AN ESTIMATION OF GRAIN STORAGE METHODS AND LOSSES IN EKITI STATE, NIGERIA

BY

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIRMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) IN DEGREE IN AGRICULTURAL AND BIO RESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

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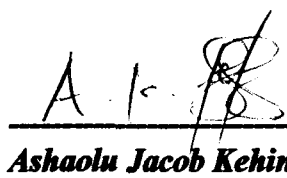
DECLARATION

I, Ashaolu Jacob Kehinde of the Department of Agricultural and Bio Resources Engineering. School of Engineering and Engineering Technology, Federal University of Technology, Minna, hereby declare that this project work has been conducted solely by me under the supervision of Prof. E.S. Ajisegiri. All source of information have been duly acknowledged.



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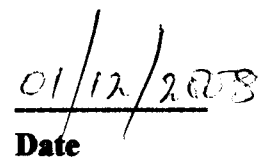

Date

CERTIFICATION

This is to certify that this project was carried out by Ashaolu, Jacob Kehinde in the Department of Agricultural and Bio Resources Engineering, Federal University of Technology, Minna.

Professor E.S. Ajisegiri	**Date**
Dr. Engr. Mrs Z.D. Osunde	2/12/2008 **Date**
External Examiner	19-11-08 **Date**

DEDICATION

This project is dedicated to Almighty God who is the all in all, a present help in the time of need for His grace and mercy that made this valuable goal and for making this large of my dream to come true.

I also dedicate this project to my late both Father and Mother Pastor E.A. Ashaolu and Mrs. Omowura-ola Ashaolu and lastly my beloved wife Mrs. Esther Taiwo Ashaolu and the lovely children (Princess, Rose, Opeyemi and Grace Ashaolu.)

ACKNOLEDGEMENTS

I give to God all the praises and adoration for He is the Alpha and Omega the beginning and the end. All the credit of this project is belong to him alone. He alone has made this project a successful. His unfailing grace helps me all through my life.

My profound gratitude goes to my supervisor Prof. E.S. Ajisegiri, a Father indeed for his immerse contribution to the success of this project. Also special thanks to my head of Department in the person of Dr. Engr. Mrs. Z.D. Osunde a good Mother and my sincere thanks go to all my lecturers the time would not permit me to mention their names and lastly my thanks go to the entire staff of Agricultural and Bio Resources Engineering Department.

I also wish to express my profound gratitude to my late parents; Late Pastor E.A. Ashaolu and Late Rachael Omowura-ola Ashaolu for their good careering during their life time over me. Thanks to my wife Mrs. Esther Taiwo Ashaolu and my children Princess, Rose, Opeyemi and Grace for their good understand even when the road was highly rough.

ABSTRACT

The study of grain storage structures, method and losses in Ekiti State was carried out with eight randomly selected local government areas, involving towns and villages within each of these local government areas.

The sample random selection method was used in collecting data from the various local government areas which involve the use/administration of questionnaires to the people concerned. In addition interviews were conducted randomly.

The storage system was divided into three small scales, the medium scale and the large scale storage systems. It was discovered the bamboo crib method is more popular than the other storage methods.

The following were the methods employed in the estimating storage losses the count and weight method and weight-in weight out method. These methods were chosen because of their simplicity. The study showed that maize was the major grain grown in the local government areas. The major grain storage problems and the agent storage losses were found to be micro-organism insects, mites, birds, rodents fire hazards and thieves.

During the course of study it was discovered that averagely, the quantity lost to insects is about 45,000kg out of the 245,000kg produced (900 bags) while qualitatively about 19% of the grain product were lost to the agent of losses, in monetary value about 3.375 million naira.

It is almost impossible to recommend a particular type of storage method or structure in all the eight local government areas covered but based on finding or research carried out the silos and bamboo crib is recommended for grains in most areas.

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1.0 INTRODUCTION

1.1: Storage losses

The factors that promote deterioration and which eventually lead to losses in agricultural crops production can be grouped under the following:

a. Physiological changes in the crop especially the rate of the respiration. Since respiration is a destructive process, it results in a loss of dry weight, quality, food value and crop viability for seeds.
b. Biological factors including attacking by micro-organisms, insects, mites, rodents and birds.
c. Inefficient processing methods due to poor storage techniques which predispose the crops to damage by the above biological factors.
d. The storage atmosphere of the grain i.e the exposure to adverse weather.
e. Infestation of crops in the field prior to harvesting. This will result into poor quality grains with short shelf life.
f. The duration of storage. The longer the storage time the more the deterioration.

The major aim of storage in crop production is to preserve the crop in acceptable condition until it is needed for use.

Storage of grains is carried out to accomplish one or more of the following objectives:

- To ensure all-round supply of high quality food throughout the year in the country.
- To preserve food for emergencies such as war, drought, flood, natural or man made disaster.

- To preserve seeds from one season to another in order to get enough plants stands.
- To supply raw materials to agro-based industries.
- To serve as a form of loose hold enterprise such as beer brewing or the preparation of food for sale.
- To earn foreign exchange for the bid farmers from international trade in grains by either importing or exporting of grains.

1.2: Objectives of the Study

This research work is carried out to achieve the following objectives:

i. To collect storage data in the area which covers all Local Government Areas. The storage data was also in some farmers (both large and small scale farmers). These local government areas from Ekiti state were chosen because of the field office of one of the agricultural establishments visited during the project work, that is Agricultural Development Project (ADP) Ekiti state.

   The establishment divided the local government of Ekiti state into four zones. The above local government areas were randomly (selected) and it spreads across these four zones for research convenience.

ii. Identification and evaluation of performance of the different storage methods in the area.

iii. Estimation of the quantity of grain lost annually during storage in the Local Government Areas.

iv. Give suggestions as to how best to minimize the storage losses.

v. Make a conclusion on the storage structure which can best suit a particular area.

1.3: Justification

It has been observed that inspite of increases in food production, the benefits of the increases have not been very evident. This is because of high level of food losses which occur from the farm gates through the marketing outlets to the point of consumption.

Although some reduction in crop losses after harvest have been noted in the country, a major reason for the losses still suffered has been attributed to ignorance or inadequate knowledge of the suitable techniques available for storage and pest control methods.

It is therefore important to continue to examine present storage techniques and strategies with a view to identify storage problem areas and suggesting possible solutions to this problem. In this lies the justification of this study.

1.4: Limitation

The following were my limitations while I was carrying out this research work:

i. Considerations are for rice, cowpea, maize, guinea-corn and groundnut. Any other cereal or oil production crops which are not in this list are not within the scope of this study. Legumes are widely grown at all due to its pronounced storage problems.

ii. Only eight Local Government Areas were selected out of the total Local Government Areas of Ekiti state.

iii. Consideration is only for the 2006/07 harvest seasons.

iv. The method of evaluation comprises of personal distribution of questionnaires and collection of samples.

All other method of evaluation outside the ones mentioned are not applicable.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1: Major Grains Produced in Ekiti State

Ekiti State is known to have the good climatic which favours the growth of crops most especially the cereal crops.

The grain crops grown in this part of the country are therefore categorized into the following:

i. Cereal crops - Maize
Guinea corn
Rice

ii. Legume - Beans
Soya beans

iii. Oil producing crops - Groundnut
Melon

2.2: Methods of Grain Storage

Storage as it defined by professor (Ajisegiri, 1987) is "the setting aside for future use of separable items". It was stated that most farmers do have some methods of storing their grains. No matter how crude these methods are, changes can only be achieved when believe in the new ideas as being better than their existing practices (Ajisegiri et al, 1992).

Farm or traditional storage methods at producer level are usually well adapted to both the types of grains for which they are indented and the environment in which they are employed.

It is an established fact that rural communities are very slow in their attitude towards change.

Thus, if a community is forced to move to a new environment which is very different in all ramifications both climatically and geographically to that which they are accustomed. In this case, it may take a long time to adopt or change their grain storage practices.

Another major problem faced by the local farmers is the growing shortage of materials traditionally used for the construction of grain stores due to extensive use of such materials. This way enables the rural farmers to adopt alternative means of storing grain.

The farmers in Ekiti state especially those farmers in some towns called Igbimo Ekiti and Ifisin Ekiti both in different local government areas have been able to come out with different types of farm level or traditional storage methods through which they have been able to store most of the grains to a very large extent.

These methods constitute the most popular aspect of food storage methods which is mostly carried out after the threshing. Mostly the unthreshed grains and legumes are placed under a smoke or flame by a platforms which the smoke can be penetrating through underneath, house or raised on platforms or simply heaped on the ground either arranged in an order way or radically around a shade or just a heap in crib or bundled together and stored on the roof of living houses. Though it most be checking time to prevent the rodents or pests activities.

2.2.1: Farm level Storage System

This is the storage technology at the grass root and it constitutes the most popular aspect of food storage method. At the family level the quantity of grains usually stored is not more then 4-6 bags. In Ekiti state a full bag is weighed to one ton, in order word, at the family level , the quality of grains stored as about 4-6 tons .

Maize constitutes 95% of the grain stored at the family level.

This is harvested at 20 to 25 prevent moisture the cob is either air or sun dried to about 13 to 12 prevent moisture before it is shelled . Whether shelled by hand or with the local small hand shelled, drainage to the kernels should be avoided especially when local small hand shelter is being used. It is highly recommended further drying to about 11% moisture before finally stored the grain.

2.2.2: Farm level Storage System

This is the traditionally storage technology again at the grain roof and it farm among the rural farms especially in Ekiti state.

Storage at this level is either before or after threshing. The unthreshed grain and legumes mainly maize, rice, guinea corn, and cowpea are raised platform or simply heaped on the ground either arranges in a special way mostly radially around a shade or just a heap in crib.

The threshed grain could be regarded as processed and these are stored in calabashes, kerosene tins polythene bags and sacks.

Baskets

Though baskets are mainly used in the dry tropics but they are equal used in the humid tropics only ventilation has to be good. They are not supposed to be put close together .

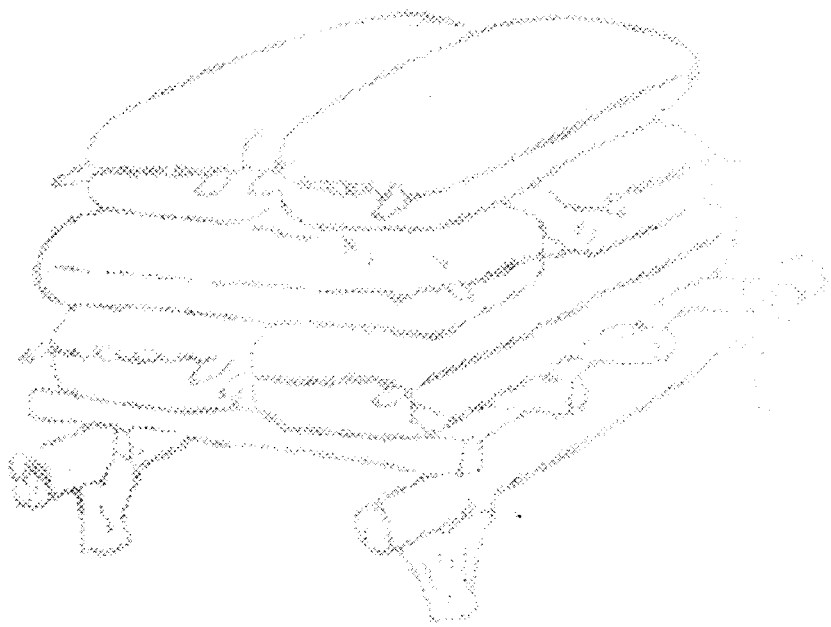


Fig 2: Pile of sacks on a pallet

They are used to store shelled or dehusked grain such as guinea corn and rice. This method of storage is widely practice in Ekiti state especially in areas where they cultivated both rice and guinea corn. They are usually raised of the ground on a platform with rodent bafflers on the legs of the platform. The baskets are closely knitted using raffia palm fronds. They have the capacity of about I ton to 1.5 tons or even more for rice. Baskets are known for not given enough protection against insects but this can be improved by applying mud, clay to the inner and outer parts. But a more efficient way is to line the inner part of the basket with a thick plastic bag. This also provides an air tight structure with this storage method, if the basket is plastered, further ventilation is made impossible therefore to most grains should not be stored since it will go mouldy and rot quickly. This storage method enables one to use insecticide most especially with big basket. The inner part of the basket is dusted and the grains mix with insecticide but the grains needs to be thoroughly washed before consuming.

