GRAIN STORAGE STRUCTURES, METHODS AND LOSSES IN KOGI STATE.

BY

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DECLARATION

I AHMED ABDULLAHI KINTA, declare that this project work was carried out by me under the supervision of Prof: E.S.A. Ajisegiri.

03/03/05

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PGD/AGRIC ENG./2001/02/158.

CERTIFICATION

This is to certify that this project work on grain storage structures, methods and losses in Kogi state was carried out by Ahmed Abdullahi Kinta of Agricultural Engineering Department, Federal University of Technology Minna. Niger State.

In partial fulfillment of the requirement for the award of post Graduate Diploma in Agricultural Engineering.

Prof. E.S.A. Ajisegiri

PROJECT SUPERVISOR.

4-07-'05

DR. D ADGIDZI

HEAD OF DEPARTMENT.

DEDICATION

This project work is dedicated to my late parents, Mallam Ibrahim Yanusa and Mallama Amina Nnagi.

ACKNOWLEDGEMENTS

Gratitude and praises are due to Almighty ALLAH whose Grace and Mercies have made it possible for this work to be carried out.

I wish to express my profound gratitude to my able supervisor Prof. E.S.A. Ajisegiri of Agricultural Engineering Department of Federal University of Technology Minna, for all his efforts in terms of time, materials and guidance during the course of this work. I also wish to appreciate the contribution of Dr. D. Adgidzi, Head of Department, Dr Z.D. Osunde, Coordinator of postgraduate studies, Engr P. A. Idah and all other academic and non-academic staff of the Department of Agricultural Engineering.

My appreciation also goes to my wife, Aishatu and our Children for their wonderful understanding, patience and prayers during the course of this work. I am also grateful to my course mates for the love and support we rendered to each other during the period of the course.

My acknowledgement will be incomplete without a mention of my employers, the Federal Capital Territory Agric Development Project. I remain grateful to the management of the project for giving me the opportunity to come and upgrade my self. I am also grateful to the

management of Kogi Agricultural Development project, most especially the staff of zone C, under the zonal manger Mallam I. Idris .

There are many other people who have contributed in one way or the other to the completion of this work and time and space will not permit me to mention to you all, I remain grateful and indebted. May Allah in His infinite mercy reward all of you abundantly, amen.

ABSTRACT

This project on grain storage structures, methods and losses in Kogi state was carried out through survey of some selected seven local government areas of the state, from which data and samples were collected.

The data collection which involved the administration of questionnaires was done randomly from villages and towns in the local government areas. Data were also collected from the state Agric. Dev. project.

The questionnaires were administered on a total of 155 respondents mostly small scale farmers. Also, a total of 210 grain samples were collected and subject to count and weigh procedures. All possible causes of grain losses were investigated and the losses were estimated, using the weight-in weight-out and the count and weigh methods. After analysis of the data and samples collected the findings are as indicated below:

The major grains grown in the state are maize, millet, sorghum, Rice, cowpea and groundnuts. Maize is the most widely cultivated crop, grown by 84.52% of the farmers interviewed, then Rice (78.07%), sorghum 74.20% and the least is millet with 36.77% of the farmers growing it.

The most popular method of storage is bag being used by 87.74% of the farmers interviewed, the housing storage with 81.94%, Rhumbus (76.13%) and the least storage method practiced is the use of silo (4.52%). The highest

form of grain lost comes from insects (34.05%) then handling losses (21.76%) Rodent (20.63%), bird, (12.70%), fire (5.78%) while thieves account for only 5.07% of the losses.

Maize recorded the highest lost of 34.02% followed by sorghum (25.35%), cowpea (15.49%), Rice (11.29%), millet (6.30%) and groundnut (6.17%). The highest amount of about 2121 kg of the grains (Maize, Rice, Millet etc.) was lost per person from Okehi L.G.A., the 2073 kg from Okene, 1782kg from Kogi, 1452kg from Lokoja, 1361kg from Adavi, 1281kg from Ogori Magongo and 1136 kg from Ajaokota L.G.A. All these are on kg lost per 100kg stored.

The total amount of grain lost for the year 2003/2004 cropping season in all the seven L.G.A. is about 87536 tones of maize, 63.470 tones of sorghum, 38.482 tones of cowpea, 28.062 tones of Rice, 15.647 tones of millet and 15.341 tones of groundnut, amounting to a total of about 248.5 tones out of about 24,854tones that were stored.

Bags storage is recommended to be promoted in the state since it is an effective means of storage once appropriate steps are taken to prevent or reduce losses.

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CHAPTER ONE

1.0 INTRODUCTION

Food ranks first out 0f the three basic needs of man for survival. The bulk of this food is provided by grains (that is cereals and legumes). As much as about 70% of the total cultivated areas of the world are devoted to grain production and this provides well over half of the world's food requirements (Ajisegiri etal, 1998).

Agricultural products can be grouped into five classes (Adeniji, 1988), namely-

1. Cereals and legumes such as Beans, Rice, Maize, wheat etc
2. Nuts such as Groundnuts, Bambara nuts etc
3. Tubers and roots, example yams, cassava, sweet potatoes.
4. Fruits such as mangoes, pawpaw, oranges etc
5. Vegetables such as tomatoes, peppers, okro etc

Of these five classes, grains (cereals and legumes) constitute the bulk of Man's food. The crops which provide this food requirement are not available all the year round – hence the need for their storage.

Grains have other uses apart from being used as food by man. They are used as raw materials for agro-based industries as well as feed constituent in livestock feeds formulation. Grains are very easy to store when adequately

dried compared to other crops such as fruits and tubers (Janick, etal, 1974). Farmers have over the years developed one method or the other of storing their crops. These methods no matter their crude form have served the farmers in storing their crops. The methods may differ in form and their effectiveness. Some traditional storage structures are pots, baskets, calabashes and empty cans or tins.

Until recently the emphasis has been on ways of increasing production per unit area of land with little or no attention being paid to preserving what has been produced. A lot of food crops are lost after harvesting in the developing countries, Nigeria inclusive. A conservative estimate of about 10% of grains harvested in this country are lost before consumption or utilization (Opadokun, 1992).

In 1996 alone grain losses in developing countries amounted to about 103 million metric tons worth a staggering sum of about N9.5 billion (Ajisegiri, etal, 1999). This loss would have provided enough calorific requirements of about 168 million people. In essence this grain loss would have fed Nigeria's population of about 120 million people.

The combined effect of these grain losses annually on the nation is its in ability to feed its teeming population and no nation can talk of any meaningful development when its citizens are not well fed. The agro-allied

industries that depend on agricultural products for raw materials will also be under utilized due to insufficient supply of raw materials. All these are in addition to the huge financial loss to the nation in terms of income.

To offset these effects, it has become imperative to prevent or at least reduce to the barest minimum these annual losses in grains produced. It is opined (Life vol.20, No.3, 2002) that only 50% reduction in post harvest losses in developing countries would drastically reduce or eliminate the present trend of importation of huge quantities of food by the developing countries. Therefore all necessary step need to be taken to reverse or at least stop the current trend in grain losses annually.

1.1 GEOGRAPHICAL LAYOUT OF KOGI STATE.

Kogi State with capital at Lokoja was created on the 27th of August, 1991 by the then Military administration of General Ibrahim Babangida. The State was carved out of the then Kwara and Benue States.

The State is centrally located and is within Latitudes 4^0 and 8^0 and Longitudes 4^0 and 6^0. It shares boundaries with Kwara, Ondo, Ekiti, Niger, Benue, Nassarawa, Enugu and Edo States as well as the Federal Capital Territory. The confluence of the two biggest Rivers in the country, Rivers Niger and Benue is also at Lokoja, the State capital.

With a population of about 2.1 million people (1991 census) the sate consists of 21 local government areas and has two distinct seasons:- the wet season which spans from March – October and dry season spanning October to March. The annual rainfall is between 1016mm – 1520mm and the mean daily temperature is between 24^0C and 27^0C, although temperatures of as high as 38^0C are sometimes recorded during the dry season (Kogi State hand book, 2001).

About 80% of the people of the state are engaged in Agricultural production. The state has a very wide stretch of arable land for farming, good grazing ground for livestock as well as large water bodies for fishing. Crops such as yams, cassava, maize, cashew, cocoyam etc are grown in the State.

TABLE 1. ANNUAL GRAINS PRODUCTION IN THE STATE.

YIELD (METRIC TONNES)

NO	CROP	1999	2000	2001	2002	2003
	MAIZE	251566	245800	234000	240850	250000
	MILLET	24025	23700	22600	20000	16450
	SORGHUM	80071	45000	43000	50000	57000
	RICE	113295	102500	86000	80000	77730

	G/NUT	40335	41000	36000	35710	32790
	COWPEA	31718	32000	33000	30000	32000

TABLE 2. AVERAGE PRICES OF THE GRAINS IN THE STATE

PRICE: ₦/kg

NO	CROP	1999	2000	2001	2002	2003	2004
	MAIZE	17.89	14.53	38.00	45.64	32.14	32.03
	MILLET	23.41	17.64	34.54	44.70	36.78	38.34
	SORGHUM	22.54	18.60	41.59	45.41	35.71	36.44
	RICE	59.70	43.06	70.45	80.94	63.83	88.64
	G/NUT (S)	64.80	59.46	72.24	97.07	83.20	—
	G/NUT (U)	41.71	32.72	62.40	71.91	71.72	45.88
	COWPEA	36.69	36.83	58.71	66.20	59.20	69.93
	BENISEED	71.29	47.31	46.15	53.03	76.05	88.64

Kogi State Agric Dev. Project reports the following as the production figures for the selected crops, 250,000 metric tones, 16,450 metric tones 51,000 metric tones, 77,730., metric tones, 32,790. metric tones and 32,000 metric tones for maize, millet, sorghum, rice, g/nut and cowpea respectively for the year 2003. (Table 1).

Taking a conservative 10% loss (Opadokun, 1992) this means 25,000 tones of maize, 1645 metric tones of millet, 5100 metric tones of sorghum etc would have been lost during storage. When this is translated to monetary value about ₦ 800 million worth of maize, ₦ 63 million worth of millet and ₦ 185 million worth of sorghum would have been lost. (Using the prices of ₦ 32,030/ton, ₦ 38,340/ton and ₦36,440/ton for maize, millet and sorghum respectively as reported by the state agric dev. project for the year). See table 2.

The need to minimize this awful waste of food grains, human labour and time put in to the production of this crops therefore necessitates this study.

1.2 AIMS AND OBJECTIVES

This work is being carried out with the following objectives in mind:-

i. Collection of grain storage data from some seven selected local government areas in the state

ii. Identify and evaluate different storage methods found in use in the selected local government areas.

iii. Estimate the annual grain losses in these local areas

iv. Suggest ways of minimizing these loses

v. Recommend suitable storage structures

1.3 JUSTIFICATION

The country is yet to feed its ever increasing population adequately, despite the attention the agricultural sector has been receiving from successive governments. Though some level of increases in food production has been recorded over the years, the demand for food is still far above the supply. This is in addition to annual grain storage losses that are recorded. Renewed efforts are therefore needed to minimize or prevent these annual grain losses so as to make available for consumption all that has been produced.

This therefore justifies any work or effort which is put at studying the current storage methods in order to identify problem areas and proffer possible solutions

1.4 LIMITATIONS

In carrying out this work, the under listed have been my consideration.

i. The crops considered in the course of this work are maize, sorghum, rice, millet, groundnut and cowpea. Any other crop outside this group is out of scope of this work

ii. Data collection and evaluation was based on the use of questionnaires, personal inspection and sample collection.

iii. Any other consideration not listed above is outside the scope of this work.

CHAPTER TWO

2.0 LITERATURTE REVIEW

2.1 MAJOR CROPS PRODUCED IN THE STATE

Kogi State being a transitory region between the Rainforest zone of the Southern Nigeria and the Savannah zone of Northern Nigeria has a climate that favours the production of crops grown in these two zones. The crops that are grown in large quantities in the State are:-

1. CEREALS AND LEGUMES (grains).

This category of crops form the bulk of the crops produced in the state as reported by Kogi State Agric Development Project. The crops in this group are maize, Rice, Sorghum, Millet, Cowpea, Soyabeans, Melon, Groundnut and Benniseed. (Table 2)

2. CASH/TREE CROPS:- The crops predominantly produced in this group are Cocoa, Coffee, Cashew, Palmfruits, Oranges, Mangoes and Sugar cane (Kogi State hand Book, 2001)

3. ROOT AND TUBER CROPS

Yams and Cassava are the major crops produced in the state under this category. Although potatoes and Cocoyams are also produced in smaller quantities (Kogi State handbook, 2001).

2.2 STORAGE AND STORAGE STRUCTURES

Storage is setting aside for future use of separable items (Ajisegiri, 1987) while storage structure refers to a container or housing used for the safe keeping of crops (Mijinyawa, 2002)

According to Idah, 2002, the fundamental functional requirement of such a structure is to retain the quality and quantity of the crops for as long as it in store.

2.2.1 REQUIREMENT OF GOOD STORAGE STRUCTURE

A good storage structure should perform the following functions;-

1. Eliminate the destructive effects of weather.
2. Provide adequate protection against insect, birds, rodents and mites attack.
3. Prevent losses due to moisture and temperature variations.
4. Be strong enough to provide security against theft.
5. Provide a conducive environment to facilitate easy loading, unloading and inspection.
6. It must economical on the basis of the unit cost per storage

(Idah, 2002)

2.2.2 WHY WE NEED TO STORE

Mijinyawa, 2002 enumerated the following as reasons why storage is necessary.

1. To maintain seeds which are used as planting materials in the following cropping season.
2. To meet human and animal food requirement by making the crop available all the year round.
3. For economic reason: since during the harvest period there is abundance of the crop which command low prices, therefore the need to keep till prices are better.
4. For research purposes. Problems relating to production, processing and storage are studied; there by making it necessary to make sure such crops are available.

2.30 CROP STORAGE SYSTEMS

Based on the storage method, the following crop storage system exist (Gwinner, etal, 1990)

1. Open storage system.
2. Semi –open storage system and
3. Closed storage system.

2.3.1 OPEN STORAGE SYSTEM

Under this method of crop storage, the crops are either placed on plat form or on raised ground and left in the open. Some times the crops are hug on frames or under roof of houses (fig 1 a)

The advantages of the system are: -

1. Very simple construction of the structure as well as the availability of the construction materials.
2. Continued drying of the crop because of the strong aeration that takes place continuously.
3. Restriction in fungi development because of the continuous aeration.

However, the system offers unrestricted access to insects, birds, rodents and thieves.

2.3.2 SEMI – OPEN SSYSTEM

This system uses woven grasses, twigs or straw containers supported by wooden frames usually raised from the ground level.

A thatched roof offers protection from rain (fig 1)

The system gives better protection from weather conditions, material. for its Construction is available and cheap. But there is reduced aeration and no protection against pests and rodents attack.

2.3.3 CLOSED STORAGE SYSTEM

In this system, the storage is done under closed condition. The containers or structures used here are those that can be completely closed (fig 1 c). Some of these are calabashes, clay pots, oil drums, pit and trenches, silo and Rhumbu.

This system has the following advantages:-

1. Maintains cool and dry inside microclimate particularly for structures made from mud.
2. Offers good protection against pests and rodents attack.
3. It allows air tight condition, therefore fumigation is possible.

ITS DISADVANTAGE ARE: -

1. Danger of condensation exists particularly when metal containers are used.
2. Cracks in mud structures provide hiding places for insects.
3. Mud structures are not resistant to rain, therefore regular repair is necessary.

FIG 1a: Open storage structure

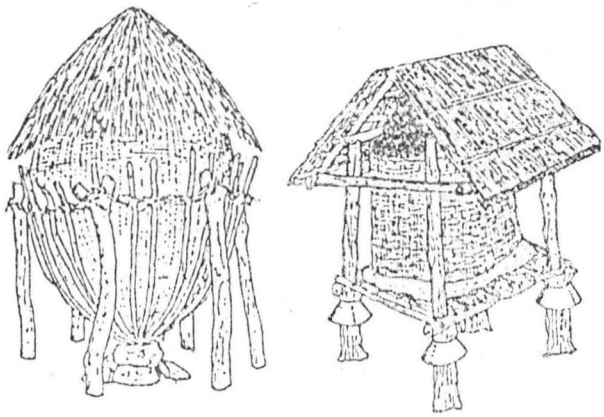


FIG 1b: Semi-Open storage structure

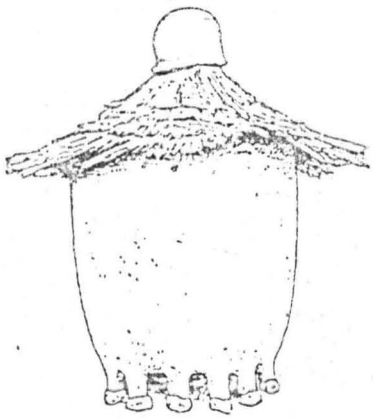


FIG 1c. Closed storage structure

2.40 CROP STORAGE STRUCTURES

Based on their capacities, storage structures are divided into three: - subsistence or family level storage structures, middle level and commercial level storage structures (Ajisegiri, 2002)

2.4.1 FAMILY LEVEL STORAGE STRUCTURES

These are storage structures used at the family or grass root level. The quantity of grains stored at this level are rarely more than 3-5 bags of threshed grains per farmer (Olajide, 1998). But the bulk of the grain storage is under taken at this level, because about 80% of crop production is carried out at this level (Birewar, 1990). The storage is done either in threshed or unthreshed form.

