invest in long term production and adopt long term production technologies such as tree planting and control of soil erosion while those who rented land are likely to invest in short term production ventures such as production of annual crops.

Access to land for farming is essential in any farming business. Sibuga and Mdoe (1985) reported that land is an essential factor of production. Land is recognized by various financial organizations as a valuable resource that can be used as collateral when one applies for a loan that can be used as a capital for investment. For this matter, those who do not own land are not likely to access loans/credit facilities if land is to be used as collateral.

Farm expansion is one way of increasing crop production or crop diversity in Tanzania. Results in table 6 indicate that most farmers (40%) did not expand land for crop production due to inadequate labour, 33% due to inadequate capital, 24% due to inadequate land for expansion while 2% was due to health problems and 1% due to adequate land.

Table 6: Distribution of respondents (n=240) on the reasons for not expanding the land

Reasons	Number	Percent
Health problems	5	2
Inadequate labour force	96	40
Inadequate capital	79	33
Inadequate land for expansion	57	24
Adequate land	3	1
Total	**240**	**100**

This implies that majority of households in the study area mainly relying on family labour. Household analysis results (Table 3) indicated that on average households had 2 persons who can actively participate in farming activities, which is certainly not adequate.

4.2.2 Income

Results in Table 7 indicate that majority of respondents (63%) had income of between 51 000 to 100 000 Tshs per year, 22% had 100 001 to 200 000 Tshs per year while 7%had income of less than 50 000 Tshs per year. About 5% had more than 300 000 Tshs per year whereas 3% had income of between 200 001 to 300 000 Tshs per year.

Table 7: Income situation in the study area (n=240)

Income per year	Number	Percent
< 50 000	17	7
51 000-100 000	151	63
100 001-200 000	53	22
200 001-300 000	7	3
>300 000	12	5
Total	**240**	**100**

These results suggest that most farmers in the study area had low income compared to average per capita of 315.8 USD (URT, 2006).

Chilowa (1998) indicated that most small scale farmers in Tanzania have low income due to low production. Low income is undoubtedly one of the major limitations of productivity of both food and cash crops. Orr and Ritchie (2004) noted that crop losses from pests, low soil fertility and high fertilizer prices are major factors that lead to low income among smallholder farmers and therefore availability of credit would likely be a strong incentive for system productivity to them. Ownership of productive assets and access to implements for cultivation influences production, thus, use of agricultural inputs such as organic and inorganic fertilizers, pesticides along with improved seeds assures someone to get reasonably high yields (Feder *et al.*, 1985).

4.2.3 Labour

Household respondent's opinions were sought on the source of labour for production activities. Responses from respondents are summarized in Figure 2. The results indicated that about 84% of respondents were depending on the household members as the main source of labour for production activities whereas 14% indicated that the household labour was not sufficient for all production activities. They were therefore using hired as well as family labour. Only 2% of the respondents depended on hired labour.

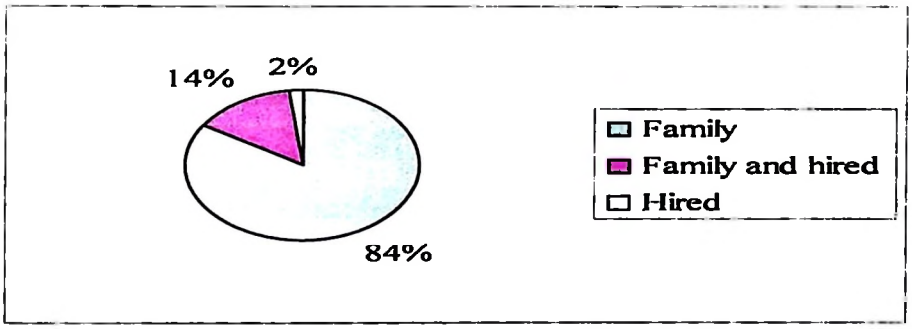


Figure 2: Sources of labour for production activities in the study area

This implies that majority of households rely on family labour. Only few people are capable of hiring labour suggesting low income to most farmers as shown in income situation analysis results (Table 7) that most farmers had income of between 51 000 to 100 000 Tshs per year which is certainly not adequate to run farm operations using hired labour.

4.2.4 Crop production and area under cultivation

The majority of the residents in the study area engage in crop production and livestock keeping. According to Boi (2004) these are the major household production activities and are among the major sources of household income. Major food crops grown are maize, beans, cassava and peas (Table 8). Among these crops maize is ranked high followed by beans and cassava.

Table 8: Pairwise ranking of major food crops in the study area

	Maize	Peas	Cassava	Beans	Score	Grade
Maize	X	Maize	Maize	Maize	3	1
Peas		X	Cassava	Beans	0	4
Cassava			X	Beans	1	3
Beans				X	2	2

Results from group discussions indicated that cotton and tobacco used to be major cash crops in the past but due to collapse of the cooperative unions farmers decided to replace them with food crops.

Analysis of information contained in Table 9 indicates that crop yields are far below the potential yields.

Table 9: Crop harvests and area cultivated in 2004/05-2005/06

Crop	Area cultivated (ha)	Total harvest (t)	Yield (t/ha)	Potential yield (t/ha)
2004/05				
Maize	14 032	13 053	0.9	4.0-8
Beans	3 328	4 655	1.4	1.5-3
Cassava	76 010	15 340	0.2	2
Peas	7 433	5 060	0.7	1.5-3
Other crops	38 005	15 202	0.4	-
2005/06				
Maize	12 410	1 023	0.1	4.0-8
Beans	1 847	30	0.02	1.5-3
Cassava	22 126	605	0.03	2
Peas	4 139	283	0.07	1.5-3
Other crops	20 081	1 720	0.09	-

Source: Tanzania Mainland Basic Data Agricultural Sector 1994/95-2000/01

Results of the focus group discussions indicated that reasons for the low crop yields include among others, poor soil fertility, dependency on rainfed agriculture, inferior seeds, and high price of fertilizers, pests and diseases (Table 10).

