SOCIO-ECONOMIC FACTORS INFLUENCING THE USE OF GRAIN STORAGE METHODS IN MOROGORO REGION

BY

PAULA EPHRAIM TEMU

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF SCIENCE (AGRICULTURAL EDUCATION AND EXTENSION) OF SOKOINE UNIVERSITY OF AGRICULTURE

1996

ABSTRACT

This study was designed to investigate the socio-economic factors influencing the use of different grain storage methods in Morogoro region. The study concentrated on maize and beans, which are the grains for which proper post-harvest storage is most important in Morogoro region. The study was undertaken in Morogoro rural and Kilosa districts. Morogoro district is situated in the highlands while Kilosa is situated in the lowlands. It was hypothesized that choice of grain storage methods is independent of socio-economic factors. Data were collected using two types of structured questionnaires. One was for the farmers who grew maize and beans, the other was for the extension workers. Out of 130 households sampled, 120 were farmers while 10 were extension agents. The Statistical Package for Social Sciences was used for data analysis. It was found that various traditional and modern systems for grain storage are used in the region. These included;

a) Modern systems such as insecticides,

b) Traditional systems, such as storage structures and locally available materials. The differences in the storage systems between the highlands and the lowlands was in principle due to their differences in agro-ecological conditions. Visits by extension agents had a strong association with the use of either improved traditional storage structures, or insecticides. This was

particularly so for the case of maize. Extension agents visits were also strongly associated with the use of modern chemicals especially for beans storage. In general, modern methods are a result of farmer advancement in techniques. However there are significant cases of improvisation i.e using traditional structures with modern chemicals. It is recommended that: For the farmers who adopt the use of insecticides, the traditional storage structures such as 'Kilindo', 'Kihenge,' etc. can be used instead of the sacks which were reported to be vulnerable to insect infestation. Further research is needed to investigate effectiveness of different local materials such as ash, tree leaves, and tobacco leaves, and also the residual effect to the consumers. Advancement of crop storage and hence household and the economies food security can be significantly improved by farmer education. Extension services have proved to be influential, and hence need to be strengthened. The focus should be in a) educating more extension workers b) strengthening agricultural extension services - research centres linkages. c) Extension workers should closely supervise the farmers on the use of insecticides for food grain storage. d) Extension workers should advocate specific innovations which suit specific agro-ecological conditions. e) Economists should investigate which types of storage practices are economically more viable and compatible to the farmers' environment.

DECLARATION

I, PAULA EPHRAIM TEMU do hereby declare to the Senate of the Sokoine University of Agriculture that the work presented here is my own, and has not been submitted for a higher degree in any other University.

Signature.....Temu.....

Date.....22/5/1996.....

COPYRIGHT

ACKNOWLEDGEMENT

I am indebted to many individuals for their support and encouragement throughout my programme. My sincere appreciation is due to my sponsors Swedish Agency for Research Cooperation (SAREC), for their financial suport which enabled me to carry this study. I also thank Dr. N.M. Mollel for his dedication, constructive criticism and valuable guidance throughout the research work and report writing. The Head of the Department of Agricultural Education and Extension, Dr. A. Z. Mattee is specifically acknowledged for his assistance, encouragement and keen interest in my research work since the earlier stages. I also owe debts of gratitude to the following: members of the family of Dr. and Mrs A. E. Temu who I stayed with during my research study. All academic members of staff of the Department of Agricultural Education and Extension together with my classmates are highly appreciated for creating a socially harmonious environment during my stay at the University. I also wish to acknowledge with thanks all extension workers and farmers in the two districts for their time and co-operation in making the completion of my research possible. Though I can not specifically mention all of you here by names, I remember all of you with great gratitude.

DEDICATION

To my beloved parents, specifically my mother Victoria Evelyn Temu who laid the foundation for my education.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS AND SYMBOLS

CDTF	Community Development Trust Fund
FAO	Food and Agriculture Organisation
FRQ	Frequency
HYV	High Yielding Varieties
Kg	Kilogram
LGB	Larger Grain Borer
MRALG	Ministry of Regional Administration and Local Government
PCT	Percentage
SAREC	Swedish Agency for Research Cooperation
TShs	Tanzanian Shillings

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The issue of increasing food production to meet the population needs for the present time and in the future has been given due weight and attention in Tanzania, whereby farmers have always strived to produce more. It is also, however, equally important to focus on the ways and means of storing whatever is produced by these farmers, since improper as well as inadequate means and ways of post harvest grain storage is among the important determinants of the post harvest losses. Crops which are grown in Tanzania are many but for this study maize and beans are the crops which proper storage seems to be necessary. For example in Tanzania there have been numerous studies on the losses of beans caused by bruchids. The losses which have been reported vary from 3% to 50% (Mphuru, 1986). For the case of maize the losses range from 10% to 50% during storage (Croon *et.al.* 1984; Mphuru, 1986). If maize is stored poorly, the losses can run as high as 100% (Croon *et al.*1984). Normally the loss of such grains is both qualitative and quantitative. In Tanzania, there are two systems of grain storage used by the farmers; traditional and modern. Under traditional systems, farmers use their conventional ways and means of grain storage such as variety selection whereby different cultivars with different

abilities to resist storage-pest damage are used. Other means of storage include sun drying, use of insect repellant plants (such as tobacco dust), neem leaves, kernel oil and wood ash. Traditional storage structures may include 'vihenge' (cribs), ventilated interwoven baskets, clay pots, gourds and others. While in modern systems farmers use chemicals which are mainly insecticides e.g. Malathion, Actellic super dust (permethrin), lindane and grain bags. In traditional systems most of the food losses are caused by fungi, mould, insects, mites and vertebrate pests. These affect the volume of the grains, weight quality and value of the food material. All these losses occur in stores, godowns whether traditionally made or modernized. The problem becomes extraneous when farmers have adopted improved technology using High Yielding Varieties (HYV) which have proven to be more susceptible to storage pests and the outbreak of Larger Grain Borer (LGB) *(Prostephanus truncatus)*. Other major primary pests for maize include *Sitophilus sp.*, *Sitrotoga cerealella* and *Rhizopertha dominica* (Mphuru, 1986).

Beans like other pulses are heavily damaged by pests (storage damage pests). The two main species causing severe damage to stored beans are *Z.subfaciatus* (Boheman) known as spotted weevil and *Acanthoscelides obtectus* (Say) - a common bean weevil. During storage beans are heavily damaged by bruchids and losses of up to 30% are common in Tanzania

(Kiula and Karel,1984).

Normally the loss of such grains (maize and beans) is large and indirectly lead into other serious problems such as qualitative losses. These include losses in nutritive value and seed germination rate; factors that are particularly important at subsistence farming level, (Forster and O'Kelly, 1983). Associated with these is the loss of wholesomeness and oral palatability, caused by contamination of the grain in storage by microbes, insects and small animals (rodents and birds). More tangible is the economic loss, often a combination of quantitative and qualitative losses, suffered by farm families who rely on marketing surplus food grains (Mphuru, 1986). Sometimes producers are forced to sell prematurely because of inadequate storage facilities (Ringia, 1990). They therefore sell at very low prices and this seriously lead to food insecurity problems in the household. The inability to store food against pests for inter-seasonal periods deprives families of valuable sources of protein and carbohydrate diet (Ringia, 1990).

It is pertinent and advisable for researchers to continuously study post harvest storage systems for smallholder producers. The aim of which should be to improve the quality and adequacy of food to the household. Despite the fact that Tanzania government advocates the use of modern systems of post harvest grain storage, it is valid and worth researching on traditional

systems, their effectiveness and factors determining their employment.

1.2 Problem statement

In developing countries like Tanzania, governments have continued to advocate the use of modern systems of grain storage, although these can be very costly, unavailable to some rural farmers and known to cause environmental and health hazards. On the other hand farmers still use traditional systems of grain storage whereby huge food losses are being experienced. Odogola (1991), expressed concern over the farmers' continued use of traditional grain storage systems and questions the basis on which these decision are made. In addition, Ashimogo (1994) suggested that there are a number of issues which need to be addressed to establish why farmers' adopt a particular pest control strategy.

Therefore the aim of this study is to find out why farmers use the system they are using by looking on the socio-economic factors influencing the choice of the grain storage techniques.

1.3 Significance of the study

Pests and diseases account for substantial pre and post harvest food/grain losses in Tanzania. The losses may be reduced at any stage of post-harvest

even pre-harvest by using improved storage and handling methods respectively. In subsistence production, the activity is very important since harvesting usually takes place at one time but cannot be consumed immediately. Part of the produce must therefore be stored. It is therefore important for researchers to direct their efforts to finding an effective and economical pests and disease control methods suitable for small holder farmers. The study will highlight on pertinent issues that need to be considered when addressing grain storage in a specific locality.

Based on cultural and socio- economic differences, there are reasons to believe that there are considerable variations among the farmers under the study on the systems (traditional and modern) used for grain storage. It is therefore important for this study to identify the socio-economic factors influencing their use. Since blending together these technologies (traditional systems of grain storage (including materials and structures) have the potential of providing effective and long-term measures of controlling the losses.

As it was reported by Mohammed (1990), that Mgeta farmers have a wealth of undocumented information on crop protection. Some of this information concern traditional chemical pesticides which may be

developed if the potential for efficient use exists by finding out the factors which influence their use. Local materials which are used as traditional storage methods (structures and materials) may be cheaper for small holder farmers, better for the environment, easier to use and familiar to the farmers since they can be locally obtained compared to modern ones. Therefore the study will facilitate an inventory of factors influencing the use of grain storage techniques and explore how they could be improved and used by more small holder farmers. In Morogoro region the bean project continues to advice farmers to use new varieties, it is also important to advice the same farmers on the better ways of storage methods, since increasing food production does not guarantee food security unless there is an effective means of storage.

1.4 Objectives

1.4.1 General objective

The general objective of the study is to identify the socio-economic factors that influence the use of grain storage systems in Morogoro Region.

1.4.2 Specific objectives

i) To identify different traditional and modern systems that are used for post-harvest grain storage.

ii) To establish the extent to which traditional and modern systems identified in (i) above differ in two agro-ecological zones of Morogoro Region.

iii) To identify the socio-economic factors associated with the use of the different grain storage techniques.

iv) To determine the perceptions of farmers and extension agents on the effectiveness of various traditional and modern systems of grain storage.

1.4.3 Hypothesis

The choice of storage methods is independent of socio-economic factors.

1.5 Research questions

i) What are the traditional and modern grain storage systems in Morogoro region?

ii) How do the above methods differ in two agro-ecological conditions?

iii) What are the socio-economic factors influencing the use of traditional and modern grain storage systems in the region?

iv) What are the farmers and extension workers perception regarding the effectiveness of various traditional and modern methods of grain storage?

1.6 Definitions of major and important terms

1.6.1 Traditional systems of grain storage

For the purpose of this study this implies the indigenous practices which already exist in the farmers' localities used to store their grain by using locally available materials. Hindmarsh, Tyler and Webley in Compton *et al.* (1993) defined traditional structures as normal containers made of plant materials, mud or stones often raised on platform and roofed with thatch. Appearance and construction vary according to local customs and the materials available.

1.6.2 Modern systems of grain storage

This implies the new technologies or practices developed in most cases in the exogenous, western knowledge system. These are types of storage practices, materials such as chemical pesticides as well as structures.

1.6.3 Socio-economic factors

The social factors here imply those which relate to the human life e.g. educational level, culture, marital status, age, gender, awareness of different systems of grain storage, attitudes towards the use of either system, perception on the effectiveness of either system and size of the family.

The economic factors imply those related to the farmer's financial status. These include purchasing power, labour costs, farm size, possession of house, livestock etc. There are many traditional and modern pests control techniques used by small farmers in the world. These have had varying degrees of success. The techniques include materials as well as structures. There are different factors which determine the use of either a traditional or a modern system of grain storage. As it was reported by Forster and O'kelly (1983), traditional storage structures vary with crop, climatic regime, ethnic background and social and economic situation and these have to be studied for each of the socio-economic set up.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section reviews some of the factors (social and economic) which influence the use of different methods of grain storage in different parts of the world. It also highlights on the environmental factors influencing the use of these methods. The review of literature shows that there are variations observed in most of storage methods used in the tropics which are related to climate, but local natural resources and customs also influence the choice of these storage methods (FAO, 1980; Egwuatu, 1987). Social factors may also influence design of stores. Ashimogo (1995) reported that on farm storage encompasses many indigenous storage systems, developed in a remarkable diversity of socio-economic, climatic and cultural environments throughout Sub-Saharan Africa. Another example was from the study done in Bwakira Chini whereby the author found that Socio-Economic position had far more influence on the type of storage used than culture (CDTF, 1977). Furthermore this section touches on different materials used as storage insecticides in different areas.

2.2 Factors determining the use of grain storage methods

2.2.1 Economic

There are various methods used in other parts of the world but require a lot of money so that they can be used effectively as grain storage methods. Examples of these are underground pits used in Asia, Europe and Middle East. These are not air tight so grains are easily destroyed by mould. The pits require lining with bitumen, concrete or plastic materials to prevent moisture, this undoubtedly will lead to progress but not, however, for the subsistence farmer due to high costs of such modification (Pingale, 1976). A study done in Mgeta showed that pesticides (a modern method) are not commonly used to control pests in beans. One of the reasons might be the costs of purchasing them (Mohammed, 1990). Among 120 interviewed farmers in Sumbawanga district 20% reported that they are not using pesticides, their reason of not using pesticides was that they had no cash to buy pesticides (Ashimogo, 1994). Another study done in Moshi villages has similar results; that farmers did not use pesticides because they were too expensive (Mamiro, 1991). Rogers (1983) reported that the majority of the poorer farmers in developing nations lack resources and either can not adopt innovations or else must adopt relatively later. Furthermore the author reported that on the same nations farmers with more land, more money and more knowledge can more easily obtain credit, further information and other

inputs to adopt technical innovations. Apart from pesticides, there are large store houses, new building materials and temperature regulating houses used as storage structures but these are often highly dependent on fossil fuels, imported equipment and expertise (Alders *et al.* 1993). Due to high costs involved almost all farmers can not afford the modern systems of grain storage. In a few cases, there are modern methods for grains storage such as cribs and silos which have been adopted by farmers and sometimes been successful in some wealthier areas (Egwuatu, 1987). For the case of Tanzania, most of the rural farmers continue to use traditional storage structures since they are cheaper. It was reported that in Tanzania farm level storage investment costs are not very high, because farmers may use locally available materials in slack season labour (Ashimogo, 1995). Sometimes due to small harvest farmers throughout Africa use small containers such as sealed tins or pots. These are suitable for small quantities of grain (FAO, 1991). Furthermore it was reported that grain storage in Tanzania villages is influenced by the socio-economic position of the family. The report suggest that poor farmers generally store their maize on a ceiling platform in the house, usually above the kitchen fire. Most of these houses are grass thatched. Different from rich farmers households whereby majority store grain in jute bags in a store or unoccupied room, often with concrete floor (CDTF, 1977). For the case of adopting

innovations Rogers (1983), reported that, the social structure in developing countries has been found to be a powerful determinant of individual's access to technological innovation. Furthermore the author points out that farmers who own larger farms; enjoy a higher socio-economic status and have more exposure to mass communication are most innovative in adopting new agricultural technologies.