The unthreshed maize, millet, beans, groundnut etc. are hung on trees, heaped on the ground, on raised platforms or simply bundled together and kept in attic of living houses. The threshed grains are stored in pots, calabashes, drums, pits, kerosene tins, Rhumbu etc

2.4.1.1 GOURD AND CALABASH STORAGE

These small containers which are fruit cases of cucaumbitacae are used to store small quantities of grains. These containers have cool interiors and can be made hermetic. They are mainly used to store seed grains.

They are fragile and therefore, easily broken. This leads to the stored grains being prone to attack by insects, rodents and other deteriorating agents. Apart from their fragile nature, gourds and calabashes are very limited in their capacities.

2.4.1.2 POTS STORAGE

Pot are made from clay and are usually used to store threshed grains, they have higher capacity than gourds and their wider mouths make loading and unloading easier than in gourds.

The pots are placed directly on the ground or could be buried up to the neck in the ground. Adeniji (1998) reports that though this practice minimizes the risk of breakage, moisture could easily be absorbed from the ground, thereby leading to moulding or sprouting of the stored grains.

2.4.1.3 DRUMS, KEROSINE TINS AND PLASTIC CONTAINERS.

These containers are used to store grain in houses in the village by farmers and even small-scale grain merchants. Drums and Kerosene tins are made air tight by the use of clamps or plugs (fig 2). This therefore makes it possible to use fumigants to prevent incidence of insects attacks.

occasionally, the inner sides of the drums are lined with polytene material or painted to arrest the problem of rust.

Dried shelled grains of cowpea, maize, Soyabeans, Millet, Rice and other grains are stored for upward of six months using these structures (Kinta, 2003).

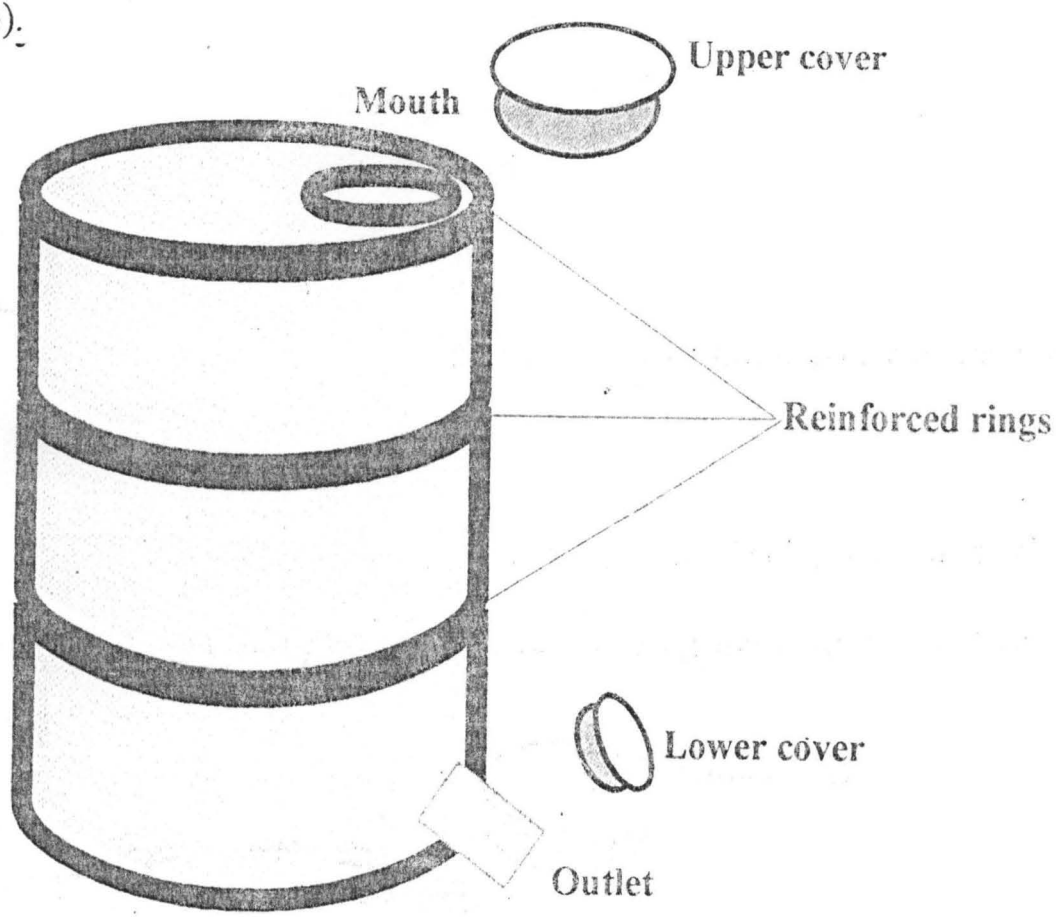


FIG 2: Specially constructed Drum for grain storage.

2.4.1.4 HANGING STORAGE

This is an on farm as well as off-farm method of storage used to store maize, millet and sorghum. The unthreshed crops are hung on eaves of houses, specially erected structures or on branches of trees (figs 3). The maize sheath is used to tie the cobs into bundles of 5 to 20 cobs, which are hung on eaves of houses or over fire places in which case the smoke helps in driving off insects.

One of the advantages of this method is its cheapness, but losses could result from sprouting, insects and Rodents attack and pilferage (Kinta, 2003).

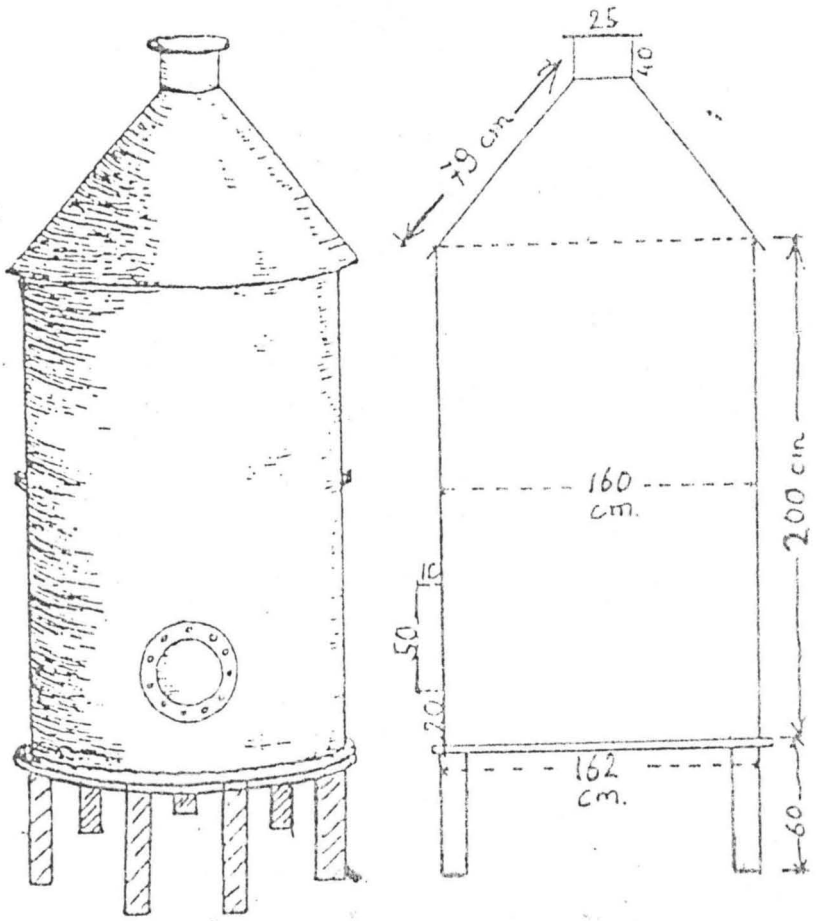


Fig 3 Sheet metal silo

PLATE 1: Hanging storage method for maize

2.4.1.5 UNDERGROUND STORAGE STRUCTURES

These are holes of between 0.1-2.5 tonnes capacity (Ajisegiri, 2002) of various shapes dug on the farm or at the back yard, which are used for grains, and tuber storage. The sides and base of the pits are usually lined with straw and cemented with cement mortar or clay. After filling with the grains, the same lining material of straw or grass is used to cover the grains before soil is heaped on top of it (fig 4).

When the structure is to be used to store tuber or root crops, the base is first lined with leaves or grasses after which the tubers are arranged, then another layer of grasses is put on the tubers. This is repeated until the pit is filled up.

When straw is used as lining material it absorbs moisture and this leads to development of moulds. The moulds use up the oxygen in the system thereby creating a reduced oxygen level environment which makes it impossible for insects to survive (Mijinyawa, 2002).

Another system of underground storage is to leave the matured crop unharvested in the soil. This is only applicable to crop like yams, sweet potatoes, cassava and some varieties of groundnut. The storage duration here is usually a few weeks after which the crops are harvested.

Inspite of the reduced oxygen level, termites, insects, and burrowing animals could pose some problems. This is in addition to losses that could take place as a result of excessive moisture content, caking and sprouting. There also exists the danger of some dangerous reptiles finding hiding places in such underground structures.

Incorporating bitumen layer or using polythene materials for lining to prevent moisture absorption from the soil, and erecting temporary shelter over the pit site to protect it from rains are some improvements that can be done to arrest defects of traditional underground storage structures.

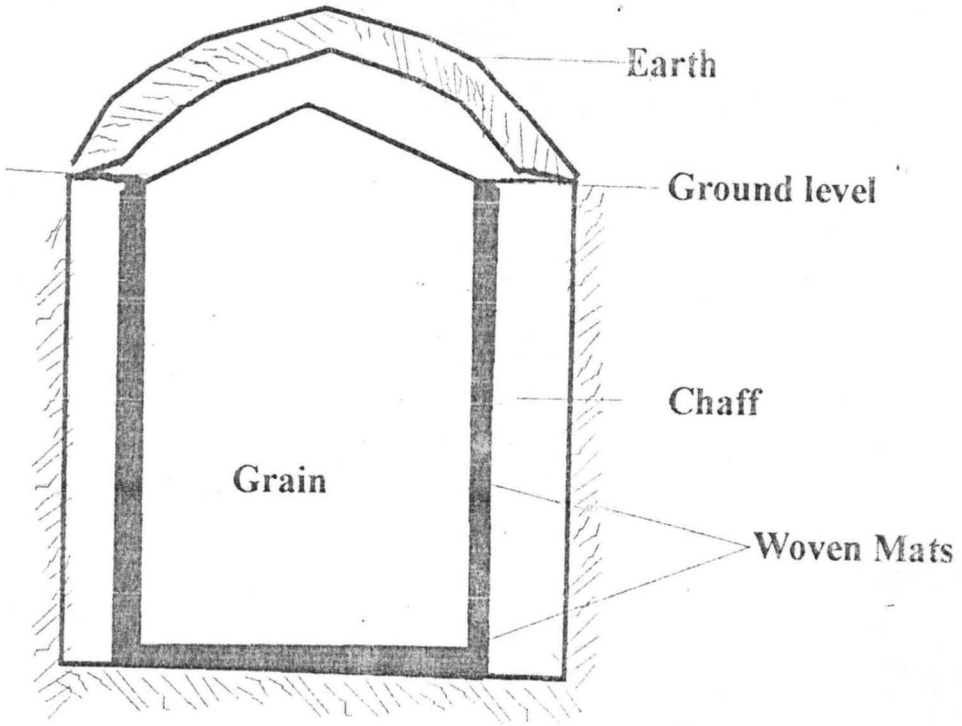


FIG 4a: Circular pit storage structure

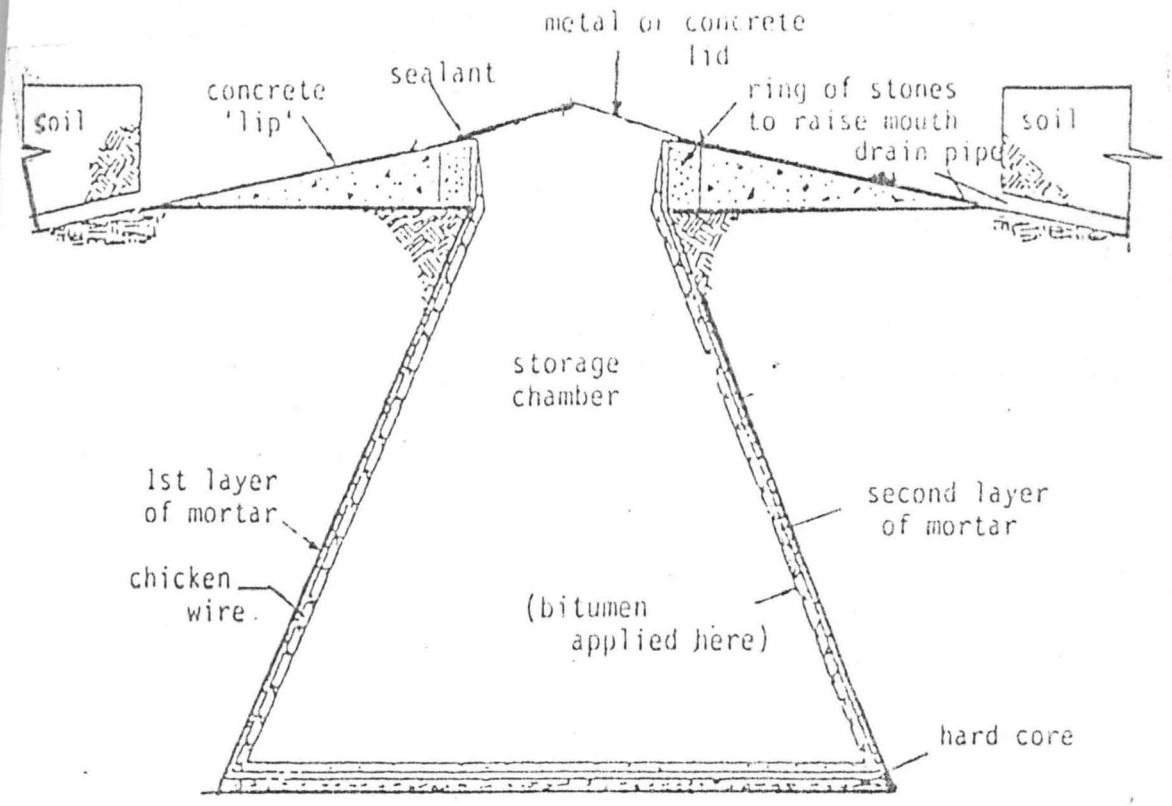


FIG 4b: Improved Ferro cement lined underground pit.

2.4.1.6 HEAP STORAGE

This is a form of temporary storage method being practiced by farmers. Heap storage is a common practice not only for grains storage, but also for tubers and root crops (Ajisegiri,2002). The crops are heaped on the ground to form a circular or pyramidal shape. The ground is first lined with corn stalk or vines of harvested yams. The crops are then put on the lined ground and covered with grasses or other fibrous materials.

The obvious defect of these storage techniques is attacks from Rodents, insects and termites. Risk of fire and stealing of the crops also exists. Sprouting may also occur in case of an incidence of rainfall (Kinta, 2003).

2.4.1.7 PLATFORMS

Platforms are used to store grains in unprocessed form. The platform structures consist of supporting poles on which a raft is built. The height of the platform varies according to the farmer's desire.

Maize cobs, panicles of sorghum, cowpea and unpicked groundnuts are put on this platform., They could be covered with grasses or leaves or

left open. This is a transitory form of storage before the grains are transferred into Rhumbus or granary or threshed and bagged.

High level of insect's infestation, high risk of loss to fire, theft and sprouting are the disadvantages of this method. The use of rodent guards, traps, insecticides and provision of leak proof roof are some measures that could be adopted to minimize the effects of these spoilage agents.

2.4.1.8 BASKETS

Woven baskets specially made for the purpose are used to store grains in shelled form. The use of basket for storage is very common in the middle belt and other rice producing states of Rivers and Cross Rivers. Baskets have a capacity of up to half a ton or more for rice (Adeniji, 1988).

The baskets are usually placed on raised platform or on stones to avoid ground moisture. They are also supported at the sides by poles or sticks to hold them in place and also to maintain shape. The supports are sometimes fitted with barriers to guard against rodents attack (fig. 5)

Through the basket is not air tight, the structure is safe from rain since it is usually placed indoors. Insects attack could be a problem, though farmers sometimes smoke local herbs into the structures to drive away

insects. Lining the inside and outside of the baskets with clay, cow dung or mud can also enhance protection against insect attack (Segun, 1988).