Heaps

Heap storage is a common practice not only for cereals but also for crops such as tubers. According to (Ajisegiri, 1982). He further stated that the grains most especially is harvested with the stake and then arranged face up in circular form and usually covered with straw. The obvious disadvantage of this method is the insect, mite and rodent attack the cereals. If practice in the raining season, sprouting may occur (Opadokun, 1992).

Kerosin tins

This type of storage method is highly common among small scale traders and the rural area dwellers especially the ageing people who make the use of containers to store shelled grains in their homes.

They can be made relatively air tight by tightening a clamp to hold the lid to the tins. For kerosene tins, storage, fumigants are usually required to reduce the incidence of insect attack. This method is used to store mainly the grains like, cowpea, maize and guinea corn. The inner part may be lined with polythene materials to prevent rusts problem. The grains need to be properly dried before storage since heating up is a major problem (Anonymous, 1982).

Plastic bags

This method is suitable for storage in the dry tropics and humid tropics region. The grains have to be dried very well because during storage further drying is impossible. This is mainly due to lack of air circulation. When the plastic bags are closed very well, air tight storage is obtained.

This method does not offer much protection against rodents attack so extra attention is required. During marketing which may require transporting these bags over a long distance, it is always advisable to use plastic bags that are thick enough and of high strength so as to prevent the bag from becoming too weak. Grains already infected with insect pest should not be stored in the bags to avoid the plastic bag from being puncture when the insects want to escape from the bag. Plastic bags should not be exposed to direct sunlight since they become very weak or brittle after along time of exposure. Transparent plastic bags make the product visible which makes checking the content easier. The major disadvantage of using

transparent plastic bags is that reptiles such as lizards can see insects which may be moving about inside and may snap at them which may cause damage to the plastic bags.

This storage method are good for the sowing seed, cereals and groundnut which has a storage time of 6- 9 months with 50 – 100 litres capacity. They cost fairly high when good quality bags like fertilizer bags are used. (FAO, 1983).

Hanging

This method of storage is mainly for unthreshed grains it is used for storing maize cobs majorly. This is tied in bundles and then suspended from tree branches, post or tight lines outside of the house especially near the kitchen where the smoke of fire cooking will be moving towards hanging maize cobs. This radiation of cooking fire will be radiated to this hanging maize so this will contribute to the further drying of the grains, and disallowed the insect, rodents to penetrate.

The disadvantages of this method is that during the raining season the method of storage by hanging so not be encourage because the grains would be moulded.

Again the storage is limited to small quantity of grains and finally the thieves are to be putting into consideration before embanking on this method.

Platforms

This method is mostly used to store grains in unprocessed form. It consists essentially of a number of relatively straight poles laid horizontally on a series of upright poles on which a raft is built hence this is where the name platform is derived. It should be raised 30 – 50cm above the ground to facilitate clearing and inspection. They are mostly rectangular in shape. Grains are stored on platform in heaps, woven baskets or bags. The grains that are usually stored on top of the

platforms are maize cobs, guinea corn, beans in pods and harvested groundnut which are not yet picked are stored. This is then covered by grasses or leaves which may serve as a form of roof to the stored products.

According to (Ajisegiri, 1982). that the infestation of grains stored in this way is heavy. rodents attack may be controlled by the use of rodent guards or trap while treatment with the appropriate insecticides like (Phostoxin) in which the active ingredient is the Alluminium phosphide would reduce insect attack (ADP, 2006). He (Ajisegiri) further stated that the possibility of sprouting is high and the provision of teak rook raps or thatched roof would help to eliminate this.

2.2.3: Medium scale Storage Method

Bags

This method of storage is highly common in the developing countries which Nigeria is included. It is more economical and well accepted to local grain transporting and marketing conditions. Stored grains are in bags which are neatly stacked in carefully prepared areas. These bags containing shelled grains are stacked mostly on raised planks in stores, barns, houses or even ware houses.

The major disadvantage of this method is that it encourages insect attack with the exception of thick plastic bags. They also break easily when old and allow free passage of moisture. This forms of storage is popular with marketers and retailers. It could be improved by the provision of plastic lining to the inner parts. This would increase it's strength, water exchange capacity and insect infestation would also be reduced.

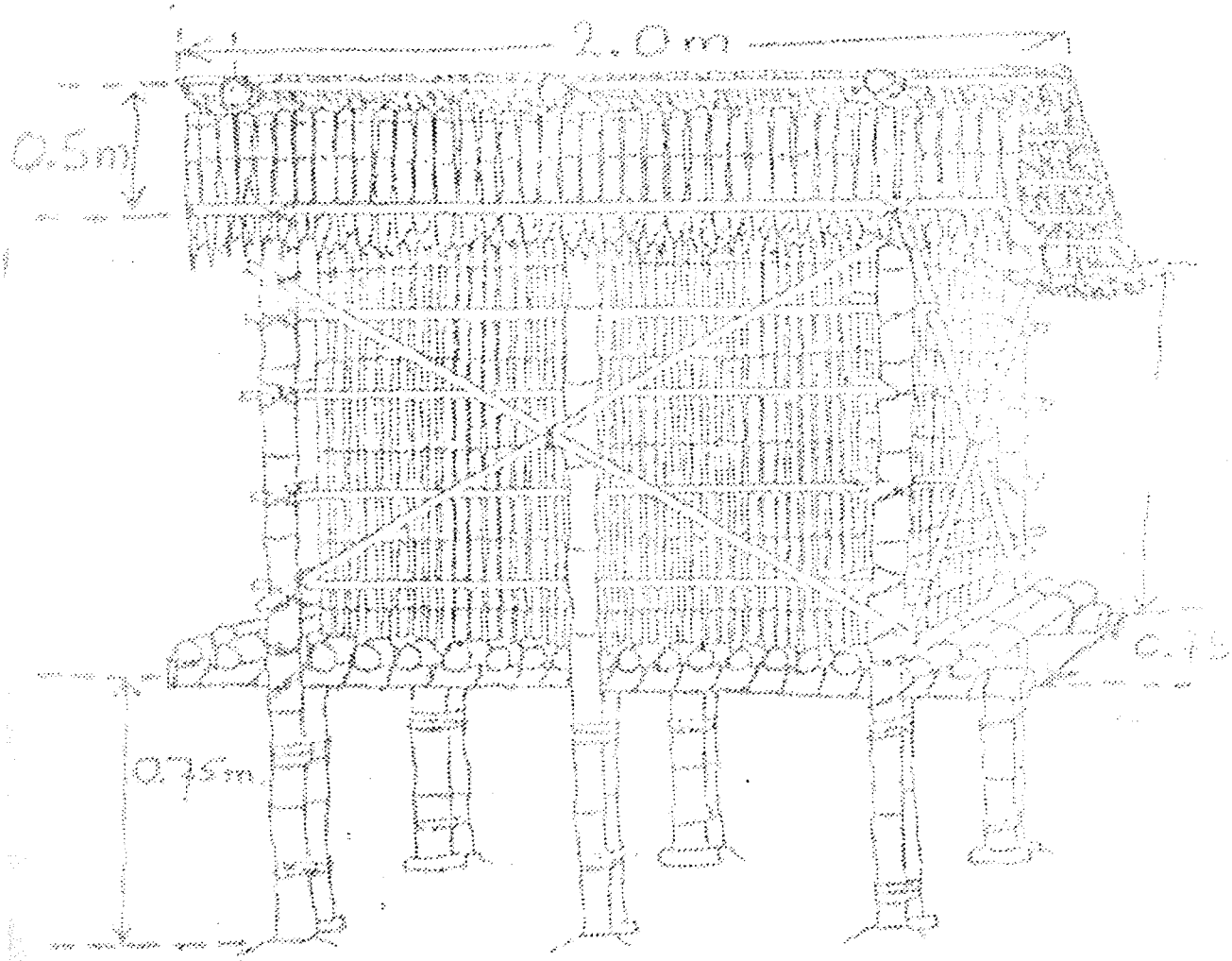


Fig 3: Maize crib made of bamboo

Fumigants or chemicals can also be applied to the stored grains to give protection against insects and pest infestation. The husks should be removed so as to accelerate the drying procedure of the cribs (Hayma, 1990).

2.2.4: Large scale Storage Method

This is also referred to as the commercial grain storage system. Grains under this system of storage are received from farmers and safely stored for more than 2 years or more than that, until it can be exported or disposed off domestically.

Storage of grains in commercial quantities is carried out by large scale farmers, traders, exporters, agro-based and allied companies including government agencies such as strategic grains.

According to (Ajisegiri, A. 1992) the structure for this method of storage is long lasting and permanent.

They are mainly silos and ware houses (stores)

A. Ware houses

These are used mainly for the storage and physical protection of goods. The produces are already bagged before storage in stores or ware houses. The construction of ware houses is a specialized function which must be required the services of the skilled engineers.

Before selecting a site that will be suitable for the construction of large ware houses, several factors should be considered which includes the topography of the areas which should be well drained and not prone to flooding. The characteristics of the soil which include it's load-bearing capacity, resistance to compaction and drainage efficiency. The doors and windows must be tight fitting to facilitate fumigation and to prevent rain and rodents from entering the store or ware house.

The bags must be stacked on wooden pallets away from the walls. This method have been proved to be highly successful in both developing and undeveloped countries (F.A.O. Bulleting NO. 53)

B. Silo

Silos are of different types but the most very common are: the inert gas silos, metal type silo, butyl rubber type silo, conventional type silo and wooden type silo. Silos are storage structures in which grains can be stored loosely in bulk without putting them in bags. Apart from butyl rubber type and some other forms of silos are fabricated from metals (aluminium, zinc etc) but the type of silo in Ekiti state are of wooden type and very modern. The wooden typed silos are cylindrical in shape.

This wooden type of silo in Ekiti state is very heavy and each can accommodate up to 80 tons to 90 tons of grains at once. These silos in Ekiti state were installed in 1984, they are six in numbers, two of these silos are dryer silos which there purposely to drying the grains before it could be transported the grains to the other remaining four silos through the conveyor bucket elevator.

The heat source in the dryer silos has the thermobile machine which generate heat to dryer silos and this can be regulating as it pleases.

These silos have the many small openings which are there to measure the moisture cotent of the grains through the probe to the device known as protmeter grain master.

The silos have the inlet system through the cleaner. This cleaner is a machine which is to remove the husks or the shaft and the grains will move to the dryer silos through the bucket elevator and move to the other silos for the proper storage.

The dryer silos have the inner pipes of diameter 50cm, this pipe served as heat source to the silos and remaining four silos have pipes of 20cm to refurther heating the grains.

When grains are put in silos, insects control is absolutely controlled is achieved by the use of suitable fumigants and perhaps the heat condition within the silos would never allow the insects to survive. Dry grains can be safely stored in silos.

Over the years the grains which are kept or stored in silos are very secured for many years minimum of 3 years and maximum of 10 years.

2.3: Storage Structures

The major storage structures and method used in the randomly selected local government areas are:

i. Basket

ii. Sack/bags

iii. Tins

iv. Ware house

v. Housing storage

2.4: Grain Storage Problems

The problems encountered during storage of grains, have been noted to reduce the quality and quantity of the grains, most especially when adequate measures are not taken before the storage. Under this, the following problems are considered and extensively discussed.

2.4.1: Environmental Influences

These include:

a. **Relative humidity**

Generally grains are believed to be living during which they either give off water content or absorbed water in the form of vapour from their immediate environment. At a given temperature, the surrounding air has a limit of moisture absorption capacity and cannot absorb any more water vapour. This equally affects the grains and it therefore said that the grains or the atmosphere is "saturated" it then conclude that the relative humidity is 100%.

The relative humidity is a percentage measurement of the amount of moisture which air could hold at the temperature.

$$\text{Relative Humidity (\%)} = \frac{\text{Amount of water vapour present in air}}{\text{Maximum containable amount of water vapour}} \times 100$$

Warm air can contain more moisture. Therefore, if the amount of moisture in the air is constant and the temperature increases, the relative humidity will decreases. To increase the "drying power" or the ability of grains loosing their water content to the surrounding, it will be necessary to provide a source of heat.

b. Temperature and Respiration

The store products as well as the organisms attacking stored products are living things. They breathe during respiration, oxygen is used up and carbon dioxide, water and heat are produced. Of carbondioxide, water and heat that are produced are strongly dependent on the temperature and the moisture content of the product. The rate of respiration is reduced approximately by one half for each 10^0C reduction in temperature (Agrodoxzi).