2.2.2 Socio-cultural factors

In many parts of Tanzania food storage in the house is a factor of culture, beliefs and traditional practices in a specific community. Ashimogo (1988) reported that the same type of storage structures are not equally important among the respondents in the study area. The author reported that farmers in Ukwamani who are semipastoralists do not use 'Chanja' as those of Ulaya Kibaoni, instead they use 'Chidong'a, a structure which can be shifted from one place to another easily. Compton *et al.* (1993) reported that store design may change as a result of social changes. For example; traditional store types (chanja) which is high as the roof, may become inconvenient for the old couples whereby all the younger ones have been displaced because of school, marriage, *etc* instead they use chanja situated just above the fire place which simplify the access to the store. Further more it has been explained by Ashimogo (1995) that traditional storage

methods used in the region are often those that have been used for centuries. Therefore, Traditional practices, are not likely to be abandoned unless it can be clearly demonstrated to the farmers that these new technologies and methods will be effective and that they will not result in intolerable strains on the life style of the farmers (NAS, 1978). In other parts of the world, e.g. India the applied storage method depends on the quantity harvested, farm and family size (Joshi *et al.* 1990). Having small harvest which need small containers for storage was considered as a social case and is closely related to poor farmers who can rely on gifts from friends (Ashimogo 1995). Ashimogo (1994) reported that about 16% of the interviewees of Sumbawanga did not use pesticides because they had only little grain to store. Most of the traditional structures used in particular areas depend on the technology. For example, farmers in Ilonga and Chanzuru villages in Morogoro rural district, use the ceiling method of grain storage because it is an inherited technology (Mamiro, 1991). This relates to the skills the users have in making the structures as well as the knowledge one has about the materials. For example, clay pots, gourds, mud cribs, etc are reported to be used in Botswana because people of the area had the skills of making them (Mmopi, 1986). Other structures like 'Vihenge' Chanja and Kilindo are used in Tanzania, depend on the skills the user has. Muro (1986) reported that various types of storage structures being used in the

villages are designed and constructed by local artisans. For example 'kilindo' manufactured out of treebark is a traditional Kutu skill which has been passed to a considerably reduced number of craftsmen in the Morogoro region (CDTF, 1977).

2.2.3 Marital status

For the case of storage, most of the women are involved in storage activities but the construction of storage structures are mainly done by men (Own observation). Compton *et al.* (1993) reported that men in most areas of the world are responsible for grain stores construction, although women may be the main day to day user of the store. Furthermore the Author reported that the construction skills are normally passed down within families, and particular ethnic groups may favour certain store types. For the case of receiving advice from extension services, married women are controlled by their husbands (ILEIA, 1987). Furthermore, it has been reported by Staudt (1984) that the decision of adopting a new technology will depend on how the husbands perceive the innovation because women can not have discussions alone with extension agents either on the farm or in the home. This is more apparent and evident in patrilinear societies.

2.2.4 Level of education

Education is considered to be an important factor which enable ones behaviour to change. Education level however might have an effect on the level of awareness of households, in utilizing various means, to ensure food availability in the household, hygienic condition of food storage structures etc. For example a farmer can gather information from different sources such as magazines, radio, leaflets, etc. Even non formal education offers greater opportunity for peasants to participate in their own development (Nanai, 1993). It is assumed that poor and less educated people generally lack confidence in their ability to improve their lives (Levinger and Drahman, 1980). If the farmers are Illiterate then they may not fully appreciate the need of following correct quantity of chemicals they are advised to use as far as grain storage is concerned (NAS, 1978). On the same aspect majority of small farmers in the village can neither read nor write English. As such they can not benefit from English language materials (Lugeye, 1994). Education is therefore an important social economic parameter that should be considered .

2.2.5 Gender

Gender can be one of the factors which influence the use of grain storage methods. Gender as a factor is closely related to division of labour in the

households. Women and men perform different tasks both in productive and domestic work. For example there are certain tasks that are mainly carried out by women and others that are only carried out by men (Odogola, 1994). In most cases women do have multiple roles in the households and the post-harvest grain storage practices are among their duties and the method used depend very much on the capability, skills, and knowledge of these women (Forster and O'kelly,1983). Furthermore the authors gave an example of post-harvest practices which include sieving and hand picking of the grain pests which is a traditional method and usually undertaken by women and children and can only be practical in small quantities (Forster and O'kelly, 1983). Adipo (1987) reported that in the survey done in Nigeria most of the low cost maize storage facility was used by women. This can be related to what was explained by Shayo (1990) that in many rural societies the social status of women is inferior to that of men. Due to that they become disadvantageous group especially when it comes to the introduction of new technology in their areas. Further more the author reported that it is difficult for extension agents to hold meetings or address female farmers freely. Also due to lack of ownership of resources such as land and other assets, women can not afford some of the technology recommended by extension and therefore lose interest in seeking further advice. The fact that men and women have different roles and tasks in

agricultural production should be carefully considered especially when trying to introduce new-post harvest management systems (Odogola,1994). It is therefore pertinent to study its effect in the selected study areas in Tanzania.

2.2.6 Attitudes

The attitudes of a farmer towards a new technology is closely related to perception, therefore the use of either of the systems depend on the tribal perception of that system by the farmers. To a large extent the farmers perception can influence the adoption of the new technology. In the literature Kashweka and Johnsson (1987) reported that only a system which can show obvious and quick profit in combination with reduced risks can be accepted. Due to this fact the new technology (innovations) may be perceived as a threat to some of the farmers. Golob (1991) reported that some of the farmers are reluctant to adopt the use of modern insecticides in maize storage because the method require shelled maize the practice which they were not used to. This practice is labour intensive and need appropriate containers. It is important to consider farmer attitudes and perception while studying their storage practices.

2.2.7 Age

Age as a factor which can influence the usage of grain storage is naturally related to certain characteristics. For example; rate of adoption of a new technology is likely to be higher among low age members (younger ones) than the old ones. Young and energetic people have proved to be more venturesome, active and ready to try innovations (Nanai, 1993). The same group of younger ones, Rogers (1983) call them innovators. The author point out that being an innovator has several prerequisites: These include control of substantial financial resources to absorb the possible loss owing to an unprofitable innovation and the ability to understand and apply complex technical knowledge. Furthermore the author reported that there is inconsistent evidence about the relationship of age and innovativeness. Among 228 studies done by the author, 19% show that earlier adopters were younger, and 33% indicate they were older. The results prove that, although the percentage of the younger one was small, the number is encouraging. They show how ready they are to encounter risks which can easily be avoided by being late adopters.

2.2.8 Contact with extension agents

The extension services is the most effective source of information flow to farmers for adoption of farming practices, innovation and technology

(Lugeye, 1994). Also it was reported that in most countries, the key person to give farm level training should be the extension agent. (Van den Ban and Hawkins 1988). Rogers (1983) explained an extension agent as a change agent. He reported that a change agent is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. In most cases a change agent seeks to secure the adoption of new ideas, but she/he may also attempt to slow the diffusion process and prevent the adoption of certain innovations. Also extension agents are the most important sources of information for farmers. They do receive the knowledge from the research centres and after due processing and modifying, if necessary, pass it on to farmers (Staudt, 1982). The Farmers' extension agents contacts aim at explaining characteristics of the technology to farmers and identifying social implications of the innovation (Minjas and Delobel, 1990). Further more Ashimogo, (1994) reported that lack of information on both extension staff and farmers is one of the most important problems of pest management in Sumbawanga District. Ashimogo, (1995) interviewed 120 farmers and among them 82% complained on an inadequate informed advice on proper grain storage methods and practices. This results on imperfect knowledge when deciding when and how to use pesticides. Decision can be improved by acquiring better sources of information/knowledge. It was also recommended that

strengthening of the extension services in Tanzania is important with regard to good storage practices and farmers understanding of the general principles of grain storage (MRALG/FAO, 1991). Hebblethwaite, (1985) reported that due to strong extension service systems in some of the third world farmers, extension advice on modern practices have tended to change the farmers into adopting synthetic chemical pesticides as one element in changing their farming system.

2.2.9 Availability of the local storage materials

The type of storage structures is related to the type of construction materials available locally, and the people's life styles. In a study done in Sumbawanga District Ashimogo (1994) noted slight differences between the storage structures used, based on the availability of location - specific types of construction materials. Grass-woven baskets (sesiu) which is a traditional structure commonly used in parts of Lesotho is made by special thatch grass, *Hyparrenia hirta,* available locally, while in other parts of the same country farmers make wool/mohair bags for grain storage, from the large stocks of sheep and goats they keep (Lesotho Government, 1990). Larger amounts of grains are stored in containers constructed of plant material, mud or stones, the designs and materials vary according to local resources and customs (FAO, 1980).

2.3 Environmental factors affecting the use of grain storage methods

2.3.1 Moisture

Apart from concentrating only on the socio-economic factors influencing grain storage methods, other important things need consideration when embarking on an effort to improve storage in any locality, region or country. One must be familiar with the crops, conditions under which they are harvested and conditions under which they are stored. Rain or high humidity during the harvesting season will not allow grains to dry naturally to a safe storage moisture content. Moisture is the important factor influencing deterioration and changes during grain storage. (Chung and Pedersen, 1975). Food grains with moisture content lower than 11 percent are relatively resistant to insect attacks. When moisture is in excess of 15 percent, the grain is attacked even by mites (Pingale, 1976). Furthermore Egwuatu (1987) reported that high moisture content in stored products is another factor which makes insecticides less effective. Storage methods differ from one area to another due to different climatic conditions. For example Tyler and Boxal quoted in Compton *et al.* (1993) reported that most traditional storage systems are well adapted to their environment and losses are generally low.

2.3.2 Temperature

Temperature is another important factor influencing grain quality changes during storage, along with moisture and relative humidity. For example it is not easy for farmers in wet areas to use underground pits which is traditionally practiced and suitable in drier areas as it was reported by Turrent *et al.* in Compton *et al.* (1993). Furthermore it has been reported by Pantenius (1988) that in house storage is commonly used to store Maize in Togo in Mountainous region. This method is suitable due to heat received by the stored grains and rapidly dry to the moisture content of 8-10% different from non-heated granaries used in the same country but in non-mountainous areas. FAO (1980), support this fact by explaining how sun drying can be used as a method of grain storage. The report gave an example on countries where maturity of crops coincide with the beginning of a dry season, the most popular method of drying is by exposure to the sun. At village level, several simple methods which avoid the need for building a storage container are used for drying maize. The most common method practiced is to spread the harvested, threshed or shelled crop on the ground or on a special prepared area (e.g matting, sacking or concrete) and exposed to the sun and wind- although also, unintentionally to rain (FAO,1980).

2.4 Different materials used for grain storage

There are different materials (modern and local) used by farmers to protect their grains against storage pests. The modern chemicals include recommended ones such as Actellic super dust, Lindane, malathion and sometimes unrecommended ones such as DDT, DDM and Thiodan are used by rural farmers. DDT's toxicity to man precludes its use for admixture with food products or animal feed (Odogola,1994). Locally available ones include inert materials which are referred to as admixtures of substances such as wood ash, charcoal, sand and various abrasive dusts containing fine particles. In Sri-lanka and Botswana wood ash is reported to be used to store pulses and grains respectively to prevent damage by insect pests (Mmopi, 1986). The relatively low percentage damage and weight loss reported by Busungu and Mushobozy (1991) suggest that wood ash which is readily available to farmers can be used to control *Zabrotes subfasciatus*. Furthermore it has been reported that sifted wood ash mixed with grain in equal proportions is highly effective in prolonging storage life and reducing pest damage of bean. Most of these locally available materials are reported to be non-toxic e.g sifted wood ash, coarse clean sand and vegetable oils. It has also been reported by the same authors that many farmers use wood ash to store pulses and other grains because of their availability. The material is locally available.Bruchids beetles are also reported to be

controlled by using dry sand which is locally available (Forster and O'kelly 1983).

It has been reported and confirmed by studies (NAS 1978; FAO 1991; Ashimogo, 1994) that farmers use a combination of pesticides and traditional methods for prevention and control of pests. For example Elsewhere it is reported that the combination of chemical and non-chemical methods of insect control has been recommended to farm stored grain since early 1900s (Reed *et al.* 1993). It was found by Simalenga *et al.* (1994) that post harvest losses have been tackled by farmers by either storing beans in air tight earthenware pots (traditionally made) and or by mixing beans with ashes (locally available). It is probable that these traditional practices are effective and inexpensive means of prolonging the post harvest shelf life of beans though the relative effectiveness of them need to be quantified (Simalenga *et al.* 1994). Ashimogo (1994) suggested that there must be integration, in the minds of economists and sociologists (who provide advice to farmers, national policy makers and others in between), of the diverse interrelationships between socio-economic factors and pesticides use. As it was reported by (NAS, 1978) that there is little precise published information about losses and losses reduction in developing countries, that which is available concerns mainly grain storage. More

information is needed about the socio-economic factors affecting food storage. This study aims at contributing in the effort to bridge this gap. It focuses on factors influencing the use of traditional methods of grain storage in the region. A comparative user pattern in the region and the relationship with socio-economic factors should provide substantial information needed for policy development.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1 Location of the Study

The study was confined in Morogoro Region, specifically in Morogoro rural and Kilosa Districts. The districts mentioned have the biggest number of maize and beans growers in the region.

Morogoro is situated between 6°20′ latitudes and longitude 37°39′ East. The dominant physical features are the Uluguru Mountains. The region is at an altitude ranging between 500 and 2 600 metres above sea level. Temperatures range from 27° to 31°C. The mode of production in the region is on individual basis and most smallholders produce at subsistence level. They employ simple tools and almost all farmers in the region store their harvest (proportion) for home consumption and a small proportion for seed.

The region might have different methods of grain storage, which are influenced by social and economic factors. The study is designed to investigate these factors.

3.2 The Research Design

A cross sectional survey research design was used. Under this design the data is collected at a single point in time and can be used for simple descriptive interpretation as well as for the determination of relationships between variables.

3.3 Population and sampling procedure

3.3.1 The population

The population for the study consisted of all small holder farmers in Morogoro region who grow maize and beans. Further information was collected from the extension officers. The information were on the different traditional and modern systems of grain storage used by smallholder farmers in the region and their effectiveness as perceived by them.

3.3.2 Sampling procedure

A purposive sampling technique was used to select the villages. The districts chosen had about eight villages which the Sokoine University bean project conducts its research. Researchers at the Sokoine University of Agriculture and the extension personnel encourage farmers to produce more beans and maize. The center of interest is to find out the different storage methods used and factors influencing the storage system. From the eight

villages, six were selected for this study. The interviewed households and extension workers were randomly selected. The village household was the sampling unit. The register and lists of the village households was the sampling frame.

3.3.3 Sample size

The sample consisted of 130 households. Out of 130, 120 were farmers households whereas 10 were extension workers. Total number of villages chosen were six from the two districts. Twenty households were chosen from each village. Ten extension workers, who were available in the two districts were also interviewed.

3.3.4 Types, Sources of Data and Instrumentation

The data used in the study were from secondary as well as primary sources. The primary data was collected through interviews using a structured questionnaire. Two types of questionnaires were prepared for maize and beans growers and for the extension officers respectively. The pretested questionnaire was structured to seek for socio-economic factors associated with grain storage. Appendix i and ii presents the smallholder farmer and extension workers questionnaires. Other primary data were collected through personal observations on the grain storage practices conducted in

the village at that particular time. The secondary data were collected from the official documents e.g. Ministry of agriculture or village files. Other information were collected from University Libraries to support some of the facts.

3.3.5 Data Collection

The data were collected by interviewing farmers and administering structured questionnaires to extension officers.

3.3.6 Pre-Testing

After developing the questionnaire comments were sought from lecturers in the Department of Agricultural Education and Extension and from students of the same department who were conversant with the extension work. The suggestions were taken into consideration and necessary corrections were made. The questionnaire was pre-tested in the field to the targeted group. Ten farmers were used in the pre-testing exercise. These were excluded from the sample farmers who were interviewed. All observations, corrections and amendments were made before administering the final version of the questionnaire.