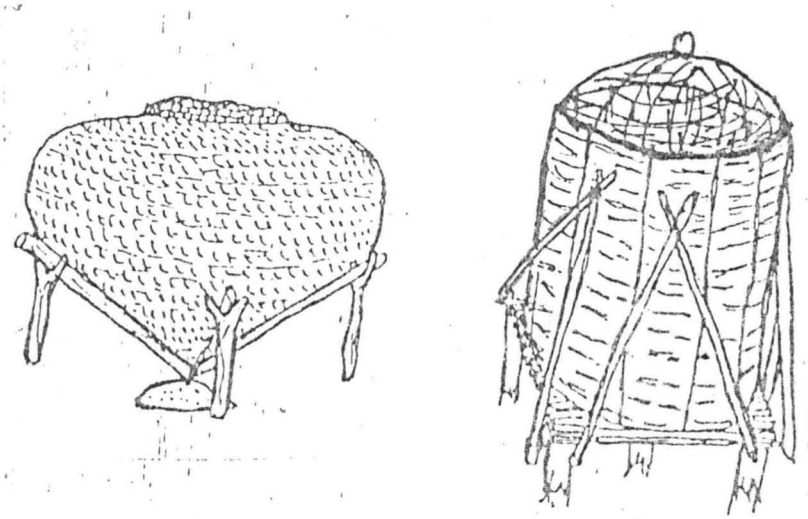


FIG 5a: Traditional Basket

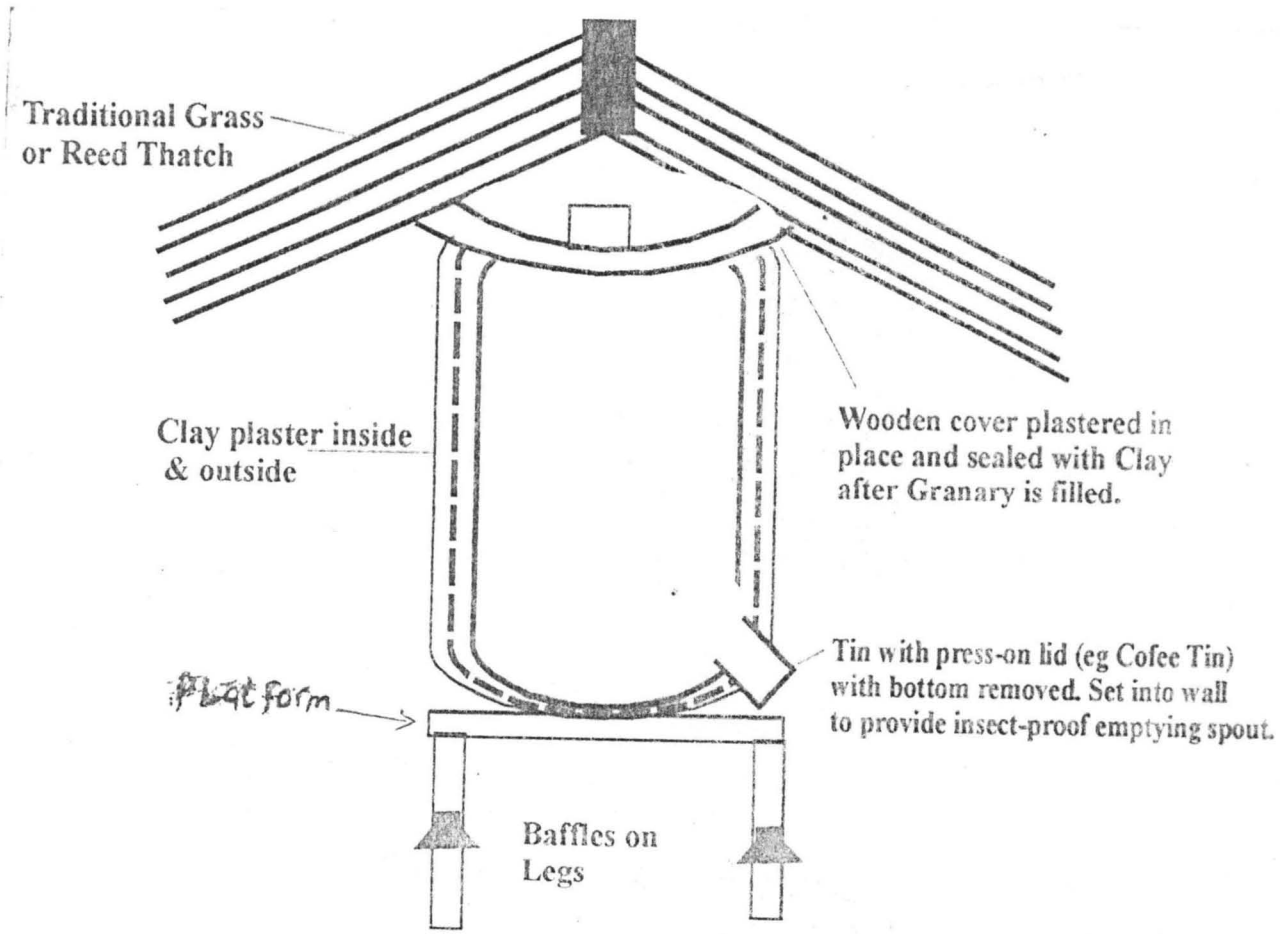


FIG 5b: Improved traditional Basket

2.4.2 MIDDLE LEVEL STORAGE STRUCTURES

Unlike the subsistence level storage middle level storage structures are used by farmers as well as small-scale grain merchants to store their grains. The capacities of these structures are higher than those of subsistence level and ventilated structures such as stores, cribs and Rhumbus are used. These structures include those discussed below: -

2.4.2.1 SACKS OR BAGS STORAGE

Shelled produce is stored in any of the three well-known sacks viz. Jute, sisal and plastic bags. The bags of grains are then stacked in barns stores, spare living rooms or warehouses. The bags are not placed on the floor directly, but placed on raised platforms or on wooden pallets to avoid ground moisture absorption. Also the bags should not be stacked too high on each other to prevent them from collapsing (fig 6)

With sacks storage the incidence of insects infestation is usually high. And usually this is not detected until much damage has been done. This therefore calls for close monitoring of the stored products.

Sisal and Jute sacks can be lined with thick plastic bags before putting grains into them to arrest the problems of insects and moisture absorption. as storage structures are conceived for transit storage but if properly

improved upon could serve as medium term storage structure (Ajisegiri,2002).

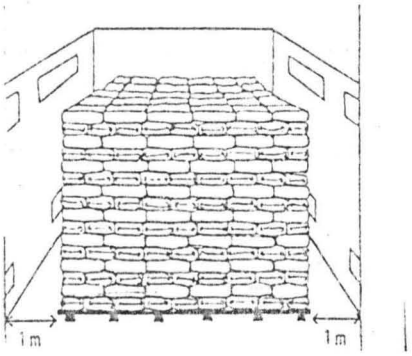


FIG 6a: Correct bags stacking in a store

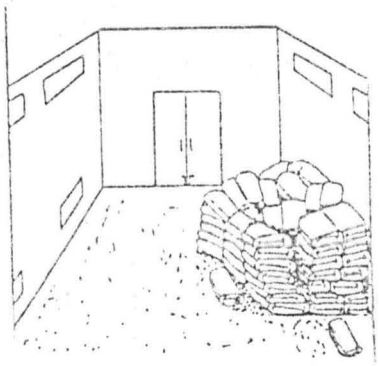


FIG 6b: Bags wrongly stacked in a store

2.4.2.2 CRIBS

Crib is a modified form of platform storage structure which is used mainly for the storage of maize cobs. Other crops such as unthreshed millet and sorghum, unpicked groundnuts and cowpea are also stored in cribs.

The crib consists of raised platform of variable height and about a meter wide. The height ranges from 0.8m to 1.5m above the ground level. On this platform a box like structure is built using Bamboo, Wood, Iron or wire mesh with a thatched or corrugated zinc roof (fig. 7)

Rodents guards are placed on the supporting poles of the platform to prevent Rodents and Reptiles from climbing. This structure is used for drying as well as for storing crops. The continuous aeration of the crops facilitate drying, thereby offering farmers the opportunity of harvesting their crops early. But insects control is a problem when cribs are used for storage.

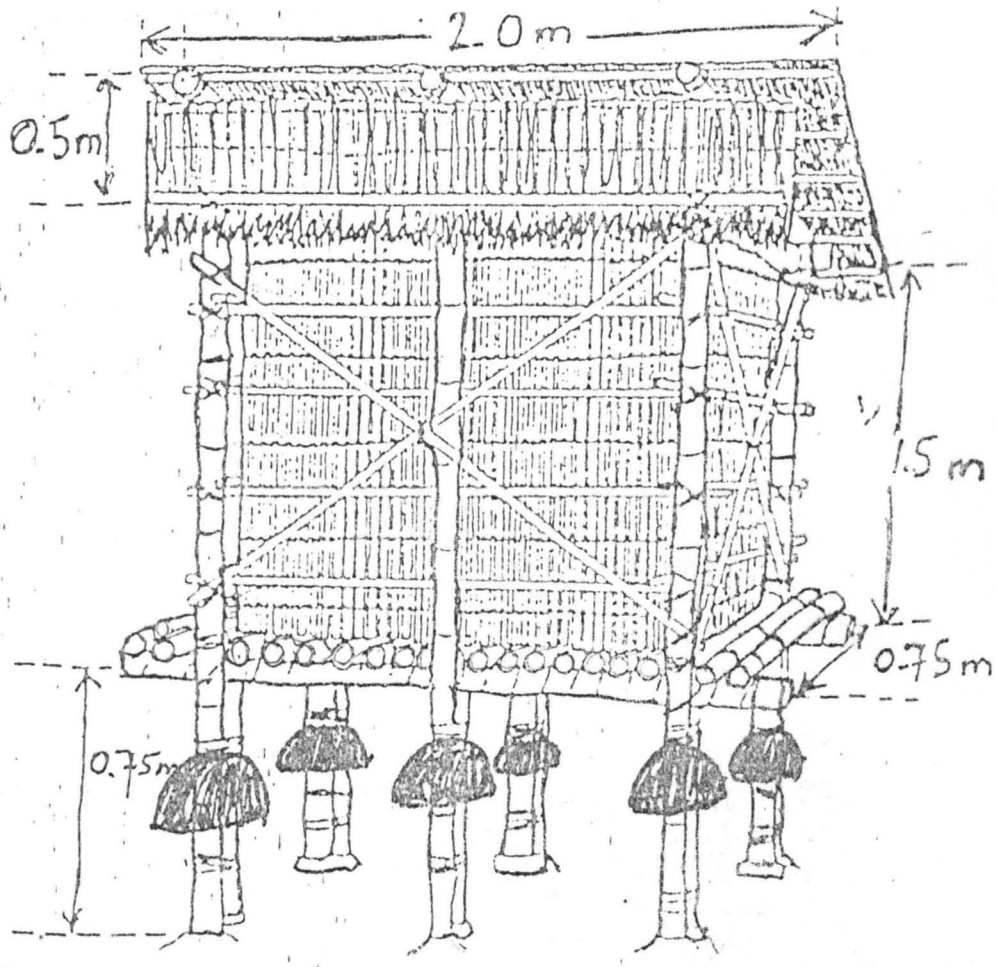


FIG 7: Maize crib (with Rodent guards) made of Bamboo.

2.4.2.2 RHUMBUS

This is a cylindrical shaped structure, which tapers at one end (fig. 8). It is constructed from a combination of mud and chopped grasses mixtures. The floor is usually raised above the ground level to avoid damages by moisture, to reduce accessibility by rodents and to facilitate unloading which is usually done by gravity beneath the structure. It has a capacity of between 3 to 4 tonnes (Birewar, 1992) and is used to store shelled Beans, Sorghum, Millet, Maize, Rice and other grains.

Since mud is a poor conductor of heat, Rhumbus do maintain a relatively constant internal temperature. The disadvantages of this structure are low capacity, difficulty in making the structure airtight and the incidence of internal heat generation. Ibgeka (1983) reported that the outside walls of the Rhumbus are painted white to increase heat reflectance.

Inspite of all these problems, Rhumbus still remains a promising structure for grain storage. Studies have shown that by using appropriate local materials, the internal temperature could be lowered by as much as 18^0C from the atmosphere temperature level (Ajisegiri,1991). Thus if proper structural and heat transfer considerations are made Rhumbus have high potentials for cereals storage.

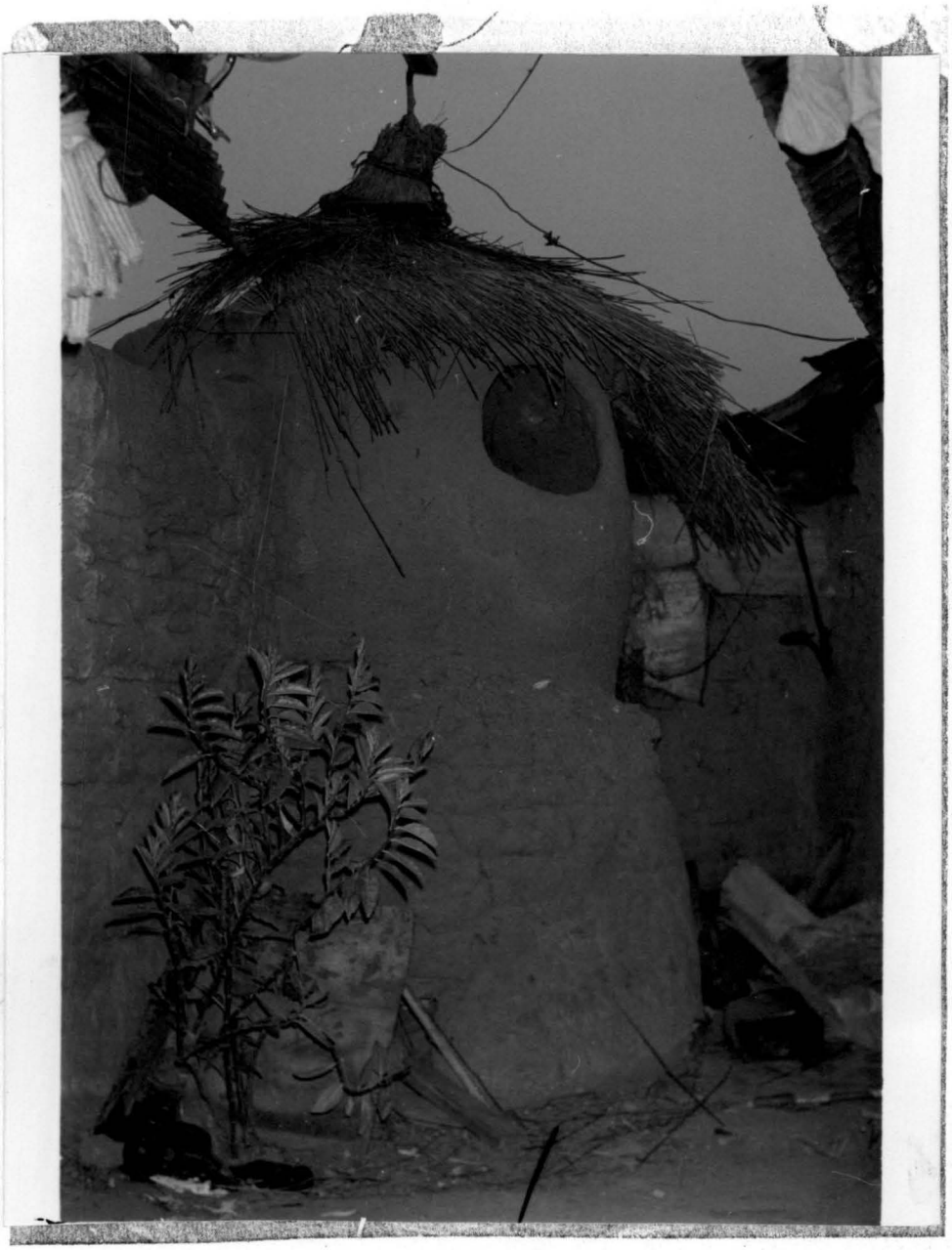
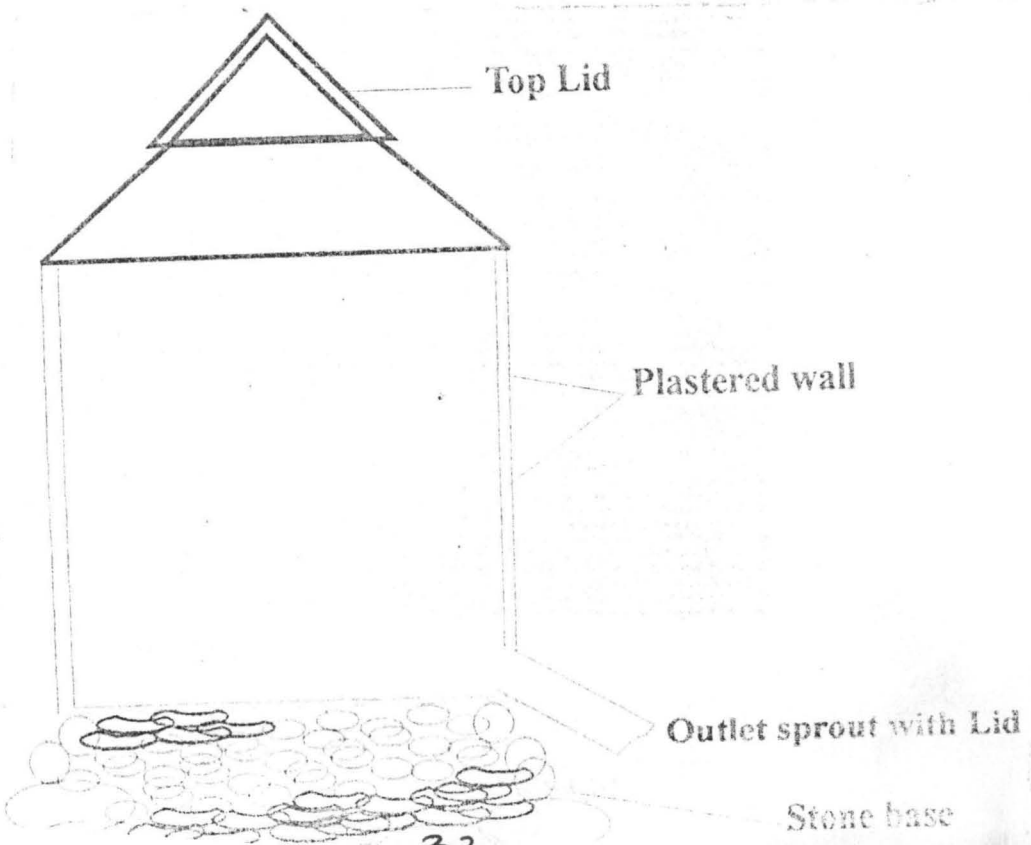


PLATE 2: Traditional thatched Rhumbu



IG 8: Improved Rhumbu

2.4.3 COMMERCIAL LEVEL STORAGE STRUCTURES

Large scale grain merchants, exporters, agro based companies, government agencies and the few existing large scale farmers carry out storage of grains in commercial quantities. The structures used for this level of storage are long lasting and more or less permanent. These are silos and warehouses:-

2.4.3.1 WARE HOUSE

The produce to be stored in stores and ware houses are usually already threshed, cleaned, sorted and bagged.