Table 10: Pairwise ranking on major reasons for low crop yields in the study area

	Poor soil fertility	**Dependency on rainfed agriculture**	**Inferior seeds**	**Pests and diseases**	**Score**	**Grade**
Poor soil fertility	X	Poor soil fertility	Poor soil fertility	Pests and diseases	3	1
Dependency on rainfed agriculture		X	Dependency on rainfed agriculture	Poor soil fertility	2	2
Inferior seeds			X	Dependency on rainfed agriculture	0	5
Pests and diseases				X	1	4

According to URT (2003) major factors that have contributed to low crop production in Tanzania include heavy dependence on rain with little emphasis on irrigation, poor access to market outlets and market information, poor crop management practices, inferior farm implements, poor physical infrastructure, decline in quality and quantity of support services. Others are lack of improved seeds, poor plant protection services and low soil fertility. Continuous production without external nutrient inputs decreases fertility of soils.

4.3 Extent of use of fertilizers and major crops fertilized

Nutrient replenishment is very important for crop production. Application of fertilizers (Organic and/or inorganic) is one of the most important solutions to enhance soil fertility hence land productivity (IFADC, 1986).

In order to establish the extent of fertilizers use for crop production farmers respondents were asked whether they use organic or/and inorganic fertilizers for crop production. Responses from the respondents are summarized in Table 11.

Results show that, only 1.3% of the respondents use inorganic fertilizers whereas 3.0% use animal manure as the source of organic fertilizer and none of the farmer respondents use both organic and inorganic fertilizers.

Table 11: Extent of fertilizer use in the study area (n=240)

Response	Inorganic fertilizers	Organic fertilizers	Both, organic and inorganic fertilizers	
	%	%	N	%
Use	1.3	3.0	0	0
Do not use	98.7	97.0	240	100
Total	**100.0**	**100.0**	**240**	**100**

The inorganic fertilizers used were only Urea (N carrier). Group discussions revealed that most farmers indicated that they have never used P and K fertilizers. These results suggest that, most farmers in Kilindi district do not use fertilizers for crop production. This implies that crop production in this district is largely carried out without fertilizer application. These results are consistent with those of Kimbi *et al.* (2004) who indicated that most of the small scale farmers in Tanzania do not use fertilizers for crop production mainly due to

high prices of inorganic fertilizers. They further indicated that animal manure is also under utilized due to low level of knowledge among farmers and extension workers. Figure 3 shows that the major crops fertilized are maize and vegetables. Results further indicate that maize is mainly fertilized by Urea whereas manure is used for fertilizing vegetables (DALDO, 2007). This was expected since most farmers tend to invest in an enterprise that gives immediate profitable returns. According to Swinner *et al.* (2005), economic value of the crop is the most important factor that determines extent of fertilizer use. Jayne *et al.* (2003) noted that removal of fertilizer subsidies has adversely affected the overall fertilizer consumption for crop production.

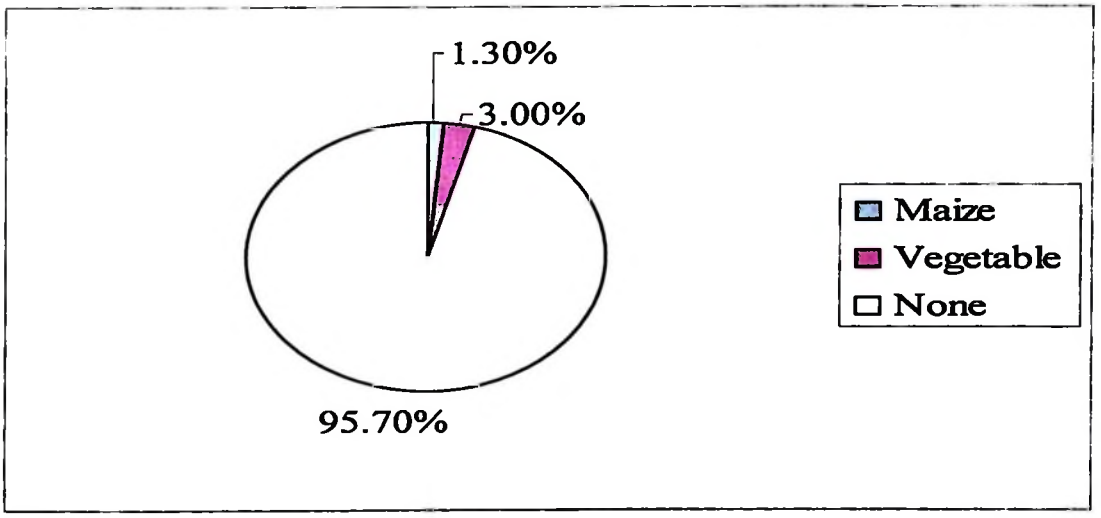


Figure 3: Major crops fertilized

4.4 Fertilizer management practices

Management is a key factor which to a large extent determines the extent to which nutrients contained in fertilizers can effectively be used for crop production. Important factors which are likely to affect the quality of fertilizers are fertilizer application rates, methods and time of application and storage of fertilizers (Rotter and Keulen, 1997).

4.4.1 Fertilizer application rates

Appropriate fertilizer application rates increase crop yields by correcting soil nutrient deficiencies. The optimum rate of fertilizer application to crop is the rate that produces maximum economic return. However, it is smaller than the amount required to produce maximum crop yield but it is likely to produce undesirable effect to the environment (Colwell, 1994).

In order to assess farmers understanding on use of proper application rates, farmer respondents were asked whether they have any knowledge on estimating rates required for inorganic or/and organic fertilizers. Results in Table 12 indicate that farmers in the study area lack knowledge on application rates. This could imply inadequate extension service.

Table 12: Knowledge on fertilizer application rates (n=240)

Knowledgeable	Number	percent
Yes	0	0
No	240	100
Total	**240**	**100**

According to Samki and Harrop (1984), recommended rate for maize production in Kilindi district is 80kg N per hectare and 40kg P_2O_5 Per hectare respectively. (Table 13). Most farmers in Kilindi district use between 20 to 35 kg N/ha and 15 to 25 kg P_2O_5/ha (DALDO, 2007). This is far below the recommended rates (Table 13) suggesting inadequate fertilization. The resultant effect of this situation is low yields observed for most crops in the area (Table 9). Abdoulaye and Sanders (2005) observed that adequate fertilization is crucial for optimum crop yield.