3.3.7 Data Processing and Analysis

Different statistical methods were used in the analysis of data. The data was first summarized, condensed from questionnaires and transferred into computer. It was then processed using a computer programme: Statistical Package for Social Sciences (SPSS/PC+). From this, descriptive statistics such as frequencies for measuring categorical data were obtained. This gave the frequency of occurrence of various coded qualitative responses. Percentages and cross tabulations were used to generate quantitative analogy report for different traditional methods (structures and materials) that are used to prevent post harvest losses in the region. Chi-square tests were used to determine if there was a relationship between storage systems and variables such as levels of income, level of education, size of the family, extension agents visits, age, gender, marital status, Farm sizes, production and availability of storage materials (socio-economic factors).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of analysis done on the data. It interprets the information and discusses this information while focussing on the following aspects:-

i) Identification of different traditional and modern systems of grain storage that are used for post harvest grain storage in Morogoro region

ii) Establishment of the extent to which traditional and modern systems identified in (i) above differ in two agro-ecological zones of Morogoro region.

iii) Socio-economic characteristics of the farmers and their relationship with the use of either systems of grain storage in Morogoro region. Socio-economic factors which were chosen as important with regard to the storage systems used in the region include levels of income, level of education, size of the family, extension agents visits, age, gender, marital status, tribes, farm sizes, production and availability of storage materials.

iv) Determination of the farmers and extension workers perceptions on the effectiveness of various traditional and modern systems of grain storage used in the region

4.2 Results of the descriptive statistical analysis

4.2.1 Characteristics of the respondents

4.2.1.1 Major crops grown in the field

Findings revealed that there were 73.3 % of the farmers who grew maize and beans while maize alone was grown by 26.7 % of the farmers, (Table 1). This is regardless of the two different agro-ecological zones.

Table 1: Distribution of households growing maize and beans (n = 120)

Crops	Frq	Pct
Maize and beans	88	73.3
Maize	32	26.7
Total	120	100.0

Nearly sixty seven per cent of 120 respondents reported that their purpose for growing maize is for home consumption while 32.5% grew it for both

cash and home consumption and the remaining 0.8% reported that they grew maize for cash. Beans are grown for food by 26.1%, for cash by 6.7% and for both food and cash by 64.8% of the farmers.

4.2.1.2 Farm sizes for maize and beans

Most of the farmers grew their maize at subsistence level. This means they just produce for consumption. Their farm sizes range from 0.5 to 6.0 acres. The total number of the respondents having this sizes of the farms was almost 91.0%. The nine per cent were farmers with more than 6 acres of maize.

Farm sizes under bean production are relatively small. They range from 0.01 to 0.5 acres and 17.6% of the bean growers were having such sizes. Forty nine per cent of the respondents have farm sizes ranging from 0.5 to 2.0 while farm sizes with 2.01 to 4.0 were possessed by 21.2% of the bean growers. Only 1.2% of bean growers have farm sizes above 8 acres.

Table 2: Distribution of acreage for maize and beans (n = 120)

Total no. of Acres	Maize		Beans	
	Frq	Pct	Frq	Pct
0.01 - 0.25	0	0.0	8	9.4
0.25 - 0.50	0	0.0	7	8.2
0.50 - 2.00	47	39.2	42	49.4
2.01 - 4.00	47	39.2	18	21.2
4.01 - 6.00	15	12.5	7	8.2
6.01 - 8.00	6	5.0	2	2.4
8.01 - 10.00	5	4.2	1	1.2
Total*	120	100.0	85	100.0

*The total is more than 120 because of the farmers who are growing both crops

4.2.1.3 Tribes

In the region of the study there were about twenty tribes where by 79.% of them were Morogoro tribes and another 21.0% being non-Morogoro tribes.

Table 3: Distribution of tribes found in Morogoro region (n = 120)

Tribes	Frq	Pct
Morogoro tribes	95	79.2
Non-Morogoro tribes	25	20.8
Total	120	100.0

The Morogoro tribes were comprised of Luguru, Kamba, Kaguru, Kwere, Pogoro, Sagara, Kutu, Sangu. The non-Morogoro tribes were Gogo, Nyakyusa, Zigua, Manyema, Makua, Yao, Ngoni, Hehe, and Zaramo. The common tribe for the two agro-ecological zones is Luguru.

Kaguru formed (19.2%) of the whole sample size which is the largest group in the lowlands while in the highlands there were no Kagurus. The smallest tribes which formed 0.8% consists of Nyakyusa, Zigua, Manyema, Zaramo, Kwere, Yao, Sagara, Kutu, Hehe and Sangu.

4.2.1.4 Education level

Forty per cent of the respondents have attained upper primary education while thirty one per cent have attained lower primary education (Table 4). There were 18.3% of respondents with no education. Adult literacy was attained by 5.8% while Secondary education which was the highest level of education of the respondents was attained by only 4.2%. Generally, the results imply that majority of the respondents were able to read and write.

Table 4: Distribution of respondents by highest education level attained (n = 120)

Education levels	Frq	Pct
No education	22	18.3
Adult literacy	7	5.8
Lower primary education	38	31.7
Upper primary education	48	40.0
Secondary education	5	4.2
Total	120	100.1*

*Sum = 100.1 due to rounding up

4.2.1.5 Persons per household

The majority of the respondents had family sizes between 4 and 8 members. The families with less than 4 members were formed by 28.3% of the respondents while those with more than 8 members were formed by 26.7% of the respondents. The results imply that these persons in the families are the labour force available for agricultural activities within the family since hiring labour has been observed to be uncommon.

Table 5: Distribution of respondents by number of persons per household (n =120)

Total number of persons	Frq	Pct
0.00 - 4.0	34	28.3
4.01 - 8.0	54	45.0
8.01 -12.0	24	20.0
12.01 and above	8	6.7
Total	120	100.0

4.2.1.6 Age of the respondents

The majority of the respondents were aged between 23 and 60 years. Those below 23 years formed 4.2% while 12.5% was formed by respondents above 60 years. The implication of this results is that more than half of the respondents were still young and energetic.

Table 6: Distribution of respondents by age (n =120)

Age groups(yrs)	Frq	Pct
Between 15-22	5	4.2
23-40	59	49.2
41-60	41	34.2
Over 60	15	12.5
Total	120	100.1*

*Sum =100.1 because of rounding up.

The results can be related to what was reported by Rogers (1983) that majority of early adopters belong to age group of the young. Furthermore, Nanai (1993) reported that this group have been proved to be venturesome, active and ready in trying innovations.

4.2.1.7 Estimated monthly income of the respondents

Table 7: Distribution of respondents by monthly income (n = 120)

Monthly income TShs.	Frq	Pct
Less than 10 000	53	44.2
10 001 - 30 000	47	39.2
30 001 - 50 000	8	6.7
50 001 - 80 000	4	3.3
80 001 - 99,000	3	2.5
More than 100,000	5	4.2
Total	120	100.1*

*Sum = 100.1 because of rounding up.

The majority of the respondents (44.2%) were in the low income group. This group receives less than Tshs 10 000 per month. Thirty nine per cent of the respondents had monthly income of between TShs. 10 000 and 29 000. Only 4.2% of the respondents had income above TShs. 100 000. Therefore the results imply that most of the respondents receive less than

basic salary of a civil servant. This means the majority of these respondents were in the low income group.

4.3 Storage systems and materials for maize

4.3.1 Storage structures

There are different systems used to store maize in Morogoro region. These do not differ much in the two agro-ecological zones but there were some which were practiced in one zone and not in another. The major reason being differences in weather conditions in the two agro-ecological zones.

Table 8: Distribution of different storage systems used for maize in highlands and lowlands of Morogoro region (n = 120)

Storage system	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Chanja inside the house*	45	88.2	15	21.7
Sacks**	6	11.8	31	45.0
Kilindo***	0	0.0	10	14.5
Kihenge***	0	0.0	9	13.0
Chanja outside the house**	0	0.0	2	2.9
Sundrying*	0	0.0	2	2.9
Total	51	100.0	69	100.0

* Cob storage only

** Cob and Grain storage

*** Grain storage only

According to data in table 8 'Chanja' (storage in the house or ceiling) which is a traditional structure, is most commonly practiced by 88.2% and 21.7% of the respondents from highlands and lowlands respectively. The structure is normally built when the house is constructed and placed on the kitchen roof. Maize cobs are usually placed on it where it is subjected to heat or smoke from the cooking fire. This difference of the farmers in the highlands to use more of the 'Chanja' inside the house and those of the lowlands to use more of the sacks is because of the different agroecological zones whereby in the highlands the farmers receive rainfall twice per year and this makes the drying process relatively more difficult. Before harvesting their maize from the field, it is normally the time for rain (double cropping) therefore in order to avoid damage, the farmers are forced to harvest earlier. The post harvest process of drying is finalized by smoke from the kitchen. Firstly the smoke does two jobs, hardening up the outer leaves of the maize and this prevents insect pests from infesting. Secondly it reduces moisture content to the one favouring storage of grains.

The second common method used by respondents from both agro-ecological zones is sacks or ('viroba'-50 kgs bags). For the case of this study sacks might be grouped under the modern system of grain storage though traditionally practiced. The sacks are normally recycled, before being used as storage containers, they normally have been used to store other items

such as fertilizer, sugar etc. Sacks are used by only 11.8% of the respondents from the highlands and 45.% of the respondents from lowlands. This storage structure can store only shelled maize. The farmers in the highlands do not prefer shelling their maize because of the wet weather which does not allow the grains to dry to the moisture content favouring storage. In lowlands where there is enough sunshine during the harvesting period, farmers were using various storage structures which can store shelled maize. For example different from the highlands in the lowlands where by its population consist of different ethnic and cultural groups with different technical practices, 'Kihenge' (cribs) are a common method used to store either shelled or cob grains. The structure is locally made. The structure is the Gogo's[1] tradition where by the respondents from the lowlands had copied from the Gogo's immigrants living in the area. 'Kilindo' which is also a traditional structure is only practiced in the lowlands. It was found to be the Kutus knowledge, who are found in the area. These structures can store up to 10 sacks of grain. However this depends on how big the structure has been made. The least commonly used methods were 'Chanja' outside the house and sundrying. The former is avoided because of risks of theft and rainfall while the later is laborious.

Gogo is a tribe from neigbouring region-Dodoma

Reasons given by farmers from the highlands as to why they have chosen a particular type of storage differ. But almost all farmers (80%) who were using 'Chanja' inside the house said it was traditionally inherited. The results are the same as what was reported by Mamiro (1991). Furthermore these respondents from highlands reported that apart from the traditional practice the weather condition was among the important factors that force them to use 'Chanja' as storage structure for maize. Different answers were given by farmers from lowlands. Most of them used sacks, 'Kihenge', or 'Kilindo' because it was the best way of storing shelled maize. It is also a suitable way that allows easy mixing of insecticides with grains.

4.3.2 Knowledge about different materials of storing maize

In the two areas, there were more farmers in the lowlands who were using different kinds of traditional materials than in highlands (Table 9). This is because, many farmers in the lowland store shelled maize. It is very easy for shelled maize to be infested. Due to this factor almost all farmers in lowlands look for resources readily available in the area and known to be effective as chemical insecticides for preventing their grains against storage pests.

Different locally available materials used by farmers in the lowlands include Wood ash, which was used by 46.8% of the lowlands respondents.

Specific wood ash from 'Muwanga' tree was used by 25% of the respondents. Ash from maize cobs was another material used to store maize against storage pests and this was used by 6.3% of the lowlands respondents. Crashed bark tree and roots are storage materials used by 3.1% of the respondents in the lowlands however the respondents could not specify from what kind of trees these barks and roots came from. Animal dung from cows and goats were used to store maize by 6.3% of the respondents from lowlands. Crashed tobacco leaves was used by 3.1% of the respondents. *Azadirachta indica* leaves was another material used to store maize and 3.1% of the farmers from lowlands reported using this material. Smoke was also reported to be used by farmers in lowlands, and this comprised of 6.2% of the respondents in lowlands.

The type of the materials used by farmers in the highlands were wood ash and smoke. Sixty per cent of the farmers who were using locally available materials were using wood ash while the remaining (40%) reported to use smoke. The farmers in the highlands did not report using different storage materials although they are available because most of them store maize without removing the outer cover. This practice is not suitable for applying any kind of insecticides.

Table 9: Distribution of different materials used for maize storage in highlands and lowlands of Morogoro region (n = 42)*

Materials	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Any wood ash	8	60.0	15	46.8
Smoke	2	40.0	2	6.3
Ash from 'muwanga' tree	0	0.0	8	25.0
Ash from maize cobs	0	0.0	2	6.3
Crashed barks and roots	0	0.0	1	3.1
Animal dung/cow goats	0	0.0	2	6.3
Crashed tobacco leaves	0	0.0	1	3.1
A.indica leaves	0	0.0	1	3.1
Total	10	100.0	32	100.0

* Out of 120 respondents, 42 only responded on this question.

Apart from the farmers who were using these locally available materials there were also a good number of other farmers from both sides who were not using them. There were different reasons given by different farmers from the two areas as to why they were not using these locally available materials.

4.3.3 Knowledge about modern systems of maize storage

According to data in Table 10 below, about 17.6% and 65.2% of the respondents from highlands and lowlands responded on having the knowledge about modern systems of grain storage respectively. This knowledge was mostly about the insecticides. The fact is that not all the respondents who reported having the knowledge were using the insecticides and those few who were using them, the majority (50%) were combining the insecticides with traditional storage structures.

Table 10: Distribution of farmers' knowledge of modern chemicals formaize storage in Morogoro region (n = 120)

Answers	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Yes	9	17.6	45	65.2
No	42	82.4	24	34.8
Total	51	100.0	69	100.0

These results are the same as what was reported by NAS (1978); FAO (1991) and Ashimogo, (1994) that farmers use a combination of pesticides and traditional methods for prevention and control of pests. Apart from not

being aware of modern chemicals, Low income, unavailability of the insecticides and low yields are the reasons given by respondents as to why they are not using the modern chemical insecticides. No respondents reported using modern structures such as silos, metal grain bins or structures strengthened with cement. This conforms to a report by Egwuatu (1987) that there are very few cases in developing countries whereby farmers use modern structures for grain storage.

4.3.4 Different modern chemicals used by farmers for maize storage

The most commonly used chemicals by both highland and lowland farmers was actellic super dust. The chemical was used by 55.6% of the farmers from the highlands and 86.7% of farmers from the lowlands. There were other types of chemicals used which are not recommended for storing grains such as DDT as reported on the literature by Odogola (1994), that DDT has got toxicity to mammals. This was used by 11.1% of the respondents from the highlands and 11.1% of the farmers from the lowlands. Thiodan used for the control of cotton pests (an inconsumable product) was used by 2.2% of the farmers from the lowlands. Blue copper which is normally used to treat diseases in coffee trees and tomato plants and sometimes in grains stored for seed was used by 33.3% of the respondents from the highlands only. The use of copper in the lowlands

was not reported probably because coffee and tomatoes were not observed to be grown in the lowlands.

Table 11: Distribution of different modern chemicals used for maize storage in Morogoro region (n = 54)*

Type of chemicals	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Actellic super dust	5	55.6	39	86.7
DDT	1	11.1	5	11.1
Thiodan	0	0.0	1	2.2
Blue copper	3	33.3	0	0.0
Total	9	100.0	45	100.0

*Response from the farmers who were using modern chemical in maize storage

4.4 Storage systems (structures and materials) used for beans storage

4.4.1 Storage structures used to store beans

The results revealed that there were no differences on the storage systems used for beans in the two agro-ecological zones in the region.

Most of the farmers used sacks or 'viroba' (50 kgs bags) for storing beans in both areas. Nearly 77% of the respondents from highlands and 67.6% of

the respondents from lowlands were using this method. In the highlands there were no Gogo farmers living in the area. This might be the reason why Kilindo (a Gogo traditional structure) was only used in the lowlands where Gogo farmers were found living. Large clay pots were used by 13.7% and 5.9% of respondents from highlands and lowlands respectively (Table 12).