The ware house should be built on a well drained area and its foundation must be strong enough to support the building and the weight of the stored grains. The doors must be tight fitted, walls and roof must be moisture prove in addition to preventing entry by insects, rodents and thieves. These requirements make it mandatory to engage the services of a qualified storage Engineer to design and supervise the construction of a warehouse or store.

Proper store management must also be maintained. Facilities for fumigation and aeration should also be provided. The bags are usually placed on specially designed wooden beams called pallets and should be arranged in such a way as to guard against collapse of the stacked bags.

Ajisegiri,2002 recommends leaving a clear space of 90cm round the stacked bags to enable personnel walk freely for inspection, fumigation or other store management practices.

2.50 GRAIN LOSSES

Food according to Ajisegiri (2002) is that weight of wholesome edible material measured on a moisture free basis that would normally be consumed by man. Loss on the other hand is any change in availability, edibility, wholesomeness or quality of food that prevents it form being consumed (Harris, etal, 1978).

Losses could be direct, which is the disappearance of the food item caused by one factor or the other. It can also be indirect, in which case it is the lowering of the quality attributes that deprives nutrient benefiting capacity of the food item or even the complete rejection of the item.

2.5.1 FACTORS RESPONSIBLE FOR FARM PRODUCE LOSSES.

Many factors are responsible for stored produce losses. Amongst these are physical factors (temperature, Moisture and air present in the system), biological factor and Engineering factors (Salunkhe etal, 1985)

2.5.1.1 PHYSICAL FACTORS

Warmth, air and water are basic needs of all living things. Living things flourish and remain alive only within certain limits of these three basic needs. The grain temperature and the atmosphere temperature are very

crucial for safe and prolonged storage of grains. When stored grains respire, oxygen is used up and carbondioxide, water and heat are given up. Daily temperature fluctuations rarely affect the store grains below a few centimeters of the grain surface. However the amount of heat generated by fungi, insects and other living organisms in the stored grains have a higher effect. Mites and insects rarely develop below 5^0C and fungi below ^{0}oC (Salunkhe, etal, 1985). The effect of temperature on an organism is correlated with the amount of moisture present, a rise in temperature results in decrease in the relative amount of moisture in the produce.

Moisture is an absolute necessity for biological activity to thrive. Moisture is contained in grain either as bound water or absorbed water. The moisture content (ie the weight of water in a product divided by the weight of the moist product, express as a percentage) of a stored grain governs the rate of deterioration of the grain. The higher the moisture in the system the faster the rate of spoilage.

At about 70% relative humidity and temperature of about 27^0C the following are the safe storage moisture content levels (PGD/Agric Eng/2002 Lecture notes).

TABLE 3: Safe storage moisture content level of some crops.

S/NO	PRODUCE	EQUILIBRIUM MOISTURE CONTENT
1	Maize	13.5
2	Wheat	13.5
3	Sorghum	13.5
4	Millet	16.0
5	Paddy	15.0
6	Rice	13.0
7	Cowpea	15.0
8	Beans	15.0
9	G/nut (shelled)	7.0
10	Cocoa Beans	7.0
11	Cotton Seed	10.0
12	Copra	7.0
13	Palm Kernel	5.0

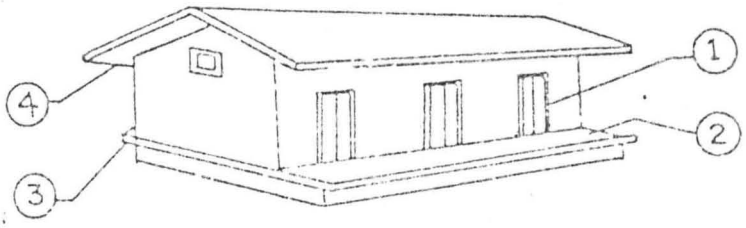


FIG 9a: Modern warehouse. (I . sealed door 2. floor 3. Rodent proof slab 4. Air proof roof

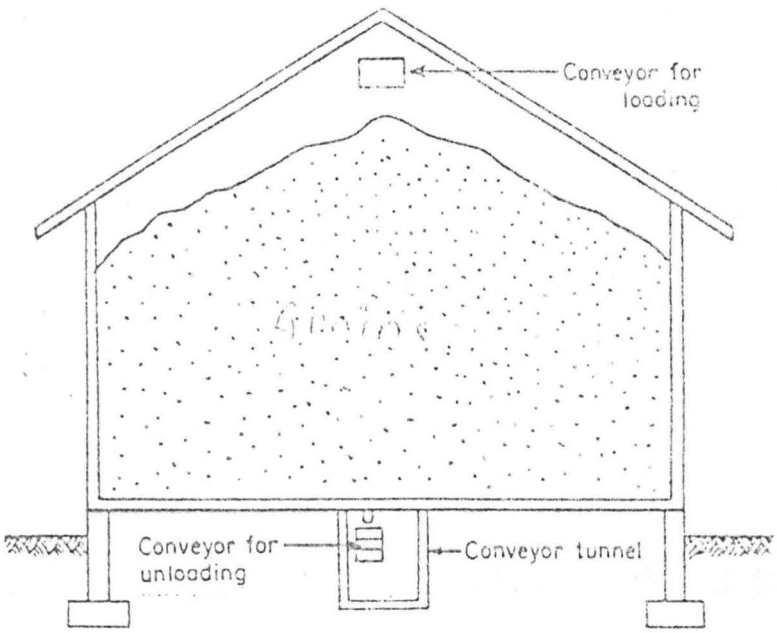


FIG 9b: Cross section of a ware house showing conveyors for loading and unloading.

2.4.3.2 SILOS

Silos are structures used for bulk storage of grains in loose form. The silos could be cylindrical in shape with smooth circular walls strong enough to carry the lateral pressures due to the stored grains. The silos could also be squat type (fig.10), pit type or horizontal type.

Based on the construction materials used, there are inert gas silos, conventional and Butyl rubber silos. Inert gas silos and conventional silos are constructed using metals (galvanized Iron sheet Aluminium sheet) Mansory bricks, mud bricks, precast concreté or asbestos sheet. Butyl rubber silos has a butyl rubber placed inside a strong wire mesh.

Whatever the type of silos, it should be constructed on a raised reinforced concrete platform. This forms the foundation which should be strong enough to support the silos structure, the weight of the stored produce as well as provide protection from ground moisture and run off.

Moisture migration and problems of condensation do militate against the use of conventional silos in Nigeria (Ajisegiri,2002). It is therefore imperative for silos to have facilities for drying and aeration of the stored produced.

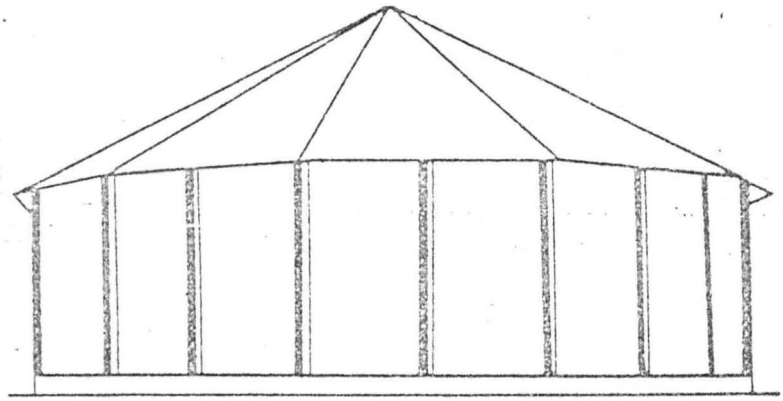


FIG 10a: Squat type silo

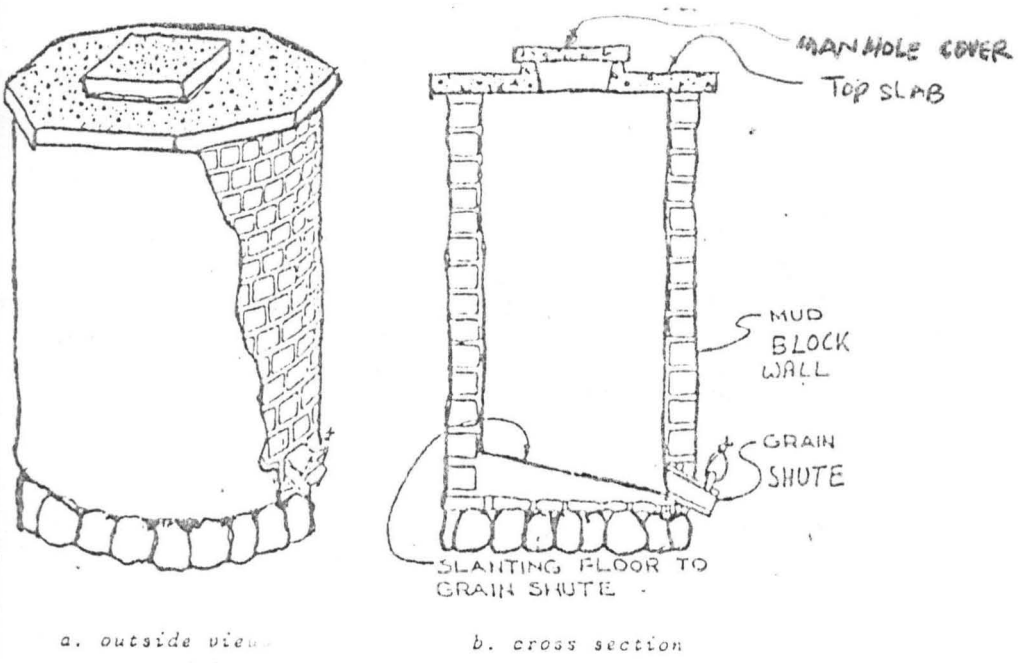


FIG 10b: Improved mud brick silo.

2.5.1.2 BIOLOGICAL FACTOR

Grains being living entities respire. The effect of this is loss in weight and a gain in moisture content of the system followed by a rise in temperature and carbon dioxide level. The degree of respiration of the grain and the invading insects determines to some extent the rate and extent of deterioration of the grain bulk.

For every 10^0C reduction in temperature, the rate of respiration in the system is reduced by half (Salunkhe, etal, 1985). Due to reduced oxygen level in storage structures, the rate of respiration is extremely low. But if grains with moderately high moisture content are stored immediately after harvest, they exhibit a higher rate of respiration. This leads to more moisture and heat generation which create favourable conditions for mould growth and spoilage to start.

2.5.2 AGENTS OF STORED GRAIN LOSSES

Several agents are responsible for grain losses from harvest through storage to the point of use. Some of these agents are insects, micro-organisms, Rodents and man.

2.5.2.1 INSECTS

Insects are very destructive agents of crops particularly food grains under storage. The insects attack the crops from the field and the attack and destruction continues in the store. They attack the crops at different stages of its development, the seed, the plant and finally the grain produced.

The result of this insects attack is loss in weight, quality and market value of the produce. Moulds infestation and caking of the stored produce are also promoted by the effect of these insects' attacks, resulting in grains contamination and loss of seed viability. Some common insects pests of stored grains are bruchus SPP, Rice Weevil, granary weevil etc.

Proper insects control in the fields of production good storage sanitation and the use of insecticides are some measures that could help reduce infestation.

2.5.2.2 MICRO ORGANISM

Fungi and bacteria attack crops in the field, during harvest and even during storage causing such crops to deteriorate. Under low oxygen levels and high moisture, moulds thrive better than fungi (Burmeister, etal, 1966).

During growth, some fungi produce chemicals that are toxic to man and domestic animals. They also indirectly affect the stored grains by

encouraging the growth of some insects and mite species. This the fungi do by supplying nutrients that are essential to these mites and insects but lacking in the undamaged grain kernels.

By creating conditions unfavorable to these microorganisms, they can be controlled. Factors such as temperature, oxygen and moisture content when regulated can control the levels of these microorganisms in the stored produce.

2.5.2.3 RATS

Rats play significant role in grain storage losses. It has been estimated that a rat consumes about 10kg of grain per year and contaminates ten times more with its urine, faeces and hairs. One rat drops between 25-150 pellets (excreta) and 10-20ml urine in a day and their multiplication rate is so high that there are six times more rats than humans (Sahay etal, 1980). Rats also destroy Jute bags, and other containers for storing grains beyond repairs. This is in addition to their carrying some transmissible diseases such as plague, Jaundice, Typhus etc.

Control measures that can be used include making the floor of the store impenetrable to the rodents by using concrete, wire mesh, or sheet metals as well as fitting tin plates at doors and windows to prevent their

entry. The use of natural predators (cats and dogs) Rodenticides, traps and good store hygiene also help in controlling the menace of rats and other rodents.

2.5.2.4 MAN

A lot of the damage to grains is caused by man, through his handling of the crops from the field during harvesting, transportation, processing and storage. Split or broken grains, immature and grains not properly dried are easier to be attacked by other agents of losses.

To guard against this, man has to properly match his harvesting, sorting and processing machines and implement to avoid causing damage to the grains. The storage structure should also be chosen carefully in order to create suitable storage conditions for the produce.

2.6 ESTIMATION OF GRAIN LOSSES

Grain losses occur at various levels of farm operations. i.e. at harvest, transportation and storage stages. These losses are as a result of physical, chemical and biological factors.

Accurate estimation or assessment of these losses is essential in order to plan for their reduction and prevention. Assessing the level of losses will

also assist in policy formations on how to cope with food shortages, that are likely to occur as a result of these losses.

Various methods exist for estimating grain storage losses. These methods includes those that estimate physical or quantitative losses and also those that estimate losses in quality. Some of these methods are (Gwinner etal, 1990): -

1. Standard volume weight (bulk density) method
2. Percentage damage factor method
3. Weight in – weight – out method
4. Count and weigh method
5. Mean kernel weight (The thousand Grain Mass) method and
6. Chemical methods.

2.6.1 STANDARD VOLUME WEIGHT OR BULK DENSITY METHOD

This method uses the mass of grain for a unit volume it occupies. This method has been used by processing industries for many years as an indicator of processing yield.

Bulk density varies with moisture content; therefore the dry weight per standard volume of sound grains is first determined over a range of moisture contents. Then the samples of the same grains are taken after damage is presumed to have taken place. The bulk density of the damaged samples is then compared to the bulk density of the sound grain at the same moisture content.

The difference is divided by the bulk density of the sound grain and the result in multiplied by 100 to indicate percentage reduction.

2.6.2 PERCENTAGE DAMAGE FACTOR

This method uses the difference between the weight of damage kernels and the weight of undamaged kernels. The percentage of damaged kernels in a grain sample is found and multiplied by a factor representing the presumed weight lost per damaged kernels.

Pointel etal (1979) recommend that grain sample of 100-1000 kernels be used to determine the percentage damage and that portions of 100-1000 kernels of which at least 10 are damaged be subjected to count and weigh procedures to determine the conversion factor.

2.6.3 COUNT AND WEIGH METHOD.

The count and weigh method compare the mean weight of damaged and undamaged kernels within the same sample. In count and weigh method the grain are first cleaned over a sieve to removes insects and other fine materials.

A small portion in then randomly removed from each cleaned sample. Each kernel is the observed and damaged ones in each fraction is then counted and weighed.

The percentage weight lost is them calculated using the following formula proposed by Anan, in 1969.

$$\text{Percentage weight lost} = \frac{(W_u \times N_d) - (W_d \times N_u)}{W_u (N_d + N_u)}$$

Where W_u = Weight of undamaged grains

N_u = Number of undamaged grains

W_d = Weight of damaged grains

N_d = Number of damaged grains.

Defects of this method are that when the grain is so heavily infected, the kernels cannot be counted because of complete destruction. Also since

infestation inside the grain cannot be detected easily, attacked kernels may be counted as undamaged.

2.6.4 WEIGHT IN – WEIGHT OUT METHOD

This is the simplest method of establishing losses in the store. The weight of the produces entering and leaving the store is recorded. The difference in the weight of the produce that entered and left is expressed as a percentage of the produce that was stored initially.

