ASSESSMENT OF THE ROLE OF TRADITIONAL MAIZE STORAGE TECHNIQUES ON FOOD SECURITY

BY

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ABSTRACT

This study assessed the role of traditional maize storage techniques on food security, in Songea district. The specific objectives were (a) to identify and determine the extent of use of the main traditional maize storage techniques used in the study area (b) to determine the effectiveness of traditional maize storage techniques and (c) to determine the perception of the concept of food security by farmers in the study area. Cross-sectional research design was used in this study. Structured questionnaires, focus group discussions, and personal observation were the main instruments of data collection. The study revealed that the most common storage structures were; storage cribs *(Litara)* (4.3%), granaries *(Chibana)* (9.3%), polythene bags *(viloba)* (84.7%) ceiling storage, mud posts *(Makarangi),* tins and gourds which amounted to 1.7%. The study revealed further that about 93.3% of the farmers acknowledged that traditional storage techniques available in their area were ineffective in controlling and preventing biological agents of deterioration. Chemical pesticides were more used in preventing and controlling insect pests and rodents. Majority of farmers (80%) who used chemical pesticides either used the wrong pesticides or wrong dosage hence posing great health risk to end-users. The study also showed that despite majority of farmers (60%) having excellent knowledge on the concept of food security, there still existed pockets of hunger. About 47.5% were found to be food insecure. It was concluded that, the failure of typical traditional maize storage techniques in combating food storage problems and low level of maize production in the ward contributed to food insecurity. It was recommended that, storage techniques and farming technologies should be improved and extension officers and other stakeholders should put more emphasize on educating farmers on proper use of chemical pesticides

DECLARATION

I, Fratela Liborius Mapunda do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own work and has not been or is it being concurrently submitted for a similar degree award in any other University.

7th-08-2007.

Fratela Liborius Mapunda Date

(Master of Rural Development)

The above declaration confirmed

7/08/2007

Dr. Ballegu W. R. W Date

(Supervisor)

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AE	-	Adult Equivalent
CIMMYT	-	International Maize and Wheat Improvements Centre.
DALDO	-	District Agricultural and Livestock Development Officer
DDT	-	Dichloro-Diphenyly-Trichloroethene
DSI	-	Development Studies Institute
FAO	-	Food and Agriculture Organisation of the United Nations
FGD	-	Focus Group Discussion
HH	-	Household
ha	-	Hectare
ICRISAT	-	International Crops Research Institute for the Semi Arid Tropics
ICN	-	International Conference on Nutrition
Kcals	-	Kilocalories
Kg	-	Kilograms
LGB	-	Large Grain Borer
m	-	Meter
MAFS	-	Ministry of Agriculture and Food Security
No	-	Number
NAS	-	National Academy of Science
n	-	Sample Size
SPSS	-	Statistical Package for Social Sciences
SUA	-	Sokoine University of Agriculture
UN	-	United Nations
URT	-	United Republic of Tanzania

TARO	-	Tanzania Agricultural Research Organization
TAS	-	Tropical Agricultural Series
TDRI	-	Tropical Development and Research Institute
TFNC	-	Tanzania Food and Nutrition Centre
Tsh.	-	Tanzania Shillings
VEO	-	Village Executive Officer
WEO	-	Ward Executive Officer
WHO	-	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Food insecurity in the world has been addressed as one of biggest problems over several decades now. The reasons for food insecurity in the world are the result of increased world population and rising standards of living. For example, the United Nations had estimated that between 1970 and 1990 world population would grow from 3621 million people to 5346 million, an increase of more than 1700 million in just 20 years. These were the extra people the world was supposed to feed in 14 years time which were not long time in terms of agriculture (Hollingswoth, 1976).

Increasing standard of living in the world also puts more pressure on demand for food, because as people grow richer they tend to consume more meat, dairy products and eggs and hence indirectly more grain. It takes an average cow 17kg of vegetable protein to put on one kg of edible animal protein. Thus whereas in India the average per capita consumption of grain was 158 kg per annum, in the United State of America it was 675 kg. Japan is an example of the switch to a meat diet as a result of increase in prosperity (Hollingsworth, 1976). In many countries, however, no single cause and effect relationship can be established to the reasons for food insecurity. Food insecurity in the world can be the result of inability of the countries to produce sufficient food, inequalities of food distribution within the countries or for certain commodities, an imbalance of distribution between countries or the inability of certain sectors of the community to obtain a diet of sufficient quality (Robison, 1983). In the third world countries, inefficient marketing systems, poor transportation and communication networks, high post-harvest losses on food, demand-outstripping supply, inefficient food crisis management, lack of credit and resource degradation are some of the reasons for food insecurity in these countries.

Almost 800 million people in the developing World do not have enough to eat, and another 34 million people in the industrialized countries and economies in transition also suffer from chronic food insecurity. Almost half of the 10 million deaths among children aged less than five years in the developing world are associated with malnutrition (FAO, 2003). Hungry people make poor workers, they are bad learners (if they go to school at all), they are also prone to sickness and they die young. Hunger is also transmitted across generations as underfed mothers give birth to underweight children whose potential for mental and physical activities is impaired. The productivity of individuals and growth of entire nations are severely compromised by wide spread of hunger. Hunger breeds desperation, and the hungry are an easy prey to those who seek to gain power and influence through crime, force or terror, endangering national and global stability. Unless hunger is reduced, progress in cutting poverty is bound to be slow. A direct attack on hunger will greatly improve the chance of meeting the other Millennium Development Goals, not only for poverty reduction, but also those related to education, child mortality, maternal health and diseases (FAO, 2003).

Reliable studies indicate that post harvest losses of major food commodities in developing countries are enormous, in the range, conservatively, of tens of millions of tonnes per year and valued at billions of dollars (NAS, 1978) and hence contribute to food insecurity at household and national levels in general. One of the factors behind food insecurity among peasant farmers in Tanzania is wastage that is pre and post harvest losses. Agricultural experts say that more than 40 percent of food crops are lost soon after harvest. The loss is enormous, and has a significant effect on the overall campaign towards food sufficiency and security in the country (Acker *et al.*, 1984, Mfugale, 2004). Pesticides play an essential role in the prevention of losses in stored produce. At farm level, insecticide dusts can be effectively utilized, but the percentage of small farmers using pesticides is very small. Several reasons for this are given, such as unavailability of pesticides in rural areas, package sizes unsuitable for effective distribution, lack of extension credit for insecticides use and high cost of insecticides to farmers. Therefore, traditional methods of food storage have some role to play in assuring food security in the country and Africa at large (Mfugale, 2004).

1.2 Problem statement

Three quarters of the poor in developing countries live in rural areas, and the rapid increase in urban poverty is in part explained by the decline of agriculture in the rural sector. The rural face of poverty, human misery and food insecurity is now well established. Many of the rural poor are subsistence farmers. They depend on agriculture for their earning in the sector that derives from farming (FAO, 2003). Since 1972 to date the government of Tanzania has made several policy declarations and carried out a number of campaigns, programmes and reforms with the objective of attaining food security. The implementations of major food security campaigns, agricultural policies and the strategy adopted have not made any significant impact on the food security situation in the country. The number of rural households who are food insecure has been rising year after year. Improper management of storage facilities and the continued existence of rodents, insects, and fungi, continue to cause high post harvest losses on food (Kavishe, 1993). The magnitude of loss has not been clearly established. Currently it is estimated that these losses for grains are as higher as 30 to 40 percent per annum (Mfugale, 2004). To reduce such losses subsistence farmers are encouraged to make use of traditional maize storage techniques on the ground that they provide reasonable storage security for local farmers, do away with chemical pesticides' side effects and most of them are inexpensive, nevertheless traditional farming systems are being improved, farmers are also encouraged to plant high yield varieties which are normally easily susceptible to insects attack and other biological agents of deterioration (NAS, 1978). Therefore, how traditional maize storage techniques have adopted to these changes and how they help to combat post harvest losses have not yet been thoroughly investigated in many parts of our country

1. 3 Justification of the study

Enhancing agriculture is the key factor for reduction of food insecurity and poverty in the country. Food insecurity is a number one enemy, which must be fought by any weapon at our disposal, so as to find everlasting solution to the pressing question of food insecurity and of sustainable poverty reduction. The challenges are known, and the possible solutions have been stipulated. The question is not whether to promote the solutions, but rather how to implement them, with what resources, with what priorities and at what sequencing scheme. Comprehensive strategies that will work to improve agricultural production, enhance food security and contribute towards poverty reduction must be identified by policy makers and researchers.

Researchers need to recognize all underlying factors behind the food insecurity in the country. The country need better policies, and improved, assured and timely access by farmers to key agricultural inputs, including improved seeds, fertilizers and storage facilities. Small household farmers need access to better technologies and large markets. These are the key issues that researchers ought to address. Researchers have to ask themselves for how long shall the farmers remain poor and vulnerable to food insecurity. Natural disasters and severe food shortages experienced in Tanzania during the drought of 1991/92, 2001/02 and 2002/03 forced the leaders to launch international appeals for food aid. For how long shall the country remain a beggar for food? The answers to these questions remain at the hands of researchers and policy makers.

Smallholder peasants produce the bulk of food in Tanzania. There is no way the problems related to food security and poverty reduction will be solved without removing obstacles in the path of the smallholder peasants production system. The country has to identify those obstacles, and have to develop interventions to remove them. It must focus on ensuring food security at the family and community level. There are still too much post harvest losses in Tanzania, (over 30 – 40 percent). Food security has to begin at the household level.

Research on the role of traditional food storage methods is important because it facilitates the understanding of factors behind post harvest losses and its magnitude. The study aimed at establishing the role played by traditional maize storage methods and structures on food security in the study area. Tanzania government through the Ministry of Agriculture and Food Security and the Ministry of Water and Livestock Development put emphasis on addressing issues such as poverty reduction, food security and raising the standard of living of rural dwellers. Food insecurity among poor peasant farmers will persist for a good number of years to come, if improved food storage methods are not introduced. This study aimed at examining ways to improve maize storage methods.

1. 4 Objectives

1.4.1 Main research objective

The main research objective of the study was to assess the role of traditional maize storage techniques on food security in the study area.

1.4.2 Specific objectives

The specific objectives were: (a) To identify and determine the extent of use of the main traditional maize storage techniques used by rural households.

(b) To determine the effectiveness of the traditional maize storage methods and structures

(c) To assess the perception of rural farmers on the concept of food security.

1.5 Conceptual framework

The types of variables shown in the conceptual framework for the research were: background variables that included gender, age of household head, and sex of household head, marital status of household head, main occupation of household

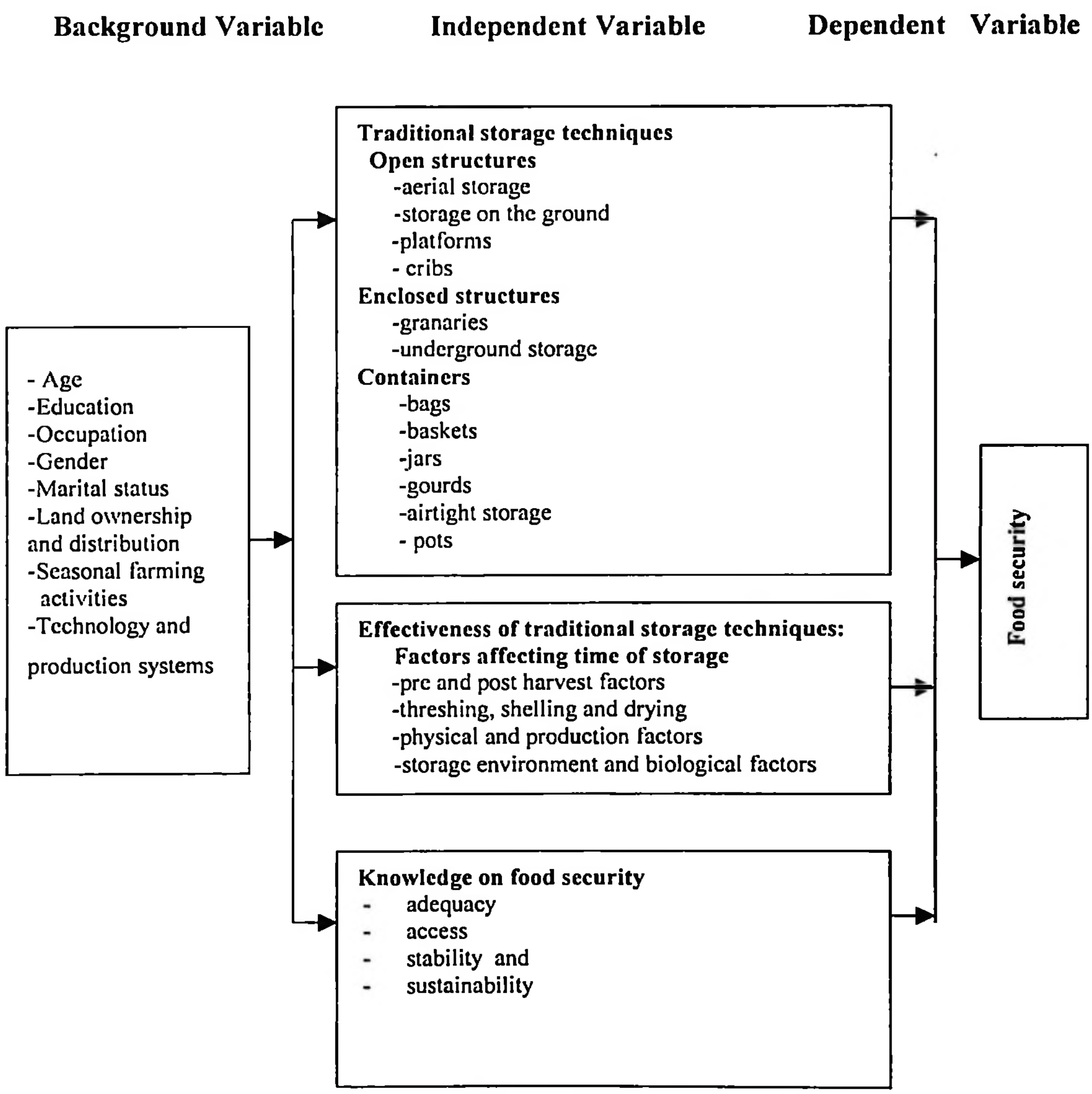

Figure 1: Conceptual framework for the research.

head, education level, non-farm activities done in the household, household composition, land ownership and distribution, seasonal farming activities, and lastly technology and production system. The independent variables included, storage methods and structures available in the study area (containers, enclosed and open structures), factors affecting effectiveness of storage techniques (pre and post harvest factors, threshing, shelling, drying, physical and production factors, storage environment and biological factors), and knowledge on food security (adequacy, access, stability and sustainability). These variables influence dependent variable, which is food security that is dietary energy consumption per adult equivalent. The conceptual framework is shown in Figure 1 above.

1.6 Hypothesis

1.6.1 Operational hypothesis

Based on the problem and specific objectives of this study, one hypothesis was proposed in this study, that is: "Traditional food storage methods and structures contribute significantly to reduction of post harvest losses and improve food security at household level."

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

In chapter one the background information on the problem of food security and its causes in the world, Africa and Tanzania in particular is provided. It was argued that reducing post harvest losses by traditional storage techniques may have positive results on the problems of food insecurity in Tanzania. In this chapter, a review of what is known about traditional maize storage techniques, its effectiveness and food security is discussed. This chapter begins by looking at the types of traditional maize storage structures and methods available in the third world countries, thereafter; factors affecting the effectiveness of storage techniques are discussed and lastly the review ends with discussion on the concept of food security.

2.1.1 Traditional storage methods and structures

More than three quarters of the agricultural output of African peasant farmers is kept at village level for use locally. This storage at farm level, in the place where crops are produced, has its advantages. It makes state investment unnecessary, does away with transportation and handling costs and eliminates the losses, which occur during these operations. Traditional systems have evolved over long periods of time to satisfy storage requirements within the limits of the local culture. The structures employed generally provide many features that are conducive to good preservation, and are inexpensive, as they are made of locally available materials. The type of foodstuff, size of crops and customs determine the design and capacity of these facilities. Farmers store their crops either outside, suspended or on platforms, in granaries and/or cribs, or even inside their dwellings. Grain for seed is frequently sealed in gourds or clay containers and kept in the house. Large amount of grain for human and animal consumption are stored in containers constructed of plant materials, mud, or stones, often raised off the ground on platforms and protected from the weather by roofing materials (TAS, 1987).

FAO (1983) has placed traditional maize storage structures in two categories, ventilated and non-ventilated structures. In ventilated storage, the crop continues to dry by exposure to moving air. This also reduces heating due to incipient mould development, but may expose the grain to fresh insect attack. This system is particularly suitable for storing cob maize in regions and periods of high atmospheric humidity, but requires careful design and control. The walls of these structures may be open or consist of slats or open-weave wicker-work. As the climatic regimes get drier, less ventilation is necessary - or indeed desirable from the pest infestation aspect - and the structures tend to be modified accordingly. Non-ventilated storage systems are normally associated with dry climates and require the crop to be at or below its specific moisture content for safe storage. The structures involved have solid walls and close-fitting filling/entry holes or lids. They are built from solid or plastered materials, such as mud bricks and woven bamboo covered with mud clay or cow dung slurries. Most of the solid walled, mud and clay structures commonly erected are slightly porous and tend to develop cracks on drying out that allow certain amount of ventilation, but prevent reinfestation from outside. An important feature of well-built non-ventilated structures is that they can be fumigated to control pest (FAO, 1983).

Traditional methods of controlling insects in storage involve mixing sand, dust, charcoal, limestone, ash or herbs with the grain. In addition to forming a barrier against involvement of insects through the grain; they abrade or absorb the wax coating of the insect's protective cuticle causing a loss of body moisture. In many areas insects and rodents are repelled by smoke from fires, used either within granaries to decontaminate them between harvests or under granaries constructed of permeable materials such as woven plant fibers. The fire also assists grain drying. (Kasambala and Mziray, 2004; FAO, 1983). In other areas stored grain is inspected frequently and is re-dried in the sun if insects are observed. Hermetic storage, that is grain sealed in impervious containers, is highly effective in excluding insects. However, the system is difficult for large quantities and is usually confined to relatively small amounts of grain seed.

Handpicking and/or sieving (e.g. weevils in rice) are frequently done for small quantities before marketing the produce or storage. According to Zehrer (1980), inflicting physical damage by vigorously agitating the grain is an active and widely practiced method for killing active pest, followed by sieving. The modern equivalent is to augur the grain frequently from one silo to another. Vegetable oils exert particularly good control of bruchid, beetles on pulses, by inhibiting development of the eggs, which are laid on the seed surface. Thus groundnuts oil at 2-5ml per kg of beans is used in the Caribbean, and 10ml of neem oil in India for controlling *callosobruchus maculates*. Adult beetles, however, are not affected. Various parts of the neem tree *(Azadirachta indica)* have been used since ancient times for insecticidal and medical purposes. For these reasons it is widely distributed around settlement throughout its native tropical India and Africa. Leaves, pieces of the bark and especially oil from the seed have marked insecticidal properties. By sandwiching leaves between layers of maize as it is placed in the store, good control of insect can be achieved FAO (1983). The insectical properties of neem have received much attention. In 1980 an international conference on the subject was convened in Germany (Schmutterer *et al.* 1981 cited by FAO, 1983). The best-plant insecticide is *pyrethrum,* which is extracted from flower of the species of *Chrysanthemum* grown commercially in Kenya and Tanzania. Tobacco leaves *(Nicotiana tabacum),* sweet flag rhizomes *(Acorus calamus)* and derris tubes *(Derris elliptical)* are examples of other widely used plant species having pesticidal properties. A comprehensive survey of the various species of plants and types of inert materials used in developing countries to deter or control pests of stored products was reported by Golob and Webley (1980) cited by FAO 1983.

The best way of dealing with rodent pest is to make the stores rat proof, that they cannot get inside and to destroy their breeding grounds. They can also be trapped, or hunted by cats, dogs (tame) and snakes. Many granaries constructed of mud are reasonably rat proof, especial if they are raised off the ground; in other cases where the stores are built up on platforms, the supporting poles can be fitted with rat baffles or guards. The mud walls of storage huts can be made as smooth as possible externally so that the rats can not get a foothold on them and, if the store is on the ground, it must, have a concrete or masonry floor or rock or brick as rats can bore up through an earthen one. Door at ground level should have a strip of metal along the bottom edge to prevent rats gnawing them, and all holes in a structure must be filled FAO (1983).

With the exception of sealed containers (including underground pit stores in dry areas that control insects by limiting the supply of oxygen), the traditional structures provide only limited protection against insects and rodent's damage, particularly in areas where the climate is warm and humid or where grain is stored for extended periods. Apart from the problems stated above, these traditional grain storage systems have evolved slowly by natural selection and provide reasonable storage security for the rural farmers. This does not mean that losses are necessarily low; it does mean that the risk of large-scale losses is minimized under traditional decentralized storage system. This type of preservation must be continued, subjected to minor improvements to certain system, in order to give the produce greater protection against pests and damp. Subsistence or traditional farming systems are being improve by the introduction of high yielding varieties of grain, which farmers are encouraged to grow. On the other hand, as a consequence of increased production the traditional storage system is proving inadequate not only in capacity, but also in protecting grain from damage, since the new variety may be more susceptible to insect attack (NAS, 1978).