Table 12: Distribution of different storage structures used to store beans in highlands and lowlands of Morogoro region (n = 85)*

Storage system used	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Large clay pots	7	13.7	2	5.9
Sacks	39	76.5	23	67.6
Sundrying	5	9.8	0	0.0
Kilindo	0	0.0	9	26.5
Total	51	100.0	34	100.0

4.4.2 Different local materials used for beans storage

Results show that the farmers from the highlands and lowlands used the same types of material for beans storage against storage pests. These materials include wood ash from the kitchen stoves and dried neem leaves (*A. indica*). The wood ash was used by 94.4% of the farmers from the highlands and 57.1% of the farmers from the lowlands. These were the common storage materials used in both areas.

Table 13: Distribution of different local materials used for beans storage in highlands and Lowlands of Morogoro region (n = 46)*

Materials	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Any kind of wood ash	17	94.4	16	57.1
A.Indica leaves	1	5.6	2	7.1
Ash from'muwanga' tree	0	0.0	7	25.0
Ash from maize cobs	0	0.0	1	3.6
Animal dung (Cow/Goats)	0	0.0	2	7.1
Total	18	100.0	28	100.0

*Responses from the farmers who only used locally available materials for beans storage

There were more different materials used by farmers to store beans in lowlands than in the highlands. This might be due to the fact that some of

the materials are available in the lowlands and not in the highlands. For example 'Muwanga' or *combretum* sp. tree was reported to be used by 25.0% of the respondents in lowlands only, because the tree can be found more frequently in the lowlands than it can be found in the highlands. Neem was used by relatively few respondents, 5.6% and 7.1% of the respondents from the highlands and lowlands respectively. Reasons for this difference might be due to the scarcity of the tree in the highlands. Ash from cow or goat dung can be available in highlands but the farmers in highlands reported to have no knowledge on the use of these materials as protectants against storage pests. Also there were very few cases of livestock keepers in the highlands compared to the cases found in the lowlands.

4.4.3 Different modern chemicals used for storing beans

Out of 120 respondents interviewed, only 70.8% grew beans at the period they were interviewed. The results show that the same type of modern chemicals used to store maize were also used to store beans but these chemicals were used by a very small percentage of the total number of the bean growers. Out of 85 bean growers only 28.2% were using modern chemicals for storage of beans (Table 14).

Table 14: Distribution of modern chemicals used to store beans in Morogoro region (n = 24)*

Type of chemicals	Highlands		Lowlands	
	Frq	Pct	Frq	Pct
Actellic super d.	7	77.8	12	80.0
DDT	2	22.2	1	6.7
DDM	0	0.0	1	6.7
Thiodan	0	0.0	1	6.7
Total	9	100.0	15	100.1**

* Out of 85 bean growers 24 were using modern chemicals to store beans

** Sum = 100.1 due to round up.

The results show that nearly 78% of the farmers in highlands and 80.0% of the farmers in lowlands reported using actellic super dust in storing beans. DDT has also been reported as one of the chemicals used to store beans. In this case 22.2% and 6.7% were the farmers using it from highlands and lowlands respectively. DDM and Thiodan were reported to be used only by few farmers from the lowland.

4.5 Extension Agents' Visits

In examining the visits of extension agents, respondents were asked to indicate whether they were visited by an extension agent or not. For the

case of this study 80% of the farmers reported being visited by extension agents. This was taken as the extent by which they get extension services irrespective of whether the initiator of these contacts was extension agent or the farmer himself.

4.6 Results and interpretation of inferential statistical analysis

The following analysis was governed by a proposition which states that 'socio-economic factors are independent of the storage systems used in Morogoro region'. This was tested in the study by employing the following socio-economic factors:- levels of income, level of education, size of the family, extension agents visits, age, gender, marital status, number of persons per household, farm sizes, amount of produce and availability of storage materials.

4.6.1 Socio-economic characteristics of the farmers and the usage of different systems of maize and beans storage

4.6.1.1 Relationship between different storage systems and age

As the results in section 4.2.1.6 show the majority of the respondents were aged between 23 and 40 years. In general across all ages the most common method used was 'Chanja' inside the house (ceiling). About 50.4% of the respondents indicated to be using this method. The results in Table 15

reveal that, members in age group between 23 and 40 have 22.7% of the respondents who used 'Chanja' inside the house and age group 41-60 years, 20.2% use this method.

Table 15: A Cross-tabulation of different maize storage systems against age in Morogoro region (n=119)*

Age group	Chanja outside		Kilindo		Kihenge		Chanja inside		Sacks		Sundrying	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
15-22	0	0.0	1	0.8	1	0.8	0	0.0	3	2.5	0	0.0
23-40	0	0.0	6	5.0	6	5.0	27	22.7	19	16.0	0	0.0
41-60	1	0.8	1	0.8	1	0.8	24	20.2	12	10.1	2	1.7
Over 60	1	0.8	2	1.7	1	0.8	9	7.6	2	1.7	0	0.0
Total	2	1.7	10	8.4	9	7.6	60	50.4	36	30.3	2	1.7

Chi-Square Test=20.025. DF=15 Significance level =0.1710

*Out of 120 respondents one did not report on any storage structure he used for maize.

The second commonly used method by the farmers was sacks or 'viroba' whereby 30.3% of the farmers were using this method and the age group with highest frequency was that of respondents with the age between 23

and 40 years. 'Kilindo' was another method of storing maize and used mostly by the same age group of between 23 and 40 years. Sun-drying and 'Chanja' outside the house were the least methods used to store maize. The age group using this method was between 41 and 60 and above 60 years old.

The chi-square test on this aspect was not significant at the chosen level of significance (5%). This means there was no significant relationship between age groups of the respondents and different storage structures used for maize storage. Furthermore the results suggest that the youngest group members which was between 15 and 22 years used more economical storage structures such as sacks, 'Kilindo' and 'Kihenge' which are suitable structures for storing shelled maize and simplify application of chemical insecticides. These results can be compared to the respondents with age over sixty years, the majority of which were still using 'Chanja' inside the house among other storage structures. It is indicative that the younger members are more active and ready to adopt new technology and encounter risks. As it was reported by Nanai (1993) the young people are more venturesome active and ready to try innovations.

4.6.1.2 The relationship between marital status and different storage systems used for maize

The marital status of the respondents include married couples and non-married individuals. The former group regardless of gender were the majority (85.7%). The non-married individuals (14.3%) comprised of the respondents who either were divorced, widowed, separated or simply single.

Table 16: A cross tabulation of different maize storage systems against marital status in Morogoro region (n=119)

Storage type	Married		Non-Married	
	Frq	Pct	Frq	Pct
Chanja outside the house	1	0.9	1	5.9
Kilindo	9	8.8	1	5.9
Kihenge	9	8.8	0	0.0
Chanja inside the house	53	52.0	7	41.2
Sacks	28	27.6	8	47.0
Sundrying	2	1.9	0	0.0
Total	102	100.0	17	100.0

Chi-square test= 6.25463 DF=5 Significance level =0.2822

The chi-square on this aspect is not significant at the chosen level of significance of 5%. This imply that there is no evidence to suggest that marital status has an association with type of storage structure used. This

might be due to the fact that marriage on its own can not change much of the storage practices.

But the impression of the results (Table 16) show that the most commonly used method by respondents with regard to marital status was 'Chanja' inside the house and sacks. 'Chanja' inside the house was used by 52% and 41.2% of the married and non-married couples respectively. Sacks were used by 27.6% and 47% of married and non-married couples respectively. The 'Chanja" inside the house was commonly used by married couples because of two reasons, firstly this group was the largest. Secondly, the construction of the 'Chanja' usually is done when the house is built and main constructor of the houses are males who have the skills and also were the majority in this study.

4.6.1.3 The relationship between storage type for maize and gender

The results show that there were 80 male respondents and 39 females. Among these there were 50.0% of male respondents and 51.3% of female respondents who were using 'Chanja' inside the house. Sacks were used by 32.5% of the male and 25.6% of the females respondents.

The chi-square test from this cross-tabulation is not significant even at significance level of 5%. This means there was no association between gender and storage structures used. However the results give the impression that except for 'Kilindo' there were more male farmers using different storage structures as seen in Table 17. This is due to the following reason: the number of males was larger than that of the females. However an important point to note is that most storage structures employ males skills. This statement can be supported by the study done by Compton *et al.* (1993) who reported that men in most areas of the world are responsible for grain storage construction. For the case of this study, 'Kilindo' which involve sewing of a tree bark in a cylindrical shape was only a skill specifically mastered by most of women.

Table 17: A cross-tabulation of different maize storage systems against gender (n =119)

Storage type	Male		Female	
	Frq	Pct	Frq	Pct
Chanja outside	1	1.3	1	2.6
Kilindo	4	5.0	6	15.4
Kihenge	7	8.7	2	5.1
Chanja inside	40	50.0	20	51.3
Sacks	26	32.5	10	25.6
Sundrying	2	2.5	0	0.0
Total	80	100.0	39	100.0

Chi-square test =5.48002 DF=5 Significance = 0.3601

4.6.1.4 Relationship between type of storage for maize and education levels acquired by the farmers

As it was indicated in section 4.2.1.4 that the majority of the farmers had attained upper primary education and lower primary education. There were few farmers with secondary education and adult literacy education, although there were some farmers who reported to have no education at all.

Table 18: A cross tabulation of maize storage systems against highest attained level of education (n = 120)

Storage/ educat.le	No educat		Adult.lit		Lower prim		Upperprim		Sec. Educ	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Chanja outside	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0
Kilindo	4	3.4	1	0.8	3	2.5	2	0.7	0	0.0
Kihenge	1	0.8	0	0.0	3	2.5	4	3.7	1	0.8
Chanja inside	10	8.4	4	3.4	23	19.3	23	19.3	0	0.0
Sacks	5	4.2	2	1.7	8	6.7	17	14.3	4	3.4
Sundrying	1	0.8	0	0.0	0	0.0	1	0.8	0	0.0
Total	22	18.5	7	5.9	38	31.0	47	39.5	5	4.2

Chi-square test = 19.90229 DF = 20 Significance = 0.4641

Generally with primary education (lower and upper) there were nearly thirty nine per cent of the respondents using 'Chanja' inside the house. The majority of the respondents who reported to have no schooling at all (8.4%) were also found using 'Chanja' inside the house. Almost all farmers with secondary education use sacks as their maize storage structure. For the case of this study sacks is considered to be an improved structure which is suitable for shelled maize.

The chi-square test on this aspect is not significant. This means there is no association between storage structures and education levels. This does not relate to what was reported by Levinger and Drahman (1980) that there is a relationship between the two. It is normally suspected that the poor and less educated people generally lack confidence in their ability to improve their lives. In this study it is apparent that some educated respondents still use the traditional storage structures such as 'Kilindo', 'Kihenge', 'Chanja' etc. This is because all these are not innovations. These are just locally available storage structures. The respondents have found them being used for a longer past period in that area.

4.61.5 Relationship between different systems for maize storage and tribes

The tribes in the area were described in section 4.2.1.3.

Table 19: A cross-tabulation of maize storage systems against tribes found in Morogoro region (n = 120)

Storage type/Tribes	Morogoro tribes		Non-Morogoro tribes	
	Frq	Pct	Frq	Pct
Chanja outside	2	2. 1	0	0.0
Kilindo	9	9.5	1	4.0
Kihenge	6	6.3	3	12.0
Chanja inside	52	54.7	8	32.0
Sacks	25	26.3	12	48.0
Sun-drying	1	1.1	1	4.0
Total	95	100.0	25	100.0

Chi-square = 7.37516 DF = 5 significance = 0.1942.

'Chanja' inside the house, was the most common method, used by 54.7% and 32.0% of Morogoro tribes and Non-Morogoro tribes respectively. The second method used by most of the respondents was sacks where by 26.3% and 48.0% are the Morogoro tribes and Non-Morogoro tribes respectively. The least common method used, i.e 'Chanja' outside the

house, only farmers originating from Morogoro reported to be using it. Due to large number of the morogoro tribes there were also more farmers using 'Kilindo' and 'Kihenge' as their storage structures for maize.

The chi-square test on this aspect yielded an insignificant coefficient. This implies that there is no statistical significant association between storage structures used for maize and different tribes found in the region. The results might be due to the fact that most of the respondents adapt the suitable storage structure for the climatic conditions they live in on that time. Also it seems that storage structure used is determined by the availability of the materials used for its construction. These might be the reasons why origin of the farmer does not influence much the storage systems used in the study area. For example the use of Kilindo, a Kutus traditional storage structure, and 'Kihenge' Gogo's traditional storage structure were found to be used in lowlands not necessarily because of the tribes, but because of the above two reasons. Another example can be given from a Zaramo respondent found in highlands but didn't use his traditional way of storing grains, instead he adapted to the 'Chanja', commonly used by almost all respondents found in highlands under this study.

4.6.1.6 Relationship between estimated monthly income and storage used for maize

Table 20: A cross tabulation of maize different storage systems against estimated monthly income (n = 119)

Storage/Income TShs.	Less than 10 000		Between 10 001-30 000		Between 30 001-50000		Between 50 001-80 000		Between 80 001-99 000		More than 100 000	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Chanja outside	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Kilindo	6	5.0	4	3.4	0	0.0	0	0.0	0	0.0	0	0.0
Kihenge	4	3.4	5	4.2	0	0.0	0	0.0	0	0.0	0	0.0
Chanja inside	32	26.9	22	18.5	1	0.8	3	2.5	2	1.7	0	0.0
Sacks	8	6.7	15	12.6	7	5.9	1	0.8	1	0.8	4	3.4
Sundrying	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0
Total	53	44.5	47	39.5	8	6.7	4	3.4	3	2.5	4	3.4

Chi -square test = 32.34950 Df = 25 Significance = 0.1481

According to data in Table 20 which presents results of cross-tabulations between estimated monthly income and storage systems used by the respondents in the surveyed area, the chi-square test was found to be nonsignificant. This means there is no statistical significant association

between estimated monthly income and storage methods for maize in the study area. The general impression is however interesting. The results on the Table above reveal that sacks were found to be the only storage method for maize in the high income levels group, i.e ones who receive more than TShs.100 000 per month. This result might be related to the fact that most members of this group are wealthier than the others therefore they can produce a large amount of maize which can not be stored in most of the traditional structures. On informal discussion it was found that most of these traditional structures have the capacity of storing only small amounts of harvested grains .

4.6.1.7 Relationship between type of storage for maize and visits of extension workers

In this section we extend observation regarding extension agents visits discussed under 4.5. Here we look into their possible effects on usage of various types of storage structures.

Table 21: A cross-tabulation of Improved maize storage systems against the visits by extension agents (n=119)

Storage type/visits of extension worker	Yes		No	
	Frq	Pct	Frq	Pct
Chanja outside	2	2. 1	0	0.0
Kilindo	10	10.5	0	0.0
Kihenge	8	8.4	1	4.2
Chanja inside	39	41.1	21	87.5
Sacks	34	35.8	2	8.3
Sundrying	2	2.1	0	0.0
Total	95	100.0	24	100.0

Chi-square =16.96765 Df=5 Significance=0.0046 At 5%

According to data in Table 21, there are many farmers who reported on the availability of extension services in their areas. This group makes about eighty per cent of the all respondents interviewed. It was reported by most of them that they were using different traditional storage methods for maize.

The chi-square test on this aspect was found to be significant. This means there was a statistical significant relationship between extension agents visits and the type of storage used for maize.

At first sight not much can be deduced from this inference. It is observable that inspite of receiving extension advice, many of the smallholder/ respondents still use traditional methods e.g. 'Chanja' inside the house, which was used by 41.1% of the respondents and even 'Kilindo' which was used by 10.5% of the respondents. The truth is that, there was an apparent improvement of these traditional storage structures in cases where farmers were visited by extension agents. This is particularly so following the campaign to control the Large Grain Borer in Tanzania. Extension agents went out to advocate proper storage, together with any economically affordable structures. They strongly advocated drying and shelling of maize as quickly as possible after harvest. In general farmers themselves went out and chose those structures which were also compatible with easy application of insecticides. This was regardless of whether the method was traditional or modern.