Table 13: Recommended rate of application of inorganic fertilizers in Kilindi district Tanga region

Crop	Fertilizer rate (kg/ha)			
	N	P_2O_5	K_2O	Lime
Pineapples (38,000p/ha)	-	-	-	-
Citrus	-	-	-	-
Bulrush-millet	-	-	-	-
Sunflower	-	-	-	-
Maize	80	40	-	-
Cotton	40	40	-	-
Sorghum	-	-	-	-
Groundnuts	-	60	-	1t/ha
Sisal: Immature	50	-	-	5t/ha

Source: Samki and Harrop, 1984

4.4.2 Methods of fertilizer application

Fertilizer application methods were identified through interviews and field observation. Farmers were asked about method they use to apply manure in the field. The data in Figure 4 indicate that most farmers (83%) in the study area broadcast cattle manure without incorporation in the soil whereas only 17% incorporate manure in the soil.

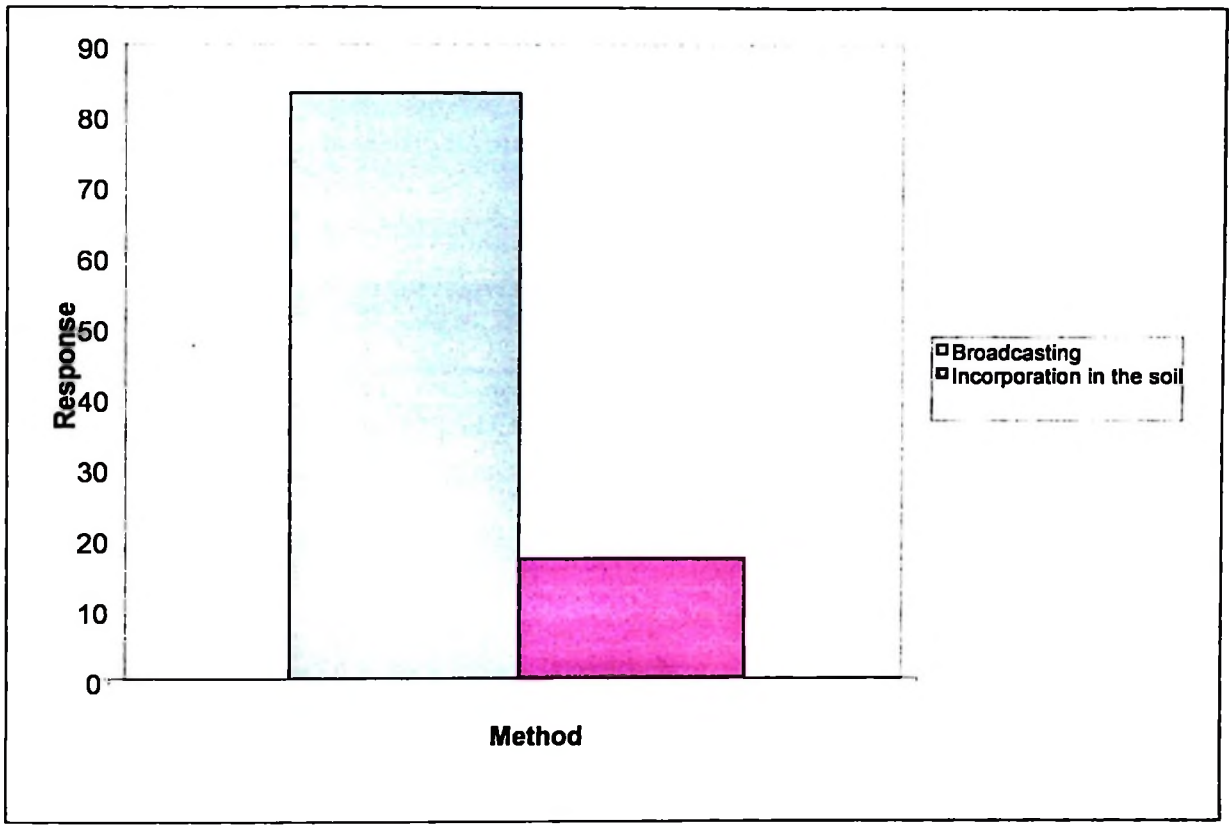


Figure 4: Percentage of respondents on manure application methods

The results therefore suggest that nutrient losses in the study area could be substantial. According to Lekasi *et al.* (2003), nutrient losses could be severe if manure is spread on the land without incorporation in the soil. Manure should be spread and ploughed under as soon as possible to minimize nutrient losses. Manure should be ploughed in the soil so as to allow materials to decompose before planting operation begins and also to avoid nutrient losses through processes such as ammonia volatization and leaching (Brady, 1984). Stevenson (1982) further noted that, unlike nitrogen in commercially prepared fertilizers, nitrogen in organic materials must be mineralized before it becomes available to plants. This mineralization occurs as micro organisms decompose the organic materials in the soil.

4.4.3 Time of fertilizer application

An attempt was made to establish time of the season in which manure and urea are applied in the field. Responses from focus group discussions are shown in Tables 14 and 15, respectively.

Table 14: Pairwise ranking on time of manure application

	After sowing	Before and after sowing	Before sowing	Score	Grade
After sowing	X	Before and after sowing	Before sowing	0	3
Before and after sowing		X	Before sowing	1	2
Before sowing			X	2	1

Results suggest that most farmers in the study area apply manure before sowing. Donald and Beemer (1981) suggested that the best time for application of animal manure is after land preparation. This is important due to the fact that nutrient release from manure requires thorough decomposition.

Table 15: Pairwise ranking on time of Urea application

	Before sowing	One week after germination	Two weeks after germination	Three weeks after germination	Four weeks after germination	Score	Grade
Before sowing	X	One week after germination	One week after germination	Three weeks after germination	Four weeks after germination	0	5
One week after germination		X	Two weeks after germination	Three weeks after germination	Three weeks after germination	2	3
Two weeks after germination			X	Four weeks after germination	Four weeks after germination	1	4
Three weeks after germination				X	Three weeks after germination	4	1
Four weeks after germination					X	3	2

Results in Table 15 show that most farmers apply Urea three weeks after germination. This is probably the best time of fertilizer N application given the fact that N crop requirement is during vegetative stage. Tisdale *et al.* (1993) noted that for cereals, maximum use efficiency of fertilizer nitrogen is obtained during vegetative phase to grain filling stage, the stage that permit maximum utilization of fertilizer N.