2.1.2 Constraints to traditional maize storage techniques use

Small-scale farmers have for time immemorial used a variety of containers to store their food products. Most of these storage techniques are the results of long process of empirical trials, modifications and adaptations. In some cases, they have reached a level of equilibrium with environment and the functional requirements for safe storage. New constraints have limited the level of efficiency of the traditional storage techniques and have also made them to be unpopular (FAO, 1987). Some of these constraints may be listed as follows: - Socio-economic constraints like the necessity to store threshed and shelled grain for marketing purposes (for example grains must be readily available for sale to get necessary cash to buy other goods, to pay taxes, fees and medical expenses) whereas storage of unthreshed grain was usually is the mastered traditional method. Also migration of work force, limiting the availability of manpower for building or maintaining storage structures is another factors.

Ecological constraints, like prolonged drought in some regions, might result in the scarcity or even the disappearances of the preferred plant materials used for building granaries that are well know to farmers for their strength and resistance to termites even their repelling effect against insects. Spreading of insect pests (such as *Trogodern granarium Prostephanus truncatus*) in the region where they were not known before, rendering the storage techniques inefficient for the prevention of food losses.

Technological constraints like introduction of mechanical threshers in areas where storage is traditionally carried out with unthreshed grains, introduction and expansion of cash crops cultivation competing with food crops, for example, the harvesting of the crops might coincide with time when farmers traditionally were collecting building materials for construction of new granaries or doing the maintenance of structures. Improved production methods resulting in increased yield might require larger storage capacity than the ones of known traditional granaries, and introduction of new varieties necessitate the change of storage techniques (FAO, 1987).

2.2 Effectiveness of traditional storage methods and structures

The effectiveness of storage methods and structures depends very much on various factors as follows:

2.2.1 Pre- harvest factors

The genetic characteristics of a grain variety greatly influence the post harvest losses it is likely to incur. Traditional varieties are generally well adapted both to their usual environment and to post harvest handling. The grains that survive storage and are used in subsequent seasons have evolved characteristics that favour their survival. These may include, for instance lower moisture content in the ripe grain. Which, then dries more readily and thicker seed coats for repelling insects and rodents. Introduction of varieties selected for high yield has resulted in greater post harvest losses where the new varieties are not as well adopted to the post harvest conditions as traditional varieties. Damage to the growing crop may affect its post harvest characteristics, as may affect crop protection treatment prior to harvest (NAS, 1978).

2.2.2 Harvesting factors

The time at which harvesting occurs has an important effect on the subsequent storage quality of grain. Typically, the harvest may begin before the grains are fully ripe and may extend until mold and insect damage are prevalent and shattering has occurred. Grain not fully ripened contains a higher proportion of moisture, and will deteriorate more quickly than mature grain because the enzyme systems are still active. If the grain remains in the field after maturity, repeated wetting from rain and dew at night, along with drying by the hot sun by day may cause grain to crack (particularly long grain) and may increase the likelihood of insect damage (especially in maize, paddy, and pulses). Crops standing in the field after maturity become more liable to harvest losses. Ripened grain is more likely to be shattered onto the ground during harvesting. Loss may result from the loosening of the husk after it is ripe and subsequent mold infection or insect attack. The probability of insect infestation in the field is also likely to increase if the crops stand too long, as is loss to rodents, grain-eating birds and other vertebrates (Mulyo,1999; NAS, 1978).

2.2.3 Threshing and shelling

Traditional methods of threshing to separate grain from the plant, such as use of animals to crush the sheaves on the threshing floor or the modern equivalent using tractor wheels may result in loss of grain not separated. This method also allows impurities to become mixed with the grain, which may cause subsequent storage problems. The use of flails to beat the grain from the stalk may also damage the grains or kernels and is not always effective. Threshing and shelling will contribute to losses if carried out in a manner that result in cracking of grains. Modern devices for threshing and shelling may be used incorrectly, or for a crop for which they were not intended, with excessive breakage of grains (NAS, 1978).

2.2.4 Drying

Drying is a particularly vital operation in the chain of food handling since moisture may be the most important factor determining whether, and to what extent, grain will be liable to deterioration during storage. Drying is used to inhibit germination of seed and reduce the moisture content to a level that prevents the growth of fungi and bacteria. It can also retard attacks on the grain by insects and mites. In developing countries the methods available to farmers for drying crops are often limited, usually to a combination of sun and air drying, although supplement heat is frequently employed (FAO, 1983). In many cases seed grain may be treated separately from food grain and with great care. Drying is a complex process requiring considerable skill and effort on the part of the farmers; the success with which the grain is preserved over shorter or longer periods depends to a great extent on the care and attention given to the drying and subsequent storage.

Drying is often complicated by the introduction of high yield varieties that mature and must be harvested during wet seasons or by production of second, irrigated crop ("double-cropping") that must also be harvested during the rains. In these cases the grain requires artificial drying. The increased production of high yield varieties and their differing characteristics may also tax the farmer's ability to handle the grain properly by traditional methods. Consequently, a new drying and storage procedure must be adopted or the crop must be sold undried. The alternative may be to forego the new variety. Over drying which can easily occur in arid regions or after excessive exposure to sun or other heat can cause breakage, damage to seed coat, bleaching, scorching discoloration, loss of germination power, and nutritional changes. Too-rapid drying of crops with high moisture content also causes damage: for example bursting (or case-hardening), which causes the surface of the grain to dry out rapidly, sealing moisture within the inner layers. Under drying or slow drying (a problem in humid regions) results in deterioration due to fungi and bacteria and in extreme cases leads to total loss (NAS, 1978; FAO, 1984).

Solar technology for artificial drying is receiving attention because of its negligible running cost in comparison with traditional fuels which are becoming not only expensive but as in the case of fire wood (increased consumption of which is causing deforestation in many areas) are adversely affecting the environment. Clearly, methods of drying must be selected for the particular climatic, economic and social circumstances in which they will be used. This is especially true where existing drying methods have evolved over long periods of time to meet community and family survival needs (NAS 1978, FAO, 1983).

2.2.5 Storage environment

Storage conditions have much to do with the rate of deterioration. High temperature and humidity encourage mold development (growth) and provide conditions for rapid growth of insect population. Deterioration is minimal in cool dry areas, more marked in hot, dry ones, high in cool and damp conditions, and very high in hot damp climates (Mulyo, 1999). Climatic conditions during and after harvest affect the ease with which natural drying may be carried out and may dictate between stored grains and the surrounding environment can result in moisture translocation or migration among quantities of bulk or bag-stored grains or in condensation of moisture on the grains. Concentration of moisture in grain can lead to conditions favorable to development of fungi. Some climates lessen the residual activity of certain pesticides and can reduce the effective life of storage containers and structures. Certain structural materials may alter the effectiveness of different formulations of given insecticide (NAS, 1978; Mulyo, 1999).

Deterioration is also related to storage methods and management. For example, cob maize stored in open sided cribs takes up moisture more rapidly during the rain season than shelled maize in mud-walled cribs, so that conditions for rapid insect development are produced earlier in the storage season. On the other hand, properly designed open-side cribs will allow relatively rapid drying of unhusked ears of maize and reduce losses due to mold. Traditional pest control methods are often effective in keeping down infestation levels. For example, some farmers storing pulses and large grains will admix a smaller seed or sand with the grains to fill the intergranular spaces. This effectively inhibits the development of bruchid beetles. Other farmers use a fire under their store cribs to repel insects, either through the effect of the smoke or by keeping the grain dry. The admixture or overlay of ashes derived from burning various woods or dried animal dung is another method affording protection against insect attack (NAS, 1978).

2.2.6 Biological factors

The principal biological agents of deterioration during storage are insects and mites, fungi and rodents.

2.2.6.1 Losses due to insects and mites

Insect pests are a greater problem in regions where the relative humidity is high, but temperature is the overriding factor that influences insect multiplication. The nutritive requirements of insect are much the same as those of vertebrates. Crops with the highest nutritive value for man are also those most susceptible to insect damage. In certain cases, farmers may keep only small amounts of a nutritious crop such as beans because they believe damage and loss to be inevitable. Furthermore insects often select the most valuable portion of seeds. For example, important pests of maize attack the embryo and reject the starchy endosperm, thus removing the most nutritious part of the grain as well as destroying the power of germination NAS (1978).

Weight loss is of economic as well as nutritive importance and, in the absence of effective control measures, insect attack on cereal grains and beans can be so severe as to reduce the commodity to empty husk and dust. A large number of insects can be expected to produce heavy weight losses and the resulting contamination by dead and live insect and their excreta can be sufficient to make the commodity completely unpalatable or unacceptable in the market. Termites in a grain store can weaken the structure, leading to its collapse (NAS, 1978; FAO, 1983).

Control measures, whether or not insecticides are available, depend first on storage hygiene. Storage containers must be checked and cleaned as carefully as possible. Old stored grain should be checked and if necessary, redried and cleaned to control existing infestation. New dry grain should be kept separate from old stored grain because of the risk of cross-infestation. Similarly, stores should be as remote from the field as possible to reduce the risk of infestation. In addition it must be assumed that new grain is infested from the field and control must include a regular system of inspection and deterrence to maintain storage hygiene and take control measures where infestation is observed, (NAS,1978; Mulyo, 1999).

2.2.6.2 Losses due to Fungi

Fungi attack in storage generally occurs when drying has been inadequate, when large numbers of insects are present, causing a temperature rise in the grain, or when the stored crop is exposed to high humidity or actual wetting. Fungal development does not normally take place when the moisture content of the commodity is below that moisture content in equilibrium with a relative humidity of 70% (FAO, 1984; NAS,1978). In recent years attention has been given to the toxic products of certain fungi, such as *aflatoxins* and *zearalenone,* which are metabolites, respectively of the fungi *Aspergillus flavus* and

Fusarium moniliforme (FAO, 1983). Mycelia penetrate the endosperm of grain, removing nutrients. In many cases the embryo is attacked first and eventually destroyed. Fungal spoilage is more serious in those regions with a permanently high humidity or where seasons of high humidity coincide with the time when grain is being dried or kept in store.

Fungal activity has been considered to be a major cause of quality deterioration in food grains. The invasion of food grains by fungi is generally reflected by losses in weight and viability, discolouration, change in biochemical and functional properties and production of toxins (Saharan, 1970 cited by FAO 1984). Microorganisms may multiply and create heat that can increase in unventilated grain to the point of complete destruction. However, losses due to fungi are reduced as a result of improvements in drying and storage technology and do not need to be treated separately (NAS, 1978).

2.2.6.3 Losses due to Rodents

Rodents' damage to stored food can occur in a number of ways. The animals not only consume the food (damage to maize grain is characteristic in that the embryo is usually removed first), but also foul a large amount with their excretions (which may carry microorganisms pathogenic to man), destroy containers by gnawing holes that result in leakage and wastage of grain, and paw into and scatter grain while they eat. This scattered grain, along with that which leaks from gnawing holes, is subjected to contamination and admixture with impurities. Damage to grain stored in bulk may be less than to grain stored on the head or in bags because rodents are unable to burrow into the bulk (FAO, 1983).

2.3 Concept of food security

Food security may have different meanings for different people. The International Conference on Nutrition (ICN), held in Rome in 1992, defined food security as "access by all people at all times to the food needed for a healthy life" (von Braun, 1991). Essentially, in order to achieve food security a country must achieve following basic aims. It must ensure adequacy of food supplies in terms of quantity, quality and variety of food; optimize stability in the flow of supplies and secure sustainable access to available supplies by all who need it.

Adequate food availability at the national, regional and household levels, obtained through markets and other channels, is the cornerstone of nutritional well-being. At the household level, food security implies physical and economic access to foods that are adequate in terms of quantity, nutritional quality, safety and cultural acceptability to meet each person's needs. Household food security depends on an adequate income and assets, including land and other productive resources owned. Food security is ultimately associated with access to nutritionally adequate food at household level, that is the ability of households or individuals to acquire a nutritionally adequate diet at all times. Which means, access to nutritionally adequate and safe food; sufficient knowledge and skills to acquire, prepare and consume a nutritionally adequate diet, including those to meet the special needs of young children; access to health services and a healthy environment to ensure effective biological utilization of foods consumed (FAO, 1997). As expressed by FAO's Committee on World Food Security (FAO 1983, cited by FAO, 1997), food security has four basic components: adequacy, accessibility, and stability of food supplies and sustainability of food procurement.

2.3.1 Adequate or enough or sufficiency food

The concept of adequate (enough or sufficiency) food is an important part of the definition of household food security. Clearly, what is adequate for one member may not be adequate for another. A person's requirements for different nutrients depend on many factors including age, sex, level of activity and physiological status. However, adequacy of diets should not be considered only in quantitative terms (that is caloric sufficiency), but also in qualitative terms (that is variety, safety and cultural acceptability). Several major conditions define an adequate diet, necessary for an individual to stay active and healthy: It should provide adequate energy and protein, it should provide micronutrients (vitamins and minerals) in sufficient quantities to maintain good health, it should be safe and free from contaminants, parasites and toxins, which may be injurious to health, it should be culturally acceptable and, in addition, should satisfy the palate and be capable of providing pleasure to the consumers (FAO, 1997). Other writers have presented in different ways the concept of enough food as a "target level" (Siamwalla and Valdes (1980), cited by Maxwell *et al.* (1992); as a "minimal level of food consumption" (Reutlinger and Knapp, 1980); or as the food "adequate to meet nutritional needs" (Barraclough and Utting 1987). In more descriptive formulation Krachit (1981) refers to "enough food for life, health and growth of the young and for private effort;" The World Bank (1986) to "enough food for an active healthy life" and Sahn (1989) to "enough food to supply the energy needed for all family members to live healthy, active and productive lives."

2.3.2 Access to food and entitlements

The second concept is "access" the question of whether individuals and households (and nations) are able to acquire sufficient food. Household food security, as noted earlier, depends not only on the availability of an adequate and sustainable supply of food, but also on the strategies employed by households for its acquisition. The ability of different households to establish access to the food supply can be considered both in terms of production and in terms of the people's ability to exchange their assets for food, for example through bartering, purchase or food-for-work. People's assets may include their income; their access to, use of and/or ownership of land; their livestock; their labour and the products of their labour; their inheritance, gifts and transfers. The value of the exchange for individuals or households will vary with market forces, including wages and prices. Food enters a household in a variety of ways. A household may produce food when it has the human and material resources to do so. Such households have direct access to food. The ability of farmers to produce food in adequate amounts and sufficient variety depends to a large extent on their access to resources - chiefly sufficient and fertile land, labour, tools, seeds, draught power, credit and other essential agricultural services – as well as the knowledge to grow crops and raise animals that provide beneficial nutritional outcomes and sustain the household's livelihood on a continuous basis. In many rural communities, gathering of wild foods and non-wood forest resources also makes an important contribution to family food supplies (FAO, 1997).

Sen (1981) talked about "entitlement," on his entitlement framework which provides a systematic approach to the definition and assessment of vulnerability. An individual's entitlement is rooted in his or her endowment. The initial resource bundle, which is transformed via production and framed into food or commodities, can be used for food. If the entitlement set does not include a commodity bundle with an adequate amount of food, the person must go hungry; in Sen's terminology, "the individual has suffered an entitlement failure." In a private ownership market economy, the entitlement relations of individual are determined by: what they own, - own labour entitlements that describes the sale of one's own labour power; what they produce – production base entitlement that describes the right to own what one produces with one's own resources; what they can trade – trade based entitlements refers to what an individual can buy with the commodities and cash owned, or services, skills, physical things that can be sold; and what they inherit or are given – inheritance and transfer entitlements – the right to own what is willingly given by others as remittances, gifts or bequests, as well as transfers from the state such as social security, pensions and food distribution. Using the entitlement framework, Sen (1981) demonstrated that a decline in food availability was neither necessary nor sufficient to create hunger. He showed that famine could occur in the absence of any change in production, if the value of peoples production and work activities decline relative to the cost of staple food.

2.3.3 Security

Another concept is "security" secure access to enough food; this builds on the idea of vulnerability to entitlement failure introduced in the previous section, focusing more clearly on risk. The notions of risk and risk avoidance have been central to definitions of food security, since the term came into use in the 1970s. However, the scope of risk analysis has widened as the scope of food security itself has widened, to focus rightly on individual and household level analysis. The World Food Conference identified the risk of "acute food shortages in the event of wide spread crop failure, natural or other disasters," as well as the risk of fluctuations in production or prices UN (1975), cited by Maxwell *et al.* (1992) and many subsequent analyses similarly concentrated on risk to national food supply and the Balance of Payments (Valdes and Konandreas, 1981). At the same time, others began to look more at welfare vulnerability (Clay, 1981), short term variability in entitlements (Chisholm and Tyers, 1982) and the ability of household food systems to resist "crises threatening to lower the achieved level of food consumption" Eide (1990).

By the mid 1980s, analysis of risk of inadequate access had become an important concern World Bank (1989)), cited by Maxwell *et al.* (1992). Food insecurity was more often defined in terms of risk as resulting "from an unfavorable balance between risk and insurance," (Phillips and Taylor, 1990), as being at "undue risk of losing access to the food needed for a healthy life" Maxwell *et al.* (1992), as " the risk of an ongoing lack of access by people to the food they need." von Braun (1991).

Linking the discussion of risk to the discussion of entitlements in the previous section, it is possible to identify the risks to food entitlements. These can originate from many sources including variability in crops production and food supply, market and price variability, risks in employment and wages, and risks in health and morbidity. Conflict is also an increasingly common source of risk to food entitlements (Maxwell *et al.* 1992).

2.3.4 Stability of household food supplies

Stability of household food supplies refers to the ability of a household to procure, through income, production and/or transfers, adequate food supplies on a continuing basis (all the time), even when the household is faced with situations of unpredictable stress, shocks or crises. Such situations could include crop failure resulting from drought, market fluctuations such as sudden price rises, the decline or loss of employment and loss of productive capacity because of sudden illness. The concept also denotes an ability to stabilize food supplies through seasonal fluctuations of production or income. It also implies the household's ability to cope with or minimize the extent and duration of the effects of food deficits. The critical test of stability is the ability to bounce back or to regain quickly on adequate food supply. For this to be a possibility, safety-net mechanisms are needed such as community grain stores or labour-intensive public works to support the purchasing power of the poor temporarily and to absorb the effects of short-term production or income losses that adversely affect the food supply of households (FAO, 1983 cited by FAO, 1997).

Maxwell *et al.* (1992), emphasized more on the importance of time on the concept as, "secure access to enough food at all times". Following the lead of the World Bank (1986), it has become conventional to draw a distinction between chronic and transitory food insecurity. Chronic food insecurity means that a household runs a continually high risk of inability to meet the food needs of household members. In contrast, transitory food insecurity occurs when a household faces a temporary decline in the security of its entitlement and the risk of failure to meet food needs is of short duration. Transitory food insecurity focuses on intra and inter-annual variations in household food access. It has been argued that this category can be further divided into cyclical and temporary food insecurity. Temporary food insecurity occurs for a limited time because of unforeseen and unpredictable circumstances: cyclical or seasonal food insecurity occur when there is a regular pattern in the periodicity of inadequate access to food. This may be due to logistical difficulties or prohibitive costs in storing food or borrowing. In practice, chronic and transitory food insecurity are closely linked. Successive exposure to temporary, but often severe, stress may increase the vulnerability of the household to chronic food insecurity, by causing households to liquidate assets in their efforts to stabilize food consumption, Maxwell *et al.* (1992).

2.3.5 Sustainability of food supplies

Agriculture is essentially an environmental activity. One of its basic functions is the modification and adaptation of natural ecosystems in order to channel energy to consumers in the form of food. Each agricultural project takes place within a complex system of social attitudes, cultural patterns and practices, economic networks and physical, chemical and biological factors, which comprise the setting for agricultural productivity. Access to adequate food and physical well being are crucial to the ability of farm households to perform work and consequently to sustain and increase food production and ultimately nutritional well-being. Sustainability of food supplies refers to the capacity to ensure the long-term stability of the household food supply and the ability of households to meet consumption and livelihood needs on a continuous basis. Sustainability has many dimensions, and means of food procurement must meet a set of multiple conditions if it is to be achieved. One of the main requirements is a sustainable food production system.

Where households depend on natural resources for their income and food (i.e. agriculture, fishing and forest products), it is important that production practices do not conflict with or damage the environment, undermining future production. Environmental degradation is often closely linked with the perpetuation of poverty and food insecurity. A second requirement is the protection of future productivity. If food procurement methods involve disposal of productive assets (for example. land, production equipments and draught animals), as could be the case during famine or conflict situations, households can suffer a loss of their future productive capacity. Current food consumption would then be achieved at the cost of future consumption. Hence, sustainability requires that food be procured in a manner that does not lead to a loss in the productive capacity of the household. A third requirement is that food be procured through self-reliance, that is through dependence on one's own efforts and resources, self-help, exchange or market processes rather than on charity, aid, philanthropy or the benevolence of others. Dependency is unsustainable as a procurement method in the long term, and it also conflicts with human dignity and self-respect. People whose resource base is adequate to enable them to procure sufficient amounts of food should not depend on direct food hand-outs beyond times of real need and should rely on them only until their production has been safely re-established. With regard to the poorest segment of society, direct welfare or well-targeted income-generating activities may be appropriate (FAO, 1997).