The impression is that although those farmers who receive extension services are still using different traditional structure for maize, the structures are those which the applicability of insecticides is easily done. This might be related to the campaign of controlling Large Grain Borer in Tanzania. A package of procedure was presented to the farmers by extension agents which among them include; drying and shelling of maize as quickly as possible after harvest and this urged the farmers to shell their maize and

look for suitable storage structures for storing shelled maize and ease application of chemicals.

4.6.1.8 Relationship between size of the maize farms and the storage structures

Most of the respondents grew maize at the subsistence level. In most cases cultivated areas determines the amount of crops produced and some how influence the type of storage structure chosen by the household members. Most of the farmers had farm sizes of about 0.5 to 4.0 acres, and this was the group of respondents who were using the common method for storing maize which was 'Chanja' inside the house. Though there were Other storage methods 'Chanja' was the most commonly used method even by farmers who were having farm sizes above 4 acres (Table 22).

Table 22: A cross-tabulation of maize different storage systems against sizes of the farm in Morogoro region (n = 119)

Storage type/Acres	0.5 -2		2.01-4		4.01-6		6.01-8		8.01 >	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Chanja outside	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0
Kilindo	1	0.8	7	5.9	0	0.0	2	1.7	0	0.0
Kihenge	2	1.7	6	5.0	1	0.8	0	0.0	0	0.0
Chanja inside	24	20.2	23	19.3	9	7.6	3	2.5	1	0.8
Sacks	19	16.0	8	6.7	5	4.2	0	0.0	4	3.4
Sun-drying	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0
Total	47	39.5	47	39.5	15	12.6	5	4.2	5	4.2

Chi-square test = 30.19335 DF = 20 Significance = 0.0668 at 5%.

The chi-square test on this aspect was found to be having slight significance. This means there is an association between the type storage used for maize and farm sizes. It is important to note that none of the respondents having above 4 acres of farms use 'Chanja' outside or sundrying. Also note that chanja inside and sacks are spread across almost all farm sizes, it is logical to assume that as farm sizes increases the most suitable means to store maize becomes sacks. Sacks can store large amount of shelled maize. Also the results show that as farm sizes decrease the suitable method for storing maize is 'Chanja' inside the house.

Most of the farmers who reported using sundrying were the ones who usually receive little harvest and after drying they look for any available containers such as tins, clay pots for storing the dried grains. The results are in line with what Joshi *et a*l (1980) reported that the storage systems used in some parts of India depend on quantity harvested. On the same case FAO (1991) reported that small containers such as sealed tins or clay pots are used throughout Africa for storing small quantities of produce. This means there are storage structures suitable for little harvest and others for large harvest.

4.6.1.9 Relationship between storage types for maize and family size

The family members of the respondents range from one up to twenty seven. Majority of the respondents (45.4%) had four to eight persons in their household which is common for African families. There were also households with above eight to twenty four persons.

Table 23: A cross-tabulation of maize different storage systems against family size (n = 119)

Storage type/family members	0.0 - 4.0		4.01 - 8.0		8.01 - 12.0		12.01>	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Chanja outside	1	0.8	1	0.8	0	0.0	0	0.0
Kilindo	5	4.2	1	0.8	4	3.4	0	0.0
Kihenge	2	1.7	4	3.4	2	1.7	1	0.8
Chanja inside	17	14.3	28	23.5	12	10.1	3	2.5
Sacks	9	7.6	19	16.0	5	4.2	3	2.5
Sundrying	0	0.0	1	0.8	1	0.8	0	0.0
Total	34	28.6	54	45.4	24	20.2	7	5.9

Chi square = 11.67235 DF = 15 Significance = 0.7036.

The Chi-square test from the cross-tabulation of persons per household sizes against type of storage had no significance. This means there is no strong relationship between number of persons per household and the storage structures used to store maize.

The results are contrary to what was reported by Joshi *et al.* (1990) that the quantity harvested and size of the family determine the storage system used. The results are different because of several reasons. Firstly, the two studies were done in different continents. Therefore the large family in this study was assumed to be more than eight persons per household but

Joshi's study did not specify how large the family is in his case. Therefore the large number of persons in the household might not be the same in these two areas. Secondly, most of the respondents in this study produce the amount of maize which can be enough for food in their families and which also can be manageable to store, while in the review of literature on Joshi *et al.* (1990) this point was not indicated. For the case of surplus the respondents on this study reported that they usually sell for cash. For the other study the author reported differently, he reported on the issue of looking on a larger storage structures when the harvest is increased. These are the reasons to lack significance in the two variables.

4.6.2 Modern chemicals

There were different modern chemicals used by some of the respondents. These include actellic super dust, DDT, DDM, Thiodan and Blue copper.

4.6.2.1 Relationship between the extension agents visits and the use of modern chemicals

Table 24 presents results of a cross-tabulations of two variables: The use of modern chemicals against visits by extension agents. These results show that, the most commonly used chemical by the actellic supper dust, 75.5% of the respondents using the chemical agreed on being visited by extension

agent in their areas. Among the things which the respondent receives when they are visited by extension agent include advice on what type of chemicals to be used against storage pests, where the chemicals are found and so forth. There were other respondents who were using the modern chemicals but were not visited by extension agents in their areas.

Table 24: A cross-tabulation of the visits of extension agents against the use of modern chemicals in maize storage (n = 53)

Chemicals	Yes		No	
	Frq	Pct	Frq	Pct
Actellic super dust	40	75.5	4	7.5
Thiodan	1	1.9	0	0.0
DDT	5	9.4	0	0.0
Blue copper	1	1.9	2	3.8
Total	47	88.7	6	11.3

Chi square test = 10.13755 DF = 3 Significance = 0.0174 at 5%

The results show that among the farmers who were visited by extension agents 75.5% used the recommended chemical pesticide for maize i.e Actellic super dust while other 13.2% used non-recommended chemical pesticides such as DDT, Thiodan and Blue copper.

The chi-square test on this aspect has a relatively strong significance. This means there is a statistically significant association between extension

agents visits and the use of modern chemicals. These results suggest strongly that extension agents have a strong influence on the usage of modern chemicals in the study area. The use of modern chemicals, to the respondents, is considered to be an innovation. Therefore in order for that to be adopted, the influence from external agent had to play an important role. This also can strongly be supported by what was reported by some of the respondents that they normally receive the chemicals from the extension agents. The results are in line with what was reported by Van den Ban and Hawkins (1988) that the key person to give farm level training and advice should be extension agents. This is also a complex innovation which needs close attention by the agent.

4.6.2.2 Relationship between the use of modern chemical for maize storage and level of education

Table 25: A cross-tabulation of modern chemicals used for maize storage against highest level of education attained (n = 53)

Storage/ educat.lev	No educ. Frq	No educ. Pct	Adult.lit Frq	Adult.lit Pct	Lower prim Frq	Lower prim Pct	Upp. prim Frq	Upp. prim Pct	Sec. Educ Frq	Sec. Educ Pct
Actellic super	6	11.3	2	3.8	8	15.1	25	47.2	3	5.7
Thiodan	0	0.0	0	0.0	0	0.0	1	1.9	0	0.0
DDT	2	3.8	1	1.9	2	3.8	0	0.0	0	0.0
Blue copper	0	0.0	0	0.0	2	3.8	1	1.9	0	0.0
Total	8	15.1	3	5.7	12	22.6	27	50.9	3	5.7

Chi-square test = 12.820 DF = 12 Significance = 0.3822

All respondents with different education levels were using actellic super dust, majority (47.2%) being the ones with upper primary education. Thiodan was used by only one (1.9%) respondent who had upper primary education. DDT was used by almost all farmers with no education to those who acquired lower primary education. There was no respondents with upper or secondary education reported using DDT.

The chi-square test on this aspect has no significance. These results imply that there is no relationship between education and usage of modern chemical insecticides used for maize storage. On the same statistical results it is worth remembering that the adoption of a certain agricultural practices could be a function of several interacting factors. There are farmers with no education but also use correct chemical insecticides for maize storage. Therefore this results support the fact that education only can not be the factor to enable farmers to adopt certain agricultural innovations. There are other factors which are associated with adoption of innovation such as availability of progressive farmers in the village, mass media, extension workers and others. For example extension workers could still assist farmers with low or no knowledge of english language by visiting them and choose appropriate chemical insecticides for their grain storage. The above interacting factors give us results which are not the same as what was reported by Lugeye (1994) who commented on association between educational level and adoption of innovation. He reported that, the majority of small farmers can neither read nor write English as such they can not benefit from English language materials.

4.6.2.3 Relationship between type of chemicals used and amount of maize produced

Table 26: A cross-tabulation of modern chemical used against amount of maize produced in 1994/95 season (n = 53)

Chemicals/bags	0-20		20.1-40		40.1-60		60.1 >	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Actellicsuper	40	75.5	3	5.7	0	0.0	1	1.9
Thiodan	0	0.0	0	0.0	1	1.9	0	0.0
DDT	4	7.5	1	1.9	0	0.0	0	0.0
Blue copper	3	5.7	0	0.0	0	0.0	0	0.0
Total	47	88.7	4	4.5	1	1.9	1	1.9

Chi-square test = 54.5620 DF = 9 Significance = 0.0000 at 5%

Majority of the respondents (88.7%) do produce at subsistence levels. This means they are producing what can only be consumed. The majority are having farm sizes ranging from 0.5 to 4.0 acres of maize. Within this range they produce different amounts, up to 20 bags of maize. Nearly seventy six per cent of the respondents use recommended insecticide i.e Actellic Super dust for maize storage. DDT was used by 7.5% of the respondents while Blue copper was used by 5.7% of the respondents.

The chi-square test on this aspect is strongly significance at level of 0.0000 ($p < 0.05$). This means there is a very strong relationship between chemical insecticides used to store maize and amount of maize produced. The general impression is that the majority of farmers who use chemical insecticides, are in a group of those who produce 1-20 bags of maize from different farm sizes. These low producers are apparent users of the chemical eg. actellic super dust, simply because they were majority in this study. Also they are trying to avoid the risk of pests infestation which can occur in their small produce. Among these respondents there were others who use non-recommended insecticides such as DDT and Blue copper. The reason for the use of wrong insecticides, can be simply traced to the costs of these chemicals. They can be cheaply obtained from the dealers. None of the respondents who produced above 60 bags use non recommended insecticides. About 2% of the producers (more than 60 bags) use actellic super dust. The results are probably due to high income level of this group. The correct chemical insecticides (actellic super dust) was reported by the respondents to be sold at a price of Tshs 1 200 per packet (500 grams, 1994 prices). The respondents indicated different sources of the chemical insecticides e.g from the shop, businessman, and sometimes from the extension agents. It is from these different sources where the respondents obtain the wrong insecticides such as DDT, Thiodan and Blue copper which

are the field insecticides, and this increase the number of respondents who use insecticides some of which being the ones not recommended for storing grains.

4.6.2.4 Relationship between usage of modern chemicals and its availability in maize storage

Among 53 respondents who agreed on the usage of modern chemical for maize storage 48 of them which is 90.6% indicated that the chemical used are readily available. Actellic super dust, DDT, Thiodan, and Blue copper were used by these respondents. Actellic Super Dust being extensively used by 81.2%, Thiodan (2.1%) DDT (10.4%) and Blue copper (6.3%). Those who did not agree on the availability of chemical all of them (100.0%) were using Actellic super dust .

Table 27: A cross-tabulation of availability of modern chemical against its usage in maize storage (n = 53)

Availability/Type of Chemicals used	Yes		No	
	Frq	Pct	Frq	Pct
Actellic super dust	39	81.2	5	100.0
Thiodan	1	2.1	0	0.0
DDT	5	10.4	0	0.0
Blue copper	3	6.3	0	0.0
Total	48	100.0	5	100.0

Chi-Square test = 1.1292 DF = 3 Significance = 0.7700

The chi-square test on this aspect has no relationship. This is due to the fact that availability of the chemicals may not be the only factor which can make rural farmers especially in the study area to use chemical insecticides. The reason for this argument is based on the fact that the chemicals which are available are not free of charge. One need cash in order to buy whatever is available. Therefore purchasing power which seems as an important factor to most of the rural farmers can influence the usage of these chemical insecticides.

4.6.2.5 Relationship between beans storage and age

The common method used to store beans in the region was found to be Sacks. Nearly seventy three per cent of the bean growers reported using this method. Large clay pots and Kilindo were used by the same number of respondents. Sundrying was the least method used to store beans. The respondents reported that they usually mix beans with either locally available insecticides or modern chemical insecticides.

Table 28: Cross-tabulation of different storage methods for beans by age in Morogoro Region (n = 85)

Storage/Age	Kilindo		Large clay pots		Sacks		Sundrying	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
15-22	1	1.2	0	0.0	0	0.0	0	0.0
23-40	5	5.9	5	5.9	30	35.3	3	3.5
41-60	3	3.5	1	1.2	25	29.4	2	2.4
Over 60	0	0.0	3	3.5	7	8.2	0	0.0
Total	9	10.6	9	10.6	62	72.9	5	5.9

Chi-square test = 15.77753 DF = 9 Significance = 0.0717

The chi-square test on this aspect was not significant. This means there is no association between different storage methods for beans and age. This results are similar to what was reported by Rogers (1983). In that study

there was inconsistent evidence about relationship between age and innovativeness. But the weakness of that study was that, the author did not specify which types of innovations were associated with age. For this study it is tempting to accept that age group above sixty years would be using traditional methods for storing beans. The data gives different result. For example, there is no respondent with age over sixty who use either 'Kilindo' or sundrying. Different from this expectation results show that the age group between 15 and 40 yrs were the ones using more of the different traditional storage structures for beans. Reasons for this result might be due to the sample size, whereby the age group between 23-40 were the majority in the study. Second, beans are produced in very small amounts and the storage system used by most of these respondents is suitable for small harvest.

4.6.2.6 Relationship between storage of beans and marital status

Most of the respondents were married couples. Nearly ninety one per cent of the beans growers were married, where as 8% of them were non married individuals. The latter group comprised of women who were either single, divorced, separated or widowed.

Table 29: A cross-tabulation of different bean storage systems against marital status in Morogoro region (n = 85)

Storage type/Marital status	Married		Non-married	
	Frq	Pct	Frq	Pct
Kilindo	9	11.7	0	0.0
Large clay pots	9	11.7	0	0.0
Sacks	54	70.1	8	100.0
Sundrying	5	6.5	0	0.0
Total	77	100.0	8	100.0

Chi-square test = 3.27608 DF = 3 Significance = 0.3510

In general sacks were the most commonly used method of bean storage. These were used by the majority of the married respondents, this comprised of 70.1% of the married respondents. Kilindo and large clay pots were used by the same percentage of married couples (11.7%). The non-married individuals were few and all of them (100.0%) were using sacks for beans storage (Table 29). For the case of beans 'Chanja' was not a suitable method of storage. This is because beans are small loose pulse grains which could easily fall off through the gaps left by the mat of sticks used to

construct 'Chanja' where as 'Chanja' was suitable for maize on the cobs.

The chi-square test on this aspect was not significant. This means that the type of bean storage chosen by the respondents does not depend on marriage. This is due to what was reported. The majority reported that what is produced is very small and the methods chosen for bean storage in most cases are the simple methods. They reported using any available containers such as tins, clay pots, sacks etc. These containers are suitable for small harvests.

4.6.2.7 Relationship between bean storage and gender

The chi-square test on this aspect did not show any significance. Therefore the results imply that there is no association between storage systems used for beans and gender in the study area. It is good to note that it has been reported elsewhere that storage might be determined by gender. For example clay pots are mostly used by women in some parts of Mgeta because they have the skill of making them. The statistical results might be due to more male respondents (69.4%) than female (30.6%) in the sample of beans growers. Therefore despite this lack of statistical significance, there is a strong justification to review traditional storage systems especially for beans with view of gender implication.