In general, the higher the temperature, the lower the moisture level will be. The lower the temperature, the higher the permissible moisture level for safe storage.

The moisture produced during respiration can increase the moisture content of the product which in turn will create favourable condition for fungus growth.

2.4.2: Moisture Content

Biological activities occur only when moisture is present. Therefore, the moisture content of the product as well as the moisture content of the surrounding air is important for safe storage (Jelle Hayma, 1990). Every stored product have an equilibrium state between the moisture present in it and water vapour in the air surrounding it.

The moisture content of a product is a numerical value expressed in percentage which is determined by the relationship between the weight of the water contained in a given sample of grain and the total weight of that sample.

$$\text{Moisture content (\%)} = \frac{\text{Weight of water in the moist product}}{\text{Weight of the moist product}} \times 100$$

Therefore a paddy rice with 25 percent moisture content means that in a sample of 100 gram of a raw product, there are 25 grams of water and 75 grams of dry matter.

2.5: Agents of storage losses

The following agents are responsible for the losses that are incurred from the time of harvest to the time the grains will be used by the framers.

2.5.1: Micro-Organisms

Micro-organisms are the primary causes of deterioration of crops after harvest. Fungal spores are in the air at all times ready to infest food grains when favourable condition such as moisture and warmth prevail. This is why deterioration due to

fungal attacks is much more serious in Nigeria in which southern part of Nigeria is included.

Fungal damage causes discolouration, offensive odour, cracking of grains and production of mycotoxins which are toxic both to man and animal (Leon and martins, 1963).

FAO Bulletin 109 pointed out that the extent of contamination by moulds is determined by the temperature of the grains and the availability of water and oxygen.

The optimum temperature for growth of mould is 20^0C (68^0C) (Reeve and Gring, 1985).

Micro-organism can be effectively controlled by controlling the temperature, moisture content, oxygen content and insect infestation.

2.5.2: Insects

Insects are the most destructive agents of crop particularly in storage. Their damage starts while the crop is in the field as they are capable of feeding on any part of the plant from roots to the seeds.

Insect infestation results into weight loss, loss in quality market value, promote mould infestation, reduce germination of seed and nutritional value of food.

Control measures for insect infestation include chemical or insecticides and fumigants. Insect control should start before harvest and proper clearing of the storage environment is necessary.

2.5.3: Rodents

Rodents are also an important cause of food storage losses both in the field, in storage structures and even in the house. Many methods have been adopted in

other to control the rodents activities both in the farm and in the house. The methods such like mechanical rodent control which involve the use of traps, meanwhile other methods are labour intensive which is better employed around house and not storage structures.

In control of rodents, chemical is also used. This is used in almost large store, it is necessary to complement hygienic practices with chemical control.

2.5.4: Birds

Birds cause a huge of damage to field crops.

Birds attacks the grain in the field and this resulted to the large loss of the quantity of grains which are yet to be harvested.

Very little measurement to control the invading of the birds to the grain and in all developing countries the controlling of attack of birds to the grain ineffective.

2.5.5: Man

The man contributes to the damage of the grain both on the field and in storage structures this range from the stage of handling during harvest though the processing stage to storage stage.

This can be controlling by introducing the machinery for the work in the field and storage structure.

2.6: Storage losses estimation

In developing countries, Nigeria particularly, post –harvest loss has only been given a very serious attention substantial food losses occur at various stage of the food chain as a result of spillage, contamination , micro- organism, birds, rodents, attack by insect and physiological deterioration in storage.

Storage losses estimation is essential for making policy decision about the allocation of resources to reduce losses. During this, various methods are used in the estimation of stored grain losses which includes the following:

i. Bulk density method

ii. Percentage drainage and factor method

iii. Count and weight method

iv. Weigh in weigh out method

v. Means kernel weight method

2.6.1: Bulk density method

This is known as standard volume weight method (SVW). It is the mass of the grains for each unit of volume it occupies. This method has been used by processing industries for many years as an indicator of processing yield. This is the most standardized method of quality measurement for most grains and oil seeds.

Since the bulk density of grains varies with moisture, the dry weight per standard volume of sound grain is always determined over a range of moisture contents before this method can be used. Then samples of the same grains are taken after damage is presumed to have occurred.

Bulk density (expressed as dry weight) of the damage sample is compared to the dry bulk density of sound grain at the same moisture content. The difference is divided by the dry bulk density of the sound grain and the result is multiplied by 100 to indicate the percentage reduction

Mathematically:

Bulk density =

2.6.2: Percentage damage and factor method

(Adams and Schotten, 1978) recommended that portions containing from 100 to 1000 grains be used to determine the percent damaged and that portions of 100 to 1000 kernels of which at least 10 are damaged be subjected to C and W procedures to determine the conversion factor called specific loss by (Pointel and Conquered, 1979).

This method is based on the difference between the mean weight damaged kernels and the mean weight of undamaged kernels.

2.6.3: Count and weigh method

The count and weight method (C and W) compares the mean weight of damaged and undamaged kernels within the same samples. This principle was proposed by Parkin in 1956. In C and W method, the grain samples are first cleaned over a sieve to remove insects and other fine materials.

A small portion is then randomly removed from each cleared sample. According to Anan in 1969, the percent weight lost is then calculated using the below formular

$$\text{Percent weight loss} = \frac{(UND) - (DNU)}{U\,(ND + NU)} \times 100$$

Where;

U = Weight of undamaged kernels

D = weight of damaged kernels

Nu = Number of undamaged kernels

Nd = Number of damaged kernels

Moreso, Adams and Scholten (1978) recommended that this portion contain between 100 and 1000 kernels, each kernels is observed and damaged kernels in

each fraction are then counted and weighed to allow the calculation of the mean kernel weight of each fraction and the proportion of damaged kernels.

2.6.4: Mean kernel weight method

This is also called thousand grain mass method. This method has been in existence for many years and widely used by wheat millers as an indicator of potential flour field.

It was proposed by Procter and Rewley in 1983 as a method of weight loss estimation which was based on the mean kernel weight.

This method is used to determine the thousand Grain Mass (TGM) of a clean sample by weighing and counting the kernels in a randomly selected portion (or duplicate portions) of a grain sample. The moisture content of the grain is determined so that the mean dry weight per kernel can be calculated. The differences between this value is expressed as the dry weight of 1000 kernels at time A and time B and is used to calculate the percent TGM lost.

2.7 Statement of problems

The statement of problem for this study is as follows:

2.7.1: Losses

To determine the quantity of grains lost in each local government area and to know exactly the quality and quantity of grains that are marketed by the farmers.

2.7.2: Structures

To assess or be able to identify the best storage structures that will be suitable for a particular local government area should be explained to the farmers. If there are new methods, the advantages derived should also be explained to the farmers including the cost that will be involved in the construction of the storage structures.

2.7.3: Methods

Advise on the appropriate methods that is suitable for the storage of some farm produce, since not all methods used in a particular area is good enough to minimize losses in that environment. Therefore, the best methods are introduced to the farmers through the extension workers.

CHAPTER THREE

3.0 METHODOLOGY

At this point, this is the chapter that clearly and simply expanciate and illustrate the various methods techniques and steps employed to evaluate the grain losses in the storage structures available in Ekiti State. It equally explains into detail the nature of the questionnaire and it's administration.

As it was stated previously that the research study covered the eight locate government areas in Ekiti state and the local government areas are as follow Ado Ekiti.

3.1: Method of data collection

In the course of data collection process, the sample random selection method was employed to cover the local government areas. This involved the use of the questionnaire to the people concerned.

Some villages in every local government were picked at random and this was done even to their local government areas. In the time of the survey, the state map was used as quide to cover the various towns and villages of Ekiti state this was done to ensure a good coverage of the total areas selected.

In the same pattern some of the villages were selected from each local government areas which makes a total of thirty two covered.

In the table 1 shows, the distribution of the various local government areas visited and the total number of villages and numbers of house sample in each of the village. This method adopted is absolute eliminates discrimination and favouring some villages or sets of people.

In each of the villages covered, at least twenty people were chosen per village this gave a broaden knowledge to this survey work that carried out in Ekiti state on storage structure on grain. The method employed was that two adjacent housed were picked along a street, and then, another set of two were picked after a specific block of housed. This depending on the population of the village. Care was taken to makes sure good distribution of sample over space.

TABLE 1 SAMPLE METHOD AND SIZE IN EACH LOCAL GOVERNMENT IN EKITI STATE

S/NO	LOCAL GOVERNMENT AREA	NO OF VILLAGE	NO. OF HOUSE
1	Aiyekive	4	18
2	Edfon	5	20
3	Emure	4	12
4	Ido-osi	3	12
5	Ijero	4	10
6	Ikole	3	12
7	Moba	5	16
8	Oye	4	10

The questionnaires were interpreted when necessary but in just a few places because some of the people in Ekiti state can read and write so no must difficulties

interm of interpretation and they were prepared to collect information such as the type of grains produced, average quantity produced annually for each grain, method of storing their grain, duration of storages, gain storage problems and estimated quantity losses annually.

3.2: Methods Employed in Estimation Storage

Out of the five available methods in estimating storage losses, the following were close because of their simplicity.

i. Count and Weight Method

ii. Weight in – Weigh out Method

3.2.1: Count and Weigh Method

This method involves the collection of grain samples from the formers. The samples collected ranges between 100 to 1000 kernels which were taken to the laboratory and carefully cleared to removed all other particles like dust and some contaminants.

The sample were carefully examined kernel by kernel to separate the damaged grains from the undamaged ones. On separating the samples into damaged and sound or undamaged kernels, each fraction was then noted each of this fraction was also weighed and noted. The percentage weight lost was the calculated using the formular as it shown below.

$$\text{Percentage Weight Cost} = \frac{(UNd - DNu)}{U(Nd + Nu)} \times 100$$

WhereU = Weight of sound or undamaged kernels

D = Weight of damaged kernels

Nu = Number of sound kernels

Nd = Number damaged kernels

This method was used because of its simplicity. Counting and weighing of the samples up to an extent could be corrected if care is fully done. The only problem with this method is the separation of the sound or undamaged kernels from the damaged ones. This separation could also introduce some errors in the calculation because some infestation may be hidden.

3.2.2: Weigh – in Weigh – out Method

The use of this method was based on the responds I the questionnaires. In the questionnaire, the farmers were asked to give an estimated weight lost during storage and the response was quite reasonable.

They were able to do this correctly because they have been handling grains for a long time especially these of them selling their grains through the government grains board.

This method was chosen to compare what the farmer felt in his weight loss and what is gotten in the laboratory, using other methods. This method reduces work load for the researcher since the farmers can equally tell when his grains are completely dry or not.

3.3: Evaluation Parameters

The questionnaires were carefully distributed to the farmers and traders for easy administration throughout the sixteen local government areas of Ekiti state. Quite a reasonable numbers of people were interviewed during the survey word and their respond his fantastic, this in all the local government areas covered.

During the interview, the various storage methods and structures were carefully observed.

IJERO	15	15	-	-	-
IKOLE	18	18	-	-	-
MOBA	20	20	-	-	-
OYE	30	30	-	-	-
TOTAL	**164**	**164**	-	-	-

From the above table it was discovered that all the farmers cultivate maize majorly.

4.2 Estimation of Percentage Weight Loss

The main method used to estimate the percentage of grain lost was the count-weigh method. This method makes use of the mean Kernel weight of the grain. This compares the kernels of the damage and the undamaged grain takes from the whole bulk.

The grain was cleaned to remove contaminants. Each grain was then classified as sound and damaged Kernels. The kernel from each fraction were counted and weighed to allow for calculation of mean kernel weight of each fraction and the proportion of damage kernels.

The following formula were used in the calculation of percentage weight lost

percentage weight lost $\frac{(UNd - DNu)}{U(Nd - Nu)} x100$

Where D = weight of damage kernels

U = weight of undamaged kernels

Nu = Number of undamaged kernls

Nd = Number of damaged kernels

4.3 Quality Loss Detection

From table 4.3 changes in colour, taste, smell modulling and rotting was discovered by some of the farmers from the eight-local government are chosen. Out of

164 people that planted maize, only 25 reported a change in colour, 15 reported damaged in smell, 4 reported changes in taste while12 people reported for moulding and rotting.