The last requirement is that efforts by households to achieve food security must be understood and placed in the context of a wider overall framework of basic household needs in which resources are limited and there is competition among needs and priorities. It is important that an adequate and stable food supply be achieved without compromising the fulfillment of other basic needs considered important by households such as education, health, drinking-water and housing. A household that has to spend a large proportion of its resources to obtain adequate food may find it difficult to meet basic needs and thus may find it difficult to sustain itself in the long term. This factor highlights the critical importance of enhancing the real incomes of households for them to be able to meet total livelihood needs. Nutritional well-being at the household level depends on the sustainability of agricultural productivity and on the concurrent sustainability of access for all household members to sufficient food of adequate quantity, quality and safety to meet their nutritional requirements (FAO, 1997).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

The aim of this Chapter is to provide the details of all the procedures used in this study. The Chapter is divided into six sections: Section one presents the location of the study area, section two presents the research design used, section three presents the sampling procedures that were employed, section four presents sampling techniques used to determine cases to be involved in the study, section five presents the data collection methods, and section six presents the data processing and analysis.

3.2 The study area, study population and justification for selection

This study was conducted in Songea district. Songea district is one of the four districts of Ruvuma region, with a total area of 34,219 square kilometers (URT, 1997). Other districts of Ruvuma are Tunduru, Namtumbo and Mbinga. The district lies between latitudes 9°12′ and 11°2′ South and longitudes 35°40′ and 35°52′ East. The district shares the border with republic of Mozambique in the South, Mbinga district in the West, Namtumbo district in the East and Njombe, Kilombero and Ulanga districts in the North. The district headquarter is situated at Songea town. Songea district has 26 wards and a total population of 287,790 with an average growth rate of 2.5% between the years 1988-2002 (URT, 2003; URT, 2004).

Songea district was selected for this study due to the following reasons. First, for many years Songea has been reporting the highest maize producing area, comparing to other three districts of Ruvuma region. Second, traditional maize storage techniques were more common in maize producing area (Songea district) compared to other low-maize producing area (Namtumbo, Mbinga and Tunduru). Third, despite the district being the highest maize producing area there existed the pockets of hunger among the farmers of Songea district.

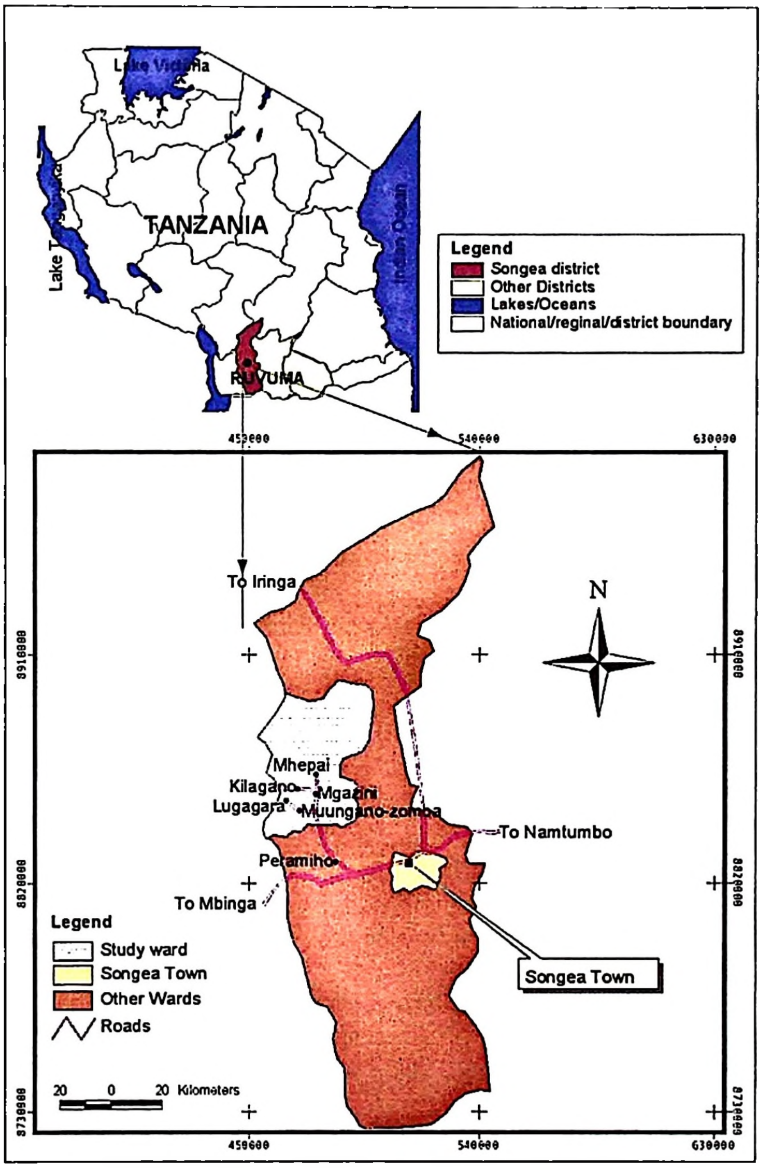

Figure 2: Map of Songea District showing study area. (Study ward).

3.3 Research design

The cross-sectional research design was used in this study. That method allowed data to be collected at one point in time and establish relationship between variables for the purpose of testing hypotheses (Bailey, 1998). That method was considered to be useful because of limitations on resources (time and funds).

3.4 Sampling procedure

3.4.1 The population

The population sample for this study was drawn from small-scale maize farmers of Songea district.

3.4.2 The sample

The sample comprised households where farmers stay. A household in this contest refers to a group of people who eat from a common pot sharing the same dwelling and cultivate the same land (Katani, 1999). A household was chosen because it is the ultimate unit of analysis and most appropriate unit to be measured (Blackwood and Lynch, 1994).

3.4.3 Sample size

Ideally, the sample size was supposed to be 400 respondents (Appendix 1) but due to financial and time constrains, an alternative procedure for sample size determination recommended by Akitanda (1994), was adopted. According to Akitanda (1994) the minimum size of sample unity for a population ought to be not less than 30 for each sampling category. Thus 30 respondents were randomly selected from four villages of Kilagano ward hence, making a sample size of 120 respondents.

3.5 Sampling technique

Purposive and random sampling techniques were used to determine cases to be involved in the study. The purposive technique was employed at district level, while Ward, and villages were randomly selected. At district level, Songea district was selected.

Justification for selecting purposive sampling technique was that, the study focused on the area where maize is grown, Songea district is famous in maize production as compared to the other districts of Ruvuma region. Kilagano ward and the four villages namely Mgazini, Mhepai, Kilagano and Muungano-Zomba were randomly selected. Within each village, farmers, who use different types of storage methods and structures, were also randomly selected as respondents.

3.6 Data collection methods

3.6.1 Primary data

Both quantitative and qualitative data were collected for this study. Structured questionnaires (containing close-ended and open-ended questions), focus group discussions, personal observation and informal talks were the main instruments used for primary data collection in the study. The questionnaire technique was selected because of its ability to elicit information about household characteristics and because it can help to collect much information within short time. The structured questionnaire consisting of various section (see Appendices 2) focused on extend of traditional maize storage methods and structures use, effectiveness of the traditional food grain storage techniques and knowledge on food security.

According to Booth *et al.* (1998), qualitative methods are often more appropriate for capturing the social and Institutional context of people's lives than the quantitative methods. This study also collected qualitative data because of its significance in social study surveys. A total of four focus group discussions were conducted in all four villages of Kilagano ward, involving 60 participants (15 from each village). These participants were the farmers who were not involved in quantitative data collection methods. FGDs were conducted in the village executive's offices. The principle researcher was the discussion facilitator assisted by one research assistant. The FGDs were guided by focused topics including farming system; extend of traditional structures use, effectiveness of the traditional food grain storage methods and structures and knowledge on food security. In order to verify some information given by discussants during FGDs informal talks were conducted with key informants (VEOs,) on farming system and effectiveness of traditional maize grain storage methods. Identification of traditional maize storage structures was one of the specific objective of the study, hence transit walks and personal observation were made in all four villages, for the purpose of identifying and describing the storage found in the ward.

3.6.2 Secondary data

Secondary data were derived from existing information/literature i.e. published and unpublished reports. This included different reports from Nation Bureau of Statistics such as population size, and production data research, reports from various institutions, international organizations, Government (Songea District Agricultural and Livestock Development Officer-DALDO) and Non-Governmental Organizations

3.7 Data processing and analysis

The collected data were verified, summarized, coded and transferred to the computer code sheet for processing. Statistical Package for Social Sciences (SPSS 10.0/PC-2004) was used to determine descriptive statistics such as means, frequency and percentage. Qualitative data were processed, categorize, summarized and presented in tabular form.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

In this Chapter, the results of the study are presented and discussed. Results presentation and discussion is divided into two section: Section one describes general observations whereby the background characteristics of respondents; land ownership and distribution, seasonal farming activities together with technology of maize production, maize yields and aggregate production are examined. Section two discusses the results by addressing the specific objectives of the study, that is; (i) traditional storage techniques available in the study area, (ii) effectiveness of traditional storage techniques, and (iii) implications of maize storage on food security.

4.1.1 General observations

The main identification features of sample households are shown in Table 1. The majority of households (78.3%) had 1-6 members, with an average household size of 4.9, which is the same as the national average and was above regional and district averages of 4.7 (URT, 2004). Across all villages the number of dependants, mainly children, accounted for more than half of households sizes. This implies that only a half of the population (adults) perform agriculture activities since children attend school. In general, more than 99% of the population is literate, (ability to read and write). They have either attended adult, primary or secondary education. Most of the respondents (64.2%) were of aged between 15-44 years. The possible explanation of that situation may be because the ward constitutes large number of the young generation compared to old ones. Crops farming was the main activity performed by many farmers of the surveyed area. About 96.7% of the sampled households engaged themselves in that occupation. Some teachers and businessmen were also observed to engage in the farming activities but they were few in number. Adequate and reliable rainfall, soil fertility and good climatic condition for maize and other crops production, explains why the majority of farmers in Kilagano ward engaged in crops farming activities. Marital statuses of respondents in the surveyed area showed that more than 87.5% of the heads of the sampled households were married or were married before. The possible explanation, of majority of young farmers in Kilagano ward and Songea (rural) in general of getting married early is that, various farming activities are done manually, hence in order to assist each other in doing farming operations, getting married seems to be the solution rather than working single. About 61% of the respondents had been living in the ward for more than 30 years. Male respondents were more readily available compared to female respondents, when this survey was conducted. Only 16% of the respondents were females compared to 84.2% of male respondents. Patriarchal system was observed to be one of the possible explanations of this phenomenon whereby women were restricted to have contact with outsiders (researchers), without their husband's permission.

4.1.2 Land ownership and distribution

According to the agricultural policy of Tanzania, (URT, Ministry of Agriculture, 1983) all land in Tanzania is publicly owned and vested in the state. During Focus Group Discussions (FGD) most of agricultural lands in surveyed area were noted to be held under customary system and most of the land was not properly surveyed or mapped. Individual households were given the right to use specified pieces of land indefinitely.

Farmers cultivate as many hectares as they can on their customary owned land except in few restricted areas especially in mountain ranges, which act as rain catchment areas, for example, *Lihanje* ranges. However, through observation, some farmers were noted to violate these regulations and the village councils, which were responsible for maintaining

Table 1: Household characteristic for the sampled household in four surveyed villages in Kilagano Ward, Songea District (n = 30 for each village)

Characteristics	Village (%)				
	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n = 120
Sex of household heads					
Male	83.3	73.3	83.3	96.7	84.2
Female	16.7	26.7	16.7	3.3	15.8
Household size (number)					
1-6	80.0	66.7	83.3	83.3	78.3
> 7	20.0	33.3	16.7	16.7	21.7
Dependants (number)					
0 – 4	80.0	66.7	83.3	83.3	78.3
> 5	20.0	33.3	16.7	16.7	21.7
Age of household heads; (years)					
15 -34	23.3	20.0	50.0	53.3	36.7
35- 44	20.0	33.3	30.0	26.7	27.5
45- 54	23.3	26.7	10.0	13.3	18.3
>54	33.3	20.7	10.0	6.7	17.5
Education of household head;					
Adult education	13.3	23.3	3.3	0.0	10.0
Primary	80.0	66.7	90.0	90.0	81.7
Secondary	6.7	10.0	6.7	10.0	8.3
Marital status of the household heads;					
Married	80.0	86.7	86.7	96.7	87.5
Divorced	3.3	0.0	0.0	0.0	0.8
Widowed	10.0	10.0	0.0	0.0	5.0
Single	6.7	3.3	13.3	3.3	6.7
No of Years, household heads lived in the village;					
1- 10	13.3	13.3	20.0	20.0	16.7
11-20	13.3	10.0	16.7	13.3	13.4
21-30	20.2	43.3	30.0	30.0	30.8
31-40	13.3	33.3	16.7	30.0	23.3
41-50	23.3	0.0	16.7	3.3	10.8
> 51	16.7	0.0	0.0	3.3	5.0
Household heads occupation					
Farmer	100.0	96.7	100.0	90.0	96.7
Employed	0.0	3.3	0.0	6.7	2.5
Business/ trade	0.0	0.0	0.0	3.3	0.8
Farming experiences of Household Heads (in years)					
1 – 10	20.0	13.3	43.3	53.3	32.5
11-20	26.7	36.7	30.0	33.3	31.7
21-30	23.3	23.3	16.7	10.0	18.3
31-40	30.0	26.7	10.0	3.3	17.4

law and order seemed to be silent on dealing with violators. Village councils in some occasions had a responsibility of distributing the land to villagers and new comers. In fact the immigrants who settled in designated villages had to formally request for land. In the surveyed villages immigrants from Iringa (*Wapangwa* and *Wabena*) had been provided land by either the village councils or fellow farmers.

Table 2: Average plot size, number of plots and distance from homestead for sample Household (n=30 in each village) in four surveyed villages of Kilagano ward 2003/2004

Parameters	Mgazini	Mhepai	Villages Kilagano	Muungnao Zomba	Pooled Sample n = 120
Average No of plots	1.3	1.5	1.6	1.1	1.4
Average distance (km)	3.8	4.2	2.9	2.3	3.3
Average plot size (ha)	1.7	2.1	1.9	1.9	1.9

Farmers in the surveyed area held a number of small plots of land located at different places in the ward. About 30% of the sample households worked on adjacent plots. The rest had their total farm area dispersed in different places around the villages. The average numbers of plots and plot sizes for the sampled households were calculated to be 1.37 and 1.9ha respectively per household (Table 2). So in average most people owns at least 1 plot of 2ha. on average size. Always, fresh plots are added through clearance of bushes and forest especially for finger millet and tobacco, which require fresh land for better growth and productivity. The consequence of this process has been to create a circumstance where farmer's plots can often be found at substantially far distances away from his house. In the surveyed area the average distance to the farm is more than 3km with several farms located as far as 8 to 15km. Farms located at far away distance call for availability of means of transport.

Table 3: Land use in the four surveyed villages in Kilagano Ward, Songea District 2003/2004.

Type of use	Village (ha.)				
	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled Sample n = 120
Total available farm area	3.0	3.0	3.0	3.2	3.0
Fallow land	0.9	1.0	1.0	0.9	0.9
Total cultivated area	2.1	2.0	2.0	2.3	2.1
Area under:					
Maize	1.37	1.0	1.35	1.50	1.37
Cassava	0.20	0.15	0.17	0.25	0.19
Beans	0.40	0.34	0.34	0.35	0.39
Groundnuts	0.01	0.01	0.01	0.01	0.01
Sesame	0.07	0.10	0.04	0.08	0.07
Mixed cropping	0.05	0.40	0.09	0.11	0.07

Note:

Mixed cropping is the cultivation of all other crops like finger millet, sweet potatoes and paddy.)

Table 3 illustrates the average total farmland owned by sample households ranging between 3 to 3.2ha, being 3ha in Mgazini, Mhepai, and Kilagano and 3.2ha in Muungano-Zomba. The average for all sampled households is 3 ha. Renkow (1990) reported that, ICRISAT, (International Crops Research Institute for the Semi Arid Tropics) classified areas of between 0.21 – 2.50 ha as small farms; between 2.51 – 5.25 ha as medium farms and above 5.25 as large farms. Therefore according to this classification the sample households of surveyed area fall under medium farm. This finding is similar to what was reported by Ashimogo (1995) where he found that peasants land in Sumbawanga district (Rukwa region) falling under medium size. Maize is the main staple food crop as well as a major cash crop in Kilagano ward and Songea (rural) in general. Findings from sample households surveyed showed that maize and beans occupied about 65% and 19% respectively of total cultivated land (Table 3). Beans is a source of plant protein for most farmers and is consumed more often as relish together with maize and cassava. Beans also play another role in meeting cash needs of most households before maize harvest.

Cassava occupies 9% of land cultivated, it is a source of carbohydrate and the crop is mainly consumed when the stock of maize runs out. Sesame and groundnuts constitute about 3.3% and 0.4% respectively and are mainly cultivated for household consumption (Table 3). Although the main occupation of the surveyed rural households is agriculture, mainly crops farming, they keep livestock to a small extent. Animals kept are goats, pigs and very few cows. These animals are kept in order to meet mainly cash and animal protein needs. Cattle keeping plays insignificant role to most farmers in the surveyed area.

Table 4: Distribution of cultivated land[a] between sampled households (n = 30 in each village) in four selected villages of Kilagano Ward 2003/2004

Land size	Mgazini		Mkepai		Kilagano		Muungano Zomba		Pooled sample n = 120	
	%HH[b]	%ha[b]	%HH[b]	%ha[b]	%HH[b]	%ha[b]	%HH[b]	%ha[b]	%HH[b]	%ha[b]
0 - 1	46.7	28.2	36.7	19.6	50.0	26.8	33.3	17.2	41.7	22.5
1.1-2	30.0	28.2	33.3	30.0	20.0	20.5	36.7	25.4	30.4	26.2
2.1-3	13.3	18.3	20.0	27.3	10.0	15.7	13.3	23.0	14.1	21.3
>3	10.0	25.3	10.0	23.1	20.0	37.0	16.7	34.4	14.1	30.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a = Land actually cultivated, excluding fallow land.

b = %HH means percent households; % ha means percent of total cultivated land falling under different land size.

The outline of allocation of cultivated land between different farm sizes and between different farmers groups is set out in Table 4. It is apparent that the allocation of cultivated land in the ward is disproportionate. About 51.3% of the land is cultivated by 28.32% of households (comprising mainly large farmers group) owning more than 3ha, while 72.1% of the households (comprising mainly small and medium scale farmers group) cultivating less than 2ha hold only 48.7% of the land. This model is more or less the same across all villages. This finding is similar to what was reported by Ashimogo, (1995). For all households the median households (that number which divides the series into two equal part or mid value of the series) was 1.1-2 ha. Group and the range between the group of households having the least land and the group having the most were from 1ha. - 6.3ha. These later measures indicated the holding that may be considered representative for the area. The largest single group, (comprising mainly small scale farmers) fell in the interval of 0-2ha. representing modal group of the ward (Table 4).

4.1.3 Seasonal farming activities

In general there is a clear demarcation on seasonal pattern of agricultural operations, since most of cropping system is the rain fed. This pattern of agricultural operations always is characterized by episode of high and low demand for production resources mainly labour and food. Rainfall regime, which exists in Songea district, allows only one maize crop in a year. During Focus Group Discussion (FGD), farmers mentioned four seasons based on maize production operations and climate. These seasons were harvest, post harvest, rainy and pre-harvest. This finding is quite similar to what was found by Ashimogo (1995). Activities for each of those seasons are discussed as follows.

(a) Harvest season (July – September)

Between July and September, maize harvesting and marketing is carried out by most of farmers in the surveyed areas. Occasionally harvesting may start a few weeks before or after the stated months. Variations on harvesting are mainly caused by differences on the planting date and maize variety planted. Asked when farmers harvest their maize crops, 29.2% of respondents harvest in July, 60% in August, 9.2% in September while only 1.7% harvested in June.

(b) Post-harvest season (October – November)

After harvesting season is over most of the farmers start concentrating on storage activities, like looking for storage structures and purchasing of chemical pesticides. This season also experiences a lot of post-harvest ceremonies like weddings, *Majamanda* (traditional ceremony which involves maize flour giving to fellow farmers as gift) and traditional brew (*komoni)* drinking. Maize marketing activities that begin during the harvest period also go on at this particular time. Despite many traditional and religions ceremonies that exist at this time some farmers start land preparation for the next crop as early as October.

(c) Rainy season (December – February)

During this season farming operations like land cultivation (especially on hard soils which are difficult work when dry), planting and weeding are mainly done. As stated before rainfall regime dictates what kind of farm operations are to be done. Planting always begins shortly after the first rains begin, mainly in late November and early December. During focus group discussion the majority of discussants stated that majority of farmers plant their maize in December and January.