4.4.4 Fertilizer storage techniques

In order to enhance fertilizer quality, emphasis should be on proper ways of storage so as to minimize nutrient losses resulting in low nutritive values.

Focus group discussions (Table 16) and field observations revealed that most of the farmers do not manage animal manure properly. Manure is left piled in open shelters and is hardly removed from the kraals. This is also an indication that most farmers do not use manure for crop production. Macintosh and Varnet (1973) observed that manurial quality is drastically reduced through processes such as ammonia volatization and leaching if left unprotected in open areas for substantial period of time. When manure accumulates in the ban or shed or pile high and protected from direct exposure leaching and volatization losses are reduced. According to Cooke (1982), rapid handling and application in the field could also substantially reduce such losses. Kimbi and Semoka (2004) observed that manurial quality in intensive grazing system in Tanzania is higher compared to extensive grazing system largely because of improved storage practices. In intensive grazing system frequency of manure removal is higher and most farmers store manure in sheltered places.

Table 16: Pairwise ranking on frequency of manure removal in kraal

	Once after every year	**Twice after every year**	**Leave manure in kraal and shift to another**	**Score**	**Grade**
Once after every year	X	Once after every year	Leave manure in kraal and shift to another	1	2
Twice after every year		X	Leave manure in kraal and shift to another	0	3
Leave manure in kraal and shift to another			X	2	1

4.5 Constraints to fertilizer use

Results in Figure 5 indicate that 72.1% of respondents felt that inorganic fertilizers were not used because they are expensive whereas 22.5% indicated that inorganic fertilizers are not readily available at the right time. About 5.4% felt that inorganic fertilizers were not used due to inadequate knowledge among the farmers suggesting low adoption of inorganic fertilizers in the study area. Jayne (2005) noted that inorganic fertilizers in Sub-Saharan Africa are expensive due to removal of fertilizer subsidies. According to Swinner *et al.* (2005), one of the major reasons for low use of inorganic fertilizers is low purchasing power of resource poor farmers. This is consistent with the results in Table 7 which testify that most farmers in the study area have low income, hence low purchasing power of agricultural inputs.

Poor and inefficient fertilizer supply and distribution system makes it unavailable to farmers at the right time (Elsevier, 2008).

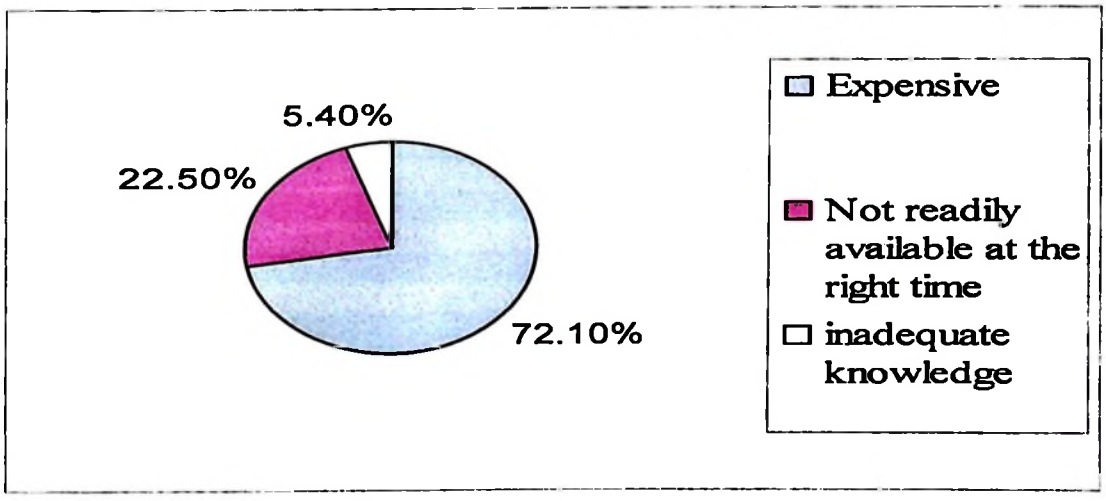


Figure 5: Constraints to inorganic fertilizer use

Results in Figure 6 indicate that 45% of respondents were not using animal manure due to low level of knowledge whereas 30% were not using animal manure because it is labour

intensive and 15% felt that long distance to farms made them not to use animal while 10% were of the opinion that animal manures were not enough suggesting that most farmers in the study area do not use animal manure as the source of organic fertilizer for crop production.