The monetary value of 50kg bags is between 3500 -4,000, so if a whole unit of g (about 50kg) show a clear change in colour half of the monetary vale is gone about 1,750 – 2,000 is lost. Same could also be said for the other changes detected in some units.

Table 4.3: Quality Loss in All Local Government Area

	MAIZE
Change in colour	25
Change in smell	15
Change in taste	4
Moulding &rotting	12

4.4 Quality of Grain Loss Estimation

Summary of the quantity of grain loss to fire hazards, n lost due to the various agents of losses such as insects, birds, rodents, loss due to thieves, are shown on table 4. this loss estimate was based on the number of Kilograms lost per hundred, kilograms produced, while the quantity loss of thieves and fire hazards were estimated in kilograms.

Table 4.6 shows the distribution of the various storage structures available in the eight local government area.

TABLE 4: ESTIMATED QUALITY LOST OF MAIZE FOR THE EIGHT LGA (kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	35	23	52	58	41	29	16	-	254	2,717.5
Birds	17	13	14	10	3	5	-	-	62	500.25
Rodents	55	41	14	10	3	5	-	-	62	500.25
During Handling	37	27	43	34	14	7	4	-	166	1,447.20
Fire Hazards	--	-	-	-	-	-	-	10	10	3300
Thieves	-	-	-	-	-	-	-	11	10	3000
Total number of respondents	**144**	**104**	**123**	**116**	**73**	**48**	**23**	**21**	**652**	**12,083.7**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN AIYEKIYE LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	4	2	7	5	7	4	2	-	31	316.25
Birds	4	4	3	-	-	1	-	-	12	82.5
Rodents	1	2	-	-	7	-	-	-	10	106.25
During Handling	5	4	3	2	1	-	-	-	15	92.5
Fire Hazards	5	4	3	2	1	-	-	-	-	-
Thieves	-	-	-	-	-	-	-	-	-	-
Total number of respondents	**13**	**12**	**13**	**7**	**15**	**5**	**2**	**-**	**68**	**597.5**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN EFON LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	10	4	3	4	10	2	-	-	33	303.75
Birds	-	1	-	-	-	3	-	-	4	54.25
Rodents	8	4	5	10	-	-	-	-	27	209
During Handling	-	-	5	-	-	-	-	-	-	43.75
Fire Hazards	-	-	-	-	-	-	-	3	3	900
Thieves	-	-	-	-	-	-	-	4	4	1200
Total number of respondents	**18**	**9**	**13**	**14**	**10**	**5**	**-**	**7**	**81**	**2,710.75**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN EMURE LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	2	3	1	5	3	2	-	-	16	165
Birds	3	4	5	7	2	1	-	-	22	202.5
Rodents	2	1	-	-	3	1	-	-	7	71.25
During Handling	10	6	4	2	-	-	-	-	22	132.5
Fire Hazards	-	-	-	-	-	-	-	-	-	-
Thieves	-	-	-	-	-	-	-	1	1	300
Total number of respondents	**17**	**13**	**10**	**14**	**8**	**4**	**-**	**1**	**68**	**817.25**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN IDO-OSI LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	1	2	7	5	4	6	8	-	33	436.25
Birds	-	1	-	-	-	-	-	-	1	6.25
Rodents	10	8	6	-	-	4	-	-	28	205.00
During Handling	2	4	6	8	4	3	2	-	29	316.25
Fire Hazards	-	-	-	-	-	-	-	2	2	600
Thieves	-	-	-	-	-	-	-	-	-	-
Total number of respondents	**13**	**15**	**20**	**13**	**8**	**13**	**10**	**2**	**99**	**1,563.75**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN IJRERO LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	9	2	4	6	5	1	2	-	29	269.75
Birds	4	-	-	-	-	-	-	-	4	15
Rodents	4	10	2	1	2	2	2	-	23	190.25
During Handling	4	3	5	5	-	-	-	-	17	133.75
Fire Hazards	-	-	-	-	-	-	-	-	-	-
Thieves	-	-	-	-	-	-	-	2	2	600
Total number of respondents	**21**	**15**	**11**	**7**	**7**	**3**	**4**	**2**	**75**	**1,208.75**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN IKOLE LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	4	5	10	11	3	4	1	-	38	382.50
Birds	3	-	2	2	1	-	-	-	8	64.75
Rodents	10	6	4	1	2	1	1	-	25	184.00
During Handling	5	5	6	7	2	2	2	0	29	287.75
Fire Hazards	-	-	-	-	-	-	-	2	2	600.00
Thieves	-	-	-	-	-	-	-	-	-	-
Total number of respondents	**22**	**16**	**22**	**21**	**8**	**7**	**4**	**2**	**102**	**1,519.00**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN OYE LGA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	2	5	2	6	7	6	7	-	35	480.70
Birds	3	4	4	6	4	5	3	-	29	388.00
Rodents	-	4	4	2	3	4	4	-	21	280.25
During Handling	3	5	2	3	4	2	2	-	21	280.00
Fire Hazards	-	-	-	-	-	-	-	-	-	-
Thieves	-	-	-	-	-	-	-	-	-	-
Total number of respondents	**8**	**18**	**12**	**17**	**18**	**17**	**16**	**-**	**81**	**1428.95**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN MOBA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	1	3	10	8	5	4	3	-	34	390.00
Birds	2	1	-	-	-	-	-	-	3	13.75
Rodents	10	5	4	-	-	-	-	-	19	103.75
During Handling	11	5	4	6	4	-	-	-	30	230.00
Fire Hazards	-	-	-	-	-	-	-	4	4	1200.00
Thieves	-	-	-	-	-	-	-	1	1	300.00
Total number of respondents	**24**	**14**	**18**	**14**	**9**	**4**	**3**	**5**	**91**	**2,2375**

Table7: ESTIMATED QUANTITY OF MAIZE LOST IN MOBA (Kg/100kg)

	AVERAGE QUANTITY OF GRAINS (KG)									∑ Average quantity x N0. of respondents
	3.75	6.25	8.75	11.25	13.75	16.25	18.75	300	Total number of quantity produced per 100kg	
Insects	1	3	10	8	5	4	3	-	34	390.00
Birds	2	1	-	-	-	-	-	-	3	13.75
Rodents	10	5	4	-	-	-	-	-	19	103.75
During Handling	11	5	4	6	4	-	-	-	30	230.00
Fire Hazards	-	-	-	-	-	-	-	4	4	1200.00
Thieves	-	-	-	-	-	-	-	1	1	300.00
Total number of respondents	**24**	**14**	**18**	**14**	**9**	**4**	**3**	**5**	**91**	**2,2375**

The quantity of grain lost during handling by each farmer in the eight local government area is given as

= (1500 – 2028.1) kg per 16600kg

The percentage lost during handling by each farmer ranges between 9.2% to 12.4%

The quantity lost to fire hazards was given as

$$\frac{1}{8}[13(100-500)]kg = \frac{1}{8}[(1300-6500)]$$
$$(162.5-812.5)kgper100kg$$

or 14.78% to 73.8%

The quantity lost to fire hazards ranges from 162.5kg to 8125kg while the quantity lost to thieves is calculated as

$$\frac{1}{8}[11(100-500)]kg = \frac{1}{8}[(100-5500)]kg$$
$$\frac{1}{8}[(1100-5500)]kg$$

Quantity of grain lost to thieves for the eight local government area is given as (137.5-687)kg

Therefore, the quantity of grain lost to thieves ranges between 137.5kg to 687.5kg and percentage lost is between 12.5% to 62.5%.

4.2.3 Evaluation of Weight Losses

The estimated distribution of weight loss given in percentage is given in table 14. the information was all obtained from questionnaire and the personal interviews conducted during the study. It was observed from the table that out of six hundred people that cultivated maize 50 people to have lost 1 – 3% weight, 60 people farmer lost between 3 – 5% of their maize, 150 people lost between 5 -7% of their maize, 100 people lost between 7 – 9% of their maize, 140 people lost between 9 – 11% and 100 lost between 11 – 13%

Table 4.2.3: Estimated Percentage Weight Loss

Crop	No. of Cultivators	1 – 3% Loss	3 – 5% Loss	5 – 7% Loss	7 – 9%	9 – 11%	11 – 13%
Maize	600	50	60	150	100	140	100

Table 4.2.4: Total Maize Loss for Eight Local Government Area

Local Government Area	Quantity of grain Lost (kg)
Aiyekiye	644.75
Efon	2713.75
Emure	1,361.00
Ido –Osi	1,563.75
Ijero	871.75
Ikole	1,223.75
Moba	1,510.00
Oye	2,237.50
Total	**12,086.25**

Average lost per local government = $\frac{12,086.25}{8}$

= 1510.78kg

Therefore for 30 local government

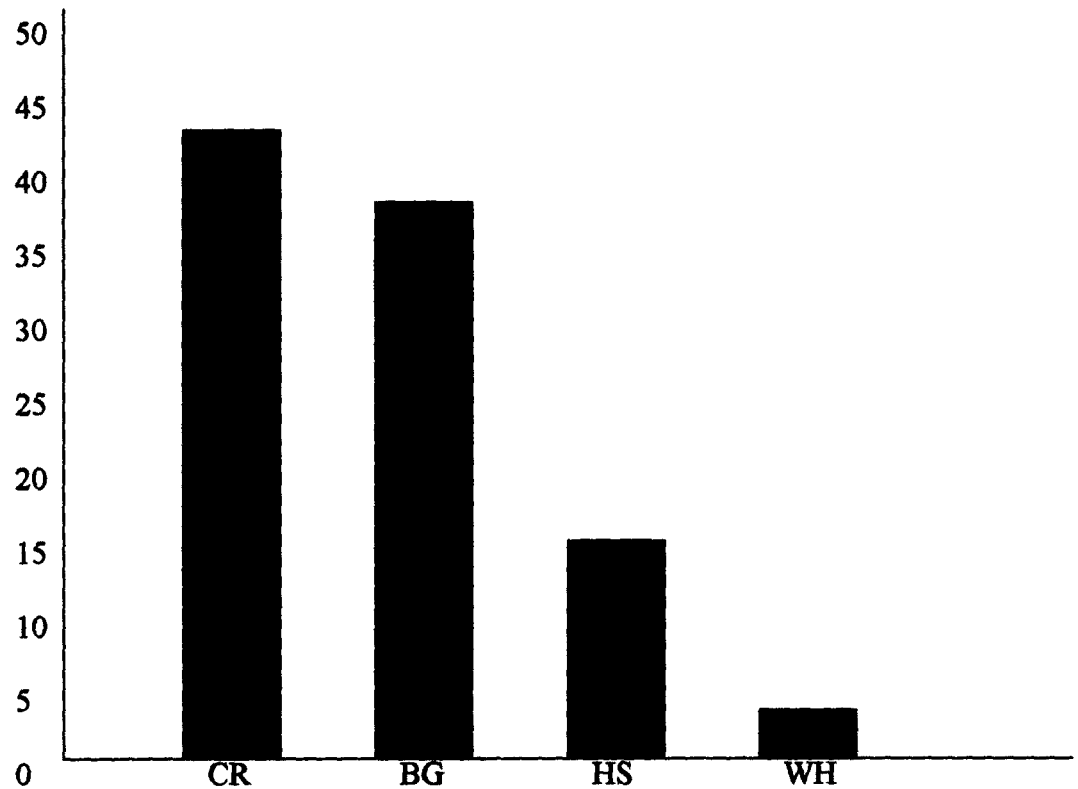
1510.78 x 30 45,323.48kg in round figure 45,000kg per 244500kg