(d) Pre-harvest season (March – June)

Most of activities done during this season are a little bit similar to those that are carried out during rainy season. A predominant feature of this period is that most of farmers fall in maize deficit and rely mainly on eating cassava flour saved with green beans; it is the time of food shortage and potential famine.

4.1.4 Technology, maize yields and aggregate production

Farming system in the surveyed village and Songea district in general is characterized by both fields and crops rotations. Various crops are either intercropped or grown as pure stands followed by fallow periods (*know as lifusi)*, which can last between 3 to 4 years. For example most farmers of Songea district intercrop maize with beans. Crops rotation system that is very common among the farmers of surveyed area is maize, tobacco, cassava and beans in that sequence. This system gives rise to two basic issues, first; intercropping and fallow land which develops thick vegetation helps to restore soil fertility of the land. Second considerable proportion of idle but cultivable land gives a room for possibility of shifting cultivation.

Maize production technology in the sample farms was underdeveloped. Most of sample households depended very much on muscle power and simple implements like machete, hand hoes, and axes for various farm operations. As can be noted from Table 5, about 100% of sample households prepare there farms by hand hoes. The use of ox-ploughs does not exist. Only 38.3% planted hybrid seeds that basically was the highest yield variety while, 47.5% and 14.2% planted either composite or local seeds varieties respectively. Most of farmers of survey area use chemical fertilizers. About 45.4% of sampled households used between 51 – 200 kg per season. The percentage of sample households who use, more than 201 kg decrease with increase in number of kilogram of fertilizers.

In some cases, for example Mhepai and Mungano – Zomba villages, it was noted that some farmers used less than 50kg or did not use chemical fertilizers at all (Table 5). Similar findings have been reported by Kavishe *et al.* (1993) when explaining the reasons for food insecurity. They noted that generally in Tanzania, farming technology is low:

about 85 percent of cultivation is still done by hand hoe, and only 10 percent by oxen, and 5 percent by tractor. Farm inputs (fertilizers, hybrid seed, insecticides, herbicides, etc) are fast becoming inaccessible to the smallholder due to rising prices. During (FGD), discussants complained that they failed to expand their areas of maize production because most of them did not have enough capital to buy farm implements especially chemical fertilizers and seeds (hybrid seeds). Hence they did not find any substantial reasons of cultivating more land while they have less capital to invest.

Table 5: Maize production technologies and yield per hectare in sampled household (n = 30 in each village) in four selected villages in Kilagano Ward 2003/2004 (%)

Technology of Maize production	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n = 120
Hand hoe	100 0	100 0	100.0	100.0	100.0
Oxen plough	0.0	0.0	0.0	0.0	0 0
Seed varieties: -					
Hybrid	37 5	33.3	30.0	36.7	38.3
Local	14.2	26.7	27.7	10.0	14.2
Composite	58.3	40.0	43.3	53.3	47.5
Fertilizer uses: -					
0 - 50	6.7	0.0	17.2	0.0	5.9
51- 200	45.0	46.7	44.8	43.3	45.4
201- 400	29 4	33.3	20.7	30.0	29.4
401 - and above	18.5	20.0	27.3	26.7	19.3
Maize production (kg)					
1 – 3000	50.0	53.3	53.3	46.7	52.5
3001 – 6000	23.7	33.3	33.0	26.7	35.5
> 6000	26.3	13.4	13.7	26.6	12.0
Yield (kg/ ha)					
1 – 1000	43.3	66.7	66.7	66.7	51.7
1001 – 2000	50.0	33.3	33.3	33.3	46.7
2001 – 3000	6.7	0 0	0.0	0.0	1.6

Maize potential yield at high altitude area above 1000m (when H. 632, H 622, Kilima and UCA maize seed varieties is planted) is 7 tonnes per hectare, but reported yield under good management so far has reached 5 tonnes per hectare (TARO, 1987) while Tanzania Seed Company has reported to reach 6.8 tonnes per hectare. Generally aggregate maize production among peasant farmers in Kilagano ward is very low. Maize production among survey households for 2003 and 2004 production year, (Table 5) show that majority of farmers (52.5%) produce maize below 3 tonnes, 35.5% of them produce between 3 to 6 tonnes, while only 12% produce above 6 tonnes. Maize yield per hectare ranged between the average of 1 to 3 tonnes per hectare. About 51.7% and 46.7% of sample households produced between 1 and 2 tonnes per hectare respectively, while only 1.6% producing above 2 tonnes per hectare (Table 5). In comparison with the Tanzania National Average (which is 1.6 tonne per hectare) and other Subsaharan countries which is 1.5 tonnes per hectare) Kilagano ward appears to be above average. (CIMMYT, 1990).

4.2 Traditional maize storage techniques available in the study area

4.2.1 Overview

Generally in Sub-Saharan Africa three broad storage locations are prevalent at household and village levels; indoor, out door and underground. In the first two cases, maize crop may be stored shelled or unshelled. Underground storage is predominantly for shelled grain and is common only in dry parts of the continent. Storage structures types vary between countries, based on: - the architectural culture of the locality, type and availability of local construction materials, type and value of the crops to be stored, product storage requirements, length of storage, climatic conditions, prevalence of storage loss agents (birds, insects and rodents) and prevalence of grain theft at the locality. Most of these structures in Sub-Saharan Africa have evolved over the years to the point of optimum suitability, using local materials and construction techniques (Odogola, 1991).

4.2.2 Types of storage structures and methods in the study area

The common type of storage structures used in Kilagano ward and Songea district in general are storage cribs (known as *Litara*), granaries (*Chibana*), polythene bags, ceiling storage, clay pots (*Makarangi*), tins and gourds (*Madenge*) (Table 6). *Litara* is an out door storage structure raised about 1m above the ground, rectangular in shape, made of plant materials normally mite resistant poles, stalks, reeds or bamboo trees and thatching grass. This storage crib, which is bigger than known Nigerian cribs, has the storage capacity of 1-3 tonnes or more, and normally store-dehusked maize. Granary *(Chibana)* is also an out door storage structure raised from the ground about ½ meter, round in shape made of plant materials normally thin flexible reeds of bamboo and mud. This storage structure has the capacity of storage of 1-2 tonnes. Granaries are normally used to store finger millet, but sometimes are used to store maize. Polythene bags are industrially manufactured bags having different storage capacity ranging from 50 to 250 kg per bag.

Table 6: Characteristics of major types of grain storage structures in Kilagano ward 2004/2005.

Types of structure	Construction material	Utilization	Method of storage
Storage crib (*Litara*) *Figures 6 and 7.*	Mites resistant poles stalks, reeds of bamboo tree and thatching grass	Mainly for large storage of grain for food.	De-husked maize cobs
Granary *(chibana)* *Figure 5.*	Thin flexible reeds of bamboo tree, mud for floor making and thatching grass	Mainly for storage of food and beer making grain	Unshelled finger millet
Ceiling storage *(vihudiku)* *Figure 4.*	No materials used	Seed grain	Sheathed maize on cob
Small containers *Figure 3.*	Mud pots *(makarangi)* tins and gourds *(madenge)*	Seed grain	Beans and ground nuts
Polythene bags *Figure 8.*	Synthetic materials, (normally bought ready-made)	Mainly for large storage of grain for food, sale and seeds	Shelled maize treated with chemical.

Figure 3: Mud pots *(makarangi)*

Figure 4: Ceiling storage *(vihudiku)*

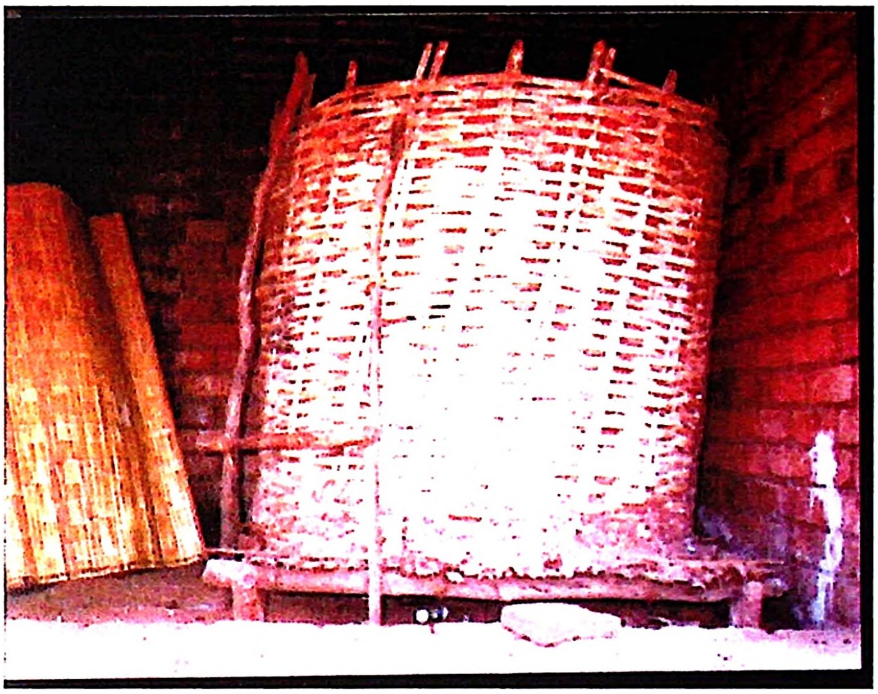

Figure 5: Granary *(chibana)*

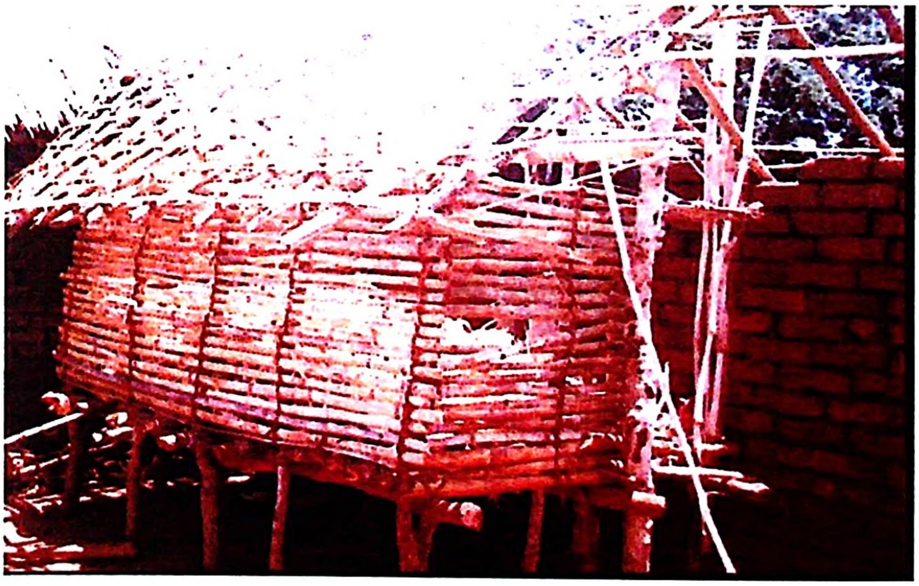

Figure 6: Storage crib (*litara*), under construction.

Figure 7: Storage crib *(litara)* thatched.

Before 1980, majority of Ngoni people used these traditional storage structures *(Litara, Chibana, Makarangi and Madenge)* for their various storage purposes like seeds storage, and storing grains for food and marketing. Nowadays *Litara* and *Chibana* have lost their significance due to effect caused by Large Grains Bore (LGB). At the time being polythene bags are more used by majority of farmers than traditional structures mentioned above.

As it can be seen from (Table 7), 84.7% of sample households used polythene bags for various storage purposes. The rest either used granaries 9.2%, storage cribs 4.2% and others 1.7% (mud pots, tins, gourds and kitchen ceiling storage). A numbers of reasons were given for change of this trend that is, from traditional structures use to polythene bags as follows: -

Figure 8: Storage of maize in polythene bags.

Table 7: Types of maize storage structures used in the four selected villages in Kilagano ward 2003/2004 (n = 30 in each village) (%)

Types of storage structure	% of respondents				
	Mgazini	Mhepai	Kilagano	Muungano zomba	Pooled sample n = 120
Storage crib (*litara*)	3.3	3.3	3.3	6.7	4.3
Granary (*chibana*)	10.0	3.3	10.0	13.3	9.3
Polythene bags	80.0	86.7	80.0	80.0	84.7
Others	6.7	6.7	6.7	0.0	1.7
Total	100.0	100.0	100.0	100.0	100.0

About 85% of the respondents pointed out that polythene bags are more effective in pest and insect control especially if maize are shelled and treated with chemical pesticides. Asked why they preferred specified type of structure, 70% of respondents reported that polythene bags are very economical in space utilization, could easily be stored in the living house and can easily be protected against theft. About 30% attested that they prefer polythene bags to other means of storage because the bags are readily available in the market and are cheaper compared to construction and maintenance expenses of traditional structures. Most of polythene bags are bought between Tshs. 300 – 600 per bag, while traditional structures (Storage crib and granary) are always constructed at more than 30,000 Tshs. (Table 8). About 13.3% out of 120 respondents explained that they used traditional storage structures not because they like using the structures but simply because they don't have enough money to purchase insecticide and polythene bags.

Table 8: Cost of purchasing/constructing storage structures in the four selected villages in Kilagano ward 2003/2004

Type of storage structure	Average cost per structure (Tshs.)	Responses	
		Number	%
Polythene bags	300 – 600	101	84.7
Kitchen ceiling gourds and pots	1000 – 5000	1	0.3
Airtight storage	1500 – 30000	3	2.5
Granaries and storage cribs	≥30000	15	12.5
Total	-	120	100.0

During transit walks in the villages, especially to farmers who owned storage cribs and granaries, it was observed that some of storage structures are not well kept. The immediate surroundings of some of the structures were not clean and could offer shelter to rodents. The structures visited had no rat guard against rodents, for that matter rodents were freely coming in and out of the structures. But in some occasions it might be difficult to express a good storage structure, but Bengtsson (1987) cited by Ashimogo (1995), helped in defining the proper container and structures for grain storage for consumption in the farm family as "among other things the storage structures should be able to meet the following requirements, protect the grain from attack or re-infestation by insects by appropriate preventive and hygienic measures, should be constructed using cheap and locally available materials, durable and easy to clean, repair and maintain, easy to load and empty and have sufficient capacity."

4.2.3 Capacity and life span of storage structures

The capacity of storage structures available in the study area varied between 50 kg to 250kg per bag for polythene bags and small containers, 0.25 to 4 tonnes for storage cribs and granaries (Table 9). For polythene bags the total capacity of storage increases with increase in the number of bags used. The storage capacity of traditional structures (storage cribs and granaries) in the surveyed area had similar capacity as reported by Coulter and Golob (1992) who reported the storage capacity of up to 40 bags of 100kg, which is equivalent to 4 tonnes.

Given the homogeneity of materials used to construct the granaries and storage cribs, the useful life span of this traditional structure varies between 4 and 9 years (Table 9). Asked the type of repair carried out by those sample households who use granaries and storage cribs, majority stated that normally most of them repair only the grass lid and granaries floor. The grass lid is always changed annually, but in very rare cases can be left for more than 2 years. Granaries floor coating is done before new crops are kept in the storage structures each year. The rest of the structure is left untouched because granaries and storage cribs are constructed by using mite resistant trees. Polythene bags, despite its cheapness and its ready availability, had the shortest lifetime of 1 to 2 years. The structure wears very easily if left under the sun for some weeks and rodents can easily make holes in it. Therefore farmers ought to purchase new bags each year.

Table 9: Capacity and life span of different storage structures in the four selected village in Kilagano ward 2003/2004.

Storage structures	Life span (year)	Storage capacity (kg)	Total responses	Mgazini (%)	Mhepai (%)	Kilagano (%)	Muungano Zomba (%)	Pooled sample n = 120 (%)
Polythene bags	1 - 2	≤ 250	101	83.3	83.3	85.2	85.0	84.2
Granaries/ storage cribs	4 - 9	250-4000	15	6.7	10.0	8.2	15.0	12.5
Others	> 15	≤ 250	4	10	6.7	6.6	0.0	3.3
Total	-	-	120	100.0	100.0	100.0	100 0	100.0

Airtight storage structures have the highest life span of all the structures. These structures (mainly steel drums initially used as oil containers) have different storage capacity ranging from 1 to 250 kg per drum. The farmers who use these structures mentioned poor availability and higher purchasing price to be the major constrains to most farmers in using these structures.

4.2.4 Storage structures location.

Various storage structures can be located out side or inside the living house. Findings from sampled households show that 89.2% of the structures used by sample farmers were located inside the living house, the rest 10.7% of the structures were located outside the living house. The storage structures found inside of living house were polythene bags and airtight storage structures. Storage cribs and granary were mainly found outside the living house. Through observation it was noted that 53.3% of 15 granaries and storage cribs had maize inside. Most of the sampled households 75.8% preferred inside to outside main house location. When asked why they prefered that type of location, the majority 90% mentioned, assurance against theft and economy of scale in space utilization were reasons behind their preference, 10% mentioned easy to load, empty and inspect the structures as reasons for their choice. About 14.2% of respondents, mainly those who use granary and storage cribs, stated that they prefer outside to inside main house location because storage cribs, and granaries need and occupy large space hence it is difficulty locating it inside. This finding is similar to that reported by Ashimogo (1995). As "it seems plausible that factors like space availability and security against theft exert considerable influence in store location."

Table 10: Experience of using various grain storage structures by farmers in the study area as of 2003/2004.

Type of storage structures	Response		Experience of use (years)*			
	No	%	0 – 10	11 – 20	21 – 30	> 30
Polythene bags	101	82.0	10.0	72.0	0.0	0.0
Granaries *(chibana)*	10	8.3	0.0	0.0	0.8	7.5
Storage cribs(*litara*)	5	5.4	0.0	0.0	1.6	4.2
Others**	4	4.1	0.0	0.0	0.8	3.3
Total	120	100.0	-	-	-	-

* Entries are in percentage of respondents.

** Others storage structures include (i) gourds (ii) pots, (iii) kitchen ceiling and (iv) airtight drums.

Table 10 shows experience of using various grain storage structures by farmers in the study area. It can be noted that traditional storage structures *litara* (Storage crib), *chibana* (granary) and others have been used for about 30 years, compared to storage structure like polythene bags, which has been used for not more than 20 years. This can be interpreted that polythene bags are the new storage structure introduced in the study area. Asked for how long various storage structures have been used by sample households, 82% mentioned to use polythene bags for not more than 20 years. The rest (18%) reported their experience of using traditional storage structures (cribs and granaries) as being about 30 years

4.2.5 Traditional storage structures and their ability of storage

As noted in chapter two, traditional systems have evolved over long periods of time to satisfy storage requirements within the limits of local culture. However, with the exception of sealed containers (including underground pit stores in dry areas that control insects by limiting the supply of oxygen), the traditional structures provide only limited protection against insects and rodents damage, particularly in areas where the climate is warm and humid or where grain is stored for extended periods (NAS, 1978).

Findings from sample households in the surveyed area showed and supported the above facts that traditional storage structures and methods give limited protection particularly to high yield varieties. Asked whether traditional storage methods and structures have ability to store high yield varieties or not 93.3% of 120 sample households disqualified traditional storage methods and structures on maize storage stating that the methods and structures have no ability at all in preserving maize grains from biological agents of deterioration.

Even those who agreed (6.7%) when asked how long can traditional storage methods and structures stored maize, 5.03% sample households mentioned 1-3 months of storage, while 1.67% sample households mentioned 4-6 months, which in fact is the shortest period of storage, compared to more than one year when maize is stored in polythene bags with chemical treatments. A number of reasons were given to explain why traditional storage structures and methods have no ability of storing longer high yield varieties. About 84.2% of respondents said pests and insects were the biggest problem to these maize varieties because high yield varieties can easily be attacked and reduced to nothing if stored by traditional means. Fifty two percent of the respondents said it is difficult to control rodents in traditional storage system. About 61.7% and 5% mentioned the difficulties of treating maize with chemical pesticides and preventing mould formation respectively as the reasons behind the failure of traditional storage systems on preserving high yield varieties, 10% mentioned limited time of storage as the reason that makes these storage structures ineffective. Asked which method is more effective in storing high yield varieties, majority (90.7%) of respondents mentioned chemical pesticides treatment as the best method of preserving maize for longer period of time and 9.1% mentioned airtight storage to be the best method of storing food maize.

When asked to establish the relationship between storage structures and methods used by sample households to store their maize grain, about 92.5 percent of respondents agreed that there existed a relationship between some storage structures with the method of controlling storage pests. These farmers explained that for best results of storage, maize stored in polythene bags must be treated with chemical pesticides and not otherwise. The farmers who disagreed (7.5%), were mostly those who grew local varieties, they explained that for traditional storage structures, especially storage cribs *(litara),* maize can be stored without any industrial chemical application. However through informal talks with other farmers in the surveyed area, it was established that those farmers who use traditional storage structures are normally small-scale maize producers, hence they run short of maize just a few months after harvest, hence the effect of storage pest on their storage cannot easily be noted.