The defect of this method an reported by Gwinner etal, 1990 is that when weighing the produce after storage period, left overs, pests carcasses, rodents droppings may also be weighed as produce and this may affect the final result.

2.6.5 MEAN KERNEL WEIGHT (THOUSAND GRAIN MASS) METHOD

This method was proposed by Proctor and Rewley, in 1983 as a method of weight loss estimation based on the mean kernel weight. A thousand kernels are counted and weighed from a sample of grains. The moisture contents of the grain are determined so that the mean dry weight per kernels can be calculated. The difference between this value is expressed

as the weight of 1000 kernels at time A and time B and is used to calculate the percentage thousand grain mass lost.

2.6.6 CHEMICAL METHOD

These are methods used to determine quality losses in grains. The chemical analysis of infested and uninfested grains is carried out to determine the percentage of different nutrients such as proteins, carbohydrates, lipids, fats, minerals and vitamins. The result of such analysis may include several contaminants of insects, microorganism and rodent origin

CHAPTER THREE

3.0 METHODOLOGY

The steps, methods and techniques used in gathering and processing information about grain storage losses are discussed in this section.

The study cover selected seven local government areas in the state. The local government in which the study was carried out are Kogi, Lokoja, Adavi, Okehi, Okene, Ogori Magongo and Ajaokuta. In each of the selected local government areas between 20-25 farmers were selected from 3-5 villages.

Table 4 LOCAL GOVERNMENT AND VILLAGES COVERED BY THE SURVEY

S/N0	LOCAL GOVT	NO OF VILLAGES	N0 OF PEOPLE INTERVIEWED
1	KOGI	5	23
2	LOKOJA	5	20
3	OKECHI	3	22
4	ADAVI	3	20
5	AJAOKUTA	4	23
6	OKENE	4	23

7	OGORIMAGONGO	3	24
	TOTAL	27	155

3.1 METHOD OF DATA COLLECTION

The services of the Kogi State Agricultural Development project were sought and used during the data collection stage.

Data pertaining to the farming families in the state, total area cultivated to each of the selected crops in the state, total yield of each of the selected crops and average prices per kilogram of the selected crops were obtained from the state Agric Development Project.

During the interview stage where questionnaires were administered on the farmers, farmers were selected at random from villages and towns within the local government areas. The area extension agents and area enumerators of the State Agric Development Project assisted greatly on this project, since they are the field officers with close contact with the farmers.

In order to avoid favouratism and discrimination, no defined pattern was taken in choosing farmers on whom the questionnaires were administered. Both the villages and the farmers were chosen randomly,

thereby eliminating the possibility of favouring some farmers and villages over others.

In each of the local government area covered three to five villages were selected for the survey. In these villages between 20-25 respondents were chosen. The questionnaires were read, interpreted were necessary and the various responses noted in the questionnaires. Table 4 shows the distribution of the local government, villages and number of respondents.

The information sought from the farmers includes average annual production of each grain being studied, storage pattern and duration, storage problems, estimates of losses due to storage, prices of the crops being studied.

Also grain samples were collected from the farmers and grain sellers randomly from the towns and villages in the Local Government Areas studied. Five samples of each of the six grain studied were collected from the seven Local Government Areas. This brings to a total of two hundred and ten samples collected.

3.2 METHODS USED IN ESTIMATING STORAGE LOSSES

Out of the various methods available for estimating grain storage losses, the following two were chosen because of their simplicity thereby making it possible for even local farmers to use.

3.2.1 COUNT AND WEIGH METHOD

This involved the collection of ... grain samples from the farmers. The samples of sizes ranging between 300 to 1000 kernels (Adams & Schulten, 1978 recommended sample size of between 100 and 1000 kernels) of the grains were clean to remove dust and other contaminants such as weevils etc.

Each kernel was then carefully examined to separate damaged ones from the sound ones (PLATE 3:8). After separation of damaged from sound ones, the weight of each fraction were then taken and recorded.

The percentage weight loss was then calculated thus:

$$\text{Percentage weight lost} = \frac{(UxNd - Dnu) \times 100}{U\,(Nd+Nu)}$$

Where U = weight of undamaged kernels

D = weight of damaged kernels

Nu = number of undamaged kernels

Nd = number of damaged kernels

As explained earlier this method is very simple to use but its major defect is that damaged kernels may be used as undamaged. This is because sometimes some kernels may have already been damaged internally without showing any sign outside.

3.2.2 WEIGH –IN – WEIGH -- OUT METHOD

This method simply regards the difference between the weight of the grain at the onset of the storage and the weight at the end of the storage period as the loss due to storage.

Though great care needs to be taken when using this method not to regard loss due to moisture loss as storage loss. This is why the grains must be dried to safe storage moisture content when using this method and also care should be taken to prevent moisture gain during storage.

The farmer's responses on perceived weight losses during storage were used to assess the grain losses in each of the selected local government areas of the state. This is because it is assumed that farmers must have gathered enough experienced on assessing their grain losses during storage.