Table 30: A cross-tabulation of beans storage systems against gender in Morogoro region (n = 85)

Storage type/Gender	Female		Male	
	Frq	Pct	Frq	Pct
Kilindo	2	7.7	7	11.9
Large clay pots	3	11.5	6	10.2
Sacks	19	73.1	43	72.9
Sundrying	2	7.7	3	5.1
Total	26	100.0	59	100.0

Chi-square = 0.53732 DF = 3 Significance = 0.9106.

4.6.2.8 Relationship between bean storage systems and education level

The findings show that there were more than half of the respondents who attained primary school education and this include lower primary and upper primary school education. There were 36.5% of the respondents who attained lower primary school education and 42.4% of the respondents who attained upper primary school education.

Table 31: A cross-tabulation of beans storage systems against education of the respondents (n=85)

Storage/ educat.le	No educat		Adult.lit		Lower prim		Upper prim		Sec.Educ.	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Kilindo	2	2.4	1	1.2	3	3.5	3	3.5	0	0.0
Large clay pots	0	0.0	1	1.2	5	5.9	3	3.5	0	0.0
Sacks	8	9.4	5	5.9	19	22.4	29	34.1	1	1.2
Sundrying	0	0.0	0	0.0	4	4.7	1	1.2	0	0.0
Total	10	11.8	7	8.3	31	36.5	36	42.4	1	1.2

Chi-square = 8.83720 DF =12 Significance= 0.7168

The cross-tabulation in Table 31 was pursued to asses the effect that education may have on beans storage systems amongst farmers. It was pre -supposed that education may have an influence of shifting respondents from using traditional methods to adopting modern methods. Results in Table 31, did not suggest there is a relationship between education and different storage systems for beans. More apparent is that, education on its own may not be the most important factor to shift one (farmers) from using their way of storing methods. Most of them being traditionally inherited. On the review of literature, for example (Mamiro,1991; Ashimogo, 1995)

reported on the issue that most of the traditional storage methods used in their study areas often were the ones that have been used for a very long time. The methods have been inherited from one generation to the other. For example 'Kilindo', Large clay pots and sundrying are not regarded as innovations. They can be used by anybody regardless of his level of education. Sacks which can not be regarded as innovation either but an improved storage method is also practiced by both respondents with secondary education to the illiterate ones.

4.6.2.9 Relationship between bean storage types and farmers' tribe

The following analysis was done to asses the possibility of ethnical, tribal and cultural factors on beans storage systems. A cross tabulation of Morogoro tribes against bean storage system was conducted, results are presented in table 32 below. The results show no statistically significant relationship, although for both tribes sacks were the popular method for bean storage. It is imperative to note the higher incidence of 'Kilindo', Large clay pots and sundrying under Morogoro tribes. Note also that sundrying was solely practiced by Non-morogoro tribes. One may not be able to conclude that the tribal factor influences storage system. It may be appropriate to relate the storage systems with where one is found. This is particularly so because of availability of material and economical

consideration of the system.

Table 32: A cross-tabulation of bean storage systems against tribes found in Morogoro region (n=85)

Storage type/tribes	Morogoro tribes		Non-Morogoro tribes	
	Frq	Pct	Frq	Pct
Kilindo	8	11.1	1	7.7
Large clay pots	8	11.1	1	7.7
Sacks	51	70.8	11	84.6
Sun-drying	5	6.9	0	0.0
Total	72	99.9*	13	100.0

Chi-square test= 1.43265 DF = 3 Significance = 0.6979

*The sum is not equal to 100 because of rounding up.

The chi-square test on this aspect has no significance. The type of storage used did not specify certain traditional practices but the method was determined by the availability of the materials on the study area and the climatic conditions of the area.

4.6.3 Relationship between beans storage systems and estimated monthly income

Results of the estimated monthly income of respondents was described in section 4.2.1.7. They were found to be low and ranged from less than TShs. 10 000 to more than 100 000 per month. The majority of the respondents were found to belong in a group of farmers with estimated income of less than TShs. 10 000 per month.

Table 33: A cross-tabulation of beans storage systems against estimated monthly income in Morogoro region (n = 85)

Storage/ Income	Less than 10 000		Between 10001-30 000		Between 30 001-50 000		Between 50 001-80 000		Between 80 001-99 000		More than 100 000	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Kilindo	5	5.9	4	4.7	0	0.0	0	0.0	0	0.0	0	0.0
Large clay pots	3	3.5	4	4.7	2	2.4	0	0.0	0	0.0	0	0.0
Sacks	22	25.9	29	34.1	3	3.5	3	3.5	2	2.4	3	3.5
Sundrying	2	2.4	2	2.4	0	0.0	1	1.2	0	0.0	0	0.0
Total	32	37.6	39	45.9	5	5.9	4	4.7	2	2.4	3	3.5

Chi-square test = 11.16499 Df = 15 Significance = 0.7408

The results in Table 33 suggest that there is no significant relationship between the storage systems used for beans and estimated monthly income of the respondents. However note that sacks were used by all respondents with income levels between TShs. 10 000 and 1 000 000. The largest group being the one with monthly income between TShs. 10 000 and 30 000. Reasons for this is due to this group comprising of large percentage of the bean growers. It is notable also that none of the respondents with incomes lower than TShs. 80 000 used either 'Kilindo', large clay pots or sundrying. With these respondents sacks were popular storage method for beans. Sacks were observed to be sold at a price of between TShs. 200 to 500.

4.6.3.1 Relationship between beans storage systems and visits of extension agent

The largest group of the respondents who were frequently visited by extension agent were the ones who were using sacks. They make the percentage of those who used sacks for bean storage and visited by extension agents to be 74.2% while 69.7% used sacks but were not visited by extension agents. Nevertheless there were still respondents who reported to have been visited by extension agents and were still using traditional storage structures for beans. These included systems such as

Kilindo, Large clay pots and sundrying (Table 34).

Table 34: A Cross-tabulation of different bean storage systems against visits by extension agents (n = 85)

Chemical type/visits of extension worker	Yes		No	
	Frq	Pct	Frq	Pct
Kilindo	8	13.0	1	4.3
Large clay pots	7	11.2	2	8.6
Sacks	46	74.2	16	69.7
Sundrying	1	1.6	4	17.4
Total	62	100.0	23	100.0

Chi-square = 8.41595 DF = 3 Significance = 0.0382

The chi-square coefficient from this cross-tabulation was significant at 0.05 level. This means that there is a significant association between the storage systems used for beans and the visits by extension agents. The results suggest that most of the respondents who were visited by extension agents adopted the best way of beans storage. These methods facilitate better use of insecticides, though some of these were basically traditional. For example, there were very few respondents who were visited by extension agents and continued using sundrying as their method of bean storage compared to those who were not visited by extension agents. Sundrying is in principal an unsuitable method when one needs to apply insecticides to

the grains. Furthermore the majority of the respondents who were visited by extension agents did agree on mixing modern chemical insecticides in the different traditional storage structures. For example actellic super dust was reported to be mixed in 'Kilindo' by 13.0% of the farmers who were using modern chemicals. DDT again was used by 13% of the insecticides users for beans storage. The type of storage structures used to mix this were equally divided, 'kilindo' (4.3%) and large clay pots (4.3%). It is logical to infer that the use of chemical insecticides in the study area has been influenced by extension agents.

4.6.3.2 Relationship between beans storage systems and family size

Most of the households (42.4%) had family members between four and eight. Followed by those with one and four which was comprised of 29.4% of the bean growers. There were few cases whereby families had more than twelve members per household.

Table 35: A cross-tabulation of different bean storage against family size (n = 85)

Storage type/family members	0.0 - 4.0		4.01 - 8.0		8.01 - 12.0		12.01 >	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Kilindo	4	4.7	2	2.4	3	3.5	0	0.0
Large clay pots	4	4.7	3	3.5	1	1.2	1	1.2
Sacks	6	18.8	28	32.9	14	16.5	4	4.7
Sundrying	1	1.2	3	3.5	1	1.2	0	0.0
Total	25	29.4	36	42.4	19	22.4	5	5.9

Chi square = 5.60882 DF = 9 Significance = 0.7783

According to Table 35, the cross-tabulation yielded an insignificant chi square. This means there is no statistically significant association between the storage systems used for beans and household sizes. But the results show that in each households, sacks are the most common method used compared to other methods, this is because of its availability .

4.6.3.3 Relationship between different bean storage systems and amount of beans produced last season 1994/95

Table 36: A cross-tabulation of different beans storage systems against amount of beans produced in last season 1994/95 (n=83)**

Storage type/Amt produced	0-2 bags		2.01-4 bags		4.01-6 bags		6.01-8 bags		8.01bags>	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Kilindo	8	9.6	0	0.0	1	1.2	0	0.0	0	0.0
Large clay pots	8	9.6	0	0.0	0	0.0	1	1.2	0	0.0
Sacks	42	50.6	13	15.7	2	2.4	1	1.2	2	2.4
Sundrying	5	6.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	63	75.9	13	15.7	3	3.6	2	2.4	2	2.4

Chi-square test = 12.03914 DF= 12 Significance = 0.4433

** There was no response from two respondents.

The Chi- square test on this aspect has no significance. This implies that there is no relationship between type of storage method used for beans and amount of beans produced. Furthermore the results suggest that in relation to the amounts of beans produced, sacks were extensively used by most of respondents who produced different amount of beans from different farm sizes including few respondents who were producing more than eight bags

per season. These comprised of 2.4% of respondents. On this group there were no respondents who reported using either 'Kilindo', Large clay pots or sundrying. The majority nearly seventy six per cent produced amount of beans between 0-2 bags per season on different farm sizes. 'Kilindo', Large clay pots, sacks and sundrying were different methods used by these respondents. Generally in this group sacks were being extensively used by 50.6% of the respondents.

4.6.3.4 Relationship between bean storage systems and farm sizes

Table 37: A cross-tabulation of bean storage systems against acreage in Morogoro region (n = 85)

Storage type/Acres	0.0 1- 2		2.01-4		4.01-6		6.01-8		8.01>	
	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct	Frq	Pct
Kilindo	8	9.4	0	0.0	0	0.0	1	1.2	0	0.0
Large clay pots	4	4.7	3	3.5	1	1.2	0	0.0	1	1.2
Sacks	39	45.9	11	12.9	8	9.4	2	2.4	2	2.4
Sundrying	2	2.4	3	3.5	0	0.0	0	0.0	0	0.0
Total	53	62.4	17	20.0	9	10.6	3	3.5	3	3.5

Chi-square test = 14.39173 DF = 12 Significance = 0.2764

Table 37, presents results of a cross-tabulations between beans storage type and farm sizes. The process produced an insignificant chi-square. It is however important to look into general pattern emanating from the table. In general most of the respondents are smallholder producers, having small land areas (acres) and possibly producing basically for subsistence consumption. In view of this most types of storage cluster under the 0.01-2 acres group. It is imperative to note that, it is only across the 'sacks' type of storage row, that respondents having above 4.0 acres were found prominent. There is a strong reason to believe that as acreage increases,

yield also increase and hence methods beyond traditional ones are adopted. The chi-square test has no significance on this aspect. This results imply that the storage systems used for storage of beans are independent of the amount of beans produced. From the results of this study it has been observed that beans are produced in small quantities and most of the farmers are using the cheapest method of storing beans. The method include sacks, large clay pots, Kilindo and sundrying. The results are not different from what was reported by FAO (1991) that small containers are used throughout Africa because of the small quantities of grain harvested.

4.6.3.5 Relationship between amount of beans produced last season and the use of modern chemicals

Majority of the respondents (72.7%) do produce at subsistence levels. This means they are producing what can only be consumed. The majority are having farm sizes ranging from 0.5 to 4.0 acres of beans. Within this range they produce different amounts. From the study, it was very difficult to find a respondents who have harvested up to 4 bags of beans.

Across the table, seventy seven per cent of the respondent use Actellic super dust, DDT was used by 13.6% of the respondents while DDM was used by 4. 5% of the respondents. Thiodan was used by 4.5% of the

respondents growing beans.

Table 38: A cross-tabulation of amount of beans produced last season 1994/95 against the use of modern chemicals (n = 22)

Type of chemical/Amount produced	0-2 bags		2.01-4 bags		4.01-6 bags	
	Frq	Pct	Frq	Pct	Frq	Pct
Actellic super dust	13	59.1	2	9.1	2	9.1
DDT	2	9.1	0	0.0	1	4.5
DDM	0	0.0	1	4.5	0	0.0
Thiodan	1	4.5	0	0.0	0	0.0
Total	16	72.7	3	13.6	3	13.6

Chi-Square test = 8.1062 DF = 6 Significance = 0.2304

Different from the results from maize which had a larger sample size than that of beans, the chi-square test on this aspect on beans has no significance. This means there is no relationship between chemical insecticides used to store beans and amount of beans produced. The general impression is that the majority of farmers who use chemical insecticides, are in a group of those who produce 0-2 bags of beans from

different farm sizes. These low producers are apparent users of the chemical eg. actellic super dust, simply because they were majority in this study. Also they are trying to avoid risk of pests infestation which can occur in their small produce. Among these respondents there were others who use non-recommended insecticides such as DDT, DDM and Thiodan. The reason for the use of wrong insecticides, can probably be traced be due to the costs of these chemicals. They can be cheaply obtained from the dealers.

4.6.3.6 Relationship between modern chemicals used for beans storage and visits of extension agent

Table 39: A cross-tabulation of different modern chemical used for beans storage against extension agent visits(n = 24)

Chemical type/visits of ex-	Yes		No	
tension worker	Frq	Pct	Frq	Pct
Actellic super dust	14	73.6	5	100.0
DDT	3	15.8	0	0.0
DDM	1	5.3	0	0.0
Thiodan	1	5.3	0	0.0
Total	19	100.0	5	100.0

Chi-square = 1.66205 DF = 3 Significance = 0.6454

As seen in Table 39, 19 of the respondents reported that they normally receive visits by extension agents. The remaining were not visited by extension agents in the near past. Those who were visited by extension agents (73.6%) were using actellic super dust, 15.8% used DDT, While DDM and Thiodan was used by 5.3% of the respondents.

From the respondents who reported that they were not visited by extension agents, all of them were using actellic super dust for beans storage against pests.

The chi-square test on this aspect has no significance. This means there is no relationship between modern chemical used to store beans and the visits of extension agent in the study area. The results imply that there might be other sources of knowledge farmers get especially when they encounter a serious problem like the one they were facing i.e storage pests on beans (weevils). It is important to compare the two relationships between extension agents visits and the use of modern chemical for the case of maize and beans. For the case of maize there was a strong relationship between the two variables probably because of the large sample size.

4.5.3.7 Relationship between educational levels and modern chemical used for beans storage

Table 40: A cross-tabulation of modern chemicals used for bean storage against education level (n = 24)

Chemical/ Educ. level	No educ Frq	Pct	Adult lit Frq	Pct	Lower Pri Frq	Pct	Upper Pri Frq	Pct	Sec.Educ Frq	Pct
Actellic super	3	12.5	1	4.2	3	12.5	11	45.8	1	4.2
DDT	0	0.0	1	4.2	2	8.3	0	0.0	0	0.0
DDM	0	0.0	0	0.0	1	4.2	0	0.0	0	0.0
Thiodan	0	0.0	0	0.0	1	4.2	0	0.0	0	0.0
Total	3	12.5	2	8.4	7	29.2	11	45.8	1	4.2

Chi-square = 12.63158 DF = 12 Significance = 0.3964.

According to Table 40 above, all respondents (45.8%) with upper primary education were using actellic super dust. The respondents with lower primary education, 12.5% and 8.3% were using actellic super dust and DDT respectively. DDM and Thiodan were used by the remaining percentage (4.2%). There were few respondents with secondary education and all of them were using actellic super dust.