$$\%Lost = \frac{45,000}{245,000}$$

$18 \approx 19\%$

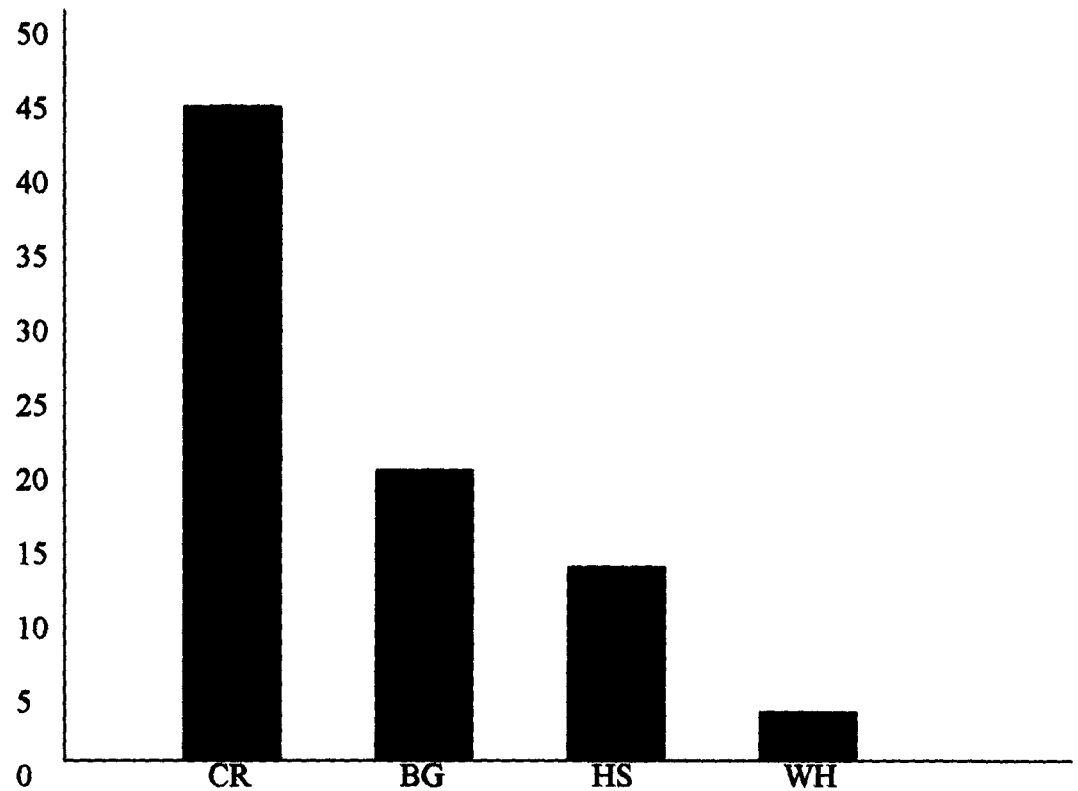
Average grain lost per L.G.A.	Number of LG.A	Quantity lost in kg for all L.G.A.	Quantity produced in kg for all L.G.A.	Percentage lost in Ekiti State
1,515.78	30	45,000.00	2450.00	19

FIG 4.2: Percentage Distribution of Storage Structure in Aiyekiye L.G.A.



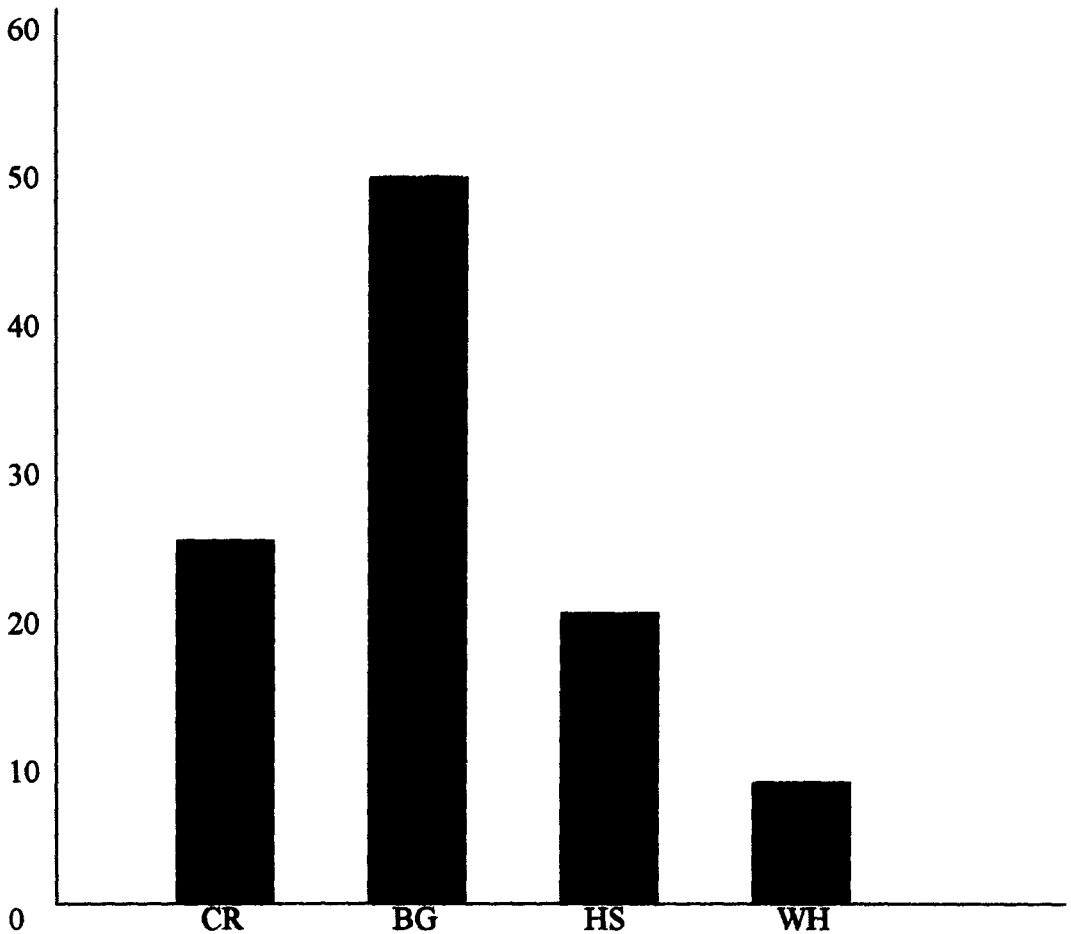
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Efon L.G.A.



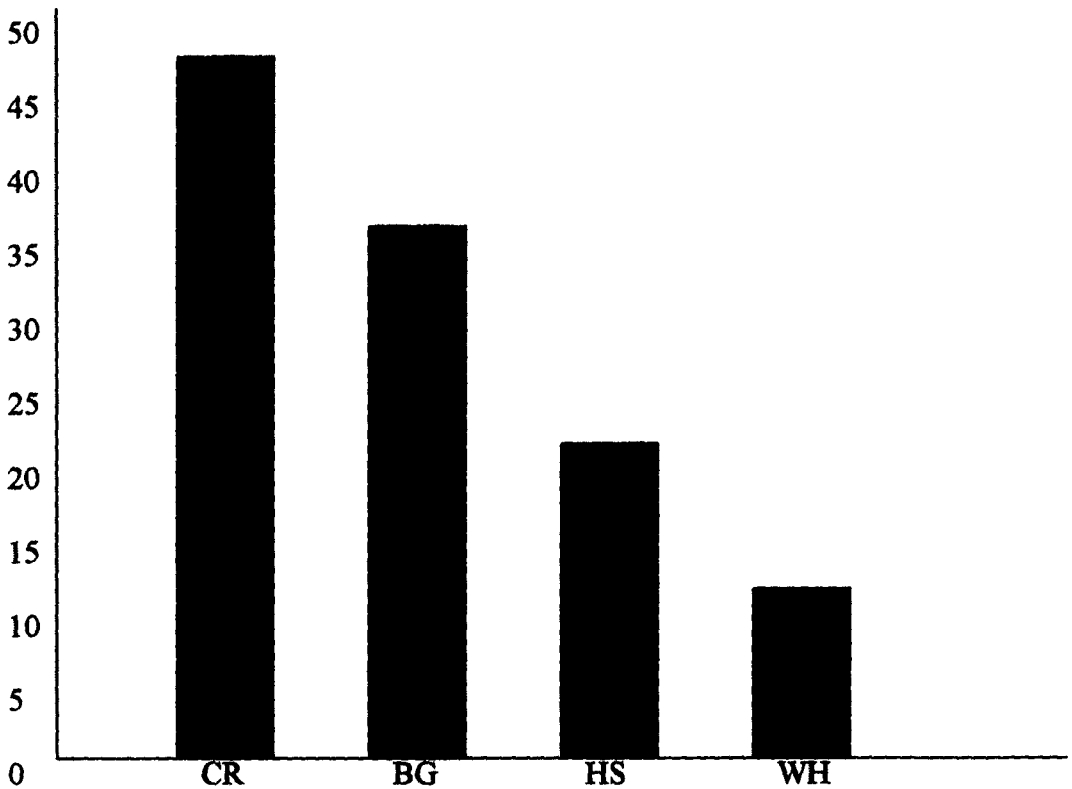
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Emure L.G.A.



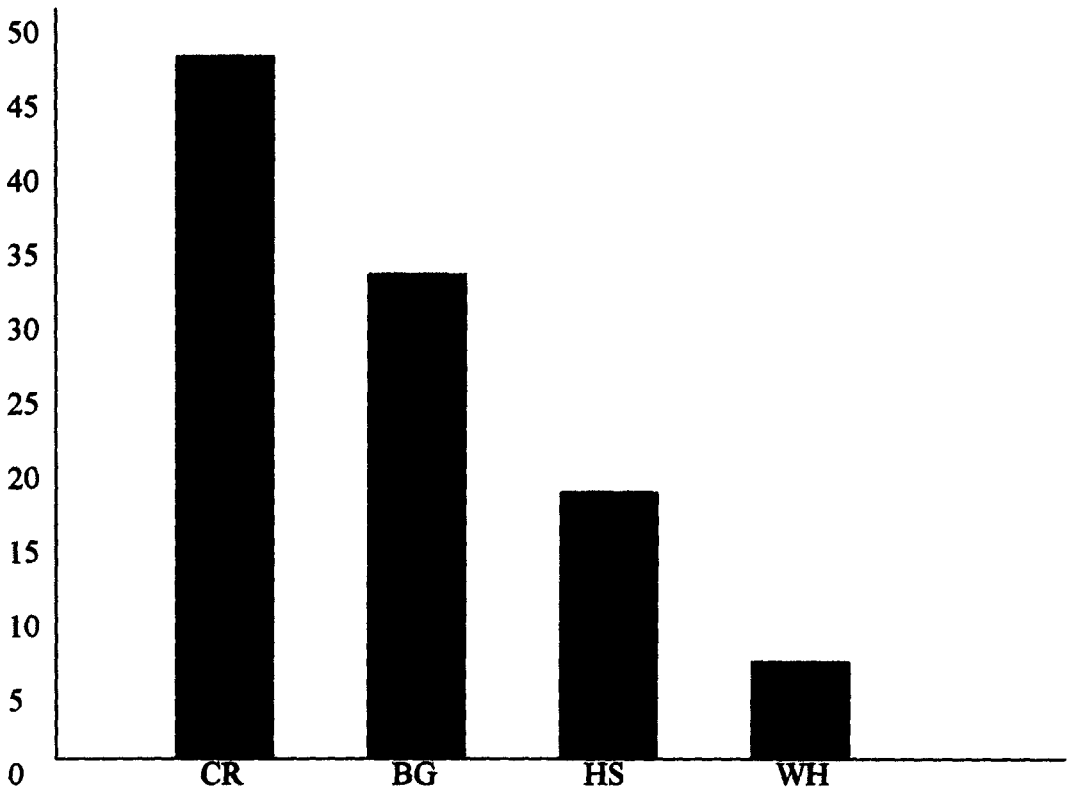
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Ido-Osi L.G.A.