4.2.6 Extent of use of traditional storage methods and structures

Findings from this study showed that traditional storage techniques were unpopular among the farmers of the surveyed area. Asked how popular were the traditional storage techniques among the farmers, 90 sample households (75%) said that traditional methods and structures were no longer popular among the farmers, only 30 (25%) of respondents agreed to be popular. These 30 respondents were those who didn't use polythene bags. A numbers of reasons were given by sample households to explain why traditional techniques were unpopular. First, deforestation due to farms expansions had caused scarcity on availability of preferred plant materials used for building storage cribs and granaries. When asked whether preferred plant building materials for storage structures construction were still available or not all sample households agreed that plant building materials are available, but 32.5% said they could not use the materials for storage construction because it was a harder job, time consuming and trees were not easily available. Thirty five percent and 30.5% mentioned ineffectiveness to pest and theft control plus the limited possibility of saving the produce in case of fire break out respectively, to be the reasons which hinder the farmers using the materials for building traditional storage structures.

Second, spreading of insect pests especially LGB, *(Prostephanus trancatus)* in the survey area where the insect was exotic had made the traditional techniques to be ineffective on controlling the insect pest. When asked if there were any new insect pests, which had rendered the traditional storage techniques inefficient for prevention of food loss, 93.3% respondents mentioned *Prostephanus trancatus (dumuzi)* to be very a stubborn storage pest since 1980s. Other respondents 6.7% mentioned *Angoumois* (Grain Moth) to be another stubborn storage pest in the surveyed area.

Third, introduction of high yield maize varieties was mentioned by farmers to be another cause of rendering traditional storage technique ineffective. About 98% of the respondents acknowledged that introduction of high yield maize varieties had effects on traditional storage techniques, only two sample households had a different opinion. When asked to explain those effects, 84.2% of sample households stated that hybrid varieties need large storage capacity structures, compared to local varieties, 70% of all sample households mentioned that high yield varieties are more vulnerable to pests and diseases compared to local varieties, 71.7% of all sample households said that if stored ear with sheath these varieties can easily be subjected to insects pest attack.

Fourth, the necessity of storing threshed/shelled grain for market purposes has facilitated the change from using traditional techniques to other new techniques especially polythene bags. As noted earlier, storage of unthreshed grain usually was the mastered traditional method. Asked whether the necessity to store threshed grain for market purpose had effect on traditional storage techniques, all (120) sample households agreed to have effect on traditional storage on the ground that threshed maize grain can easily be sold. About 15.8% gave the reason that a farmer can easily know the amount (quantity) of his/her produce, this is not possible under traditional storage techniques. Eleven point seven percent of all sample households said storing shelled maize had made maize budgeting for food more easy compare to traditional storage techniques. Five percent of sample households acknowledged that storage of threshed maize grain had reduced women's chores on maize flour preparation, women now used less time than before when maize was stored in traditional structures.

Another reason given by 33.3% of sample households was that new storage techniques have reduced transport costs. Farmers no longer need to transport huge volumes of unhusked maize ears, farmers nowadays transport only shelled maize for storage, cobs and husk are left in the fields. Thirty point eight percent of sample households said traditional storage structures were the sources of insect pest especially (LGB) *(dumuzi)* and rodents multiplication. Farmers explained that they had experienced difficulties in disinfecting traditional storage structures; especially storage cribs as a preparation before each new crops storage. Insect pests already present on the structure easily infested new crop stored. As noted above, 25% of sample households said the traditional storage techniques were still popular among a few households. When asked to justify their argument seventeen out of 30 respondents (56.7%) said these methods and structures were still in use by those who grow local maize varieties, seven respondents out those thirty (23.3%) mentioned that these structures were popular to those who can not afford polythene bags and chemical insecticides, while six out 30 (20%) said the traditional structures were still used by those farmers who do not like the side effects of chemical pesticides.

4.3 Effectiveness of different storage techniques

4.3.1 Overview

In order to have a comprehensive understanding of the implications of farmer's grain storage strategies, it was important to have an overview of the pre-storage practices at farm level. The main pre-storage factors and practices that impinge on grain excellence and that possibly would cause losses when performed inappropriately were the transportation of maize from the field to homestead, harvesting time, drying process and shelling and cleaning operations. Bourne (1984) cited by Ashimogo (1995) listed other factors as inherent stored grain stability, environment sanitation and duration of storage.

4.3.2 Maize harvesting and drying.

As noted earlier, rainfall regime dictates what kind of farm operation to be carried out at the farm. Maize harvesting in the surveyed area is done mainly between July and September. Harvesting is carried out at this particular time because of its low relative humidity, when the rains have stopped, the rest of the year the sky is clear, day time temperature is high and maize crop reach maturity at the start of the dry season. When sampled households farmers were asked why they prefer harvesting between July and September, 55.8% answered that at this particular time maize is completely dry and rains have stopped, 25% of them reply that they prefer this particular time to avoid not only thieves who may steal maize if not harvested at particular moment but also wild fire, termites, rodents, insect pests and maize eating animals especially monkeys. Others (19.2%) pointed out that this was ideal time of maize marketing and budgeting.

Normally farmers in Kilagano ward and Songea rural district in general do not dry their maize after harvesting process is over. Maize is left to dry while standing in the farms, harvesting always starts after realizing that the maize is completely dry. Majority (98.3%) of the farmers said that always maize cob is not harvested immediately after reaching its physiological maturity, but maize is left to dry in the farms with its sheathe, until maize is completely dry. Harvesting, which involves removing ear from its standing stalk, is followed by removing husk. Harvested cornhusk is then taken to shelling ground and bundled, a farmer will keep pilling cornhusk until he/she finishes harvesting. As stated before most of farm operations are carried out manually. A farmer may require several days of harvesting his maize, that situation gives room for further maize drying.

One of the possible explanation for 98.3% of sampled households preferring the stated methods of drying to other method like home and field drying is that it is the easiest and cheapest drying method, and most farmers can easily dry their maize to a reasonable safe storage moisture content. These findings are different from what was found by Ashimogo, (1995). His findings showed that field and home drying are predominant methods of maize drying after harvest to most of Sumbawanga farmers. However this drying procedure has or bears some risk that can easily be identified as follows: It is difficult to control incoming field infestation. Husked corn, if left for several days in the shelling ground unattended, may easily be attacked by termites. Normally maize kept on shelling grounds is not protected from unexpected rain, and lastly natural falling of maize stacks cause great losses to most of farmers of the survey area. As a result, all these may lead to early grain infestation and rotting.

Asked the effect of early harvest, majority of farmers from sample households seemed to be aware of the importance of knowing appropriate level of moisture content in maize intended for storage. About 76% of all sample households mentioned that easy mould growth and decay of maize would develop if maize was to be harvested early. Sixty three point three percent of total sampled household farmers mentioned storage difficulties, as the maize become easily attacked by pest and insects during storage and lastly forty one point seven percent of all sample households gave the reason of fetching lower price in the markets as the effect of early maize harvesting. For effective and positive result on maize storage all sample households appreciated the importance of drying on storage. All sampled respondents agree that there does exist a positive relationship between drying and the ability of storage methods to store for shorter or longer time. For longer time of storage maize must be dried completely.

Table 11: Different methods of maize shelling in the four selected villages in Kilagano ward. 2004/2005 (%).

Method of maize shelling	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n = 120
Hand shelling	3.4	3.3	13.3	6.7	7.5
Beating in a sack	6.6	3.4	6.7	6.7	5.0
Beating on shelling structure	90.0	93.3	80.0	86.6	87.5
Total	100.0	100.0	100.0	100.0	100.0

4.3.3 Shelling

Damage in shelling is proportion to the moisture content of the grain. Maize shelling in most of Sub-Saharan countries is traditionally accomplished by hand. This method though hard, tedious and labour intensive, is efficient in stripping the cobs and minimizing damage to the grains; it also permits hand separation of damaged or infested grain from sound grain. Increased production increases the amounts of grain to be shelled and this can strain the capacity to shell the dried cobs by hand. Methods of shelling increased quantity of cobs include beating bagged cobs with stick which results in increased loss due to incomplete stripping of the cobs and damage to the grain. Mechanical shelling losses are relatively low when the equipment is adjusted and operated competently and grain moisture levels are low (NAS, 1978).

In Kilagano ward, and Songea district in general, storage of shelled maize is predominant. Findings from survey area showed that 90% of sample households stored shelled maize. Immediately after harvesting operation is over farmers start shelling their maize. Shelling is done by beating the dried cobs with sticks at a shelling structure known as *kichanja* made purposely for this work. *Kichanja* is a traditional shelling platform made of reed or bamboo tree, ropes and grass. *Kichanja* which looks much like drying cribs normally unroofed is constructed by raising the platform about 1 meter from the ground. Three

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Figure 9: Maize-shelling structures *(kichanja)*, grass type.

Figure 10: Maize-shelling structures (*kichanja)*, clothe type.

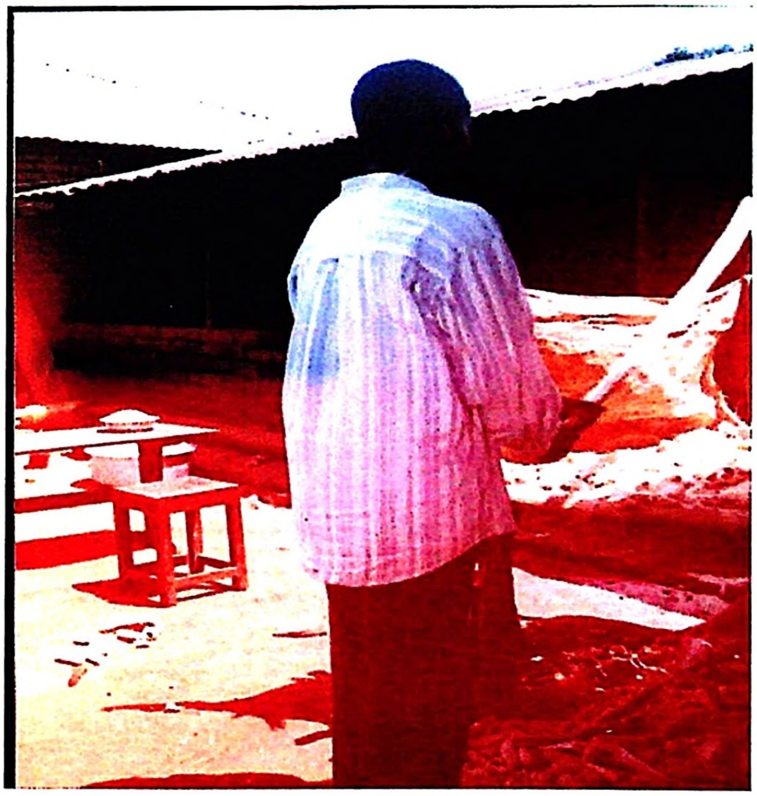


Figure 11: Maize shelling action.

Findings from sample households reveal that 87.5% of the farmers use this structure for maize shelling. The rest 5% beats in sacks and hand shelling 7.5% (Table 11).

Farmers who store their maize unshelled are the ones who normally don't use this shelling structure probably because maize withdrawn from their storage structures are in small quantity for their consumption, hence they don't find a reason of constructing this structure for shelling purposes. Asked to what extent maize shelled by using this structure *(kichanja)* affects the effectiveness of maize storage, about 88.3% of sample households said maize shelled by using the structure explained above has no effect on subsequent storage of the produce, because the amount damaged during shelling is too little to affect storage and normally the maize is shelled when is completely dry. About 11.7% of sample households acknowledge that, shelling maize by using *kichanja* has effect on subsequent storage, provided the shelled maize will be intended for seed, because beating action causes cracks and damage of embryo.

4.3.4 Transportation from farm to household

Harvested maize, shelled and bagged in polythene bags from the field to the homestead is transported by lorries, donkeys, and bicycles and as a head load (Table 12). The most reliable transport facilities available to the sample households were mainly by hired lorries 59.2%, followed by head load 15.8%. Next to head load transportation is hired donkeys 14.2% and lastly bicycle transportation 10.8%. Some farmers who own and keep few donkeys for transport explained the relatively significant reliance of farmers in Muungano - Zomba on the use of donkeys transport for haulage. Other villages don't keep draught animals as few villagers of Muungano Zomba do.

Table 12: Major means of transporting maize from field to homestead for the sampled household (n = 30 in each village) in four selected village of Kilagano Ward 2003/2004. (%)

Method of transport	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n = 120
Hire donkey	0.0	0.0	0.0	56.7	14.2
As a head load	13.3	16.7	30.0	3.3	15.8
By hired lorry	83.3	66.7	56.7	30.0	59.2
Bicycle	3.6	16.6	13.3	10.0	10.8
Total	100.0	100.0	100.0	100.0	100.0

4.3.6 Post harvest operation and losses

Published information on actual measurements of food loss and estimates by experienced observers, show that post harvest losses of food in developing countries are enormous. The variability of these losses - from season to season among different crops from location to location and under different kinds of post harvest treatment makes accurate measurement of their extent extremely difficult and hence expensive. In certain cases, it may never be possible or economically feasible to estimate losses whether of weight, quality or nutritive value, with any statistically significant degree of accuracy. For example, maize present particular problems of loss estimation because it can be stored either on the cobs or shelled, affecting the subjective evaluation of what are edible. Storage on the cob enable a process of selection at the time of shelling; individually damaged grains may be separated as the grain is shelled or the cob may be considered so heavily damage that it is rejected, good kernels and all. Accurate estimation of losses are impossible unless clear definition of these factors accompany numerical data (NAS, 1978).

Although the methods of loss estimation are frequently suspect and the supporting data rough, there are sufficient data to show that substantial amounts of food are being lost annually in the post harvest system. Table 13 shows post harvest operations which majority of farmers in the survey area experienced most important losses. From the Table, 48% of 120 sample households said they had been experiencing severe losses during storage. Storage pests were mention to be the main cause of the problem, followed by rodents and termites. Pre-harvest factors ranked second (24%) where maize eating animals, especially monkeys were mentioned to be the cause of losses. Losses during shelling (22%) ranked third, breakage, spillage and failure to collect all the shelled grains from the shelling ground were mention to be the cause of the losses. Losses during harvesting (3%) and transporting (3%) of maize from the field to homestead ranked fourth and firth respectively. These two last operations showed to have least losses compared to the other post harvest operations. Transportation of shelled maize in bags by lories and hand maize harvesting can be explained as factors behind these small losses.

Table 13: Post harvest maize losses associated with different operations in the four selected villages in Kilagano ward 2003/2004 (%)

Post harvest operations	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n =1 20
Pre-harvest factors	10.0	23.4	23.0	33.3	24.0
Harvesting	13.0	3.3	3.3	3.3	3.0
Transportation	0.0	3.3	3 3	3.3	3.0
Shelling	23.7	20.0	23.0	16.6	22.0
Storage	53.3	50.0	47.4	43.4	48.0
Total	100.0	100.0	100.0	100.0	100.0

4.3.8 Magnitude of grain losses during storage

In order to estimate precisely the magnitude of losses farmers experienced during storage, actual grain sampling and analyzing is the appropriate method to arrive at correct estimate. But due to time constraints this was not possible. Instead, farmers were asked to quantify the magnitude of grain losses they experience in their storage structures.

Table 14 shows the quantity of losses experienced by farmers during storage. Storage of shelled maize after being treated by chemical pesticides is the dominant method among the farmers in Kilagano ward. From the Table it can be seen that 60.8% of all sample households lost between 1-200kg during the whole period of maize storage, Mhepai village had the highest percentage of farmers who lost the said quantity. About 26.7% of all sample households lost between 201- 400kg, Kilagano village having the highest number of farmers falling in this group. Five point eight percent and 6.6% of sample households lost between 401- 600kg and 601 and above respectively. The possible explanation for that magnitude of losses despite of chemical pesticides applications are; first improper application of chemical pesticides in maize storage especially failure to apply recommended dose for treatment (underdose). Second, some farmers without being aware bought and made use of already expired chemical pesticides as a result the chemical failed to act on pests. Farmers mostly affected under this group were those who relied on street vendor supply. Third, some farmers did not treat their maize neither with naturals materials nor with chemical pesticides, and fourth, some farmers treated maize after commencement of pest infestation, a condition which is difficult to eradicate all pests in storage.

Table 14: Amount of losses during storage in the four selected villages in Kilagano ward 2003/2004 (%)

Losses in kg	Mgazini	Mhepai	Kilagai	Muungano Zomba	Pooled sample n = 120
	(1329)*	(1053)*	(844)*	(1143)*	(1092)*
0 - 200	63.3	73.3	53.3	56.6	60.8
201- 400	20.0	20.0	40.0	26.7	26.7
401- 600	10.0	3.3	3.3	6.7	5.8
> 600	6.7	3.4	3.4	10.0	6.7
Total	100.0	100.0	100.0	100.0	100.0

* Numbers in brackets are average amounts of maize stored in kg.

Generally losses on storage have been noted to increase with time lapse from the date of storage. The number of insects in infected grains has been detected to be very large only after six months of storage. When asked about the time of which storage losses are more serious, about 104 of the sample households (86.6%) reported the time between December and February, approximately six to eight months after commencement of storage. This finding is similar to that reported by Ashimogo (1995).

4.3.9 Prevention of biological agents of deterioration during storage

Insects pests and mites, fungi and rodents are the principal agents of deterioration during storage. Beetles and moths are the most predominant pests causing great loss and deterioration to food grain. In a number of countries in the tropics rodents (rats and mices) cause much more loss and damage to food grain than insect pests. Fungal attack in storage generally occurs when drying has been inadequate, where large number of insects are present, causing a temperature rise in the grain, or when the stored crop is exposed to high humidity or actual wetting (Odogola, 1991; NAS, 1978).

However, losses due to fungi are reduced as a result of improvement in drying and storage technology. Techniques for rodent control fall into the following broad categories. Rodents exclusion efforts in store construction, improved sanitation, including removing food and harborage from the surroundings or reducing it as much as possible, poisoning baiting, (including use of the anticoagulants such as chlorophacinone, warfarin, coumanin diphacinone and caumatetralyl, and acute poisoning such as zinc phosphide, barium carbonate, red squill, and vacor), fumigation with phosphine or other gases, trapping and hunting, use of cats and dogs and rodent repellents (NAS, (1978).

Table 15, shows how sample households controlled and prevented various biological agents of deterioration, humidity and high temperatures. Findings from the survey area indicated that chemical insecticides were more used by majority of sample household farmers to control insect pest on storage, followed by use of spent motor vehicle oil to smear poles and storage rooms. Asked how farmers controlled insect pests and mites, 67.5% of sample household mentioned to use chemical insecticides and 17.5% of them used spent oil to prevent mites attack in storage. Other means used by farmers were airtight storage structures, structures constructed by mites resistant trees especially (granaries) and thorough repair and cleaning of storage structures and rooms. Controlling and preventing rodents were explained by farmers, to be the most difficult task among the farmers due to rodent's habits and high ability of maneuvering in villager's houses. For example during focus group discussion, discussants explained that for 2004/2005 cropping season rodents caused extensive destruction to germinating seeds in the farms, that led to a decrease in productivity.

Use of rodenticides was mentioned by 58.3% of sample households to be a major means of controlling and preventing rodents. Other means were are domestic cats to kill rats

27.5%, rodents' traps 11.7% and use of solid walled structures. Majority of sample households (98.3%) mentioned arranging maize bags on the platform constructed by logs as a means of controlling humidity and high temperature (Figure 12). This arrangement of bags keeps bags off the floors or ground thereby reducing moisture uptake. Those farmers who used kitchen ceiling storage, which accounted for 1.7% of total sample households, mentioned lighting fire in the kitchen below the stored maize.

Table 15: Prevention of biological agents of deterioration, humidity and high temperature in the four selected villages in Kilagno ward 2003/2004 (%)

Biological agent and storage condition	Methods	%
Insect pest and mites	Air tight storage	1.8
	Structure constructed with mites resistant trees	2.5
	Regular repair and cleaning storage structures and rooms	1.7
	Herbs or non chemical agents	9.0
	By using chemical insecticides	67.5
	By oiling poles and maize storage room	17.5
	Total	100.0
Rodents	Solid walled structures	2.5
	Rodenticides	58.3
	Rodents traps	11.7
	Domestic cats to kill rodents	27.5
	Total	100.0
Humidity and high temperature	By arranging maize bags on platforms constructed by logs	98.3
	By lighting fire below kitchen ceiling	1.7
	Total	100.0

Figure 12: Method of controlling humidity and high temperature

4.3.10 Treatment of stored maize against insect pest.

Insect pests are a greater problem in the regions where the relative humidity is high, but temperature is the overriding factor that influence insects multiplication. At temperatures of about 32°C the rate of multiplication is such that a monthly compound increase of 50 times the present number is theoretically possible. Thus, 50 insects pests at harvest could multiply to become more than 312 million after only 4 months. Paster (1993) estimated that world wide there are 20 insect species out of 100 known to cause damage to food and are consider to be major pests.