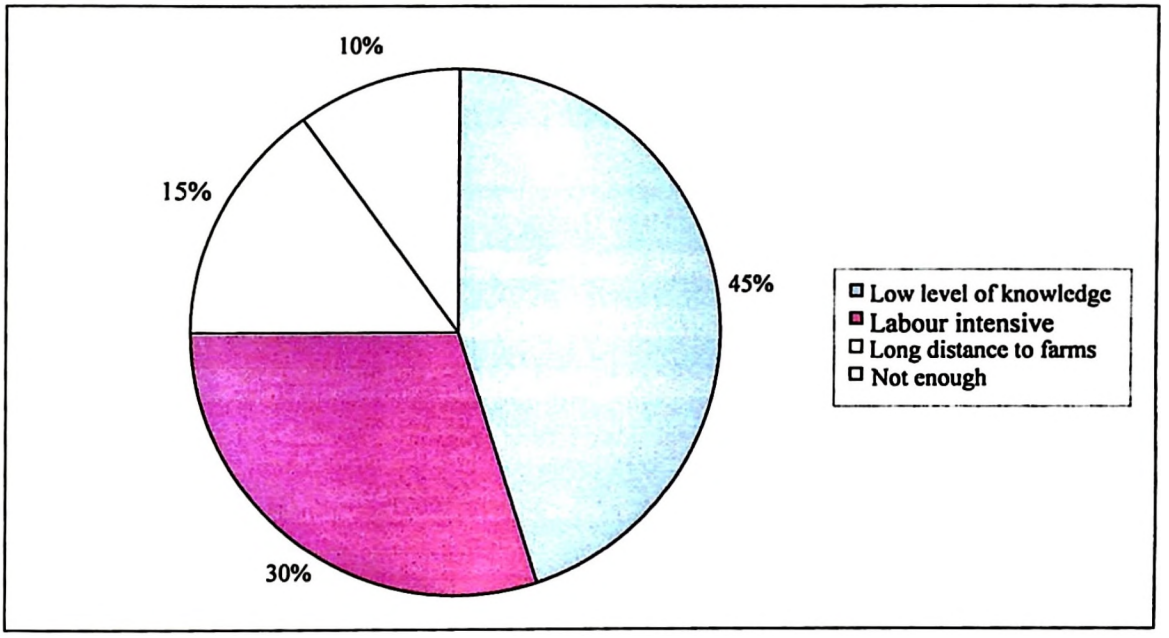


Figure 6: Constraints to organic fertilizer use

Kimbi *et al.* (1999) noted that in areas practicing extensive grazing systems main factors limiting the use of animal manure are lack of technical know-how, long distances to the fields, inferior transport facilities coupled with labouring nature of handling and applying manure.

Respondents were also asked to give their views on what should be done to improve fertilizer use (Inorganic and Organic) for crop production. A look at Table 17 (a) reveals that majority (52%) of respondents suggested that farmers should be educated/sensitized since most farmers are not aware about the importance of fertilizers. A significant proportion (38%) suggested that Government should subsidize fertilizers whereas 10% were of the opinion that farmers should be given loans/credits to buy fertilizers.

Table 17 (a): Respondents' suggestions on inorganic fertilizer use

Suggestion	Number	Percent
Government should subsidize fertilizers	91	38
Farmers should be educated/sensitized	125	52
Farmers should be given loans/credits to buy fertilizers	24	10

Table 17 (b) shows that majority (55%) of respondents suggested that farmers should be trained whereas 25% felt that appropriate technologies for manure handling and application should be developed while 20% suggested that transport facilities should be improved.

Table 17 (b): Respondents' suggestions on organic fertilizers use

Suggestion	Number	Percent
Training farmers	132	55
Develop appropriate technologies for manure handling and application	60	25
Improving manure transport facilities	48	20

This is an indication of a potential for educating farmers on the use of fertilizers to increase production in food and cash crops. According to Lapar and Ethui (2004), farmers who are educated are more likely to adopt manure utilization practices for increased crop production. Training should be qualified to include different methods such as demonstrations, Farmers Field Schools (FFS), tours, workshops and seminars (Desai, 2002). Ley *et al.* (2002) indicated that the capacity of local communities in soil fertility management should be enhanced by enabling them access available information and knowledge through short training sessions and tours. Well designed trials in the field should also be part of training programmes.

4.6 Role of fertilizer use in production levels, food security and household income

Increase in production is a pre-requisite for improvement in household food security and income. Increased food availability is closely associated with soil fertility improvement through the use of organic or/and inorganic fertilizers which, inturn, improve crop yields.

4.6.1 Contribution of fertilizer use to production level and food security

Results of focus group discussions in Table 10 indicated that major reasons for low crop yields in the study area include; poor soil fertility, dependency on rainfed agriculture, inferior seeds and high price of fertilizers, pests and diseases. Analytical results in Table 11 further indicated that only 1.3% of respondents use inorganic fertilizers whereas 3.0% use animal manure and none of the farmer respondents use both organic and inorganic fertilizers. Further analysis indicated that major crops fertilized are maize and vegetables. In any case, results indicated that most of the farmers carry out crop production without using fertilizers. This is reflected by the low yields observed for most crops (Table 9) pointing to likelihood of food insecurity.

Mkunda (2005) noted that many rural households in Tanzania experience food insecurity. One of the major causes of food shortage in the country is poor harvests, as a result of drought, poor soils, declining soil fertility, lack of capital to buy inputs and insufficient labour availability (FEWS NET, 2003). Valerie *et al.* (2005) indicated that increased use of fertilizers has been responsible for an important share of world-wide agricultural productivity growth. Tilman *et al.* (2001) noted that in order to produce the nutritious food supply needed to meet the demand of a growing and more affluent world population, the effective use of nutrients supplied from fertilizers is imperative. Instability and inconsistence in production is the most prevalent and least easily remedial cause of food insecurity among poor countries (Abbot *et al.*, 1993). UNDP (1997) indicated that in order to alleviate poverty and bring food security to a greater number increased food production is essential.

Results in Table 18 show that majority of respondents (66%) experienced food shortage in the year 2004/05 production season, which means that only 34% of the respondents were food secure. In the year 2005/06, 71% experienced food shortages whereas 29% were food secure.

Table 18: Responses on experience of food shortage in the study area (n=240)

Experienced food shortage	**2004/05**		**2005/06**	
	N	%	N	%
Yes	158	66	170	71
No	82	34	70	29
Total	**240**	**100**	**240**	**100**

In other cases 42% of respondents reported that food shortage was due to low soil fertility whereas 35% felt that the prolonged drought of 2006 caused food shortage, 15% felt that use of inferior seeds caused food shortage and 8% were of the opinion that food shortage was caused by pests and diseases (Figure 7).