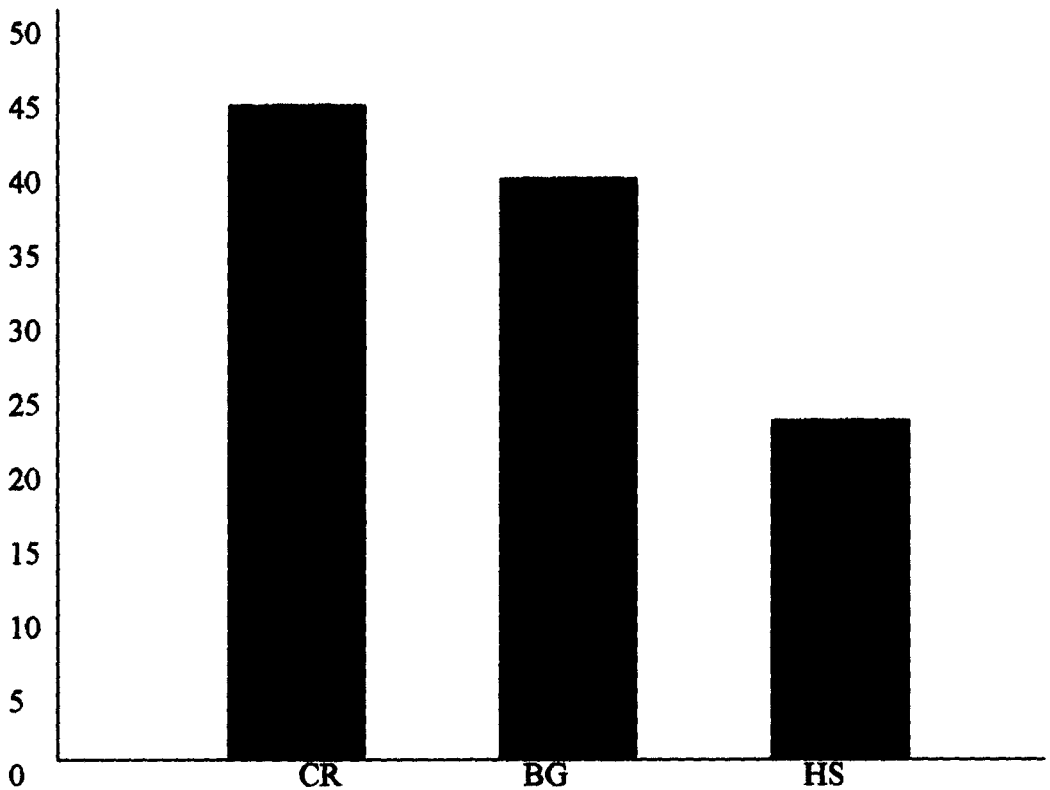
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Ijero L.G.A.



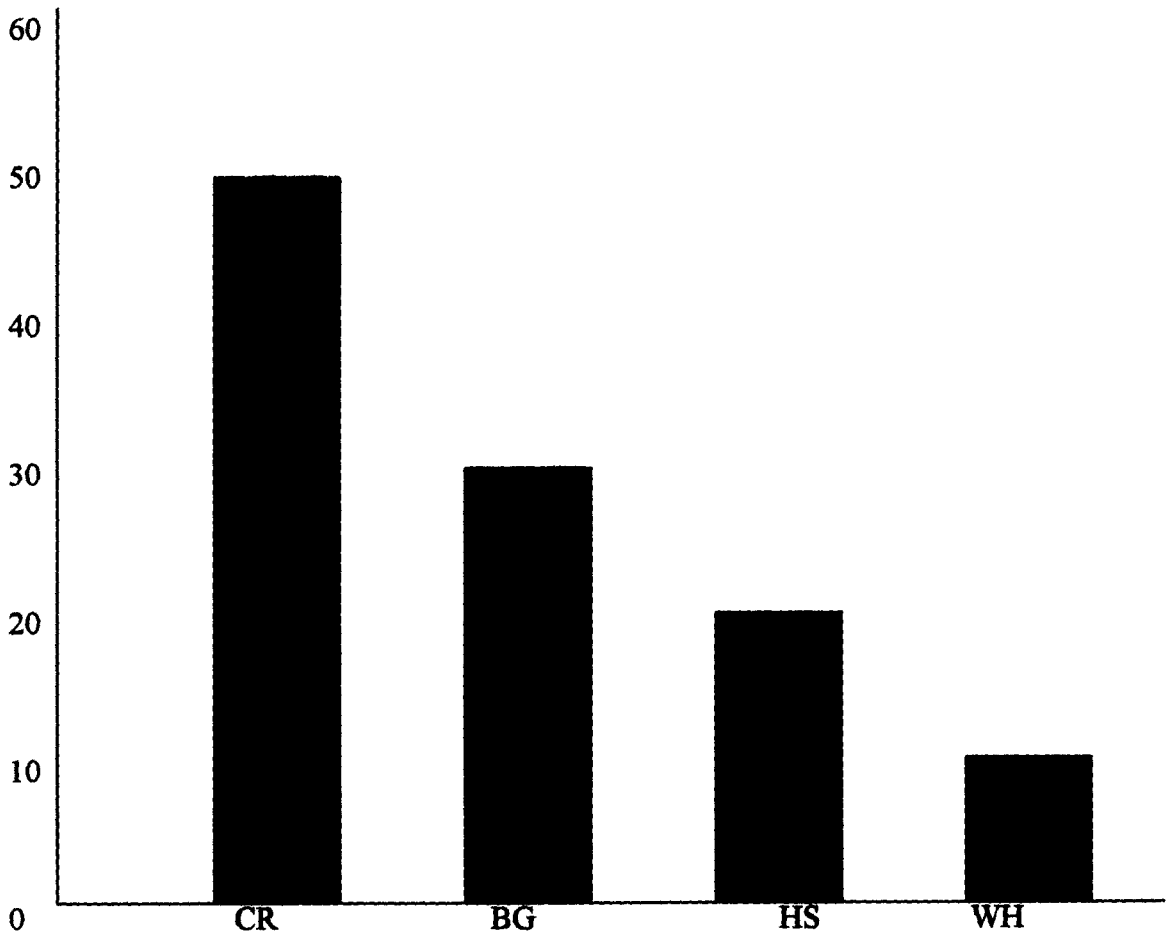
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Ikole L.G.A.



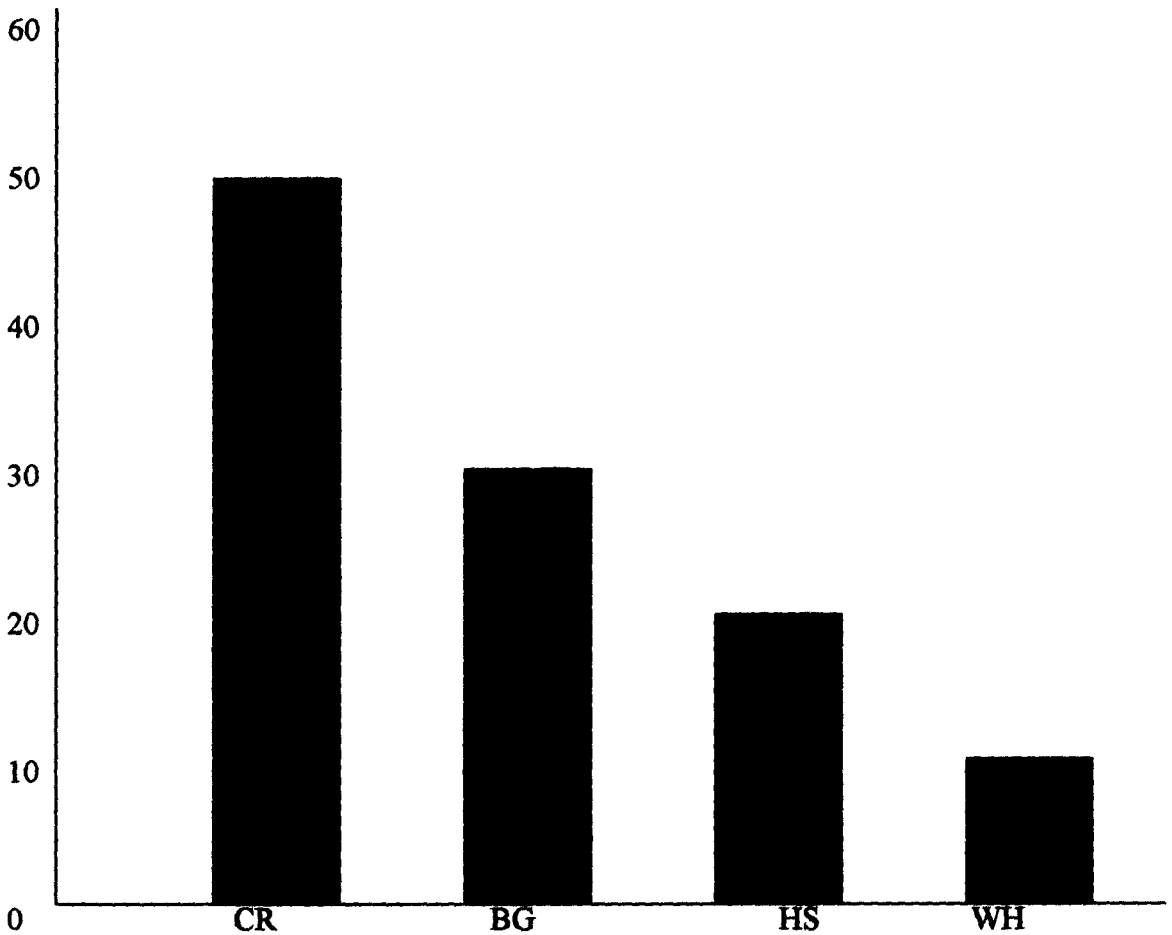
CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Moba L.G.A.



CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG 4.2: Percentage Distribution of Storage Structure in Oye L.G.A.



CR = Crib Storage Method, BG = Bag Storage Method, HS = House Storage Method, WH= Ware House Storage Method.

FIG. 4.9: Percentage of Maize Lost to Each of the Agents of Losses in Aiye Kiye L.G.A

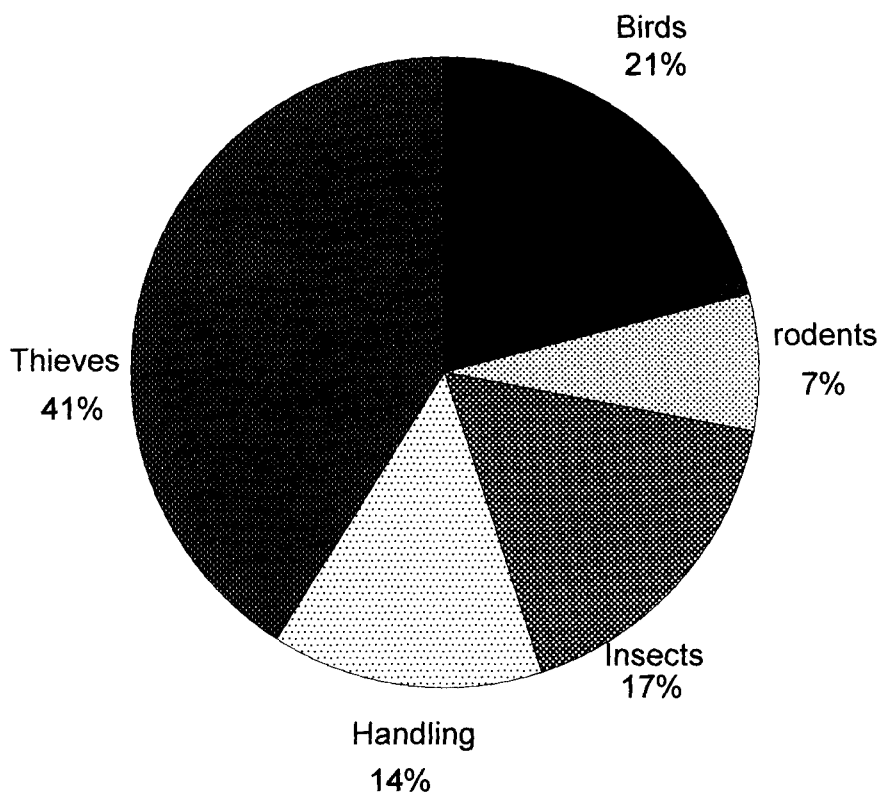


FIG. 4.10: Percentage of Maize Lost to Each of the Agents of Losses in Oye L.G.A

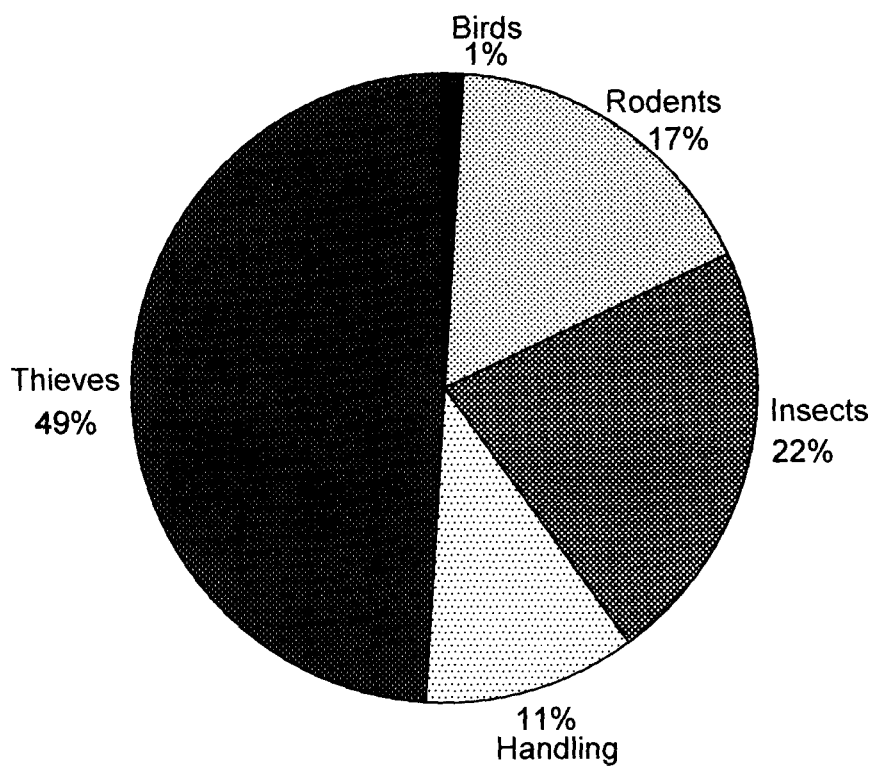


FIG. 4.11: Percentage of Maize Lost to Each of the Agents of Losses in Tfon L.G.A