Control measures, whether or not insecticides are available, depend first on storage hygiene. Storage containers must be checked and cleaned as carefully as possible. Old stored grain should be checked and if necessary, re-dried and cleaned to control existing infestation. New dry grain should be kept separate from old stored grains because of the risk of cross infestation. Similarly stores should be as remote from the field as possible to reduce the risk of infestation. In addition to storage pests, it must be assumed that new grain is infected from the field and control must include a regular system of inspection and deterrence to maintain storage hygiene and take control measures where infestation is observed. Traditional pest control systems not involving chemical insecticides like uses of local herbs, mixing ash with grain and smoking has been encouraged on the ground that insecticides uses present severe health hazards or have other environmental, ecological, economic and social implication (NAS, 1978).

Several attempts have been made to improve traditional methods and structures so as to reduce dependence on insecticides use. The efforts fail to produce significant outcome. Introduction of new maize varieties (especially high yield varieties), as it was observed by Bengsston (1991), caused a relatively higher insect damage in stored hybrid maize than in local varieties and the out break of Large Grain Boer *(Prostephanus trucancatus (Horn)* have been mentioned as the factors of this failure. McFarlane (1988), cite by Ashimogo (1995), attested that it was against the background of the unusually severe losses caused by the Larger Grain Borer that the Government of Tanzania began to organize its current control proggrammes against this pest, with the support of FAO and British Government. In such a situation it was clearly imperative to consider the possibility of using pesticides to achieve effective protection of stored produce.

Table 16: Maize treatment before storage in the four selected villages in Kilagno ward 2003/2004 (%)

Maize treatment	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample n = 120
Chemical pesticides	90.0	73.3	70.0	86.7	80.0
Natural materials	3.3	3.3	0.0	0.0	1.7
No treatment	6.7	23.4	30.0	13.3	18.3
Total	100.0	100.0	100.0	100.0	100.0

Findings from the sample households surveyed showed a kind of uniformity among farmers in their comprehension of stored maize protection as the following account demonstrates. About 80% of the 120 sample households' farmers applied chemical pesticides (Table 16), 1.7% used natural deterrent materials mainly tree ash and 18.3% did not use any protectant. During Focus Group Discussion most farmers explained that they had changed the methods of treating stored maize against pest, following the problems created by Large Grain Borer since the pest came into existence in the 1980s. The pest caused severe losses to stored maize under traditional methods therefore farmers had no other alternative other than chemical treatment, which proved to be more effective in pests control. They continued explaining that some farmers who failed to use chemical pesticide had no money to purchase pesticide or they had very little maize to store hence did not find the reason of buying the chemicals.

As it was noted more than 80% of all sample farmers used, chemical pesticide on their grain storage structures. About 85.14% of 96 sample households (Table 17) mentioned to use Actellic Super 0.5% for their maize treatment, 3.13% and 1.04% mentioned to use D.D.T. and malathion 2% respectively, 10.41% of farmers though used chemical pesticides they failed to mention what types of chemical pesticides they used in their storage. Despite the big number of farmers using chemical pesticide some shortfalls could be easily noted from the study; first about 3.13% of sampled farmers (one from Mhepai and two from Kilagano) used (DDT) which is unfit for human consumption (not recommend by FAO/WHO) because it leads to health hazards. Bengtsson (1991) and Mkoga (1992), cited by Ashimogo, (1995) also reported that 11% and 27% respectively of sampled respondents on their studies used DDT in their grain storage. Second, 10.41% of sampled farmers four (18.5%) from Mhepai and six (28.5%) from Kilagano) used chemical pesticides that they did not know even their names. Therefore under such circumstances chemical pesticides had the possibility of leading to very serious health problems. When the questions of rate of chemical pesticides application were examined, the farmers mentioned quite different rates of chemical pesticides application contrary to recommendations given by manufacturers and entomologists. For example the recommended rate of application for Actellic Super Dust *(Pirimiphosimethyl)* is 100g/per 90 kg of maize. Findings from survey area showed that, only 16% of sample households farmers who used either Actellic Super Dust or Malathion 2% used the recommended rate (Table 17).

Failure to follow the recommendations of chemical pesticides uses has been also reported by Bengtsson (1991), where he reported only 11% of the 71 farmers he surveyed used the correct insecticides and the recommended rate of application as per manufacture's guidance. About 53% of 96 sample households when asked to mention the rate of chemical pesticides they applied to their storage, simply answered that they didn't know the actual rate of pesticide application, what they actually did was to estimate the quantity of what they thought to be the right dose.

Table 17: Chemical pesticides used and their rate of application for sampled households n = 96 in four selected villages in Kilagno ward 2003/2004 (%)

Type of Pesticides and recommended dosage	Villages				Pooled sample n = 96 (%)
	Mgazini (n = 27)	Mhepai (n = 22)	Kilagano (n = 21)	Muungnao Zomba (n = 26)	
Actellic Super 0.5% (100g/90kg)	100.0	77.0	57.0	100.0	85.14
D.D.T (one part/1000 parts)	0.0	4.5	9.7	0.0	3.13
Malathion 2% (50g/90kg)	0.0	0.0	4.8	0.0	1.04
Unknown name	0.0	18.5	28.5	0.0	10.41
Total	100.0	100.0	100.0	100.0	100.0
Application rate:					
Correct dosage	14.8	9.2	9.5	27.5	16.0
Under dosage	7.4	0.0	0.0	8.0	4.0
Over dosage	26.0	31.8	33.3	19.0	27.0
Unknown dosage	51.8	59.0	57.2	46.0	53.0
Total	100.0	100.0	100.0	100.0	100.0

Other farmers even mentioned that they depended very much on street vendors who sold Actellic Super solution (that was already mixed with water) for treatment of their maize. This fact was supported by twenty farmers from the ward who reported to use Actellic Super solution for treating shelled maize, contrary to manufacturer recommendations.

Actually Actellic Super solution had been designed to be applied on dehusk maize stored in cribs Rouanet (1987).

Furthermore, 27% of farmers used more and above what has been recommended by manufacturers, leading to unnecessary wastage of resources. Withdraw period after chemical pesticides treatment was not taken in consideration by a few sampled farmers, Some of them were noted to consume maize treated with chemical pesticides before withdrawal time was over. Despite the shortfalls mentioned above the analysis revealed some interesting features as follows: First, pesticides use among the villagers was preferred to other methods of treating stored maize against pests. Second, farmers used a combination of pesticides and traditional structures for the prevention and control of pests, though this combination was of less significance. From this study and a few other studies quoted in the literature revealed some very serious problems among the farmers of Kilagano ward and Songea district in general. Forced by various circumstances like severe losses caused by Large Grain Borer, farmers have been using chemical pesticides as a major means of protecting the stored produce. Very unfortunately most farmers have been hardly following recommended insects control techniques for on farm grain storage. Findings from the study showed that information communication among interested parties that is between extension officers and farmers is inadequate. Out of 120 farmers interviewed about 77.2% complained that they never received any expert advice on proper grain storage methods and practices. Those who failed to use pesticides (18.3%) said inadequate information or lack of knowledge as the reason behind their failure, therefore these facts give an indication of the magnitude of problem. As a result, farmers have inadequate information on deciding when and how to use pesticides. Another problem involved availability of commercial pesticides.

Although more than half of the surveyed farmers were aware of the need for pesticides, lack of a well streamed distribution system was a major constraint. There came into view four employed means of distributing pesticides in the study area. Four point three percent of sample household farmers using pesticides informed that they purchased pesticides from common shops. Others obtained from dealer 55.2% and from extension agents 6.4%. The rest 34% obtained pesticides from a variety of other sources including street vendors. This diversity of sources of pesticides increased the risk of using non-recommended and expired pesticides. The final area of worry arose as a result of inadequacy integration, in the minds of entomologists and economists who offer suggestion to farmers, state policy makers and others in between, of the unfavorable interrelationship between socio-economic issues and pesticides use. Norgaard (1976), cited by Ashimogo (1995), considered the misuse of pest control inputs as a social problem. He argued that insufficient consideration is given to the economics and technological limitations of using pesticides and other pest management strategies in relation to the pest complex and the entire post harvest system. Investment in insect control for farm storage possibly will not be cost valuable for many farmers. In addition the TDRI (1984), cited by Ashimogo (1995), stressed that appropriate supervision is necessary for safe, sound and effective use of pesticides at farm level.

4.3.11 Duration of storage.

The duration of storage gives an impression of production seasonality and farmers consumption and selling strategies of stored grain. Long term storage may entail that farmers stored maize for later sale or food security purposes. On the other hand, it may be a sign of lack of alternative income sources or consumption substitutes. In both cases storage for longer period of time may be viewed as an insurance against both income and food shortages. Due to seasonality of production, the grain storage on farm remains in store for moderately long periods. Under good storage management maize could be stored for as long as one year. The duration of storage for surveyed villages worked out to be 10 months, which is from September 2003 to June 2004. Most farmers start consuming their stored maize between September and December being 39.2% on September, 13.3% on October, 16.7% on November and 30.8% on December (Table 18).

On examining the relationship between quantities of maize stored and time of maize depletion showed that small farmers fell under short period of maize storage (1-6 month), while medium and larger farmers fell under longer period (6-10 months) Table 18. The Table also shows the time when most households depleted their stored grain. Forty seven point five percent of farmers depleted stored maize between January and May each year and the rest mostly large farmers run out of stored maize in June. By looking at the performance of crops in the farms, farmers can approximate the forthcoming maize crop and if the projections are good, farmers dispose of their remaining stock.

4.4 Implications of maize storage on food security

4.4.1 Overview

In this section knowledge on food security, amount of maize consumed by sample households, and overall coping strategies of food insecure households will be examined. The assessment focuses mainly on food sufficiency from the farmer's point of view while taking nutritional references for purpose of confirming field findings. The discussion has adopted the Ogbu's (1973), cited by Ashimogo (1995), definition of "hungry season" or transitory food insecurity as a period when the resources available do not permit people to satisfy their hunger in a way prescribe by their culture. It is a period of the year when members of a population feel they eat less than they normally would or when a household faces a temporary decline in the security of its entitlements and the risk of failure to meet food needs is of short duration.

Table 18: Month of starting consuming and finishing stored maize for the sampled households (n = 30 in each village) in four selected villages in Kilagano ward 2003/2004 (%)

Month and year	No of farmers start consuming stored maize	No of farmers finishing stored maize
Sept 03	49 (39.3)	-
Oct. 03	16 (13.3)	-
Nov. 03	20 (16.6)	-
Dec. 03	37 (30.8)	-
Total	120 (100.0)	0.0
Jan. 04	-	9 (7.5)
Feb. 04	-	9 (7.5)
Mar. 04	-	12 (10.0)
Apr. 04	-	26 (21.7)
May 04	-	1 (0.8)
June 04	-	63 (52.5)
Total	0.0	120 (100.0)

Figures in parenthesis are the percentages of farmers.

It is a period that people feel what they eat is not what they consider as a good diet. Hence people in the transitory food insecure period have, more often, a compelling need or desire for food. In a nut shell this section tries to examine four basic things:-

(a) How do sample households define the concept of food security from local and international perspectives

(b) To describe the degree of sufficiency of produced maize for household consumption

(c) To explain the factors causing maize deficiency (food insecurity) and

(d) To examine the coping strategies of food deficit households including the contribution of bought and received maize to offset food deficiencies.

In this context households are defined as being food insufficient or food insecure, if they reported exhausting own produced stocks during the 2003/2004 harvest and therefore rendering the household food deficient before the next crop matured. However, in order to understand the implications of maize on food security it was important to analyze how farmers of the surveyed area utilized harvested and stored maize. As was noted before, maize crop played an extraordinary role on meeting food and cash needs to majority of farmers of Kilagano ward and Songea district in general. The aim was to give an overview on how villagers allocated maize harvested and stored among various purposes.

4.4.2 Utilization of harvested maize

Table 19 shows utilization of harvested maize in Kilagano ward. Findings from sample households showed that about 64% of maize grain harvested in the ward was sold immediately to take care of immediate cash needs while about 26% was reserved for future sales, consumptions and other purposes. Findings also revealed that only 10% were used in the transition period before households started consuming stored maize. On the other hand, the amount of maize sold immediately after harvest varied between villages.

The leading inter-village dissimilarity of grain retention was observed between Mgazini, a relatively surplus village compared to the other villages. For example, while farmers in Mgazini stored on average 1329kg each, those in other villages stored between 817 – 1143kg each. Moreover, small farmers in three villages stored almost the same amount of grain (473kg) except for their corresponding counterparts of Mgazini who stored more than 500kg. Nevertheless, the proportions of grain stored differed very much with reference to the amount of total maize produced. In comparative terms farmers in Muungano Zomba and Mgazini sold more grains (72% and 61%) right away after harvest than farmers in Mhcpai and Kilagano. This may be interpreted as relatively higher commitments that may require cash or defensive measures against a likely failure to secure markets in the future. On the consumption part for the total sample, small farmers consumed more (19%) of total grain harvested within the harvest time compare to 15% and 7% respectively for medium and large farmers. But this model was not similar in all villages. For example, in Mhepai all categories of farmers consumed about 11% of harvested maize immediately after harvest compared to 21%, 13% and 8% for the small, medium and large farmers respectively. The foregoing discussion implies that the portion of grain retained at farm level was a function of total harvest, which in turn was a result of farm size and land productivity. Whether the amount stored reflected the families desire to ensure food security in the lean season depended on how farmers utilized the stored maize grain.

Table 19: Utilization of harvested maize by sample households (n = 120) in four selected village in Kilagano ward 2003/2004 (kg)

Types of use	Small n=43	Medium n =34	Large n=43	Pooled average
Mgazini				
Harvested	1195	3047	9382	4480
Immediate consumption [a]	233	346	591	409
Immediate sale [b]	407	1287	6617	2741
Stored	555	1337	2174	1329
Mhepai				
Harvested	1206	2964	6107	3309
Immediate consumption [a]	250	388	498	369
Immediate sale [b]	483	1440	3924	1885
Stored	473	1136	1685	1054
Kilagano				
Harvested	1224	2416	6656	3333
Immediate consumption [a]	239	384	643	395
Immediate sale [b]	429	1360	4620	2121
Stored	485	672	1393	817
Muungano Zomba				
Harvested	1196	2674	11195	5787
Immediate consumption [a]	190	419	738	501
Immediate sale [b]	533	1360	8731	4143
Stored	473	895	1726	1143
Pooled sample				
Harvested	1151	2803	8429	4227
Immediate consumption [a]	223	408	623	418
Immediate sale [b]	453	1359	6070	2723
Stored	475	1036	1736	1086

a = Consumed before household starts to consume stored maize

b = Sold within the harvest month

4.4.3 Utilization of stored maize

Table 20 shows by village how sample farmers disposed of maize stored during the 2003/2004 cropping season. It was noted that the allocation of farm level maize storage in the post harvest system maintained its leading role for both subsistence and selling in the market. That the quantities used for food consumption and selling were the highest of all total quantity stored, accounting for approximately 52% of households consumption and 35% for selling.

Table 20: Utilization of stored maize for sample households (n = 30 in each village) for four selected village in Kilagano ward 2003/2004 (kg)

Type of use	Mgazini	Mhepai	Kilagano	Muungano Zomba	Total
Selling	15080	12340	4920	13300	45640
Consumption	20420	15650	16600	15840	68510
Brewing	555	780	960	1200	3495
Seed	760	1070	910	1240	3980
Presents	1560	820	1170	1585	5135
Payments [a]	1080	710	475	875	3140
Remaining [b]	420	230	275	250	1175
Total harvest [c]	134385	99240	100792	173610	508027
Total stored [c]	39875	31600	25310	34290	131075

a = In-kind payment for labour
b = Remaining in store as at end of June 2004
c = See Table 19 The difference between total stored and total harvested is the amount consumed and/or sold immediately after harvest.

Moreover, the entire portion of maize sales out of total storage underlined the trade-off between food needs and cash need from stored maize. On the other hand maize consumption did not differ significantly among villages with the sales and consumption portions uppermost in Mgazini village. Farmers in Kilagano, on the other hand, sold a small portion of total maize stored. If you examine the use pattern of stored maize, based on land size under maize (Table 4), the picture takes another outlook. As it can be noted from Table 21, generally the share of total consumption out of stored maize decreased with land size. The possible explanation of that condition was the correspondence between land size and maize production, with maize harvested. Maize sales shares related inversely to the proportion of maize consumed. It could be inferred that small and medium farmers consumed relatively bigger proportion of their maize production while lager scale farmers sold most of their stored maize.

The utilization pattern between different categories of farmers gave another clue that home consumption increased less than proportionally and the marketed surplus increase more than proportionally with increase in output (Table 21). While small farmers sold 11% of the stored maize the medium and large scale farmers sold 22% and 43% of stored maize, respectively. On the contrary large scale farmers consumed only 22% of stored grain compared to 54% and 79% for the medium and small farmers, respectively. Apart from maize requirements for food, sale in the market and seed for the subsequent farming season, the necessity to store grain was also created due to additional societal and monetary obligations that are expanding over the year, Table 21 shows that, remittances including in-kind labour payments, brewing of alcohol and seed needs accounted for a small proportion (14%) of stored maize. The comparative shares being 6%, 5% and 3% respectively. Large scale farmers used somewhat more of stored maize for labour payments, brewing, seed and presents, compared to other categories of farmers. About 1% of stored maize was noted as a carry-over stock, which implies that most farmers in the study area could store maize hardly for one year and not more than that. The analysis on utilization of harvested maize indicated three issues.

First, the total amount of maize produced for a given year could be predisposed of in several ways. It could be bartered for household consumption, sold for cash in the market, used to pay in-kind farm expenses including wages, consumed directly by farm households, or added to end of year stocks. Maize not consumed on the farm eventually found its way into market channels or beer brewing.

Second, the fact that selling of maize was roughly as important as home consumption, the choice about on farm storage was not based on household needs only. In fact Renkow (1990) attested that within a given cropping cycle, the output from which market surplus is drawn, is predetermined and exists as currently held inventories and/or recent harvest.

Third, the high quantity of maize sold out of storage in particular and out of total production in general supported the tentative explanation that "overselling" could be explained as one of the key problems leading to food insecurity. Nevertheless, maize shortage could as well be offset by use of other storable food crops like finger millet. Moreover money acquired from maize sale could be used to purchase other food items like cassava in the lean seasons.

4.4.4 Perception of rural farmers on the concept of food security.

To measure how sample households perceived the concept of food security, a five points hedonic scale was prepared in order to capture their knowledge on food security. The aim of this exercise was to examine whether the four basic components of food security were clear to them (that is adequacy, accessibility and stability of food supply and sustainability of food procurement).

Table 21: Utilisation of stored maize for sample households by land under maize, (n = 120) for four selected village in Kilagano ward 2003/2004.

Type of use	Small n=43	Medium n=34	Large n=43
Mgazini			
Selling	980	5180	8920
Consumption	4620	4800	11000
Brewing	40	315	2000
Seed	170	430	160
Presents	190	550	820
Labour payment	100	510	470
Remaining	0	250	170
Total harvested	13140	27425	93820
Total stored	6100	12035	21740
Mhepai			
Selling	620	2880	8840
Consumption	4700	5190	5760
Brewing	150	100	530
Seed	110	390	570
Presents	50	390	380
Labour payment	0	110	600
Remaining	50	30	150
Total harvested	14480	23710	61070
Total stored	5680	9090	16830
Kilagano			
Selling	440	700	3780
Consumption	4900	3000	8700
Brewing	100	100	760
Seed	160	150	600
Presents	170	110	890
Labour payment	50	0	425
Remaining	0	100	175
Total harvested	14692	12080	73220
Total stored	5820	4160	15330
Muungano Zomba			
Selling	300	2600	10400
Consumption	2000	6590	7250
Brewing	350	550	300
Seed	90	300	850
Presents	100	350	1135
Labour payment	0	300	575
Remaining	0	300	200
Total harvested	7180	32090	134340
Total stored	2840	10740	20710
Pooled sample			
Selling	2340	8060	31940
Consumption	16220	19580	16760
Brewing	640	1055	1790
Seed	530	1270	2180
Presents	1110	1400	2665
Labour payment [a]	150	920	2070
Remaining [b]	50	430	695
Total harvested [c]	49492	96105	362430
Total stored [c]	20440	36025	74610

a = In-kind payment for labour
b = Remaining in store as at June 2004
c = See table 19 the difference between total stored and total harvested is the amount consumed and/ or sold immediately after harvest.

Table 22 shows results of a 5 points hedonic scale measuring knowledge on food security. From the Table it is interesting to note that the majority (60%) of all sample households had excellent knowledge on food security, Kilagano village having the highest number of knowledgeable sampled households farmers. The possible explanation of that situation might have been because of higher literacy rate among sample households and primary health care education to the villagers. Respondents from Mhepai village, among the four villages had the least number of excellent knowledge farmers and had the highest number of neutral and moderate knowledge farmers that is 30% and 26.6% respectively.