The chi-square test on this aspect has no significance. This result implies that there is no relationship between education attained and usage of modern chemical for beans storage. These results are due to different sources of knowledge about modern chemical for grain storage. The knowledge was found to be obtained from fellow farmers, co-operarive societies members, businessman etc. Therefore from these sources other than extension agents is where the knowledge was received. It is probably due to these sources whereby some farmers come across non-recommended[2] insecticides. The non recommended ones include DDT, DDM and Thiodan for bean storage.

4.6.3.8 Relationship between usage of modern chemicals and its availability in bean storage

Among 24 respondents who agreed on the usage of modern chemical for beans storage 87.5% of them indicated that the chemical used were readily available when needed. Actellic super dust, DDT, DDM and Thiodan were used by these respondents. Actellic super dust being extensively used by 80.9% of the respondents who agreed on easy availability of chemicals.

There exist internationally recognised regulations which determine which insecticides are permissible for use on grain and what quantities. These are given by the codex Alimentarius commission and by the joint meeting on pesticides residues of the FAO/WHO. For an account of the common regulations see Gwinner *et al.* (1990:159-207).

Those who did not agree on the availability of chemical were 12.5% of the users of modern chemical for beans storage. Out of these 66.7% and 33.3% were using Actellic super dust and DDT respectively.

Table 41: A cross-tabulation of availability of modern chemical against its usage in bean storage (n = 24)

Availability/Type of Chemical used	YES		NO	
	Frq	Pct	Frq	Pct
Actellic super dust	17	80.9	2	66.7
DDT	2	9.5	1	33.3
DDM	1	4.8	0	0.0
Thiodan	1	4.8	0	0.0
Total	21	100.0	3	100.0

Chi-Square test = 1.5438 DF = 3 Significance 0.6722

From the Table 41, the chi-square test had no significant relationship. This might be due to the fact that availability of the chemicals may not be the only factor which can make rural farmers especially in the study area to use them. The reason for this argument is because the chemicals which are reported to be available are not free of charge. One need cash in order to obtain whatever is available in the market. Therefore purchasing power

which seems very important to most of the rural farmers can influence much of the usage of modern chemical insecticides.

4.7 Extension workers and farmers perception on different grain storage systems

Most of the extension workers who were interviewed reported that, the farmers in their area are still using traditional methods of grain storage. These extension workers reported that most of the traditional storage methods are less effective. For example 'Chanja' inside the house is suitable only because of its efficiency in drying the grains and its low cost of construction. Otherwise it is vulnerable to rats, unaccess for cleaning, insecticides such as actellic super dust can not be dusted freely on to the stored grains and this make ineffective application of insecticides. Furthermore 'Chanja' makes it difficult in inspecting infested grains. In addition to ineffectiveness there were reasons given by the extension workers and farmers themselves why the respondents have chosen certain type of grain storage. For example the farmers in the highlands can not use modern insecticides for storing their unshelled maize. This is due to the fact that application of insecticides become more effective on shelled grains. Farmers in the highlands can not practice this because of the wet weather condition most of the time in a year. This is because of the two rain

seasons they received per year. The wet weather prevent them from harvesting their grains at the moisture content required for storage, instead maize are stored with their leaves in 'Chanja' and subjected to heat in order to reach favourable moisture content for storage. On the opinion on which method should be improved for the storage of maize and beans in the region, Farmers and extension workers recommended the mixed system of grain storage. They supported the use of correct chemical insecticides, in the correct quantity. These chemicals should be mixed together with the grains in the traditional structures such as 'Kilindo', 'Kihenge', or locally available sacks. They regard this as the improved as well as the best way of storing the grains.

'Chanja' outside the house (raised platform) was perceived by both as a good method for drying grains, but they are not rat proof. Ventilation is high but farmers can not avoid rain or sunshine striking the grains. The only good part of this storage structure is that inspection of insect infestation is much easier than in other types of storage they were using.

'Kihenge' (cribs) is a very strong structure. It is not rat-proof but, this can be controlled by covering the top of the structure.

'Kilindo' was reported to have similar durability as 'Kihenge'. Infestation of pests can be easily controlled if chemicals are applied.

Sundrying which consumes a lot of energy (laborious) has some negative

aspects as 'Chanja' outside, but furthermore after sundrying the grains need to be stored in another temporary container till the next day. In large extent sundrying control pests infestations. It is only economical for small quantities.

Sacks are not durable at all. They provide an ideal conditions for pests multiplications. A sack can hardly last from one season to another.

Clay pots are economical only for small harvest. It provides good protection against rats. Grains are required to dry at moisture content between 10-12% without doing that grains will highly be destroyed by mould.

Storage materials

Modern chemicals are only effective for the first three months of storage for the case of controlling Large Grain Borer. Some used small quantities (under dose) therefore regard the insecticides as ineffective.

Traditional materials are only effective for the first months of storage, as time goes the effectiveness of the materials such as cow dung ash, ash from the kitchen etc become very low.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Basing on the results of the study, the following conclusions are made:-

i) There are different traditional structures used to store maize and beans in Morogoro region. For maize, farmers use 'Chanja' inside the house, sacks, sewn tree bark cylinders i.e 'Kilindo', 'Kihenge' (cribs), and 'Chanja' outside the house. Sundrying is also among the ways of storing maize. For beans, farmers used Large clay pots, sacks and 'Kilindo'. Sundrying is also a common method for beans storage.

ii) When the two agro-ecological zones are compared, the following contrasts are discerned. In the case of the highlands, the most common storage structure used by farmers to store maize, is 'Chanja' inside the house. Farmers in the lowlands in contrast, use various traditional structures mainly 'Kilindo' and 'Kihenge' to store maize. The major reason for this contrast seems to be the contrasting climatic conditions. The 'Chanja' inside the house is more suitable for the wet climate of the highlands. While the various other methods adapt well in the dry climate of the lowlands.

iii) The traditional materials used to store maize include wood ash from the kitchen (from various types of wood) and smoke. The materials are used by both farmers from the highlands and the lowlands. The specific ashes from 'muwanga' tree, maize cobs, cow dung and goat dung, crashed barks and roots from certain trees, crashed leaves from tobacco and *A. indica* (neem leaves) are the traditional materials used to store maize in the lowlands. Ash from the kitchen and smoke are the only locally available materials used to store maize in the highlands.

iv) For beans, the storage materials used in the highlands include ash from any kind of wood burnt in the kitchen and *A. indica* leaves. For the lowlands ashes from 'muwanga' tree, maize cobs and animal dung (cow and goats) are the most commonly applied.

v) A significant proportion of farmers use various modern chemicals to store maize. Maize is mixed with Actellic super dust, DDT, Thiodan and Blue copper in the highlands. In the lowlands Actellic super dust, DDT and Thiodan have also been reported to be used.

vi) Beans are mixed with Actellic super dust and DDT in the highlands. Actellic super dust, DDM, DDT and Thiodan were used to store beans in the lowlands. It is imperative to note that these modern chemicals did not differ much across the two agro-ecological zones.

vii) Various socio-economic factors were assessed with regard to their influence on the different types of storage systems used in Morogoro region. In the case of maize, there was an apparent significant association between extension agents visits and the amount of maize produced which is further associated with the use of modern chemicals. The farmers with low harvests were the ones using modern chemicals for maize storage. In the case of beans visits by extension agents (hence advice)seem to have influenced significantly the type of storage system.

viii) The visits by extension agents seem to influence the type of storage structures as well as the materials used for maize and beans storage. A common advice in the area for the case of maize farmers was to shell the maize soon after harvesting. Also they are encouraged to use modern insecticides against storage pests especially against LGB. The majority have adopted these techniques. But there are some who

are still using the traditional storage structures such as 'Kilindo' and 'Kihenge', which allow them to mix maize with chemicals easily. The type of chemicals used were, Actellic super dust DDT, DDM and Blue copper for Maize. For beans storage some of the respondents also used insecticides such as Actellic super dust, DDT, DDM and Thiodan, in combination with traditional structures such as 'Kilindo,' Large clay pots, Sacks and 'Kihenge'.

ix) There is also a relationship between the type of chemicals used and the amount of maize produced. Low production levels were more associated with the use modern chemicals.

The reasons for this association might be just because of their small harvest. It is noted that, these low maize producers do not depend solely on agriculture as their source of income. They commonly managed various petty businesses. It is plausible to assume that this enables them to afford the chemicals.

x) The other economic and social factors in the region proved to have no significant influence on the different systems used for grain storage in this study. It is pertinent at this point to emphasize that the most important factor governing storage system in the area,

(apparently the farmer are aware of it) is the climatic condition. Most of the farmers adopt storage methods suitable in the locality depending on climate. Farmers in the highlands are sensitive to the great losses caused by mould and fungus encouraged by the damp conditions.

xi) In answering the problem statement, farmers still use traditional ways of storage because of the following reasons:

a) some farmers though few, are not aware of the presence of modern chemicals.

b) The type of traditional way they used were suitable in their agro ecological conditions.

xii) The following can be concluded on farmers and extension workers perceptions regarding the best way of storage system for maize and beans. Mixing of traditional storage structures and modern chemicals seem to give good results as far as pest infestation is concerned. This may be the most plausible line to improve grain storage and reduction of post-harvest losses in the study area.

5.2 Recommendations

Based on the conclusions the following recommendations are suggested.

i) Most of the farmers are still using the traditional storage structures for maize and beans. Amongst respondents who adopt innovations, the majority look for the cheapest way of storing their grains; this includes sacks 'viroba'. However the sacks are very vulnerable to termites, rats and many other insect infestation. These materials provides an ideal condition for storage pests if the correct and right insecticides are not used. Therefore due to this problem it is much better to advice farmers to use their own traditional structures such as 'Kilindo', 'Kihenge' which are more stronger than sacks. For better results they should combine these with recommended chemical insecticides. This has proved to make them more effective against storage pests for both maize and beans.

ii) Therefore, it is better for researchers and extension workers to focus more on technicalities of combining traditional storage structure and modern chemicals. However, before introducing an innovation researchers must look for the crucial factor which may cause rejection of that particular innovation. The goal should always be to

find storage packages (innovations) suitable for particular agro ecological zones.

iii) Further research is needed to find out the effectiveness of different locally obtainable materials such as ash. Ashes in the study have been observed to be used widely. Their effectiveness, practicability and their residual effects to the human being is however not very well known. It should be researched and documented.

iv) Since Agricultural extension seems to have a great influence on farmers change in storage methods, there is a need to strengthen Agricultural extension services in the rural areas. The focus should be on:-

a) Educating more extension workers and increasing their number per village in order to serve more farmers.

b) Stronger linkages between research centres and extension services should be improved. Under this farmers should be assisted by Agricultural extension workers to experiment how effective the traditional storage materials are. These include wood ashes, neem leaves, tobacco leaves, cow dung and others. The findings of this will encourage more farmers to use

their indigenous knowledge on this aspect of grain storage.

c) To avoid the misuse of insecticides/pesticides, extension workers as well as researchers are supposed to emphasize on their proper use when offering storage recommendations to farmers. Emphasis should be on the use of correct amounts, correct chemicals and correct timing for application.

d) Farmers should be urged to buy storage insecticides from very reliable sources e.g. from extension workers.

v) The price of modern chemicals which seems to be expensive to most of the rural farmers need to be considered. This can be solved by finding out how the farmers can get support such as subsidies, credits, good markets for their produce, different income generating activities etc in order to be in a good position of adopting these agricultural inputs.

REFERENCES

Adipo, P. (1987) *Women in a Maize storage Co-operative in Nigeria Family Planning, Credit and Technological change.* Heinemman Educational Books. pp 101-117.

Alders, C.; Ann-Waters, B.; and Van der Bliek J. (1993) After the Harvest. *Ileila Newsletter* 9, (3) pp 3-22.

Ashimogo, G.C. (1988) *Economics of On Farm Maize in Tanzania. The case of Kilosa District.* A Thesis submitted in partial fulfillment for the requirement of the degree of Msc. in Agricultural Economics in the University of Nairobi.

Ashimogo, G.C. (1994) Strategies and Problems Associated with the use of Protectants of Stored grain by Small holder Farmers: The Case of Maize in Sumbawanga district of Tanzania. In: *Proceedings of the Sokoine University of Agriculture 1st Convocation Workshop, on Sustainable Agriculture and Conservation of Environment.* (Edited by Hatibu, N.; Mafu, S.I.; Machang'u R.S.; and Rutatora) 26-27 July 1994, Morogoro, Tanzania, pp 54-64.

Ashimogo, G.C. (1995) *Peasant Grain Storage and Marketing in Tanzania: A case Study of Maize in Sumbawanga District*. Druck: Multiprint, Hans Jurgen Will, Behaimstr, Berlin. pp 369.

Busungu and Mushobozy D.M. (1991) The Efficacy of Various Protectants Against *Zabrotes subfasciatus* (BOH) Colleoptera, Bruchidae in Common Bean. In: *Bean Research Proceedings of the 10th Bean Research Workshop.* (Edited by R.B. Mabagala and N. Mollel) 16-18 September 1991, Morogoro, Tanzania, pp 157.

Chung, D.S., and Pedersen, J.R. (1975) Fundamentals of Farm and Village-level grain storage. *West African Seminar on the volunteer role in farm and village level grain storage, Working paper* 3, pp 249.

Community Development Trust Fund of Tanzania (1977) *Appropriate Technology for Grain storage in Tanzania Villages.* Bureau standards of Economics. pp 94.

Compton, J.A.F,; Tyler, P.S.; Hindmarsh, P.S; Golob, P; Boxal, R.A, and Haireness P.C. (1993) Reducing Losses in Small Farm Grain Storage in The

Tropics. *An International Journal of Science, Technology and Economics Applied* 33, (3) 283-317.

Croon, I.; Deutsch, J. and Temu, A.E.M.(Eds) (1984) Maize production in Tanzania Southern Highlands: Current status and Recommendations for the future, *USAID Report*. pp 17-22.

Egwuatu, R.I. (1987) Current Status of Conventional insecticides in the Management of Stored Products Insect Pests in the Tropics. *Journal of insect Science Application* 8, (4) 695-701.

FAO (1980) Handling and Storage of Food Grains. In Tropical and Subtropical areas. (Edited by Hall, D.W.) *FAO Agricultural Development Paper* 90, pp 43-350

FAO (1991) Postharvest and Processing Technologies of African Staple Foods: A Technical Compendium. *FAO Agricultural Services Bulletin* 89, pp 1-354.

Foster, R.H. and O'kelly, E. (Eds) (1983) Processing and Storage of Food grains by Rural Families. FAO Agricultural services bulletin, pp 1-3.

Golob, P. (1991) An Evaluation of the Campaign to Control Larger Grain Borer. *Prostephanus truncatus* (Horn) in Western Tanzania. *FAO plant protection bulletin* 39, pp 65 -72.

Gwinner, J., Harnisch, R. and Muck, O. (1990) Manual on the Prevention of Post Harvest Grain Losses, Hamburg. pp 159-207.

Hebblethwaite, M.J. (1985) The Application of Economics to Pre-and Post Harvest Pest Control Programmes in developing countries. *Journal of Tropical science* 25, (3) 215-230.

ILEIA, (1987) 'Women Farmers'. *Ileila Newsletter* 3, (3) pp 21.

Johnsson, L.O. and Kashweka K. (1987) Relationship between Drying harvesting and Storage losses, Production and Consumption of Maize in Rural Household in Zambia. *FAO/SIDA Seminar on increased food production through lowcost food crops technology*. 2-17 March 1987, Harare, Zimbabwe, pp 475-482.

Joshi, B.C.; Srivastara, S. K.; Lal, S. and Prajapati, S. K. (1990) Studies on Aflatoxin Contamination in stored Gar and Jajra at Farm level. *Bulletin of*

Grain Technology. (Edited by Agrawal N. S.) 28, (1) Published by Food Technologist Research Association of India. pp 1-75.