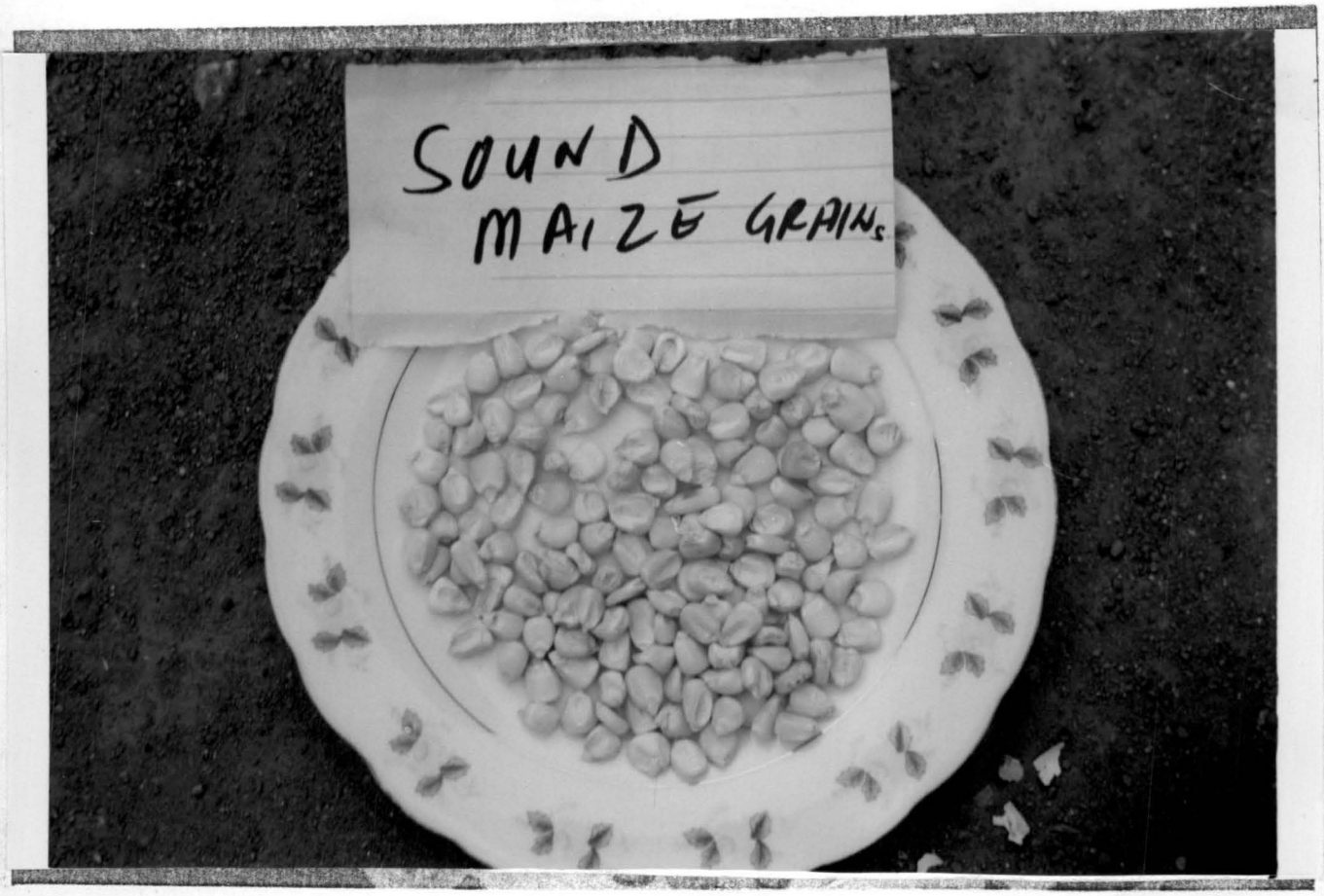


Plate 3a: sound maize grains

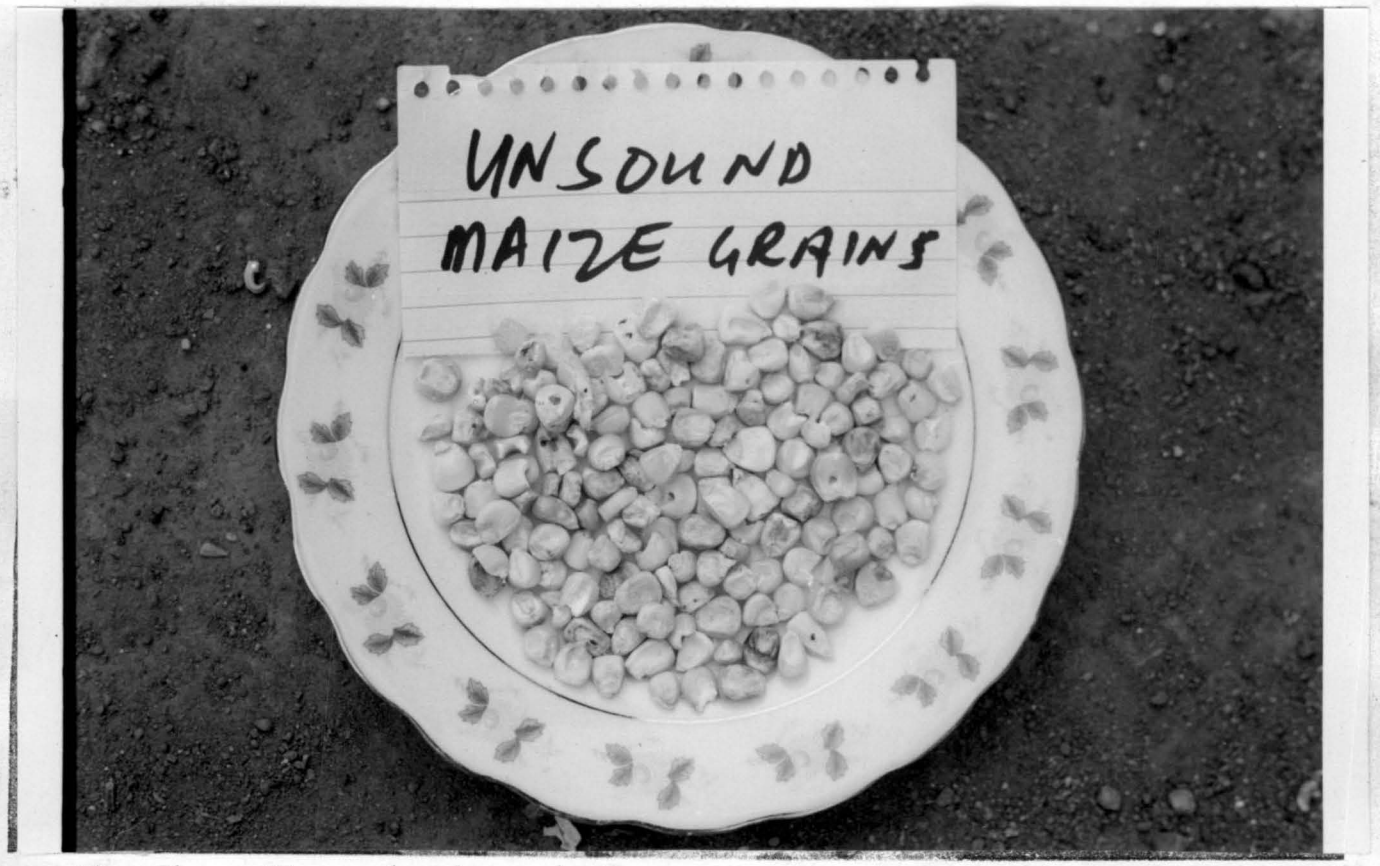


Plate 3b: Unsound maize grains

Plate 4a: Sound sorghum grains

Plate 4b: Unsound sorghum grains

Plate 5a: Sound millet grains

Plate 5b: Unsound millet grains

Plate 6a: Sound rice grains

Plate 6b: Unsound rice grains

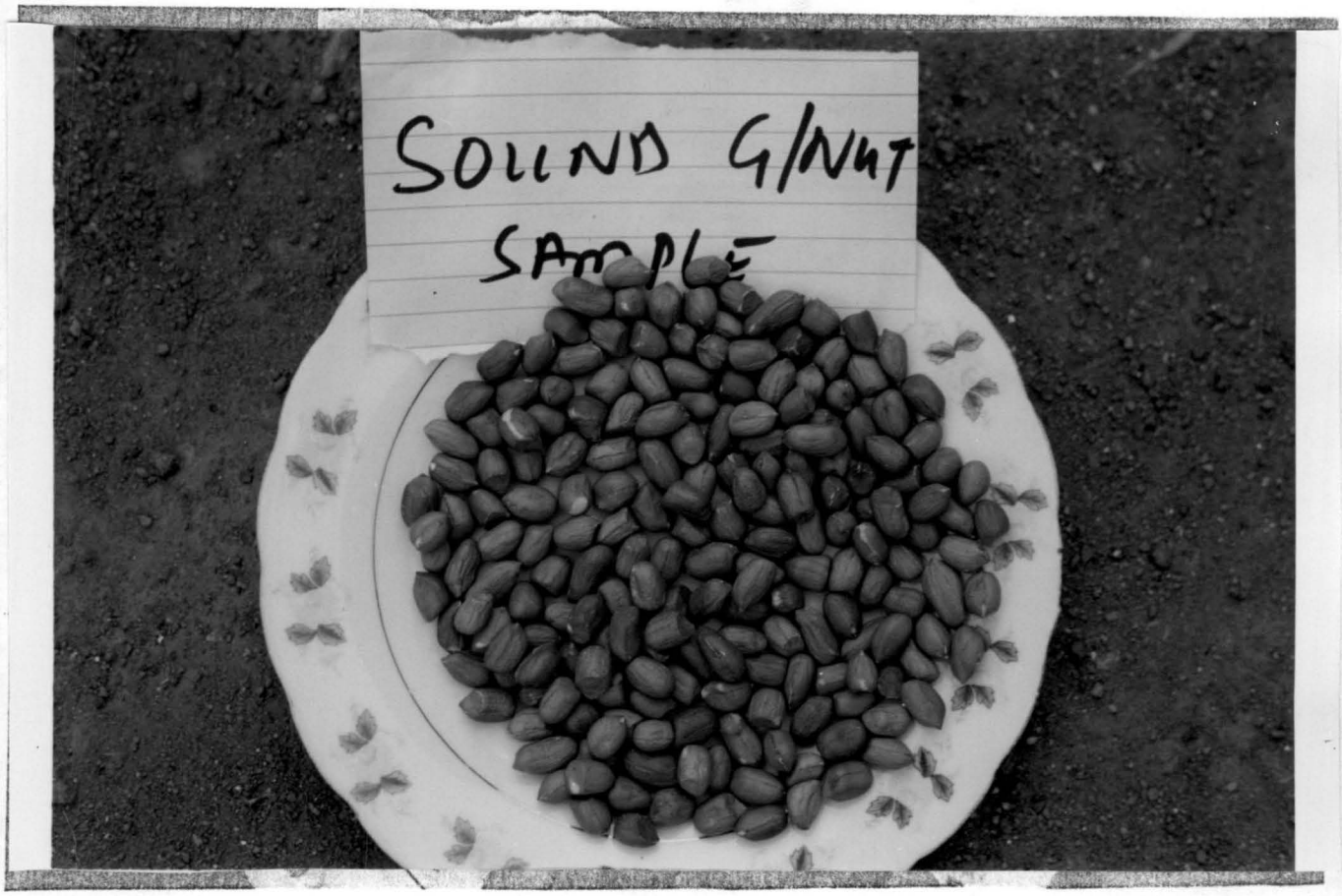


Plate 7a: Sound Ground nut grains

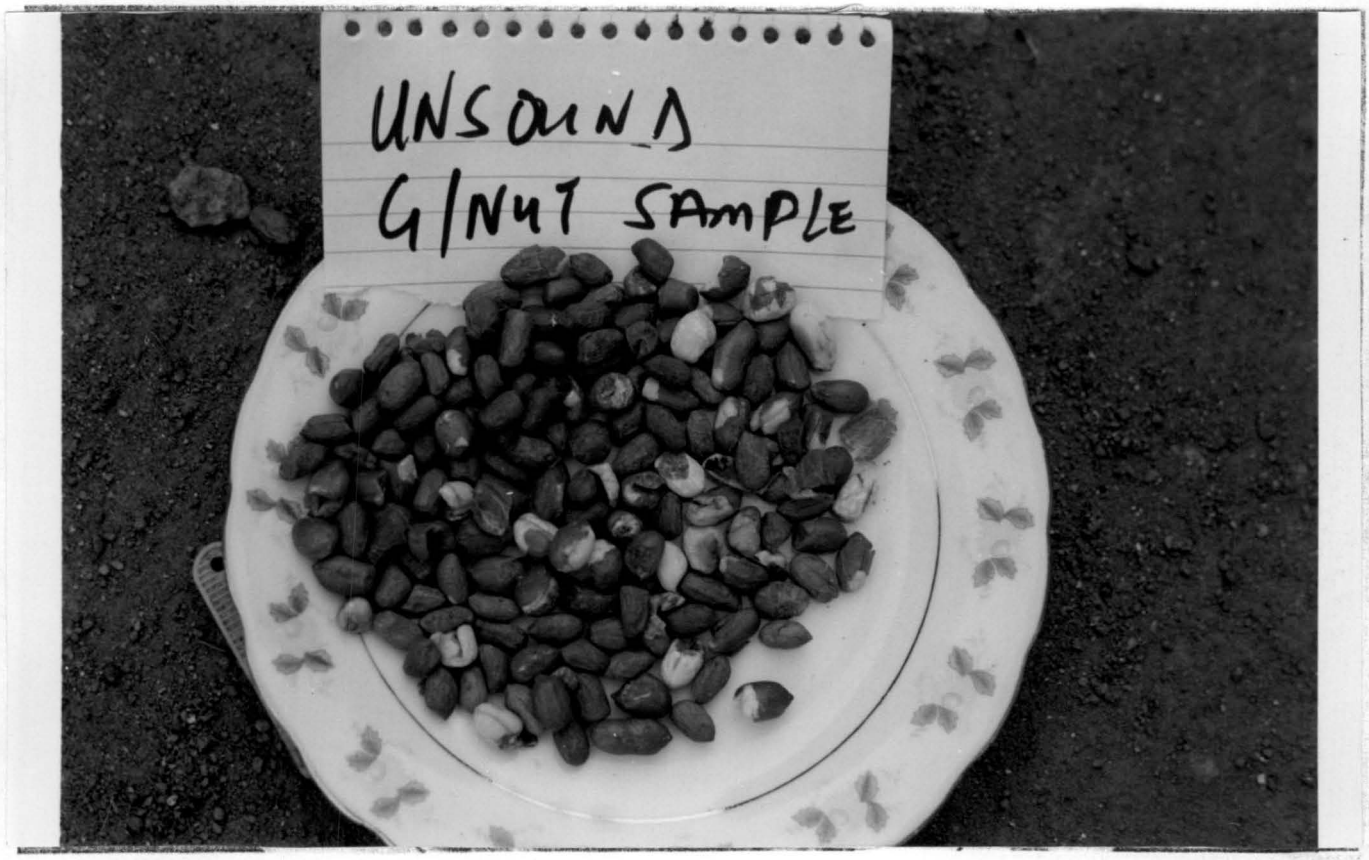


Plate 7b: Unsound Ground nut grains

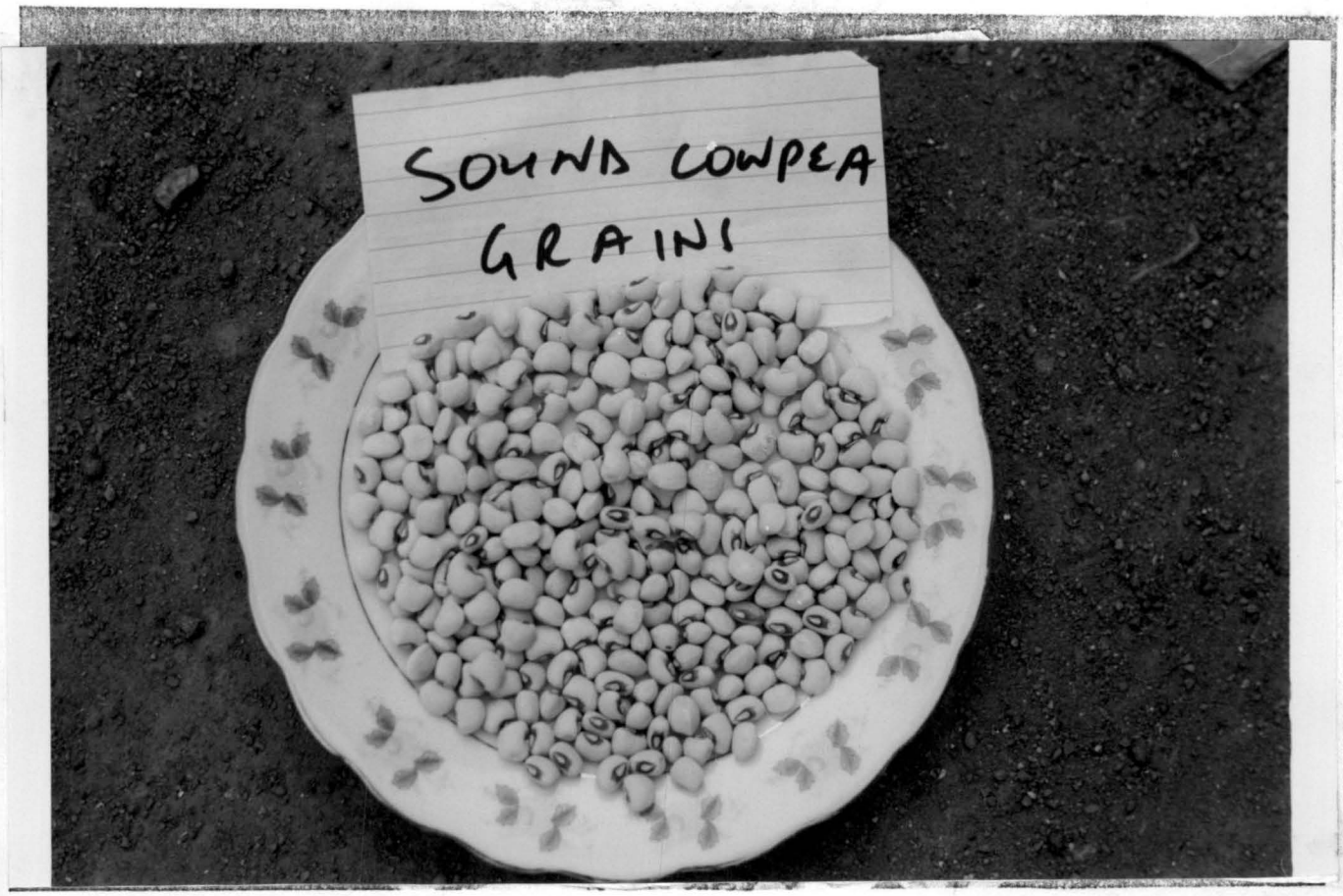


Plate 8a: Sound Cowpea grains

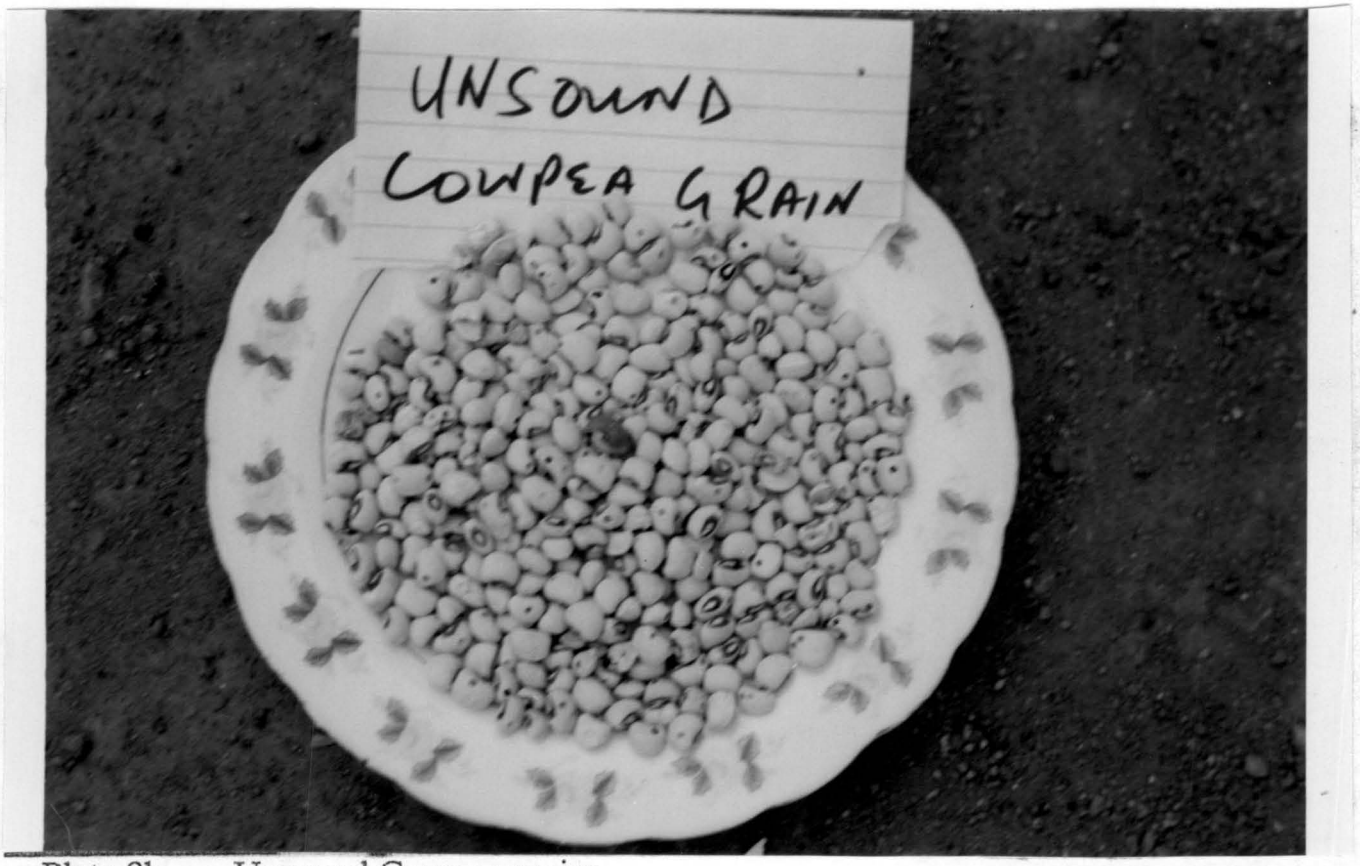


Plate 8b: Unsound Cowpea grains

CHAPTER FOUR

4.O RESULTS AND DISCUSSION.

4.1 SPREAD OF FARMERS CULTIVATING VARIOUS CROPS.

During the course of this work, it was discovered that most farmers do not grow only one type of crop. Almost all the farmers grew more than one cereal crop. The cereal crops most commonly grown by the farmers are maize, sorghum, Rice, Ground nut and cowpea, the table below shows the numbers growing the various crops.

TABLES 5: NUMBER OF FARMERS GROWING VARIOUS CROPS.

			NUMBER OF FARMERS GROWING:-					
S/No	L.G.A	NO FARMERS INTERVIEWED	MAIZE	MILLET	SORGHUM	RICE	G/NUT	CO-WPEA
1	KOGI	23	20	14	19	21	10	8
2.	LOKOJA	20	19	12	20	19	7	9
3.	OKEHI	22	19	10	16	15	15	10
4.	ADAVI	20	18	8	13	15	12	9
5.	AJAOKUTA	23	20	7	18	18	8	7
6.	OKENE	23	18	4	15	17	13	12
7.	OGORI AGONGO	24	17	2	14	16	12	6
		155	131	57	115	121	77	61

From the table above, it is seen that of the 155 farmers interviewed, 131 grew maize, 121Rice, 115 Sorghum, 77 G/nut, 61 cowpea with only 57 of

them growing millet. This shows that the most popular grain crops grown are maze, rice and sorghum in that order.

4.2 ESTIMATION OF PERCENT WEIGHT LOSSES

The average percent weight lost per person in each local government area using the count weigh method in as presented in table 6 below.

TABLE 6: AVERAGE PERCENT WEIGHT LOST PER PERSON USING COUNT AND WEIGH METHOD.

		PERCENT WEIGHT LOST FOR					
S/No	L.G.A	MAIZE	MILLET	SORGHUM	RICE	G/NUT	COWPEA
1	KOGI	6.07	4.62	3.31	3.25	6.54	2.81
2.	LOKOJA	5.77	3.82	3.19	3.80	8.55	2.65
3.	OKEHI	8.04	4.70	4.68	4.11	7.82	3.13
4.	ADAVI	8.67	3.19	4.79	2.84	7.78	4.06
5.	AJAOKUTA	6.71	3.74	4.32	4.35	9.33	3.11
6.	OKENE	5.24	5.02	3.99	3.88	9.80	3.53
7.	OGORIMA-GONGO	6.39	4.32	5.51	3.27	7.43	4.20

From table 6 highest percent weight lost for maize (8.67%) is from Adavi LGA Millet (5.02%) from Okene L.G.A sorghum (4.79%) also from Adavi, rice (4.11%) from Okehi, G/nut (9.80%) from Okene and cowpea (4.20%) from Ogori magongo L.G.A.

4.3.1 QUALITY LOSSES DETECTION

Some farmers reported noticing changes in the quality (colour, taste, viability etc) of the stored grains after storage period. This is present in Table 7.

TABLE 7 NUMBER OF FARMERS THAT NOTICED QUALITY CHANGES

		Number of Farmers that Notice Changes in:				
S/NO	CROP	COLOUR	ODOUR	TASTE	VIABILIITY	MOULD & Rot
1	MAIZE	43	28	13	5	10
2	MILLET	15	10	-	2	-
3.	SORGHUM	35	20	-	3	-
4.	RICE	7	5	3	8	12
5.	G/NUT	18	12	13	10	24
6.	COWPEA	7	12	15	7	11

As indicated from the table 7 above of the seventy seven farmers involved in cultivating G/nut, 18 farmers (23.38%) reported noticing changes in colour, 15.58%, 16.88%, 12.99% and 31.17% reported noticing changes in odour, taste, viability and moulding and rotting respectively.

4.4 PRICE REDUCTION AFTER QUALITY LOSS.

Table 8 below indicates the number of farmers that reported various percentage reduction in prices of the grain after quality loss has taken place.

TABLE 8: NUMBER OF FARMERS THAT REPORTED PRICE REDUCTION .

		NO OF FARMERS THAT REPORTED PRICE REDUCTION OF				
S/No	CROP	0-10%	11%-20%	21-30%	31%-40%	41%-50%
1	MAIZE	34	17	15	9	5
2	MILLET	17	13	8	5	3
3.	SORGHUM	28	19	21	13	6
4.	RICE	31	23	11	2	-
5.	G/NUT	22	13	8	7	8
6.	COWPEA	23	18	7	9	6
7.	TATOL	155	103	70	45	28

All the farmers in interviewed reported price reduction of between 0-10% with 103 reporting reduction between 11-20%, 70 reported reduction of 21%-30%, 45 farmers reported reduction of 31-40% and 28 farmers reported as much as 50% reduction in prices of the grain after quality loss has after place.

4.5. DISTRIBUTION OF GRAIN STORAGE STRUCTURES

The spread of the grains storage structure/methods used is presented in Figs. 11 -17 below. From the figures, bag storage is most popular with the farmers in all the seven LGAs studied. This method of storage is being practiced by about 87.74% of the people interviewed.

This is followed by grain storage in living houses with 81.94% of the farmers practicing housing storage and then Rhumbu being practiced by about 76.13%. The least method being used by farmers to store their grains in the L.G.A Stored in Silo being used by only 4.52% of the farmers.

The predominant interest in the use of bag as mean of storage could be because of the adequate measures that can be taken to protect it from various agents of grain losses. Also airtight storage of the grain can be achieved by the used of polythene bags inside the bags. This eliminates the use of chemical insecticide which could be injurious to health if not properly handled, not to talk of their prohibitive cost.

Quantities of grain produced in each of the seven local government areas of the state are as shown in table 9 below.

TABLE 9: QUANTITY OF GRAINS PRODUCED IN THE YEAR 2003/2004 CROPPING SEASON (TONNES)

LGA	No of farmers	Maize	Millet	Sorghum	Rice	g/nut	Cowpea	Total
ICOGI	23	1238.1	184	970.3	941.1	372.5	393.8	4,099.8
LOKOJA	20	1079.4	152	876.2	152	154	489.1	2,902.7
OKEHI	22	1660	107	1430	107	128.3	1231.4	4,663.8

Adavi	20	1021.5	145.8	930	146.8	232.1	257.8	2,734
Ajaokuta	23	1248.6	111	687	121	224	220.7	2,612.3
Okene	23	1483	578.9	1040	607	191.8	866.2	4,766.9
O/Magongo	24	1023	286	413.5	731.3	231.4	389.2	3,074.4
Total	155	8,753.6	1,564.7	6,347	2,806.2	1,534.1	3,848.2	24,853.9

As can be seen from the table 9, maize tops the list of annual production with 8,753.6 tones, then sorghum 6,347, cowpea 3,848.2, rice 2,806.2, millet 1,564.7 and groundnut 1,534.1 tones respectively. And the total production from all the seven local governments is about 24,853.9 tones.