Extremely ignorant and moderately ignorant sample households did not exist in Kilagano village but did exist in Mgazini village 3.3% and 6.7%, in Mhepai, 6.7% and 0%, and in Muungano Zomba both 3.3%, respectively. However, despite majority of the farmers in the ward having excellent knowledge on food security, that did not mean majority of farmers were food secure. During FGD farmers complained that, there was a problem among them on maintaining well balanced diets on their daily menu. It was observed that poverty was the reason behind this problem because money obtained from sale of agricultural produce was not enough to buy other necessary foods like meat, fish, sugar, milk and other nutritious foods throughout the year. The problem of poverty was not addressed adequately because it was out of scope of this study.

4.4.5 Knowledge on food security from local perspective.

During Focus Group Discussions, which were conducted among the four villages, the same questions on the concept of food security were asked in each village. The majority of farmers unanimously agreed that, a family would be considered food secure if and only if it had enough maize grain to run them for the whole year.

Table 22: Assessment of knowledge on food security for sample households (n = 30 in each village) for four selected village in Kilagano ward 2003/2004 (%)

Type of use	Mgazini	Mhepai	Kilagano	Muungano Zomba	Pooled sample (n = 120)
Extremely ignorant (Know nothing)	3.3	6.7	0.0	3.3	3.3
Moderately ignorant (Below average)	6.7	0.0	0.0	3.3	2.5
Neutral (No clear evidence of presence or lack of knowledge)	10.0	30.0	16.7	3.3	15.0
Moderate knowledge (above average)	13.3	26.6	13.3	23.3	19.2
Excellent knowledge	66.7	36.7	70.0	66.7	60.0
Total	100.0	100.0	100.0	100.0	100.0

A family may have large quantities of other cereal crops like finger millet, paddy and other non-cereal crops like cassava, yet the majority of farmers will still consider that family to be food insecure. Commenting on the concept of food security one member from Mgazini attested that "if the household rely very much on cassava flour for "*ugali*" preparation, that implies that, the family is in food crisis." Most households ate cassava flour after depletion of their maize stock, mainly between February and May. It was observed that the concept of food security to them implied physical and economic access to foods that were adequate in terms of quantity and cultural acceptability, other elements like nutritional, quality and safety were not considered as important elements.

4.4.6 Determination of subsistence level

In-depth studying of maize sufficiency required knowledge of the contribution of maize to total household food availability. A number of assumptions were required to determine the consumption adequacy of maize in the surveyed villages. Rogers and Lowdermilk (1991), cited by Ashimogo, (1995) stated that ideally calorie intake estimation should be based on the nutrient content of each food, adjusted for edible portion. Food availability should in a real sense be measured by the daily dietary energy and protein intake levels, adjusted for household size and age and gender composition as recommended by the FAO/WHO/UNU Expert Consultation Group (FAO-WHO-UNU, 1985) cited by Ashimogo,(1995). On the other hand, nutritional studies conducted in Songea, that have precise estimation of share of different food groups in the total energy supply by age and sex were not available when this study was conducted. Seshamani's study (1981), cited by Ashimogo (1995), on food consumption and nutritional adequacy in Iringa region recognized that on average foods other than cereals contributed about 20% of energy in the diet. Based on the fact that Iringa and Songea regions fall in the same agro-ecological zone (a study by Rassmussen (1986), cited by Ashimogo (1995)), this study adopted the figure of 80% as the contribution of cereals in total energy supply in Songea district. As long as this study collected consumption information for maize, an estimation of the proportion of calories from maize, given the above assumption was possible.

For this study calories burning up was projected based on the energy content of 357 calories per 100 grams of edible portion of white maize (FAO, 1968) cited by Ashimogo, (1995). The average daily calories requirement for a moderately active adult equivalent (AE) is 2850 kcal/day (FAO-WHO-UNU, 1985), cited by Ashimogo, (1995). According to standard of the World Health Organization (WHO), a safe minimum daily intake should not fall below 80% (or 2280 kcals/AE/day) of this requirement. With these suppositions in mind the smallest amount of daily maize requirements per adult equivalent per day turned out to be some 568gram or a minimum of 207.3kg of maize per year per adult equivalent. Another study mentioned 225kg of maize per year per adult (Rouanet, 1987).

By matching up to this minimum requirement to the amount of maize actually consumed by each household member (expressed in AEs), it was possible to evaluate the maize adequacy for each family. This method of assessing maize adequacy has been found to be superior to the "bag methods". proposed by the Tanzania Food and Nutritional Centre (TFNC) (Kavishe, 1991). The outcome of this exercise is summarized as follows. Households which consumed below 2280 Kcal/AE/day were considered to be food insecure and those which consumed amount that were equal or more than the above threshold were considered to be food secure. In other words, household were defined as being food insecure if the maize stocks immediately following the 2003/2004 harvest were below level required to meet 80% of the WHO average caloric requirement until the 2004/2005 harvest. A household could be production deficient, and either food secure or food insecure in any given season, depending on; (i) the resources available to buy food (ii) the receipt of transfer (iii) the inter temporal distribution of consumption that it chooses, and (iv) the availability of food in the market or community (Reardon and Malton, 1989).

4.4.7 Quantities of maize consumed and food adequacy

The main sources of maize food from survey sample households showed that own production was the most important one. Carry-over stocks played insignificant role in total household food maize stocks. As noted from Table 21, of all sample households only 1% of stored maize was recorded as carry -over stocks. Therefore due to this reason, food maize sufficiency analysis did not take into consideration carry-in or carry over stocks.

Maize availability as used here means a portion of production that has been set aside for consumption and amounts bought or gifts received. Results of the estimation of maize sufficiency as described above are presented in Table 23.

Table 23: Assessment of maize sufficiency for sample households (n =30 in each village) for four selected village in Kilagano ward 2003/2004 (%)

Village	Maize sufficiency [a]	Households No.	(%)	Average family size	Average area cultivated (ha.)
Mgazini	Surplus	22	73.3	4.3	2.1
	Deficit	8	26.7	5.5	1.2
Kilagano	Surplus	18	60.0	4.1	2.2
	Deficit	12	40.0	5.0	1.4
Mhepai	Surplus	12	40.0	4.3	2.4
	Deficit	18	60.0	5.9	1.8
Muungano	Surplus	20	66.7	4.7	2.4
Zomba	Deficit	10	33.3	5.6	1.4
Pooled sample	Surplus	72	60.0	4.3	2.3
(n =120)	Deficit	48	40.0	5.9	1.5

a = maize sufficiency with reference to the minimum required quantities

A number of facts have been noted from the foregoing analysis. First, among smaller farmers, there was an increasing vulnerability of maize deficit associated with own production. Table 23 shows that surplus farmers had consistently large area under maize than deficit farmers. This could be interpreted that as long as smaller maize farmers cultivated smaller areas, own produced maize was not sufficient for household consumptions for the whole year. Average family size of deficit farmers was also relatively larger compared to surplus farmers, which meant that despite producing less, yet these households had a larger number of mouths to feed. Second, there existed food inadequacy difference between villages. For example Mhepai village had the highest proportion of households that faced risks of maize insufficiency while Mgazini had the least.

Third, about 60% of farm households in the sample households satisfied their demand for maize through their own production. Deficit households, to supplement their total food requirements, normally used a number of coping strategies, as it will be noted later. As noted earlier, this analysis was meant to give a general picture of maize sufficiency from the recommended energy intake level point of view.

4.4.8 Farmers own response to food adequacy or inadequacy

Generally maize supplies are plenty during the harvest season. Food maize needed thereafter for households' consumption is normally stored. The quantity stored may or may not last up to the next harvest, either due to the small amount stored, as a result of inadequate maize production or due to the use of stored maize for the purpose other than family consumption like excessive selling of stored maize or due to loses caused by poor storage. Table 24 shows farmers response to stored food adequacy or inadequacy. When asked whether the stored maize was enough to feed the households 63 farmers which is equivalent to 52.5% declared that the quantity of food maize stored was enough to feed their families until next harvest. Fifty-seven respondents, which were equivalent to 47.5%, said the quantity of maize stored was not enough to feed the household until next harvest. These sampled households, which did not have enough stored maize for family consumption, were lacking food maize for about one to five months. Farmers who had maize deficit for two months were 43 %, followed by 22.8% who were lacking maize for three months. About 19.3% and 12.3% were the farmers who had no maize food for four and five months, respectively. Asked the reasons for maize deficit, most of sample households (77%) mentioned inadequate maize production due to poor farm implements utilization (especially chemical fertilizers and pesticides) as the main reason of storing small quantity maize food (Table 24).

Other reasons were sickness (7%), which reduced the number of days farmers were supposed to attend the farms, excessive selling of stored maize and poor budgeting and storage problems accounted for 16%.

Table 24: Farmers response to stored food adequacy or inadequacy (n = 120) for four Selected village in Kilagano ward 2003/2004 (%).

Total sample	Stored maize sufficiency	%	No of month without maize	%	Reasons of maize Deficits	(%)
	Adequate	52.5				
n = 120	Inadequate	47.5	1 Month	1.8	Poor farm implements utilization.	77
			2 Months	43.8		
			3 Months	22.8		
			4 Months	19.3	Sickness.	7
			5 Months	12.3	Excessive selling, poor budgeting and storage problems.	16
Total		100.0		100.0		100.0

4.4.9 General causes of food insecurity among sampled household

Various reasons were given during focus group discussion (FGD) conducted in four-surveyed villages, as the cause of food insecurity among farmers in the villages.

Farmers complained that they failed to increase the area under maize production because most of them perform various farm operations manually, starting from land preparation, ploughing, planting, weeding, harvesting and storage. No machines are employed to perform these operations. Under such situations, farmers have limited capacity to expand their farms.

Farmers were aware of the importance of farm inputs utilisation, especially chemical fertilizers and chemical pesticides in increasing maize production. Sky rocketing of the price of these farm inputs was mentioned as a bottleneck to their production. At the time of the study, a single bag of chemical fertilizer (50kg) was sold between 20,000/= to 25,000/= (Tsh.) depending on the distance from the sources of supply. High yield maize varieties seeds were sold at Tshs. 4000-5000/= per kg. Most farmers complained that those prices were very high.

Dependence on maize crop as a sole food and cash crop had an adverse effect on most farmers in Kilagano Ward. Formerly tobacco was used to supplement maize as a source of cash, but due to consistent decline on the selling price of this crop in relation to the higher cost of producing it, most farmers had abandoned cultivating the crop, thus leading to most farmers relying only on maize.

Poverty that is attributable to high dependant's ratio especially children and old people with low productivity, were mentioned as causes of food insecurity. Despite being aware of the importance of storing large quantity of food maize according to family size requirements, urgent call for cash to cover other daily needs forced farmers to sell a large portion of their stored maize.

Environmental degradation was also mentioned as a reason of food insecurity among the farmers in Kilagano Ward. Farming practices, especially shifting cultivation, which involves forest clearing, was mentioned to be the cause of occurrence of considerable rodents in farms and house in 2004/2005 cropping season. Asked to associate the appearance of massive rodents and environmental degradation one farmer stated that as a result of forest clearance, rodents have changed their eating habits. Instead of eating wild fruits and cereals, rodents have turned into eating and depending on maize and other crops cultivated by man, because wild fruits and cereals are no longer available.

Failure to control effectively insects and pests especially Large Grain Bore (LGB) was also mentioned to be the cause of food insecurity. Insect pests and other biological agents of deterioration have not been effectively controlled, hence causing massive losses on stored food. Failure to use recommended doze on maize treatment, and use of expired chemical pesticides was cited as an example of the causes of food inadequacy to farmers in Kilagano Ward.

Failure to use proper farming techniques including proper spacing, plant density, fertilizing and weed control were also mentioned to be among the causes of food insecurity. Improper farming techniques always have resulted into low productivity. Some farmers failed to perform weeding operations at the right time due to growing many crops. Weeding was done late after weeds had already consumed a lot of nutrients, water and space needed by maize plants. Some of them mentioned that some farmers did not apply chemical fertilizers as recommended by agricultural extension officers. Some applied small quantities and others applied merely by putting on top of ridge without covering *(Mchuzi juu)* it with soil, which is normally washed away by rains. Studies have consistently shown that late and poorly done weeding may result in yield reduction of 30 to 70 percent (TARO, 1987). Late planting of maize (after November and December) were mentioned by agricultural experts of Songea (DALDO Office) to be one of the causes of low productivity of maize because maize planted late miss *"Nitrogen flask"* which is very essential in maize growth and its productivity.

The cost of producing maize was very high while selling price of maize produce was relatively low. *"one dumla,"* (a traditional measuring container which is equivalent to 4kg) was sold at Tsh 150/= at the beginning of maize marketing season and had never crossed 300 Tshs at the end of season. Under these circumstances majority of farmers were normally compelled to sell large share of harvested maize, eventually most of them remain with little to be stored. Even selling prices were not determine by producers (farmers), buyers were normally the ones who dictated what price they would buy maize and other crops produced by farmers.

Stealing of stored maize by one of the couple member and stealing on the farm by other farmers were also mentioned to be causes of food insecurity among the farmers. Needs for cash for buying local brew was mentioned to be another cause of theft. Therefore at the end of some few months after storage the household would find itself without enough maize to feed the family.

Traditional and religious ceremonies were also mentioned to be among the causes of food insecurity among farmers. Most farmers who engaged themselves on these ceremonies always found themselves having very little maize to store because of excessive and imprudent utilization of harvested maize on these ceremonies.

4.4.10 Signs of food insecurity from local perspective

Phillips and Taylor, (1990) attested that food insecurity exists when members of a households have inadequate diet for part or all of the year or face the possibility of an inadequate diet in the future. As noted on sample household survey (Tables 23 and 24), there existed transitory food insecurity among the villagers of Kilagano ward. During focus group discussions farmers were told to mention various signs they experience when families become food insecure. Farmers mentioned these signs as follows:-

During funeral ceremonies, it is a custom in *Ngoni* tribal tradition to bring uncooked food, firewood, water, chickens and animals like goats to the relatives of the deceased persons. A sign of food insecurity can also be noted during this particular time by looking at the number of mourners who bring cassava and maize flour. If the number of villagers who bring cassava flour is bigger than those who bring maize flour it can be interpreted as a good indicators of food insecurity among the villagers. At this particular time of the year, it means majority of farmers rely more on eating cassava flour instead of maize flour.

The number of households eating *"dona"* increases than any other time of the year. *"Dona"* is the maize flour prepared from undehulled maize. Normally *Ngoni* people eat maize flour prepared from dehulled maize *(kukoboa)*. Food insecure households would avoid this process, instead the whole maize grains will be milled so as to minimize losses. The families that eat *"dona"* are always considered to be food insecure and it is taken also to be a sign of food insuffiency among the members of the villagers.

Misunderstanding and quarrels within members of the families increases especially between couples, than any other time of the year if households are food insecure. Through their experience, farmers explained that during harvesting time and few months later on when most of households have plenty of food, quarrels and misunderstandings rate among members of households is lower compared to the time when families experience food shortage.

The households reduce the number of meals taken per day and some members of the familie start relying on other families for their food needs. Deficit households' members develop a tendency of paying visits to surplus households during lunch and dinner times. If invited for food these members normally don't reject the offer. Farmers explained that if the number of households developing this tendency narrated above increases it is one of the signs of food insecurity in the village.

The quantities of food cooked per household do not correspond with the size of the family. Household members eat less than what have been accustom to. Family members eat small quantities of food in order to survive instead of living. From health point of view most farmers became weak and easily attacked by diseases at this particular period of the year because they try to work hard in farms with small quantity of unbalanced diet they consume.

Increase in theft incidences was pointed out also to be a sign of food insecurity among the farmers in the surveyed area. In order to supplement their food needs, deficit household may start stealing other farmers' properties and food items. At harvesting time and few months following harvesting periods the incidences of thefts are relatively low compared to the period when most of the households have a shortage of food.

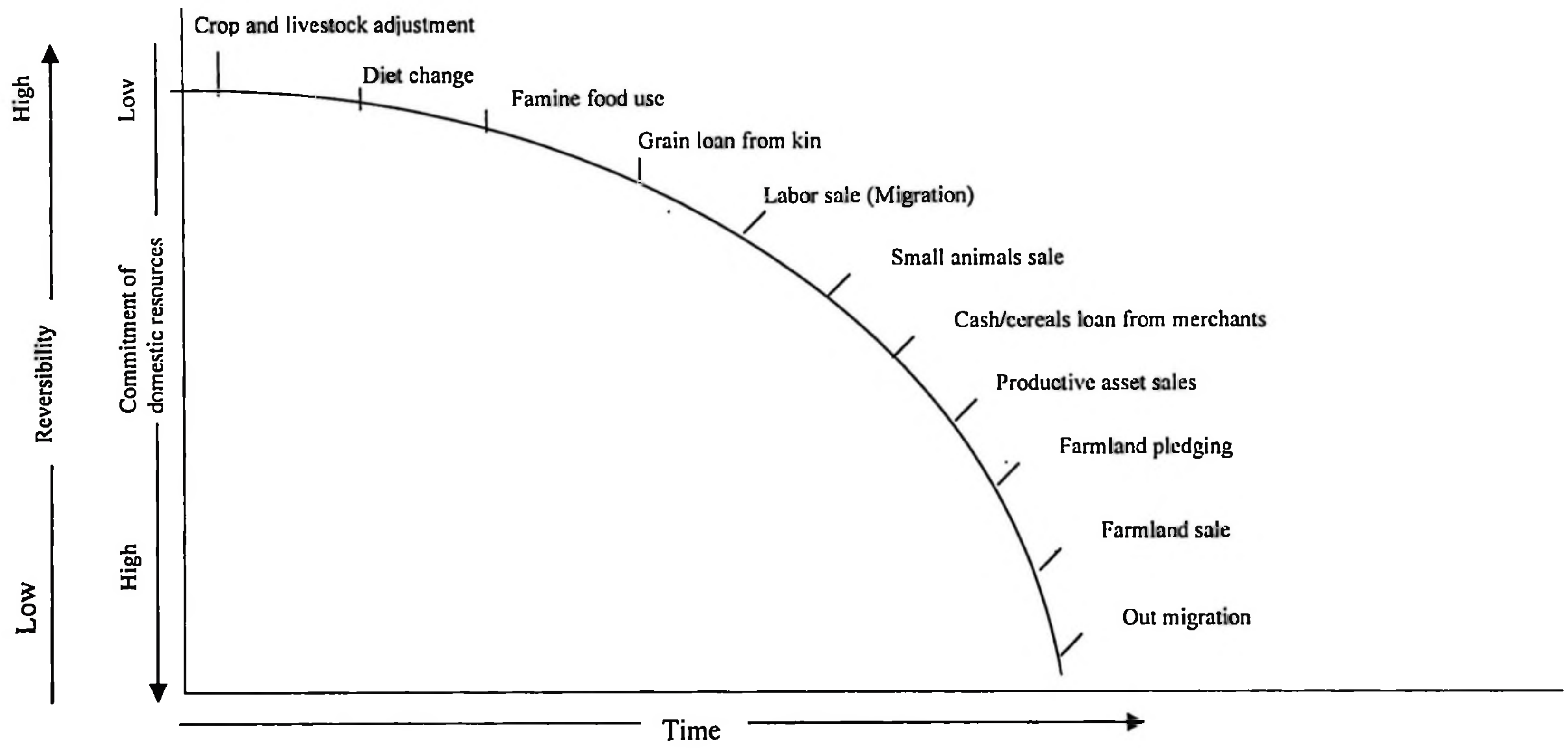
Farmers also mentioned poor school attendance to most children as a sign of food insecurity. School children from deficit household lead on having poor attendance compared to schoolchildren from surplus households. Normally attendance rises during harvesting time and few months thereafter because most of children go to school while their stomachs are full.

The rate of alcohol brewing and a number of traditional and religions ceremonies conducted during particular time of the year, can indicate a sign of food shortage or food adequacy. Normally the rate of alcohol brewing reaches climax during harvesting time and few months thereafter, because majority of farmers have plenty of maize. Various ceremonies conducted at Kilagano ward depend vary much on availability of maize. The farmers mentioned a decrease in the rate of alcohol brewing and the rate of conducting various ceremonies as a sing of food insecurity.

Increase on number of beggars was also mentioned by farmers as one of the signs of food insecurity. Deficit household usually ask for food from surplus household. Usually these deficit households are not given maize food free of charge, first they ought to work on farms of surplus households so as to be given maize food in return.

4.4.11 Maize deficit households coping strategies.

Households use different strategies to cope with maize insufficiency. Other studies for example Corbett (1988), cited by Maxwell *et al.* (1992), when comparing the sequential use of coping strategies employed in periods of food stress in a number of African and Asian cases, found that preservation of assets takes priority over meeting immediate food needs until the point of destitution, when all options have been exhausted. Frankenberger and Goldestain (1990) have taken the role of coping strategies one-step further distinguishing between various types of risk management and patterns of coping behaviour (for example asset depletion, breakdown of community reciprocity, non-farm coping strategies), as well as different types of households assets which will play different roles in the process of coping (Figure 13). On this basis they argued that "The dilemma facing small-farm households involves a trade-off between immediate subsistence and long term sustainability". But, as yet, there is little evidence to show how this trade-off works in a long-term or to what extent coping strategies are successful in striking a balance between meeting immediate food needs and longer-term livelihood sustainability. To find out about this, coping strategies, the reasons for and timing of their use and their success or failure, need to be tracked over much longer period than a single cycle of famine and rehabilitation.