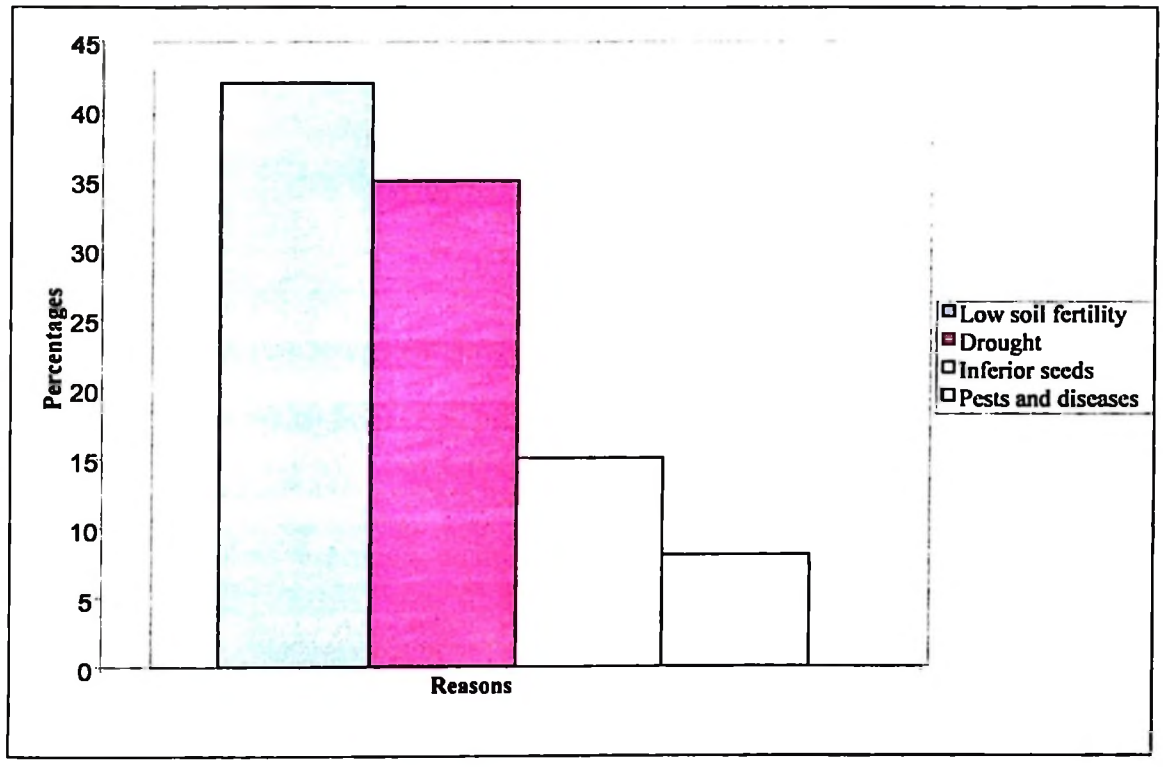


Figure 7: Major reasons for food shortage in the study area

This implies that most respondents in the study area face food shortage because of low soil fertility and drought. This is in agreement with Nyigili (2003) and Ley *et al.* (2002) who argued that, some parts of Tanzania face food shortage due to prolonged drought and low soil fertility respectively.

Results in Table 19 indicate major alternatives that are used as coping strategies during the period of food shortage. About (40%) of the respondents provide labour in exchange of

food and cash. About 28% sell livestock whereas 20% sell local beer and 12% of respondents sell firewood.

Table 19: Alternative means used in overcoming food shortage in the study area

Alternative means employed	Number	Percent
labour provision	96	40
Selling livestock	67	28
Selling local beer	48	20
Selling firewood	29	12

This implies that household facing regular incidences of food shortage normally develop mechanisms which help them to cope up with the stress. According to Nyingili (2003), various mechanisms are used in coping with food shortage. These includes: use of credits from merchants and money lenders, rationing of food consumption, sale of possessions, migration to other rural areas for employment, use of food distributed through relief programs and sale of productive assets. Rugalema (1998) cited by Mutangadura *et al.* (1999) found that household cut back the number of meals when faced with food shortages. Under such a situation households buy less expensive food as an alternative or substituting purchased relish with indigenous or wild vegetables.

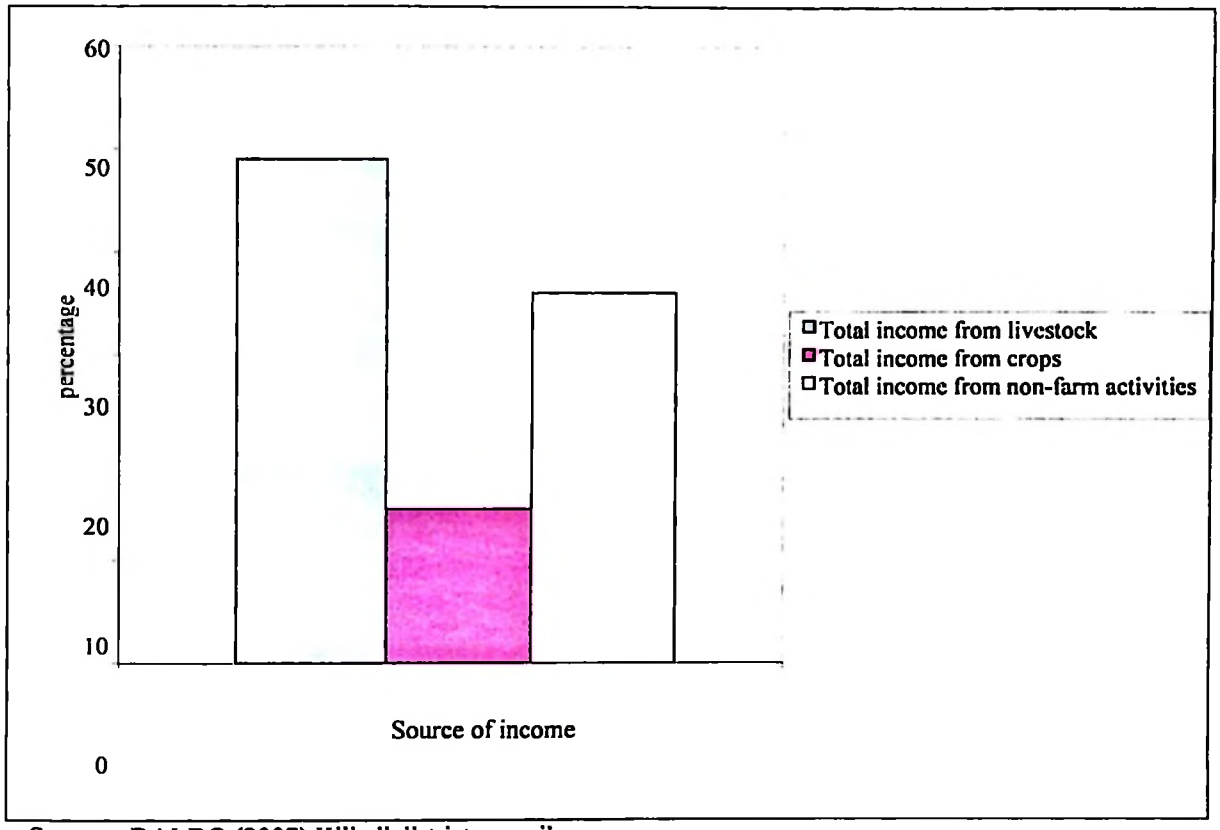
4.6.2 Contribution of crop production to household income