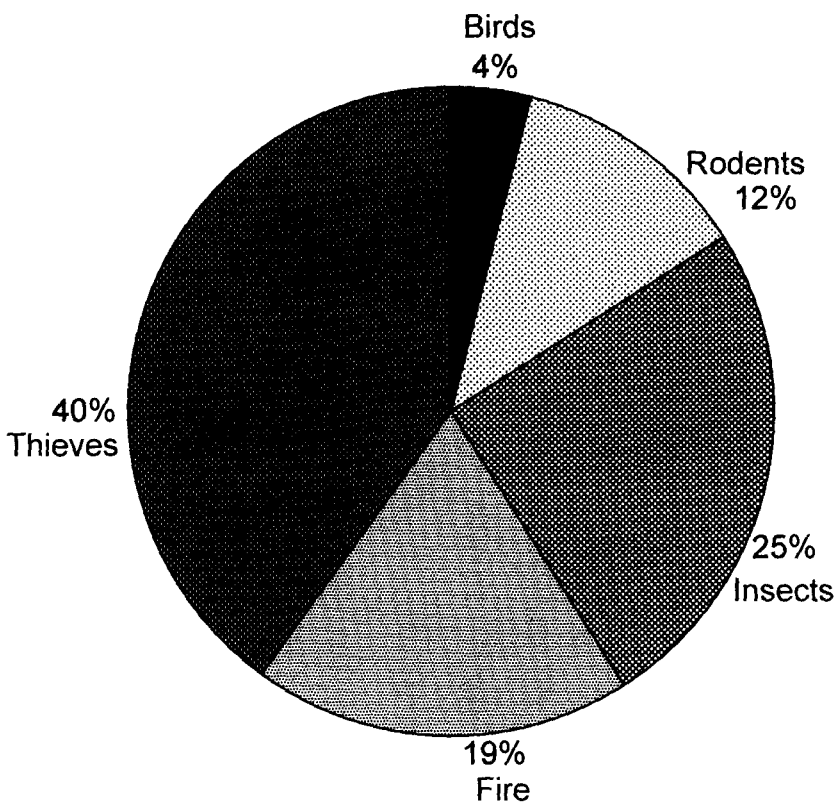


FIG. 4.12: Percentage of Maize Lost to Each of the Agents of Losses in Tmure L.G.A

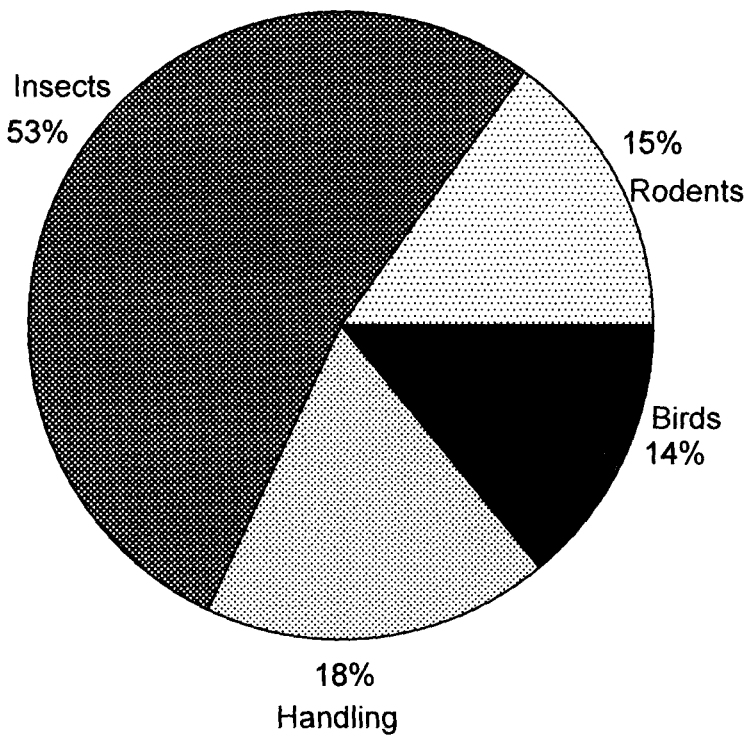


FIG. 4.13: Percentage of Maize Lost to Each of the Agents of Losses in Ido – Osi L.G.A

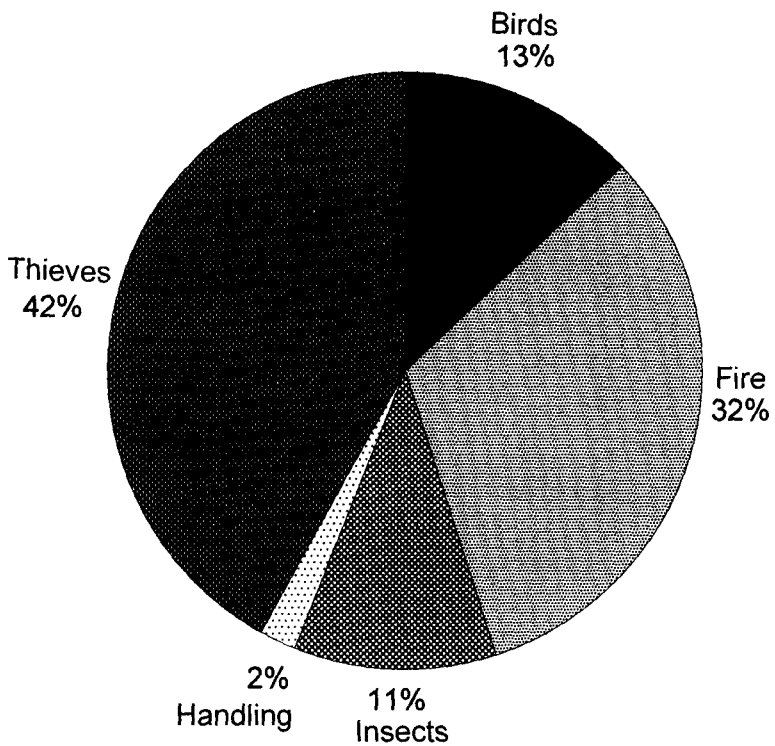


FIG. 4.14: Percentage of Maize Lost to Each of the Agents of Losses in Ijero L.G.A

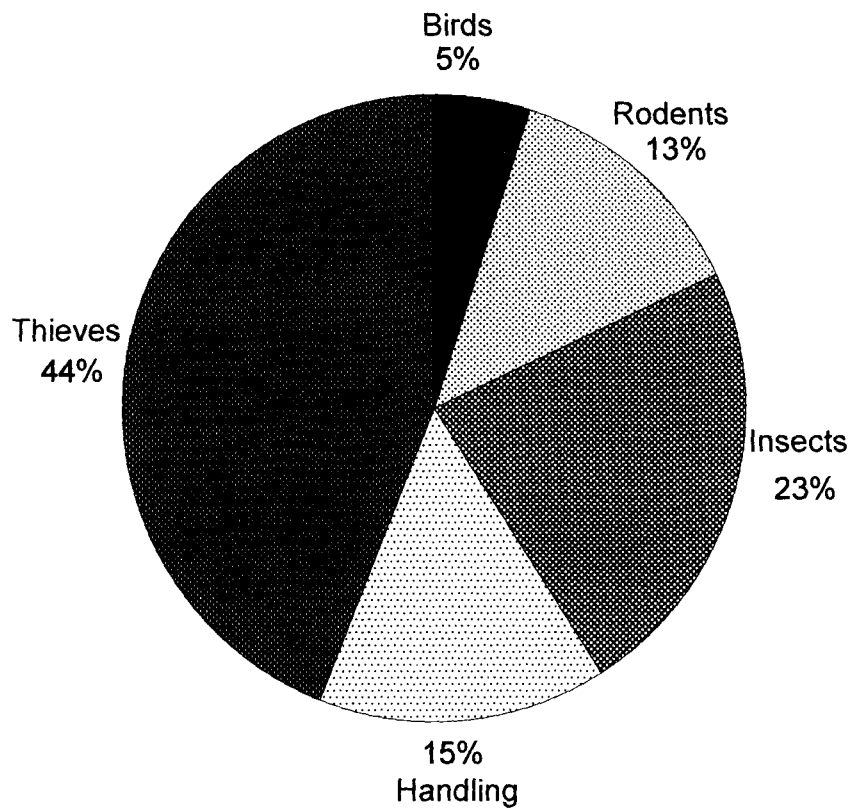


FIG. 4.15: Percentage of Maize Lost to Each of the Agents of Losses in Ikole L.G.A

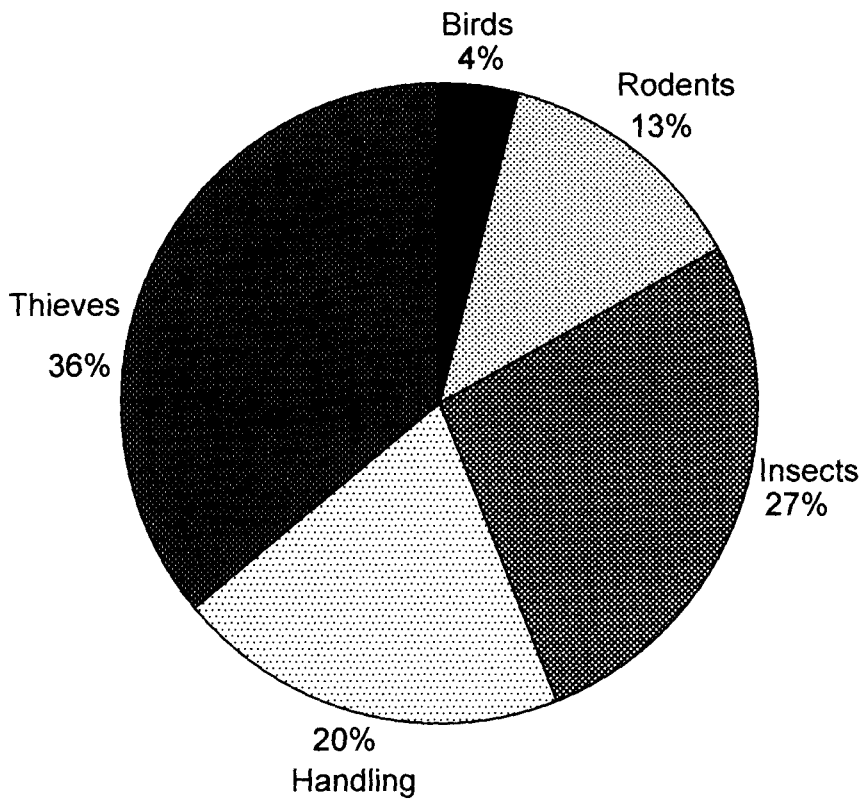


FIG. 4.16: Percentage of Maize Lost to Each of the Agents of Losses in Moba L.G.A