Source: Adapted from Watts (1983) by Frankenberger and Goldstein Office of Arid Land studies, The University of Arizona.

Figure 13: Food security coping strategies.

Table 25: Coping strategies for maize-deficient households in the four-selected village in Kilagano ward 2003/2004.

Coping strategy	Mgazini n =15	Mhepai n =19	Kilangano n = 12	Muungano Zomba n = 11	Pooled sample n = 57 (%)
Use maize crops sales money	0.0	10.5	0.0	0.0	3.5
Selling livestock	13.3	10.5	0.0	0.0	7.0
Selling labour	40.0	15.8	42.0	45.0	33.3
Using drought-resistant crops	33.3	52.6	50.0	55.0	47.4
Brewing and selling alcohol	6.7	0.0	0.0	0.0	1.8
Selling beans	6.7	10.6	8.0	0.0	7.0
Total	100.0	100.0	100.0	100.0	100.0

Findings from sampled households showed that about 47.5% of those households which reported maize consumption short falls used drought-resistant crops and labour selling as the main coping strategies depended by most farmers in Kilagano ward (Table 25). Twenty-seven respondents who had maize deficit (that is equivalent to 47.4%) declared to use drought-resistant crops especially cassava as a coping strategy against food shortage. About 33.3% mentioned labour selling as a means of addressing temporary food shortage faced by maize deficit households. Other means used by sample households were, use of maize crop sale money 3.5%, selling of livestock 7%, brewing and selling alcohol 1.8% and use of money from beans sale 7%. Reporting on coping strategies from Sumbawanga, Ashimogo (1995) attested that maize purchase from fellow farmers and other sources were the most important coping strategies among Sumbawanga farmers. In Kilagano ward maize purchase was of less importance as a coping strategy. The possible explanation for this contrast may be that dependence on draught-resistant crops especially cassava and poor market infrastructure has lessened the importance of maize purchase as a means of coping with food shortage. Even those who sold labour normally they didn't use money to purchase maize instead they purchased cassava. Generally there was an insignificant variation on deficit households coping strategies among villagers. While the use of draught-resistant crops dominated in all villages, its significance in Mhepai was more extraordinary. Since the village had the least number of households depending on labour sale.

During focus group discussions, when asked how do farmers overcome food shortage problems discussants mentioned reducing numbers of meal per day, receiving grain loan from kins and fellow farmers, exchanging animals like goats and chickens, salt and dry sardines with maize grains, cultivating fast maturing crops like sweet potatoes, pumpkins, early maturing maize varieties and vegetables, diet change that is eating finger millet and banana and selling of bamboo liquor as coping strategies against food shortage.

Tables 26 and 27 show the amount of maize bought or received by deficit sample households by quantity and months. From these Tables it can be noted that the contribution of maize bought or received by deficit sample households as a coping strategies, is of less importance or insignificance. Out of 57 households (47.5%) who ran shortage of food supply only 6 sample households (19%) bought maize, and only 25-sample households (81%) received maize. Ten sample households, (40%) received between 50-100kg of maize. Three (12%) and four (16%) sampled households received between 101-150kg and 151-200 respectively. Five respondents (20%) received 2001-400kg, and only three (12%) respondents received over 401. Asked the source from which they received or bought the maize, 31 sampled households (54%) of deficit household mentioned their fellow farmers to be the source. This finding is similar to what was found in Sumbawanga by Ashimogo, (1995) where he noted that rural food markets appeared to be playing an important role in assuring the food security of rural households and 83.4% sampled households were noted to receive or buy maize from other farmers.

On examining the months of purchasing and receiving, Table 27 Shows that majority 60% of sample household received the maize between September and October. The possible explanation of this phenomenon is that as it has been noted in seasonal farming activities these months coincide well with harvest and post harvest period, whereby most of farmers have plenty of food, traditional and religious ceremonies, which involve maize flour giving to fellow farmer as gifts are plenty, can be the reasons behind this occurrence. On purchasing side the months of March and April, have been noted to have highest number (5) of sample households, which is equivalent to twenty percent who purchased maize from their fellow farmers, compared to other months.

Table 26. Quantity of maize bought or received by deficit sample households (n = 31) for four selected village in Kilagano ward 2003/2004 (%)

Quantity (kg)	Receiving household		Buying household	
	No.	%	No.	%
50 – 100	10	40.0	1	16.7
101 – 150	3	12.0	0	0.0
151 – 200	4	16.0	2	33.3
201 – 400	5	20.0	3	50.0
> 401	3	12.0	0	0.0
Total	25	100.0	6	100.0

This can be interpreted that as the majority of farmers approach the months of May and June the number of farmers who run short of food increases, hence they are forced to buy from other sources especially from fellow farmers to offset the deficit. This finding differed from what was found by Ashimogo, (1995) where he found that purchasing increased at harvest season and season close to the next harvest. Ashimogo argued that this seasonal pattern corresponded with the households food security need and the pattern of grain stock depletion among surveyed households.

Table 27: Months of maize purchasing or receiving by number of buying or receiving sample households (n = 31) for four selected village in Kilagano ward 2003/2004

Months	No purchasing household	No receiving household
September – October (2003)	0 (0)	15 (60)
November – December (2003)	0 (0)	3 (12)
January – February (2004)	1 (17)	2 (8)
March – April (2004)	5 (83)	5 (20)
April – June (2004)	0 (0)	0 (0)
Total	6 (100)	25 (100)

Figures in parenthesis are the percentages of number of farmers.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

The general objective of this study was to assess the role played by traditional maize storage techniques on food security. This chapter therefore summarizes the main conclusions and recommendations.

5.1 Conclusions

Typical traditional maize storage techniques currently play insignificant role in combating food storage problems in the study area. As a result, there are very few traditional system employed for maize storage. Polythene bags are currently more popular for various storage purposes than other storage techniques available in the ward. Assurance against theft, convenience in maize grain handling, insect pests control, optimum space utilisation and readly availability in the markets are some of the reasons of polythene bags gaining rapid popularity among the farmers.

Traditional maize storage techniques in the study area are ineffective in controlling biological agents of deterioration acting on high yield varieties (especial insect pests). The failure of traditional maize storage methods and structures in solving storage problems, contribute to food insecurity. Heavy reliance on chemical pesticides use is the solution for combating on-farm storage problems associated with biological agents of deterioration. The biggest shortfall of chemical pesticides application is failure among the farmers to abide with recommendations given by manufacturers and entomologists on proper use of chemical pesticides.

Majority of farmers are extremely aware of the concept of food security. Inadequate maize production, excessive selling of maize produced and storage problems are the reasons of food insecurity in the study area.

5.2 Recommendations

In view of the above conclusions, the following recommendations are suggested:

5.2.1 To the farmers

Poor maize and other crops production technologies were noted to be among the reasons of food insecurity for the farmers of Kilagano ward. It is therefore recommended that farmers should start and join saving and credit societies. Credit societies will assist the farmers on mobilizing and acquiring necessary capital for agriculture development. Through these capitals, farmers will manage to buy farm machineries and farm inputs like fertilizers, which in turn will increase their production capability.

5.2.2 To extension officers and other stakeholders

Extension officers and other stakeholders should introduce and encourage farmers in the study area to use improved traditional storage techniques like concrete silos structures for on-farm storage purposes. Although the initial cost for constructing the said structures is high, in the long run it will be a cost effective method compared to polythene bags whose price tend to rise each year. For the purpose of storing maize for selling, polythene bags are more reliable means compared to other storage structures available in the study area. Therefore improved traditional storage structures should be used hand in hand with polythene bags.

Extension officers and other stakeholders should emphasize on educating farmers on how best could farmers use chemical pesticides without causing health risks.

Excessive selling of stored maize for cash need was one of the reasons of food insecurity among the farmers of Kilagano ward. It is recommended that stakeholders and Non-Governmental Organization that assist the farmers introduce new cash crops like Soya beans, sunflowers and sesame. Assurance of market for the produce introduced will reduce the pressure on excessive selling of stored maize hence improving the living standard of farmers.

5.2.3 To the government

Inadequate information or lack of knowledge on proper grain storage methods and practice from extension officers (Expertise advice) among the farmers of Kilagano ward is one of the reasons behind improper use of chemical pesticides. It is therefore recommended that the Government should increase the number of extension officer in the ward from one to two. The addition of another extension officer will smoothen information communication among the farmers in the ward.

The Government through, Ministry of Agriculture and Food Security should establish and make sure that there are well known channels of chemical pesticides distribution, that is from the manufacturers to the end users (farmers), this will help to reduce cheating and improve on farm storage.

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APPENDICES

Appendix 1: Sample size calculation.

The simple formula used.

$$n = \frac{z^2pq}{d^2}$$

where;

n = sample size when population is greater than 10,000

z = standard normal deviation, set 1.96 (approximately 2) corresponding to 95% confidence level.

p = proportion in the target population estimated to have particular characteristic; if not known use 50%

q = 1 - p

d = degree of accuracy desire, set .05 or .02 (Kothari, 1990).

Therefore sample size will be

$$N = \frac{z^2pq}{d^2} = \frac{(2)^2(0.5 \times 0.5)}{(0.05)^2} = \frac{4 \times 0.25}{0.0025} \quad \frac{1}{0.0025}$$

= 400 respondents

Appendix 2: Farmers' questionnaire for the role of traditional maize storage methods and structures in food security.

General Information

Questionnaire number ...... Enumerator's name.................

Date of Interview............. Time of interview.......................

Section I: Head household characteristics

(1) Name of village...

(2) How long have you lived in this village...........

(3) What is your main occupation? ....

(4) What is your farming experience...Years.

(5) Table I Household Members.

S/No.	Name	**Sex (M/F)**	**Age**	Occupation	Relationship	Marital status	**Educ. level**
1.							
2.							
3.							

Section II: Crop farming practices

(6) a How many hectares is your farm ....

b. How many of these hectares were cultivated in 2003/2004................

c. How many of these hectares were under fallow.............................

d. Out of the total farm area cultivated in 2003/2004 how many hectares were under

(i) Maize.....(ii) Cassava...... (iii) Beans.....(iv) Other crops (specify)...

(7) (a) In how many different place do you have plots ....

(b) What is the average distance to the plots in Kilometers?.........

(8) What type of technology did you use to cultivate the farm?

(1). Hand/manual. (2) Animal. (3) Tractor. (4) Others specify...

(9) What amount of seed did you use in the 2003/2004 maize crop ....kg

(a.)What type of maize variety did you grow in the year 2003/ 20004

(1) Hybrid varieties (2) composite (3) Local varieties

(10). How much chemical fertilizer did you use for the 2003/2004 maize crop

...(kg.)

Section IV:

Identification and extent of use of tradition maize storage methods and structures

(11) Which of the following methods of maize storage do you use to store your produce (maize)

1 Underground pits storage

2 Gourds and pots

3 Kitchen ceiling storage

4 Granaries (*vihenge*)

5 Air tight storage

6 Others (specify).

(12) Why do you use that specify methods

1 Easy to construct and cheap

2 Is more effective in pest and insects control

3 Is more effective on mould/fungus prevention

4 Is more effective in rodents control

5 Assurance of theft

6 Other reasons (specify)

(13) How long have you been using this structure..................(years)

(14) Cost of Building/purchasing storage structure and its capacity.

Structure no 1 2 3 4 5 6 7	Cost (Tshs)	Capacity (kg)

Key:

1 = Underground pits storage

2 = Gourds and pots

3 = Kitchen ceiling storage

4 = Granaries (*Vihenge*)

5 =Air tight Storage

6 = Drying cribs

7 = others (specify)

(15) Where is the storage structure located with reference to the main living house?

1. Inside 2. Outside

(16) (a) What is the type and source of the materials for traditional structure construction? 1. Local 2. Industrial

(b) Types..........................

(17). What type of repairs do you carry out and how frequent

1 Thatching (after .... months / years)

2 Coating (after ....months/ years)

3 Others specify (after ....months/ years)

(18) What traditional methods do you use to control insects in storage?

1 Mixing with sand

2 Mixing with limestone

3 Mixing with ash

4 Mixing with herbs

5 Others (specify).

(19) (a) Is there any relationship between traditional methods of controlling insects and structure to be use in storage.

1. Yes

2. No.

(b) If yes explain............................

(20) What are the problems (difficulties) associated with the structure you are using?

1 Easy breakable

2 Each year must be reconstructed

3 It is not safe methods due to theft

4 Others specify ....

(21) What is the estimate lifetime of the structure in year? ....

(22) (a) Are traditional storage methods and structures still popular among small scale farmers

1. Yes.

2. No.

(b) If yes explain ....

(c) If No explain. ....

(23) (a) Does the necessity to store threshed grain for marketing purpose have effect on traditional storage methods and structure uses.

1.Yes. 2. No.

(b) Explain..

(24) (a) Do you have enough manpower for building and maintaining of storage structures?

1. Yes 2. No.

(b) Explain ....

(25) (a) Are preferred plant building materials for storage structures construction are still available in your area?

1. Yes 2. No

(b) Explain ....

(26) (a) Is there any new insect pests, which have rendered the storage techniques inefficient for the prevention of food losses?

1. Yes 2. No.

(b) If the answer is yes mention them ....

(27) (a) Do you cultivate cash crops

1. Yes

2. No.

(b) Which cash crops? ....

(c) Do introduction and expansion of cash crops cultivation compete with food crop production and food storage construction?

1. Yes

2. No.

(28) (a) Introduction of high yield maize varieties have any effect on food storage method?

1. Yes

2. No.

(b) If the answer is yes mention ....

Section V

Effectiveness of tradition storage methods and structures

(29) During which of the following post-harvest operations did you experience a most important loss.

1 = Before harvest

2 = During harvesting time

3 = Transport to homestead

4 = During shelling

5 = During storage.

(30) (a.) Do you have storage problem? 1. Yes 2. No.

(b). How much produce did you lose during storage ....kg

(c) In which month are storage losses more serious?...........

(31) (a) Do traditional storage methods and structures have ability to store high yield variety (hybrid) ?

1. Yes 2. No

(b) If the answer is yes for how long can traditional storage method and structure store the produce?

1. 1 - 3 months

2. 4 - 6 months

3. 6 - 12 months

4. more than a year ....

(c) If No why...

(32) Which method is more effective in the storage of high yield variety?

....

(33) What are the effect of late or early harvest?

....

(34) When do you harvest your maize crop? ....

(35) Why do you prefer that particular time?..

(36) How do you know that the crop is dry and ready for harvesting?

1. When the grain is completely dry
2. At physiological maturity
3. Experience

(37) (a) Is there any relationship between drying and the ability of traditional storage methods in storing maize for longer time or shorter time

1 Yes 2 No.

(b) If yes explain..

(38) Which storage methods and structures are more effective on preventing growth of bacterial and fungi..

(39) How do you dry your grain?

1 On the floor
2 Smoking
3 Sun drying
4 Field, drying
5 Others (specify)

(40) In what form do you dry your grain.

1 Ear with sheath
2 Ear only
3 Shelled/threshed

(41) In which form do you store maize

1 Shelled
2 Ear with sheath
3 Ear only
4 Other (specify)..

(42) If shelled how did you shell it.

1 Hand

2 Beat in a sack

3 Beat on threshing floor

4 Shelling machine (tractor)

5 Other (specify)

(43) Do improper threshing and shelling of maize affect the effectiveness of traditional maize storage methods.

1. Yes 2. No

Explain: ....

(44). What types (s) of maintenance work did you carry out before storing the new maize in the storage structure?

1. Sweep and smear

2. Thatch

3. Both 1 and 2

4. No maintenance

5. Others (specify)..........................

(45) How do Grain storage structures you are using prevent humidity and high temperature m destroying the produce?..

(46) How do the storage structures and methods you are using prevent biological agents of deterioration?

Biological agent of deterioration.	**Methods**
(i.) Rodents	1. Rate guards
	2. Solid walled structures
	3. Rodent traps
	4. Rodentcides

5. Domestic cats to eat

(ii).Insects and mites:

1. Air tight storage
2. Structures constructed with mites resistant trees
3. Thoroughly clean and dry used storage containers
4. Boiling used sacks in not water wash and dry in hot sun
5. Thoroughly repair and clean storage tructures and rooms
6. Herbs

(47) Why do you prefer that particular form of storage ....

....

(48) What type (s) of storage structures are used for maize intended for

(a) Food........................ (b) Sale......... (c) Seed...................

(49) Did you treat the produce before the storage?

1. Yes
2. No.

(50) (a) What type of treatment did you use to preserve maize from pest damage during storage?

1. Chemical pesticides (2) Natural deterrent materials (3) I did not treat it.

(b) If you used pesticides or natural materials name the type of materials you applied.

Chemical pesticides	**Natural materials**
1. Actellic super dust	4. Plant tubers/leaves
2. DDT	5. Cow during ash

3. Other synthetics (specify). 6. Other natural materials (specify)

....

(51) If you used chemical pesticides

(a) How many grams of the pesticides you mentioned above did you apply per bag of stored maize?..

(b) What was the source of the pesticide?

1. Dealer
2. Shops
3. Extension agent
4. Others (specify)......................................

(c) What was the total price of the pesticide? Tshs..................... (specify unit of measurement)

(d) If you did not use chemical pesticides give reasons

a. Lack of funds
b. Pesticides not available
c. Little amount of stored maize
d. Lack of knowledge

(52) How effective was the treatment

1. Not effective
2. Slightly effective
3. Very effective

(53) How was maize transported from the field to the homestead?

1. By oxen/donkey 3. By lorry/tractor

2. As a head load 4. Other means (specify).

(54) Did you receive any advice from the extension agent on proper grain storage practice? in 2003/2004.

1 Yes 2 No

SECTION III : Knowledge on food security.

(55) Knowledge on food security were measured by using a 5 points hedonic scale as follows:-

Table II

Statement implying knowledge on food security	Yes	No	Scores by respondents
1. Food security means ensuring, adequacy of food supplies in terms of quantify quality and variety of food			
2.Food security means optimizing stability in the flow of food supplies			
3.Food security means access to nutritionally adequate and safe food.			
4.Food security means sufficient skills to acquire, prepare and consume nutritionally adequate diet including those to meet the special need of young children and pregnant mothers.			
5.Food security means access to health services and a health environment to ensure effective biological utilization of food consumed.			
Total score			

Key: Yes = 1 Mark No = 0 Mark

5 - Excellent knowledge

4 - Moderate knowledge (above average)

3 - Neutral (no clear evidence of presence or lack of knowledge)

2 - moderately ignorant (Below average)

1 - Extremely ignorant (knows nothing)

(56) (a) How many bags of maize did you harvest in the 2003/2004 cropping seasons ....

(b) The yield was thus .... kg/ acre

(57) How many bags of the total maize harvested was sold immediately within the harvest month ....bags

(58). How many bags were consumed/eaten by the household in the transition period before starting to consume the stored maize.........................bags

(59) How many bags of maize were stored for future use ....

(60) Out of the total maize you stored how much was used for the following purpose (specify unit of measure, that is bag, tin or kilogram).

(a) Selling ....(b) Consumption. ......(c) Brewing ......(d) Seeds.........

(e) Presents/remittances......... (f) Labour payment ....

(g) How much is remaining ....

(61) In which month did you start consuming the stored maize.....................

(62). In which month was the stored maize finished. ....

(63). Was the stored maize enough to feed your household until next harvest?

1. = Yes 2. = No.

(64). If the stored maize was not enough, for how many months was maize lacking...............

(65). How did you feed the household during the time without maize?

1. Use crop sales money
2. Sale livestock
3. Sell labour
4. Use dry season crop
5. Brew and sell alcohol
6. Informal sector cash (specify)
7. Others (specify)

(66). How much maize did you receive as remittances in the 2003/2004 seasons?.... Bags/tins/bowls specify.

(67). How much did you buy ……….Kg

(68). In which month (s) did you receive or buy the maize……………………..

(69). If you bought or received maize from whom did you buy…………………..

1. Fellow farmers 2. Middlemen 3. Town market

(70). Give reasons which forced you to buy or receive maize ……………………

Appendix 3: Checklist for focus group discussion

(A) Farming system

What is land ownership system of your area?

What are seasonal farming activities of your area?

(B) Identification of traditional storage methods and structures:

(i) Can you mention types of storage methods and structures in use at this area?

(ii) How do these types of storage methods and structures change over time?

(iii) What are the factors for these changes?

(C) Extent of tradition storage structures uses:

(i) Which types of storage methods and structures in use are more popular in this area?

(ii) Which types of storage methods and structures were used in the past but are not in use nowadays?

(iii) Can you tell why they are not in use?

(D) Effectiveness of traditional food storage methods.

(i) To what extent traditional storage methods in use help to preserve food grains?

(ii) Which types of traditional storage methods are more effective in storing grains?

(iii) What other techniques do you use in storing grains?

(iv) What should be done so as to reduce post harvest losses?

(E) Knowledge on Food security:

(i) What do you understand the term food security? (From local perspective)

(ii) Can you tell me various signs of food insecurity?

iii) What are the main causes food insecurity in the village?

(iv) How do you overcome the problem of food insecurity?