Majority of the population in the study area largely depend on agriculture (Crop and livestock) production (Figure 1). Further analysis indicated that most farmers in the study area have low income compared to average national per capita of 315.8 USD (Table 7).

There are three major sources of cash income in Kilindi district. These include; income from sales of livestock and livestock products, income from sales of crops and income from non-farm activities.

Table 20 indicates that income from sales of livestock and livestock products earned about 14 039 800 Tshs whereas income from non-farm activities earned about 10 345 800 Tshs and income from sales of crops earned 4 138 000 Tshs. Results in figure 8 indicate that 49% of the district's total income comes from selling of livestock and livestock products whereas 36% comes from non-farm activities and only 15% was from crop production.

The low contribution of crop production to the household income is a reflection of low crop production in the district. As it has already been alluded to, this is contributed by various factors such as poor soils, prolonged droughts, pests and diseases. There is therefore a need to address these problems in order to increase crop yields. Efforts should be directed to soil fertility improvement through integrated nutrient management approach which mainly focuses on use of fertilizers (Organic and Inorganic), management of crop residues, soil erosion control, use of mulches, intercropping and crop rotation. Farmers should also use improved seeds that are early maturing in order to cope up with insufficient rains.



Source: DALDO (2007) Kilindi district council

Figure 8: Contribution of each source of income to the total district's income in 2007

World Bank (2001) indicated that since farming remains the source of food and the most important income generating activity in rural Africa, it should be linked with increased agricultural productivity through appropriate agronomic practices, effective use of fertilizers coupled with irrigation schemes. Casterline (1989) noted that through sales of surplus produce at the household level, crop production at household level plays a significant part in the overall level of national income.

Table 20: Amount of revenue received from each source of income in Kilindi district.

Source of income	Amount (Tshs)
Livestock	
Cattle	9 275 000
Sheep and goats	1 644 500
Chickens	581 800
Other birds	57 000
Milk	2 523 900
Eggs	8 000
Total income from livestock	**14 039 800**
Crops	
Maize	164 000
Beans	3 316 000
Cassava	12 000
Other crops	646 000
Total income from crops	**4 138 000**
Non-farm activities	
Informal sector	6 892 000
Salaries	1 655 000
Remittances	1 849 300
Total income from non- farm activities	**10 345 800**

Source: DALDO (2007) Kilindi district council

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to assess the contribution of fertilizer management practices in enhancing food security and household income. The results indicated that most farmers do not use fertilizers for crop production. Very few farmers use inorganic and organic fertilizers for maize and vegetables, respectively. Results also showed that even the few ones who use fertilizers apply them at very low rates which can not suffice meaningful crop production. Results further indicated that the organic fertilizers used are not properly managed. Manure accumulates in open kraals and frequency of manure removal is quite low pointing to likelihood of nutrient losses. The study findings further established that crop yields are quite low due to poor husbandry practices especially appropriate fertilizer use leading to food insecurity and low household income.

Based on the study findings the following recommendations are pertinent:

1) Farmers should be sensitized and/or trained on proper use and management of fertilizers. Focus should be the use of integrated nutrient management approach. For multiplier effect different methods such as Farmers Field Schools, demonstration, tours, workshops and seminars should be used.
2) District authorities should come up with comprehensive packages to utilize animal manure which is abundant in the District. If wisely used for crop production, crop yields will increase hence increased income and food security.
3) Extension services should be improved. This is important if meaningful dissemination of agricultural technologies is to be attained.
4) Government, NGOs and CBOs should assist in setting up credit facilities for farmers so that they can access basic agricultural inputs

5) Increase awareness of land degradation and develop appropriate land management programmes.

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APPENDICES

Appendix 1: Questionnaire for household head

BACKGROUND INFORMATION

Name of the interviewer.....

Date of interview.....

Respondent's number.....

Name of village.....

Name of ward.....

Name of division.....

SECTION A

HOUSEHOLD CHARACTERISTICS

1) What is your age?(Tick)

a) < 18 years old b) 19 – 37 years old c) 38 – 59 years old d) > 60 years old

2.) Sex of head of the household (tick)

a) Female b) Male

3) Educational level of head of the household (Tick)

a) No formal schooling b) Standard I – IV c) Standard VII d) Secondary School e) others (specify).....

4) Marital status of head of the household (Tick)

a) Single b) Married c) Divorced/separated d) Widowed.

5) What is your family size? (Tick)

a) 1-2 persons b) 3-5 persons c) 6 persons d) >7 persons

6) Main occupation. (Tick)

a) Farming activities b) Livestock keeping c) Farming and livestock keeping

d) Small enterprises e) employed in formal sector

SECTION B.

FARMING ACTIVITIES AND PRODUCTION

7) Do you own any piece of land? (Tick)

a) Yes b) No (go to question 9)

8) If yes, how big is it? (In terms of acres) ----------

9) (A) How did you acquire/ get the land? (Tick)

a) Purchased b) Rented c) Inherited

(B) Please fill the following table

Land source	Acre(s)	Who owned
1. Inherited		
2. Purchased		
3. Rented		

10) Mention five major food crops you produce

a) ----------b) ----------c) ----------d) ----------e).----------

11) What was the production in two seasons?

Season	Food crop	Area cultivated (acres)	Total yield (kg)
2004/05	1.		
	2.		
	3.		
	4.		
	5.		
2005/06	1.		
	2.		
	3.		
	4.		
	5.		