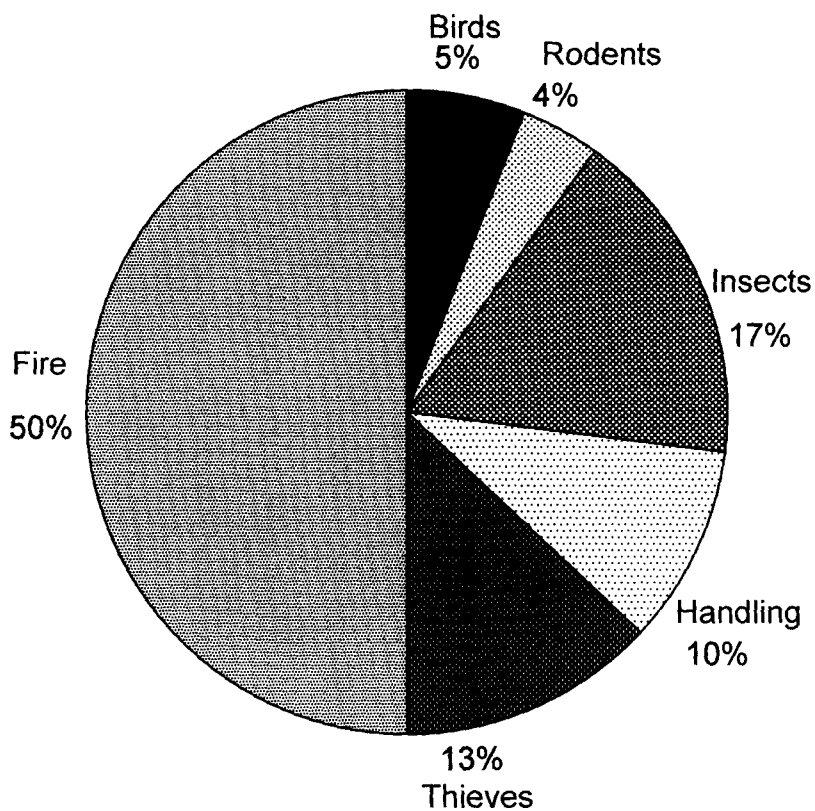
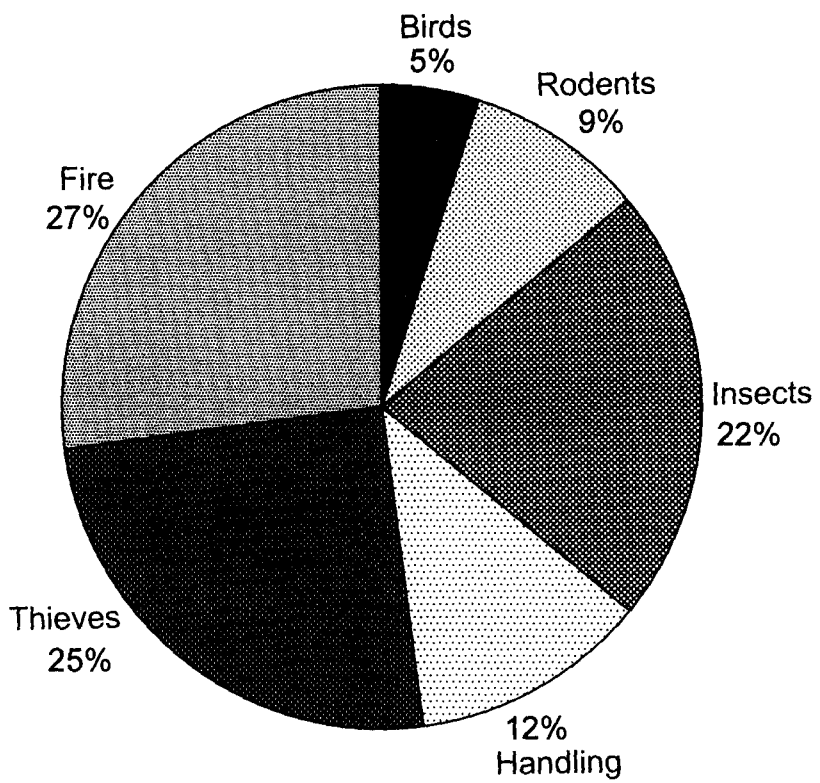


FIG. 4.17: Percentage of Maize Lost to Each of the Agents of Losses in Eight L.G.A



CHAPTER FIVE

5.0 DISCUSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

This is classified on the basis of the following

i. Pattern of questionnaire administration

ii. The storage method distribution and

iii. The results and deductions

In the administration of questionnaires, this was done randomly though it did not consider farmers with the same problems within the same village for example during the market days (every 3 days) at Ikole in Ikole Local Government Area., within a row of grain sellers, the pattern, then sixth person, the 9th and so on but bearing in mind that those interviewed do not come from the same village and if from the same village not from the same household.

The distribution of the storage structures in the eight local governments are shown in fig 6 - 13 by the charts drawn. This shows specifically the number of people using a particular storage structures for each of the local government areas. Majorly there was a particular storage structures that was mostly used by the farmers, for example table 5 shows the distribution of various storage structures in local government considered from table 5. it was discovered that 136 people made use of cribs, which followed closely by, bags which a population of 80 people using it.

As shown in chapter four, section 1, the grain lost estimation was based on the information provided by the farmers during interview and from the questionnaires. The losses due to insect, birds, rodents and during handling are estimated based on quantities

(in Kilograms) lost per 100kg of grain produced (see table 4), while table 4 shows major crop grown in Ekiti State

During the research it was discovered that maize was the only crop grown. The quantity lost in all eight local governments it shown in table 3, the quantity loss was in terms of change in colour is small and change its taste and mould growth.

The estimated quantity of grain lost in each of the eight local government area is shown in table 6 – 13 while estimated percentage weight loss in the grains (maize) is shown in table 16, while table 17 shows that the highest form of loss was from insects followed by rodents handling and fire hazards and thieves.

Form table 5, it was discovered that Aiyekiye, local government area have shown interest in the use of bags as a farm storage because of the adequate taken to protect it from the attacks of rodents, birds and fie.

Generally, it was observed that insect, rodents, birds and handling problem led to heavy loss in all parts of the state. It was discovered that the use of silo was not common; the silos present were constructed by the government but which were not in use.

5.2 Conclusion

It was almost impossible to recommend a particular type of storage in al the eight local governments but the use of the Crib reduces rodent attacks but cannot completely reduce insect infestation. It was hoped that this research work would be made available for further research on study of grain storage, structures, method and losses in other parts of the state.

This project help to qualify that about million naira was lost in the 2006/2007 harvest year.

5.3 Recommendation

In carrying out the study of this project, the research should first determine the number of local government existing in the state and the number of villages to be covered and know uniformly of the distribution also the researcher should commence on project immediately after harvest, the government should endeavour to complete the silos present and maintain the ones that are not in use. The farmers should make sure that the grains are well dried before storage.

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f) Sorghum 6 ☐

g) Groundnut 7 ☐

h) Others 8 ☐

Please Specify _____

_____ _____

_____ _____

c) PROCESSING

i) Method of processing grains

Machines		Local	
1 ☐		☐	2

ii) In what form do you store your grains

Name of grains/crops	Processed		Unprocessed	
Maize	☐	1	☐	2
Millet	☐	1	☐	2
G/corn	☐	1	☐	2
Rice	☐	1	☐	2
G/nut	☐	1	☐	2
Beans	☐	1	☐	2
Other Please Specify	☐	1	☐	2
	☐	1	☐	2
	☐	1	☐	2
	☐		☐	

iii) Which of the following operation do you carry out before storage?

e. Sorghum ☐

f. Groundnut 6 ☐

g. Melon 7 ☐

h. Others 8 ☐

xi. Quantity of grains produced by you

Name of grain		Quantity (100kg or bags)
a)	Rice	_____
b)	Beans	_____
c)	Millet	_____
d)	Maize	_____
e)	Melon	_____
f)	Sorghum	_____
g)	Groundnut	_____
h)	Others (please specify)	_____
	_____	_____
	_____	_____
	_____	_____

(iv) Types of grains marketed by you Quantity marketed (100kg or bags)

a) Beans 1 ☐

b) Rice 2 ☐

c) Maize 3 ☐

d) Millet 4 ☐

e) Melon 5 ☐

☐

d. ND 4 ☐

e. HND 5 ☐

f. First degree (Bsc) 6 ☐

g. Second degree (Msc) 7 ☐

h. Doctorates degree (PHD) 8 ☐

i. Any other qualification 9 ☐

viii. Major occupation _____

ix Address of respondent _____

x. Local government Area _____

B. FARMING OPERATIONS

i. No of hectares covered by the farmers

a. >2ha 1 ☐

b. 3ha – 5ha 2 ☐

c. 6ha – 10ha 3 ☐

d. >0ha 4 ☐

ii. Methods of farming

a. Manual 1 ☐

b. Use of tractor 2 ☐

iii. Major grains grown

a. Beans 1 ☐

b. Rice 2 ☐

c. Maize 3 ☐

d. Millet 4 ☐

☐

A. DEMOGRAPHY

i. Name _____

ii. Sex _____

iii. Age _____

iv. Married 1 Single 2

v. No of children

a. <4 1 ☐

b. 5 2 ☐

c. 6 3 ☐

d. 7 4 ☐

e. 8 5 ☐

f. 9 6 ☐

g. 10 7 ☐

h. >10 8 ☐

vi. No of Dependants

a. <4 1 ☐

b. 5 2 ☐

c. 6 3 ☐

d. >6 4 ☐

vii. Education Qualification

a. Primary School leaving Certificate 1 ☐

b. WASEC 2 ☐

c. NCE 3 ☐

QUESTIONNAIRE

RESEARCH TITLE: CASE STUDY OF THE VARIOUS STORAGE STRUCTURES, METHODS AND LOSSES IN EKITI STATE

RESEARCHER: ASHAOLU JACOB KEHINDE

DEPARTMENT OF AGRICULTURAL AND BIO RESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Dear Respondents,

Agriculture is the major source of food supply for the survival of man and animals. But all efforts of man to improve the rate of food production have been hindered due to the problem of storage structures and methods.

The various Agricultural sectors in the country have tried to create more impact; this questionnaire was produced to be able to assess the major area of problem within Ekiti State. It will be on the basis of this questionnaire that inference will be drawn on the possible solutions to these problems.

It will be appreciated if these following questions are answered accurately and as correctly as possible. Please be sure that your response will be treated in confidence. Thanks for your co-operation.

Threshing	Shelling	Sorting	Drying	Packaging
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

iv) Effect of the following on the viability of the grains produced by y☐

	High >60%	Medium 40-54%	Low <40%
Moisture Content	☐ 1	☐ 2	☐ 3
Temperature	☐ 1	☐ 2	☐ 3
Humidity	☐ 1	☐ 2	☐ 3
Pest	☐ 1	☐ 2	☐ 3
Fugai	☐ 1	☐ 2	☐ 3

v) Uses of these grains (Please indicate with %)

Human Consumption ☐

Animal Consumption ☐

Selling ☐

Seedling ☐

Exportation ☐

Industrial Usage _____

Please state type _____

D) STORAGE METHOD AND STRUCTURES

i) What type of storage method do you practice?

Small Scale	Medium Scale	Large Scale
☐	☐	☐
1	2	3

ii) If you practice small scale storage method please indicate which of the following?

		Capacity (100kg/Bags)
Calabash	☐	☐
Clay pots	☐	☐
Polythene bags	☐	☐
Airtight container	☐	☐
Drums	☐	☐

Others please specify _____ _____

iii) If you practice medium scale storage method please indicate which of the following?

		Capacity (100/Bags)
Sacks	☐	☐
Drums	☐	☐
Cribs	☐	☐
Room	☐	☐
Basket	☐	☐

v) If you practice large scale method please indicate which of the following?

Commercial Silo	Warehouse
☐	☐
1	2

v) What is the quantity of grains stored by you?

Name of grains	Quantity
Maize	_____
Groundnut	_____

e

Beans _____

Rice _____

vi) Duration Storage

3-6 months	6-12months	12-24months	others specify
1 ☐	2 ☐	3 ☐	4 ☐ _____

vii) Changes noticed after storage

Name of grains	Change in colour	Change in smell	Change in taste	Molding & Rotting
Maize	☐	☐	☐	☐
Groundnut	☐	☐	☐	☐
Beans	☐	☐	☐	☐
Rice	☐	☐	☐	☐

viii) Quantity of grains damaged due to agent of storage losses

S/No	Name of grains	No of bags stored	Number of bags due to					
			Rodents	Insect	During Handling	Birds	Fire	Thieve
1	Maize							
2	Rice							
3	Beans							
4	Groundnut							
5	Others							
6	Specify please							