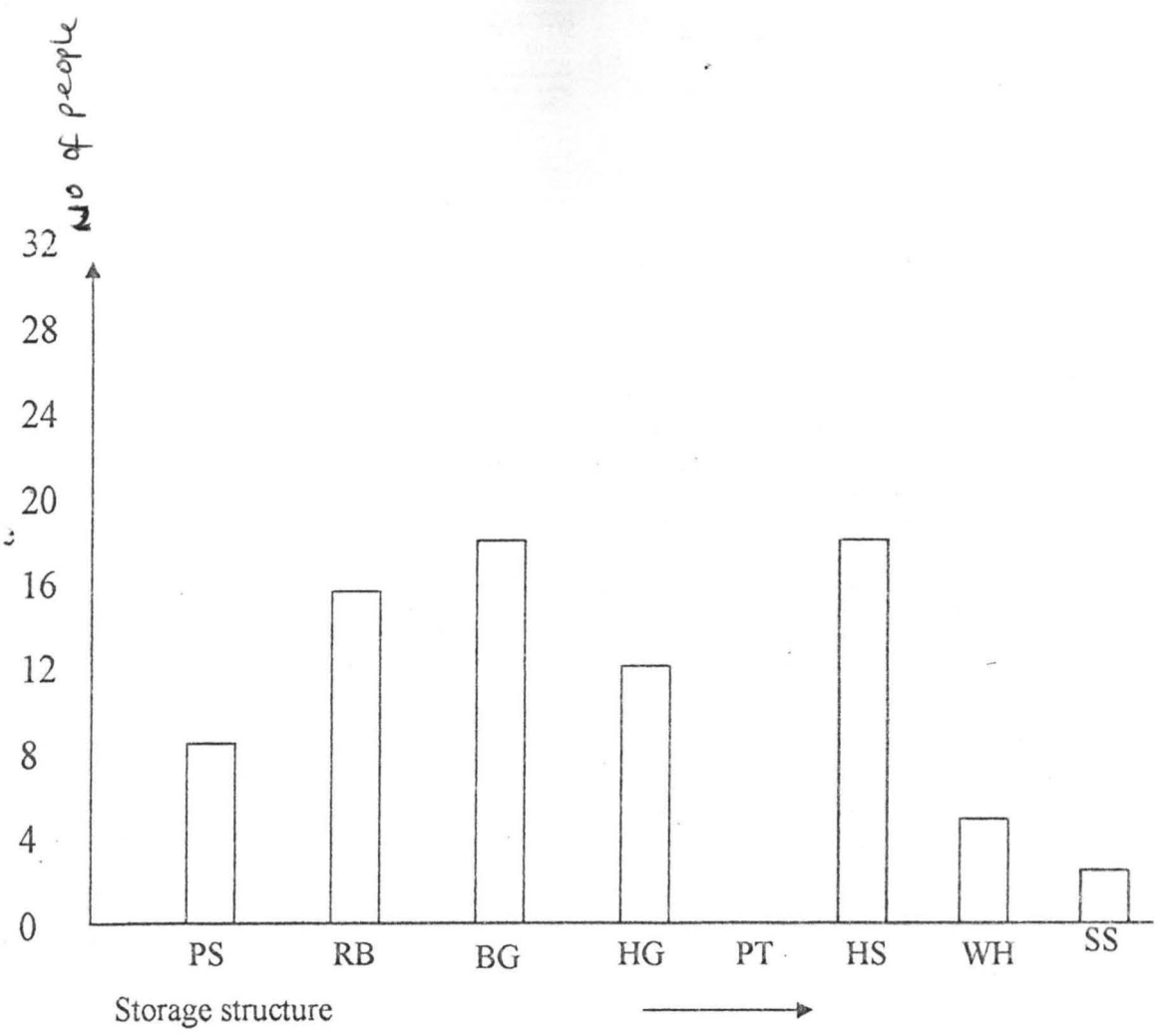


Fig. 11 DISTRIBUTION OF STORAGE STRUCTURES IN KOGI LOCAL GOVERNMENT AREA

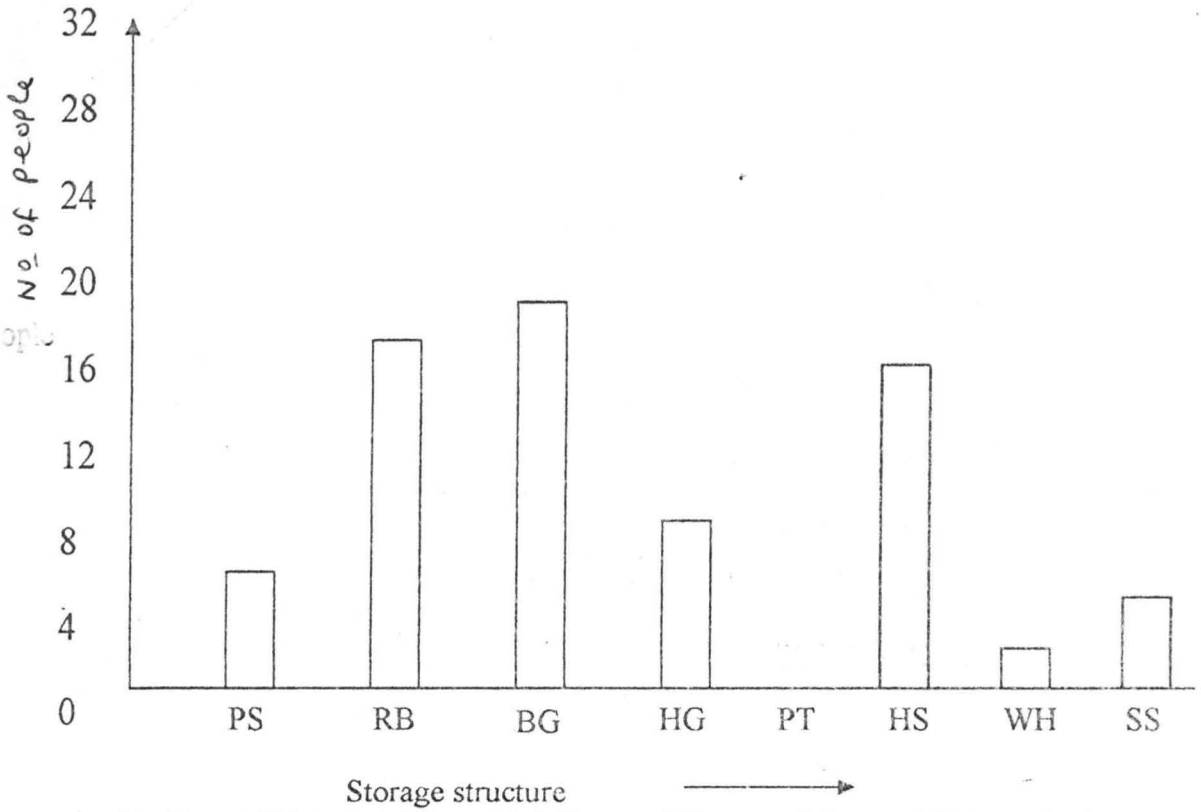


Fig. 12 DISTRIBUTION OF STORAGE STRUCTURES IN LOKOJA LOCAL GOVERNMENT AREA

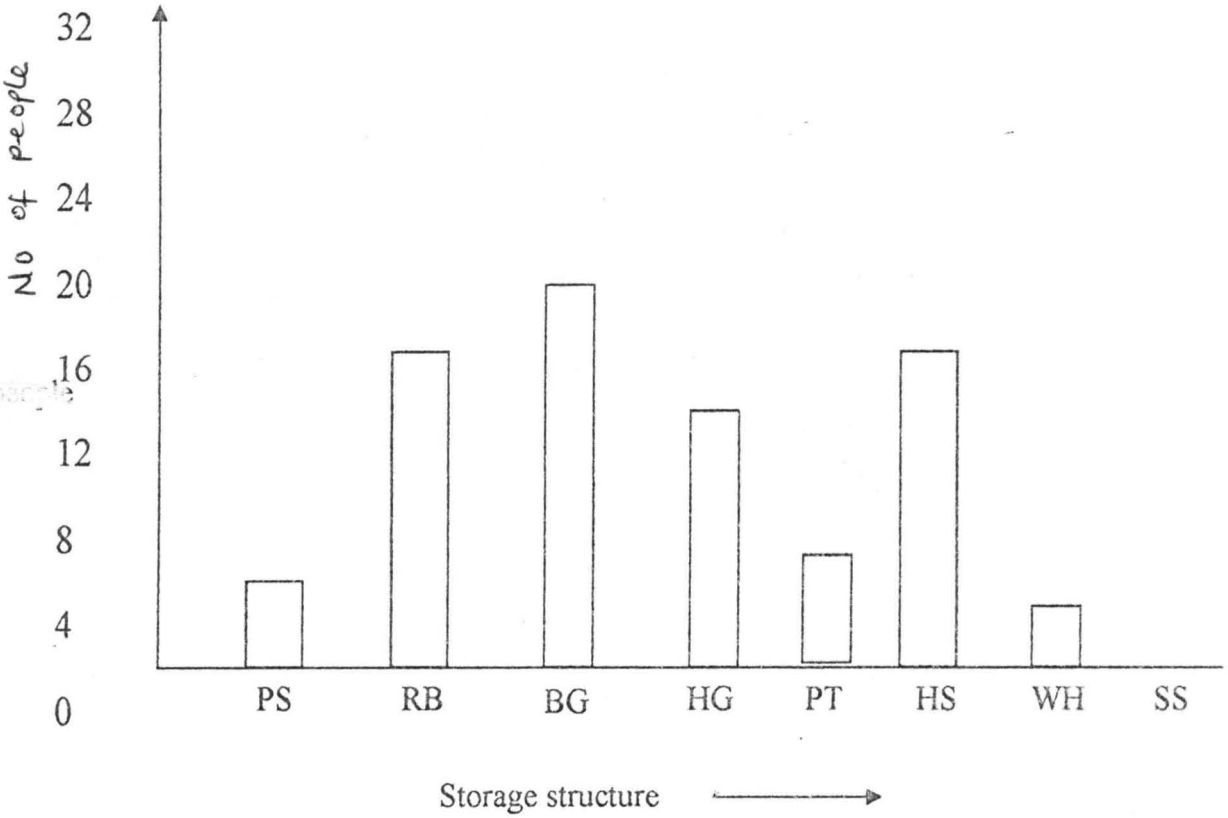


Fig. 13 DISTRIBUTION OF STORAGE STRUCTURES IN OKEHI LOCAL GOVERNMENT AREA

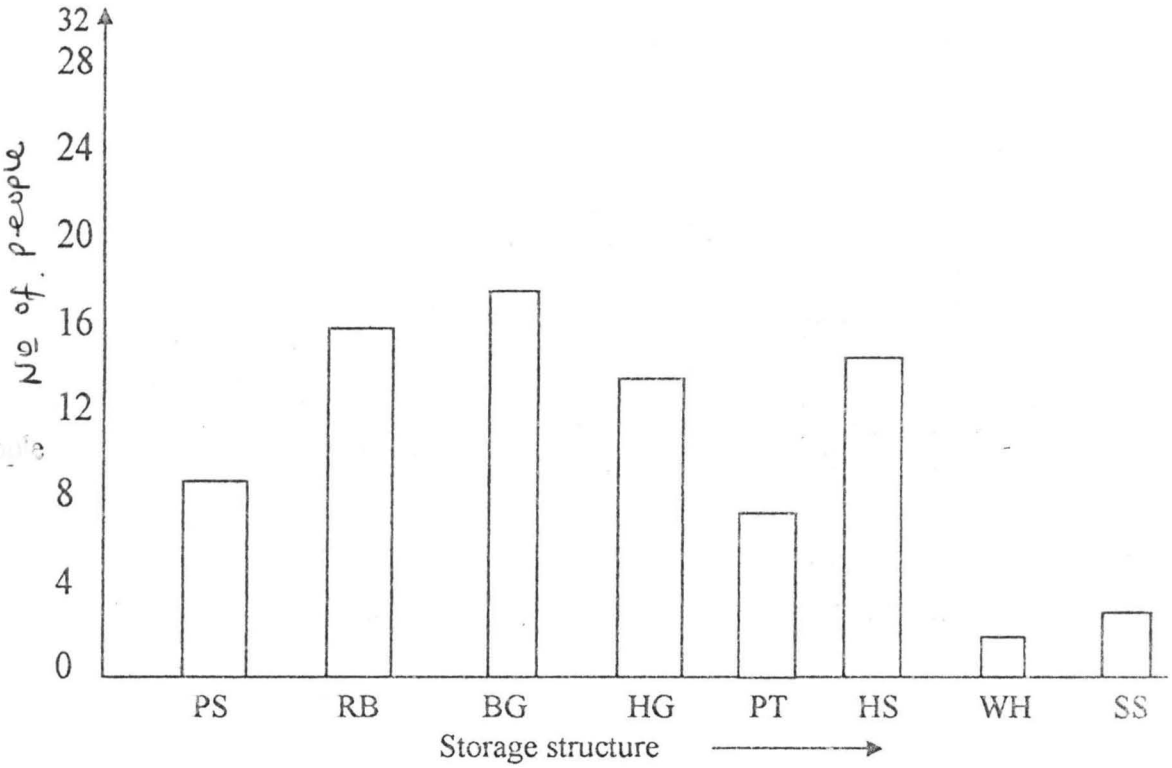


Fig. 14 DISTRIBUTION OF STORAGE STRUCTURES IN ADAVI LOCAL GOVERNMENT AREA

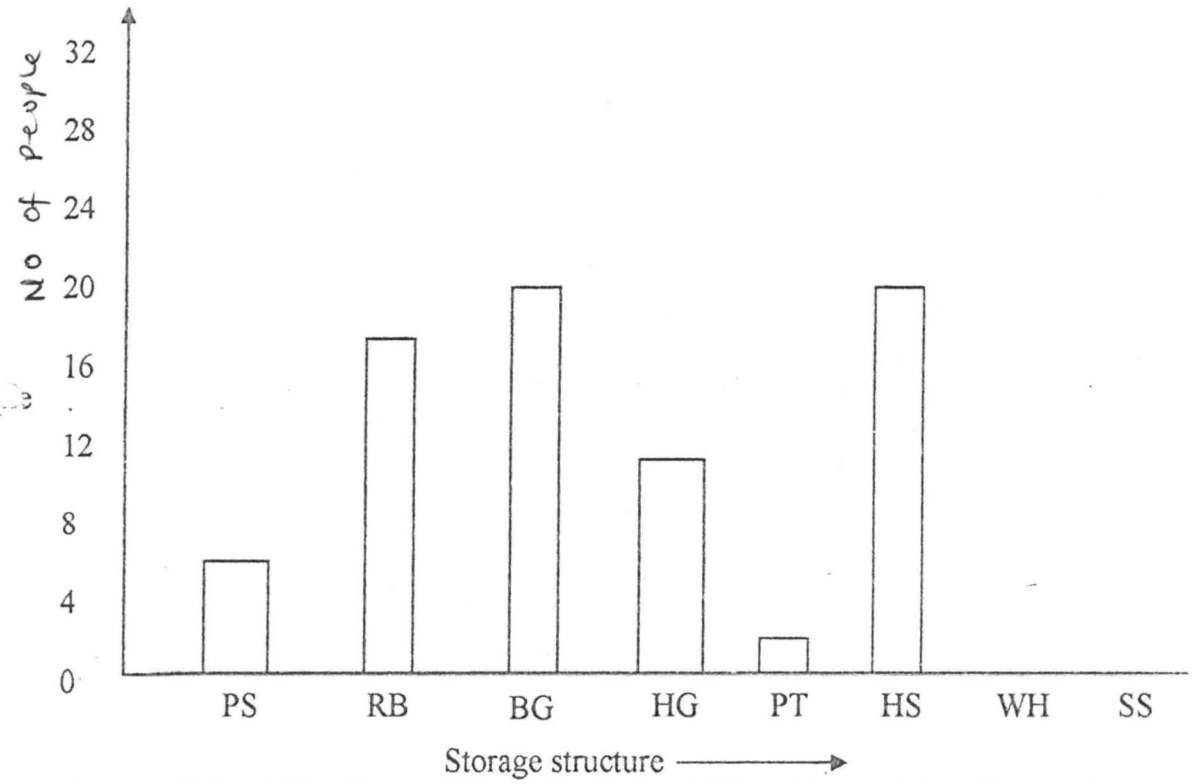


Fig. 15 DISTRIBUTION OF STORAGE STRUCTURES IN AJAOKUTA LOCAL GOVERNMENT AREA

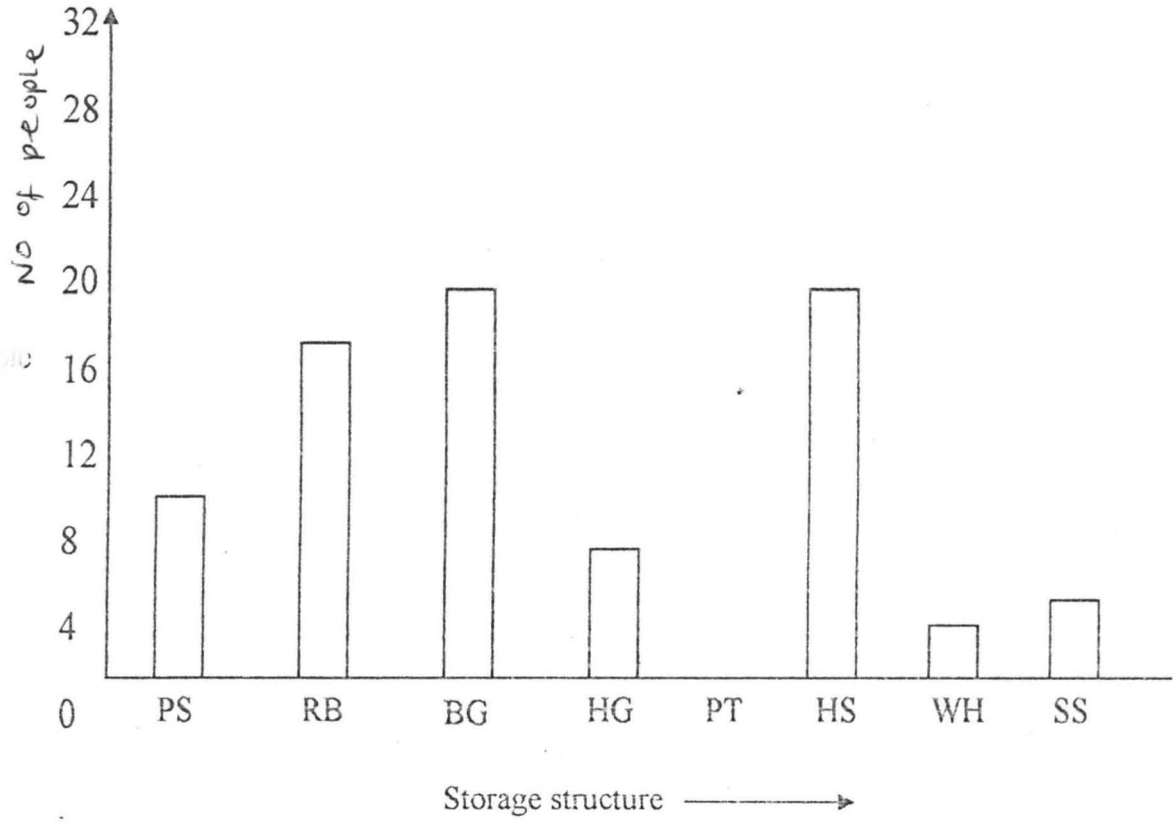


Fig. 16 DISTRIBUTION OF STORAGE STRUCTURES IN OKENE LOCAL GOVERNMENT AREA

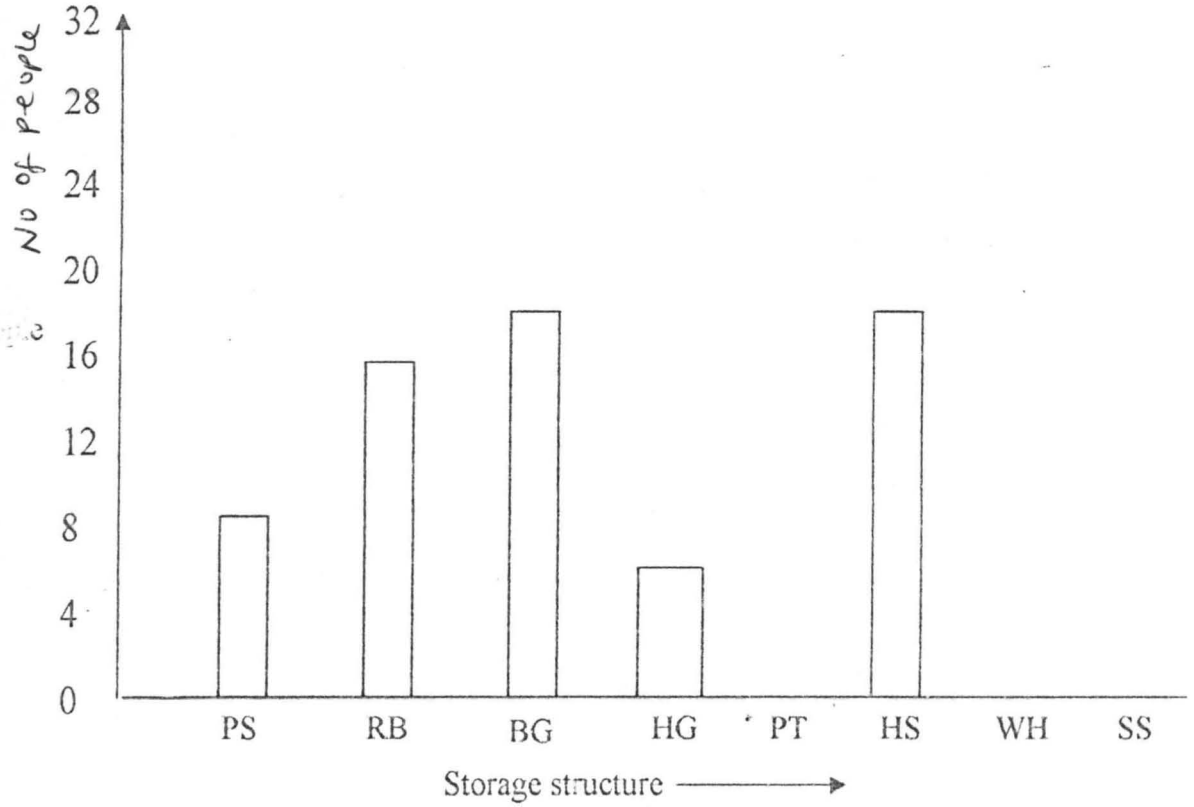


Fig. 1 DISTRIBUTION OF STORAGE STRUCTURES IN OGORI MAGONGO LOCAL GOVERNMENT AREA

Where PS= pot storage BG= bag storage PT= pit storage WH= warehouse

RB= Rhumbu storage HG= Hanging storage HS= Housing storage SS= Silo

Storage

4.6 QUANTITY OF GRAIN LOSS ESTIMATION

The summary of the quantity of grain lost per person, the grain lost to each agent of grain loss and the total grain lost in each of the seven local government areas are presented in tables 10 – 13 below.

Table 10: QUANTITY OF GRAINS LOST PER PERSON IN EACH LOCAL GOVT. AREA (kg/100kg)

		QUANTITY LOST (kg)						
S/No	L.G.A	MAIZE	MILLET	SORGHUM	RICE	G/NUT	COWPEA.	TOTAL/PER
1	KOGI	538	80	422	409	162	171	1782
2	LOKOJA	540	76	438	76	77	245	1452
3	OKEHI	755	49	650	49	58	560	2121
4	ADAVI	566	73	465	73	116	129	1361
5	AJAOKUTA	543	48	299	53	97	96	1186
6	OKENE	645	252	452	264	83	377	2073
7	O/MAGONGO	426	172	172	305	96	163	1281

The highest grain Loss of (2121 kg) per person occurred in Okehi L.G.A, then 2073 kg from Okene, 1782kg from Kogi and the least lost 1186 kg from Ajaokuta L.G.A. All these losses are based on kg lost per every 100kg stored, this implied that the farmer that lost 73kg of Rice must have stored about 7.3 tonnes of it. Table 11 below shows the quantity of grain loss to each of the six agents of losses in each local government area.

TABLE 11: QUANTITY OF GRAIN LOST TO EACH AGENT OF LOSS IN EACH LGA(KG)

Agent of loss	Kogi	Lokoja	Okehi	Adavi	Ajaok	Okene	O/Mag	Total
Insects	13185	8694	17298	8213	9219	17142	10923	84674
Rodents	8655	5898	8959	5605	5507	10711	5931	51266
Birds	4944	3727	4939	3782	3587	5892	4682	31553
Handling	9267	6984	9882	6259	6147	9906	5617	54062
Thieves	2267	1707	2780	1564	896	1340	2029	12583
Fire	2677	2017	2780	1826	768	2680	1562	1431
Total Per	40995	29027	46638	27249	26124	47671	30744	248448

TABLE 12: QUANTITY OF GRAIN LOST IN THE YEAR 2003/04 HARVEST SEASON IN EACH LGA(kg)