12) Mention five major cash crops that you produce

a)----------b) ----------c)---------- d)----------e)----------

13) What was the production in two seasons?

Season	Cash crop	Area cultivated (acres)	Total yield (kg)
2004/05	1.		
	2.		
	3.		
	4.		
	5.		
2005/06	1.		
	2.		
	3.		
	4.		
	5.		

14) Did you expand land for crop production? (Tick)

a) Yes (go to question 16) b) No

15) If no expansion of acreage, explain why?

a).....

b).....

c).....

Capital

16) Do you buy any agricultural inputs? (Tick)

a) Yes b) No (Go to question 18)

17) If yes, which ones for two seasons 2004/05 and 2005/2006 (such as fertilizers, improved seeds, insecticides)

Season	Type of input	Value in Tshs	Source of input 1=purchased 2=on credit 3=as gift 4=exchange 5=others (specify)
2004/05	1.		
	2.		
	3.		
2005/06	1.		
	2.		
	3.		

18) If no, why?

a).....

b).....

c).....

d).....

19) Are there any sources of credit facilities which support farmers in this district? (Tick)

a) Yes b) No (go to question 21)

20) If yes, mention them

a).....

b).....

c).....

d).....

21) What is the major source of labour? (Tick)

a) Family b) Hired c) Both

Non – farm activities/ income source

22) What are the main sources of income?

a) sells of crops b) sell of livestock c) Small enterprises d) Employment in formal sector e) Others (Specify) .....

23) Do you sell some of the agricultural produce? (Tick)

a) Yes b) No (go to question 25)

24) If yes, why sold? (Tick)

a) For cash b) No or lack of storage facilities c) Others

(Specify).....

25) What is your average income (Tshs) per year? (Tick)

a) Less than 50,000/= b) 51,000-100,000/=c) 100,001-200,000/=

d) 200,001-300,000/=5. Above 300,000/=

26) If business is one of the income sources, what kind of activities are carried out?

a).....b).....c).....

SECTION C

FERTILIZER MANAGEMENT PRACTICES

27) Do you use organic fertilizers? (Tick)

a) Yes b) No (Go to question 29)

28) If yes, fill the following table

Type of organic fertilizer	Crop fertilized	Total yields (kg) in 2004/05	Total yields (kg) in 2005/06
Animal manure	1.		
	2.		
	3.		
Compost manure	1.		
	2.		
	3.		
Crop residues	1.		
	2.		
	3.		

29) Do you use inorganic fertilizers? (Tick)

a) Yes b) No (Go to question 31)

30) If yes, fill the following table

Type of inorganic fertilizer	Crop fertilized	Total yields (kg) in 2004/05	Total yields (kg) in 2005/06
N-carriers (tick) Urea, SA, CAN,	1.		
	2.		
	3.		
P-carries (tick) SSP, DSP, TSP	1.		
	2.		
	3.		
K-carriers (tick) Murriate of Potash, NPK	1.		
	2.		
	3.		

31) Do you have any knowledge on estimating rates required for fertilizer application?

(Tick)

a) Yes b) No (go to question 33)

32) If yes, fill the following table

Type of fertilizer	Area grown with crops (acres)	Rate of fertilizer used	Total yields (kg) in 2004/05	Total yields (kg) in 2005/06
Organic				
Animal manure				
Compost manure				
Crop residues				
Inorganic				
N-carriers				
P-carriers				
K-carriers				

33) If no, how do you estimate rates to be used? (Tick)

a) By guessing b) By contacting Village Extension Officer c) Through instructions given by shopkeepers d) Through experience from other farmers

34) What methods do you use to apply organic fertilizers in the fields? (Tick)

a) Broad casting b) Broad casting and incorporation in the soil

35) What methods do you use to apply inorganic fertilizers in the fields? (Tick)

a) Broadcasting b) Banding

36) In which time of the year do you apply organic fertilizers in the field? (Tick)

a) Before sowing b) After sowing c) Before and after sowing

37) In which time of the year do you apply inorganic fertilizers in the field? (Tick)

a) Before sowing b) One week after germination c) Two weeks after germination

d) Three weeks after germination e) Four weeks after germination

38) How do you store organic fertilizers?

a).....

b).....

c).....

39) How do you store inorganic fertilizers?

a).....

b).....

SECTION D

CONSTRAINTS TO FERTILIZER USE.

40) How often do you use fertilizers (tick)?

a) Every season (go to question 42) b) Rarely c) Not at all

41) If rarely/not at all, fill in the following table

Type of fertilizer	Frequency of application	Reasons
Organic	Rarely	1.
		2.
		3.
		4.
	Not at all	1.
		2.
		3.
		4.

Inorganic	Rarely	1.
		2.
		3.
		4.
	Not at all	1.
		2.
		3.

42) What are your suggestions so that organic fertilizers are used in every season?

a).....

b).....

c).....

d).....

43) What are your suggestions so that inorganic fertilizers are used in every season?

a).....

b).....

c).....

d).....

44) Any problem in fertilization management/application (mention)

a).....

b).....

c).....

d).....

SECTION E

FOOD SUPPLY

45) What is the household food requirement per year? .....Kg

46) Did you experience food shortage in this household in the following seasons? (Tick)

2004/05	2005/06
a) Yes	a) Yes
b) No(go to question 48)	b) No (go to question 48)

47) If yes, what are the reasons?

a).....

b).....

c).....

48) What do you do when there is food shortage?

a).....

b).....

c).....

SECTION F

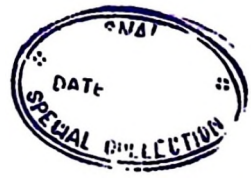
INSTITUTIONAL FACTORS

49) Do you have contacts with Village Extension Officer? (Tick)

a) Yes b) No (go to question 51)

50) If yes, how often do you have contact? (Tick)

a) Frequently b) Rarely



51) If no, why?

a).....

b).....

c).....

52) Where do you sell your crops?

a).....

b).....

53) Is the road passable throughout the year? (Tick)

a) Yes (Go to question (54) No

54) If no, in which months?

a).....

b).....

THANK YOU FOR YOUR COOPERATION