Kiula, B.A. and A.K. Karel. (1984) Effectiveness of Vegetable Oils and Other Plant Products in Protecting Beans Against Mexican Bean Weevil (*Zabrotes subfasciatus*) (Bohman). In: *Proceedings of the Sokoine University of Agriculture 3rd Bean Research Workshop. On Bean Research in Tanzania* (Edited by Minjas, A.N. and Salema, M.P.) 27-28 August 1984, Morogoro, Tanzania, pp 72-92.

Lesotho Government, (1990) Postharvest *Management and Insect Pests of Cereals and Legumes in Lesotho.* (Edited by Mofubetsoana S.L. and Ansari A.) AGROTEC, UNDP/OPS Programme on Agricultural Operations Technology, pp 1-68.

Levinger, B. and T. Drahman (1980) *'Let us look at Our Assumptions'.* World Education Reports, New york. pp 21.

Lugeye S. (1994) The role of Farmers indigenous Knowledge in Natural resources and Management. In: *Proceeding of 1st Workshop, On Sustainable Agriculture and Conservation of Environment.* (Edited by Hatibu,

N.; Mafu, S.T.A. Machang'u R.S.; and Rutatora, D.F.) 26-27July 1994, Morogoro, Tanzania, pp 116-125.

Mamiro, P.R.S. (1991) Household Food security in Tanzania: Adequacy, Stability, and Accessibility. A case study of Moshi and Kilosa Districts. Thesis in Msc. Management of Natural Resources and Sustainable Agriculture of the Agricultural University of Norway, June, 1991.

Ministry of Regional Administration and Local government/FAO (1991) *Reduction of post harvest losses through rural storage structure. Comparative study of storage techniques at household level-Tanzania* pp 1-18.

Minjas A.N. and Delobel T.C. (1990) Strategies to enhance Liaison Between Agricultural Universities and Small Scale producers. In: *Proceedings of a Workshop on the Role of Agricultural Institutions in the Advancement of Small Scale farmers in Developing Countries.* (Edited by Mattee A.Z,; Evers G. and Mollel N.M.) 8-12 May 1990, Held at Sokoine University of Agriculture, Morogoro, Tanzania, pp 24-31.

Mmopi, F.T. (1986) Extension Practices for Reduction of Postproduction food losses. In: *Proceedings of Extension Messages and Methods for Post Production Food Loss Reduction Workshop.* 16-18August 1986, Arusha,Tanzania, pp 16-18.

Mohamed R.H. and Teri, J. (1989) Mgeta Farmers and bean. *Ileila Newsletter for Low External Input and Sustainable Agriculture.* 3 October 1989.

Mohamed R.H. (1990) Strategies in Small Scale Bean Production system. A Dissertation for MSc. Sokoine University of Agriculture-Morogoro, Tanzania.

Mphuru, A.N. (1986) A Review of Research and Development Work on Post Production Food Loss Reduction in Tanzania. In: *Proceedings of Extension Messages and Methods for Post Production Food Loss Reduction Workshop.*16-18 August 1986, Arusha, Tanzania, pp 23-26.

Muro, S.A.N. (1986) A Review of Post Production Food Losses and Methods used in Tanzania. In: *Proceedings of Extension Messages and Methods for Post Production Food Loss Reduction Workshop.* 16-18August Arusha, Tanzania, pp 13-14.

Nanai, N.A.K. (1993) *Peasants Participation in Community Development Projects: Its Implications in Laying A Strategy for Participatory Extension.* Dissertation in Msc. in Agricultural Education and Extension, Sokoine University of Agriculture.

National Academy of Sciences (1978) *Post-Harvest Food Losses in developing Countries*, pp 1-183.

Odogola W.R. (1994) Postharvest Management and Storage of Food legumes. *UNDP/OPS Regional Programme Report,* pp 122.

Odogola, W.R. and Henriksson, R. (1991) Postharvest Management and Storage of Maize. *UNDP/OPS Regional Programme Report,* pp 162.

Pantenius C.U. (1988) Storage Losses in Traditional Maize Granaries in Togo. *Journal of Insect Science and its Application,* 9 725-735 .

Pingale, S.V. (1976) Handling and Storage of Food Grains. *Indian Journal of Agriculture,* 150.

Reed, C., Pederson, J.R. and Cuperus, G.W., (1993) Efficacy and Effectiveness of Grain Protectants Applied to Farm-Stored Wheat at Harvest and Later. *Journal of Economic Entomology,* 86 (5) 1590-1598.

Ringia, O.L. (1990) Household Food Security in Tanzania How are Faring. *Agriculture Research Institute-Ilonga Research and Training Newsletter.* 5 (1) pp 12-18.

Rogers, E.M. (1983) *Diffusion of Innovations*. The Free Press, A division of Macmillan Publishing Co., Inc. pp 453.

Shayo, E. (1990) Women in Agricultural extension. In: *Proceedings of a Workshop on the Role of Agricultural Institutions in the Advancement of Small Scale farmers in Developing Countries*. (Edited by Mattee A.Z,; Evers G. and Mollel N.M.) 8-12May 1990, Held at Sokoine University of Agriculture, Morogoro, Tanzania. pp 11-15.

Simalenga, T.E., Lazaro, E., Silayo, V.C.K. and Mpagalile, J.J.S, (1994) Assessment of Bean Storage Methods for Small Scale Farmers. In: Mabagala, R.B., Maeda, E.E. and Mduruma, Z.O. (Eds). In: *Proceedings of*

the Eleventh Bean Research Workshop. 16-18September, 1992, Held at Sokoine University of Agriculture, Morogoro, Tanzania, pp 28-38.

Staudt K.A. (1982) Women Farmers and inequities in Services. In: *Women in Africa* (Edited by Bay, E.G), Boulder Colorado, West View Press. pp 207-214.

Staudt, K.A. (1984) *Womens' Role and Gender differences in Development, Agricultural Policy Implementation: A case study from Western Kenya.* Kumarian Press, West Hartford. pp 68.

Van Den Ban A.W. and H.S. Hawkins (1988) *Agricultural Extension.* Longman Scientific and Technical, John Wiley & Sons, Inc., New York. pp 328.

LIST OF APPENDICES

APPENDIX I: Farmers' questionnaire

TITLE: Socio-economic factors influencing the use of grain storage methods in morogoro region

No.of Interviewee.....

Region.....District.....Division..... Ward.....

A. PERSONAL BACKGROUND INFORMATION (SOCIO-ECONOMIC CHARACTERISTICS)

1. What is your highest level of education
   1. None
   2. Adult literacy
   3. Primary education (STD I to IV)
   4. Upper Primary education (STD V to VII)
   5. Secondary Education (Form I to IV)
   6. Post Secondary Education
2. Gender
   1.Male
   2.Female
3. Marital status
   1.Single
   2.Married
   3.Divorced
   4.Widow

4. What is your age.
   1. Between 15-35 yrs old (young)
   2. Between 36-60 yrs old (middle age)
   3. Over 60 yrs old()
5. How many members are there in your household.....(total number)
   1. Relatives.....(Number)
   2. children.....(Number)
6. What is your major occupation
   1. A crop producer
   2. A Livestock keeper
   3. Both
   4. Any other (specify). .....
7. If a crop producer how many acres do you cultivate?.....
8. If a livestock keeper, What do you keep?

Animals	Number
1. Cattle	.....
2. Goats	.....
3. Sheep	.....
4. Poultry(Chicken and Ducks)	.....
5. Pigs	.....
6. Donkeys	.....

   7. Others Specify .....
9. For how long have you been involved in
   (i) Crop production .....(yrs)
   (ii) Animal keeping.....(yrs)

10. Which among the two do you grow in your fields?
    1. Maize
    2. Beans
    3. Both 1 and 2

11. Mention purpose for which you grow specific crops.

Crops	1 = Cash	2 = Food	3 = Both
1. Maize			
2. Beans			

12. (a) Mention the year for which you started growing each of the crops.

Crops	Years
1. Maize	
2. Beans	

12. b. Duration..... years

13. For how long have you lived in this village.
    1. Less than 4 years
    2. Between 5-10 years

3. More than 10 years

14. What is the staple food for the family?

1. Maize
2. Beans
3. Banana
4. Millet
5. others specify.

15. Indicate the amounts produced in 1993/94 for each crop (approximation)

Crops	Bags produced	Bags stored	Bags sold
1. Maize			
2. Beans			

B. INCOME

1. What are your sources of income other than agriculture/livestock keeping.(multiple answers are allowed).

1. Employment.
2. Selling charcoal/firewood
3. Selling local brew
4. Relatives/children send the money
5. Selling garden produce.
6. Others;Specify.....

2. What other activities do you do other than farming?
   1. Casual labourers
   2. Businessman
   3. Others; Specify. .....

3. What is your estimated monthly income
   1. Less than TShs. 10 000
   2. Between TShs. 10 001 - 30 000
   3. Between TSh. 30 001 - 50 000
   4. Between TShs. 50 001 - 80 000
   5. Between TShs. 80 001 - 99 000
   6. More than TShs. 100 000

C. BEANS AND MAIZE STORAGE RECORD SHEET.

1. What type of storage structure do you have? Name it
   1. Chanja inside the house
   2. Chanja outside the house
   3. Kilindo
   4. Kihenge
   5. Sacks
   6. Others: Specify .....

2. Which crops do you store in the particular storage structure mentioned above.

Types of crops	Storage structure
1. Maize	
2. Beans	

3. For how long have you been using this kind of structure. Give No. of years (.....)

Type of storage structure	No of years used
1. Chanja inside the house	
2. Chanja outside the house	
3. Kilindo	
4. Kihenge	
5.Sacks	
6. Others;Specify	

4. Give reasons why you are using this type of structure

.....

5. How long does your storage structure last once constructed?

Type of storage structure	No of years last

1. Chanja inside the house
2. Chanja outside the house
3. Kilindo
4. Kihenge
5. Sacks
6. Others;Specify

Number of years lasted

1. less than 2 years
2. 2-3 years
3. 3-4 years
4. 4-5 years
5. Over 5 yrs

6. What is the type and source of the materials used for the structure.

7. (a) Type of materials used for construction of storage structure

Type of structure	1 = local	2 = modern	3.mixture
1. Chidong'a			
2. Chanja			
3. Kilindo			
4. Kihenge			
5. Others;			

(b) Sources of the materials and their costs.

Place	Costs in TShs.
1. From my shamba	
2. From extension officer	
3. From the shops	
4. From the dealers	
5. From neighbours/friends	

8. Who construct the structures?
   1. Self
   2. Employ.
9. Give reasons why either 1 or 2

.....

10. Do you know any traditional materials (such as cow dung, ash, tree leaves) used to store grains.
    1. Yes
    2. No
11. If Yes mention them.

Maize	Materials
1.....	.....
2.....	.....
3.....	.....
Beans	
1.....	.....
2.....	.....
3.....	.....

12. Do you use them.
    1. Yes
    2. No
13. If the answer is yes give reasons why you are using these materials.
    .....
14. Can you explain where you did get this knowledge of using traditional method of grain storage
    .....
15. If the answer is No ; Explain the reason why you do not use the method.
16. Do you know any chemical(e.g pesticides, fungicides etc)used to store grains.
    1. Yes
    2. No.

17. If the answer is Yes; Do you use them to store your grains(maize & beans)

    1. Yes
    2. No

18. If the answer is Yes above

    Give the type of chemical you are using to store your grains.

Type of crop	chemical used
Maize	1.....
	2.....
Beans	1.....
	2.....

19. Why do you prefer these chemicals?

    .....

20. Are these chemicals readily available?

    1. Yes
    2. No

21. Where did you get the knowledge about the chemicals?

    1. Friends
    2. Extension officers
    3. Other farmers(neighbours)
    4. Shop keepers
    5. Other sources; Specify them;

    .....

22. If you are not using chemicals give the reasons why.

    .....

23. Explain the division of labour during storage period.

Members of the family	Storage activities(processes)
1. Mother	
2. Father	
3. Children	
4. Others;Specify	

24 Do you hire labourers during storage activities?

1. Yes
2. No

25. a) If yes give the reasons of hiring these labourers

.....

25. b) If the answer is Yes, How do you find the costs?

1. Very expensive
2. Expensive
3. Reasonable
4. Cheap

26. If you do not use storage facilities (structures as well as materials) give reasons for not doing so.

1. Small harvest
2. Immediate selling
3. Crop failure.
4. Others; Specify.

.....

27. Is there any agricultural extension worker visiting you in this area?
    1. Yes
    2. No

28. If the answer is yes give his/her name
    .....

29. How frequently does the agricultural extension worker visit you, after every.....
    1. 7-14 (very frequently)
    2. 14-28 (frequently)
    3. 28-above (not frequently).
    .....

30. What messages does he/she give you.(multiple answers are allowed with concentration to storage advice) .....

D. THE PERCEPTION OF FARMERS ON THE EFFECTIVENESS OF TRADITIONAL SYSTEMS OF GRAIN STORAGE.

1. During storage last season did the crop which you stored show any sign of damage?
    1. Yes
    2. No

2. If yes what were the major causes for damage?
    1. Rodents
    2. Insects
    3. Mould/Fungi
    4. Others; Specify.

    .....

3. How effective are the traditional methods of grain storage compared to the modern ones.

a) (Materials)

1. Very effective
2. Effective
3. Less effective
4. Not effective at all

b) (Structures).

1. Very effective
2. Effective
3. Less effective
4. Not effective at all

4. a) What is the loss when using the traditional methods of grain storage? Losses occurring when using structures the losses are;

1. Very high
2. High
3. Little
4. Very little
5. No loss at all

4. b) When using Materials.....

losses are;

1. Very high
2. High
3. Little
4. Very little
5. No loss at all

5. Did you experience some losses last year?
   1. Yes
   2. No
6. If yes how much of your main crops did you lose last year? Estimate in number of tins per bag.....
7. From your own experience which method would you like your fellow farmers to use for storing their grains and why? .....

APPENDIX II: EXTENSION WORKERS QUESTIONNAIRE

Region..... District.....

Division..... Ward.....Village.....

Name of extension worker .....

No. of the questionnaire.....

1. What are the major day to day Agricultural Activities which you engage yourself with farmers.

   1.....

   2.....

   3.....

2. What other activities do you do in villages.

   1.....

   2.....

3. On average how many days a week do you spend in contacting farmers.....days

   a. Contact in farmers homesteads per week.

   (How many contacts _____)

   b. Contact in your office/home per week.

   (How many contacts _____)

4. Who initiates those contacts ?.....

5. What do you normally discuss with those farmers ?

   .....

6. What Agricultural & Livestock materials do you give / take to the farmers ? (examples: brochure, leaflets)

   1.....2.....3.....

7. What are the contents of those livestock and agricultural materials?.....

8. What Agricultural and/or Livestock messages have you disseminated to farmers in the past three years?

.....

9. What extension methods do you use to pass agricultural & Livestock information to farmers.

.....

10. What specific technical recommendations on storage did you distribute/disseminate to farmers on the pest & diseases control (e.g identification, control, storage methods etc.)

.....

11. What system of storage do the farmers use most in this area?

1. Traditional systems
2. Modern system

Mention the methods.(structures / Materials)

.....

12. Give reason why the trend is like that.

Reasons why the farmers are still using traditional systems

.....

13. What do you think about the effectiveness of using the traditional system when compared with modern system.

1. very effective
2. effective
3. less effective
4. not effective.

14. Have you ever encourage the farmers to use the modern systems of grain storage.
    1. Yes
    2. No
15. Can you explain the rate of adoption.Indicate if it was
    1. Low
    2. Moderate
    3. High
    4. very high
16. Give your own recommendations on which method should be used and if necessary to be improved as the best method of storing grain by the small holder farmers.

.....

THANK YOU ALL FOR YOUR CO-OPERATION