L.G.A	MAIZE	MILLET	SORGHUM	RICE	G/NUT	COWPE	TOTAL	PPLE
KOGI	12381	1840	9703	9411	3725	3938	40995	23
LOKOJA	10794	1520	8762	1520	1540	4891	29027	20
OKEHI	16600	1070	14300	1070	1283	12314	46638	22
ADAVI	10215	1458	9300	1468	2321	2578	27249	20
AJAOKUJ	12486	1110	6870	1210	2240	2207	26124	23
OKENE	14830	5789	10,400	6070	1918	8662	47671	233
OLI -MA	10230	2860	4135	7313	2314	3892	30744	24
Total	87,446	15,647	63470	28062	15,341	38482	248448	155

The percentage of grain lost in each local government areas on grain type bases is shown below.

TABLE 13: PERCENTAGE OF GRAIN LOST IN EACH L.G.A.

L.G.A	MAIZE	MILLET	SROGHUM	RICE	G/NUT	COWPEA
KOGI	14.16	11.76	15.29	33.52	24.28	10.23
LOKOJA	12.34	9.71	13.80	5.42	10.04	12.71
OKEHI	18.98	6.84	22.53	3.81	8.36	32.00
ADAVI	11.58	9.32	14.65	5.23	15.13	6.70
AJAOKUJA	14.28	7.09	10.82	4.31	14.61	5.74
OKENE	16.96	37.00	16.39	21.63	12.50	22.51
OGORI-MAGONGO	11.70	18.28	6.52	26.06	15.08	10.11

Table 12 above reveals that the highest lost of grain on grain type bases was recorded in maize (35.20%), then sorghum (25.55%), cowpea (15.49%), Rice (11.29%), Millet (6.30%) and G/nut (6.17%)

Also from the table and fig 26 below, it is apparent that Okene LGA recorded the highest form of grain lost of 19.20%, followed by Okehi 18.77%, Kogi, 16.50%, Ogorimagongo 12.37%, Lokoja 11.68%, Adavi 10.97% and Ajaokuta 10.51%.

The percentage of grain lost to each of the six agents of grain losses is as shown in fig 18 below.

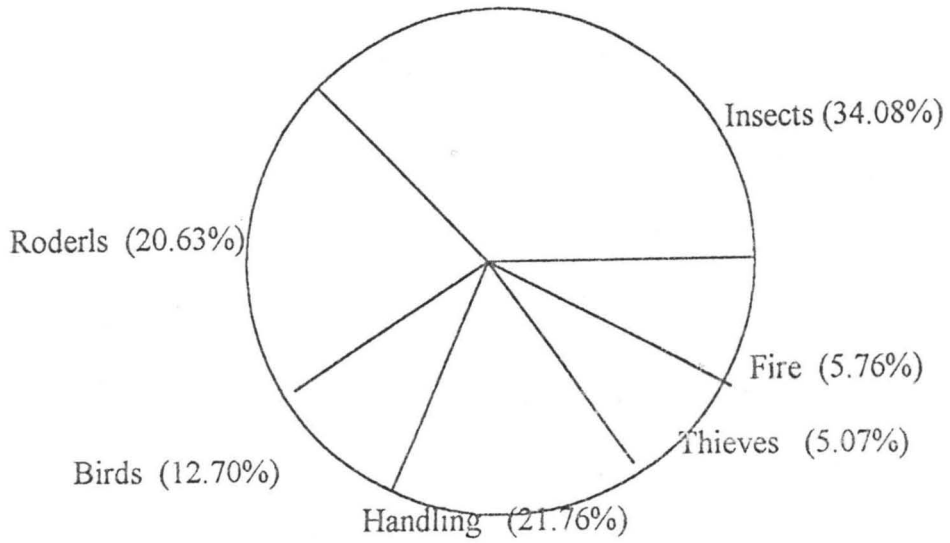


Fig 18: PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN THE SEVEN L.G.A

.Insects accounting for the highest percentage of the grain lost of about 34.08% is not surprising taking into consideration the fact that the predominant storage structures of bags, housing and Rhumbu. Insects can gain easy access to these structures and if not detected early could result in a lot of losses occurring.

Figures 19-25 below show the percentage of grain lost to each of the agent of losses in each of the seven L.G.A, where as appendices 1-42 show the percentage weight loss for the grain in each local government area using count and weigh method.

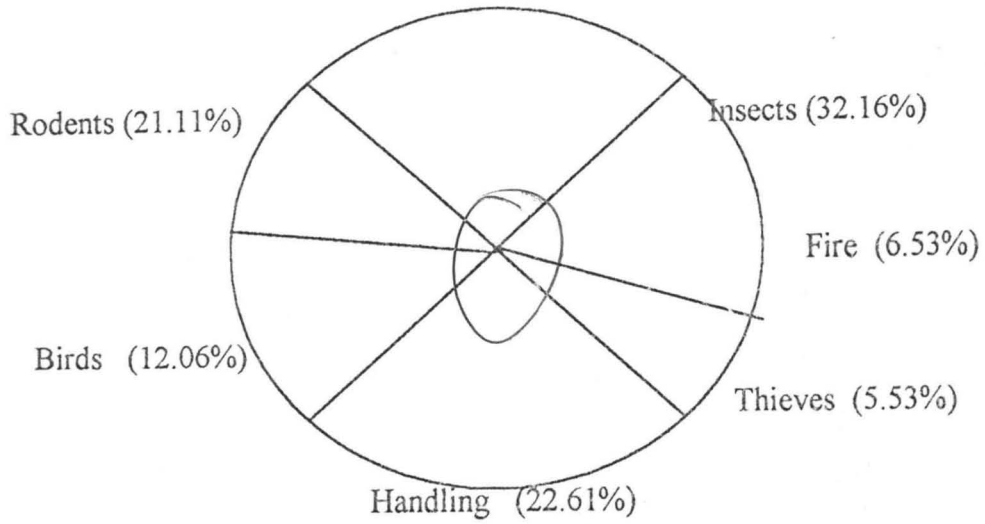


FIG. 19 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN KOGI LOCAL GOVERNMENT AREA

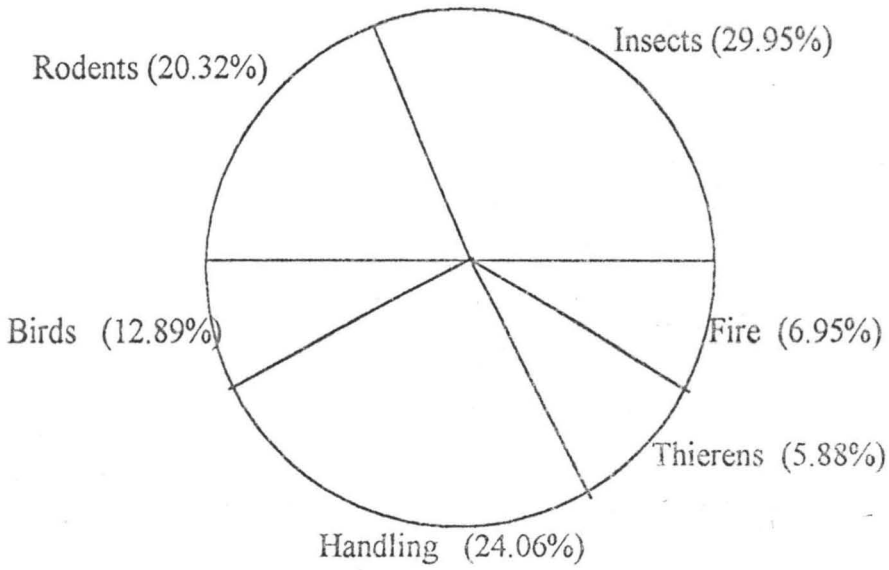


FIG: 20 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN LOKOJA LOCAL GOVERNMENT AREAS OF THE STATE.

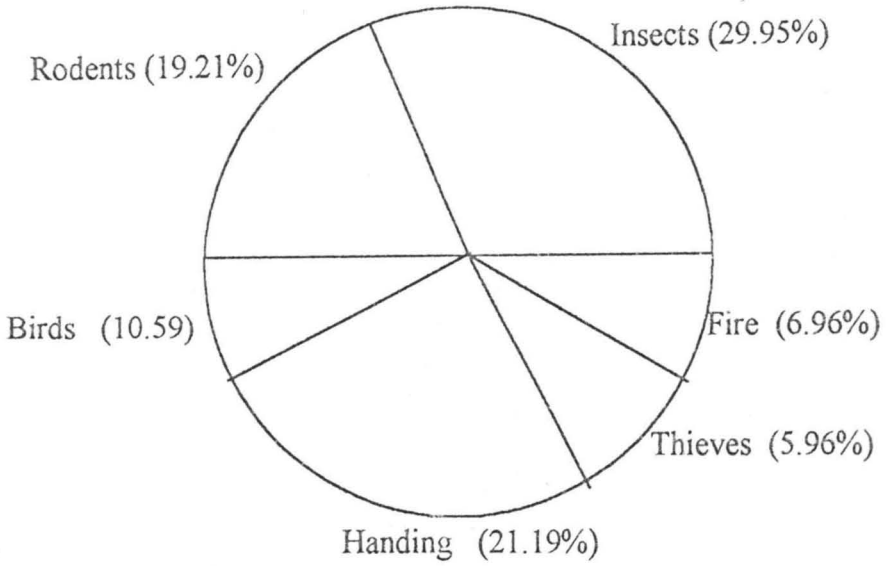


FIG: 21 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN OKEHI LOCAL GOVERNMENT AREAS OF THE STATE. .

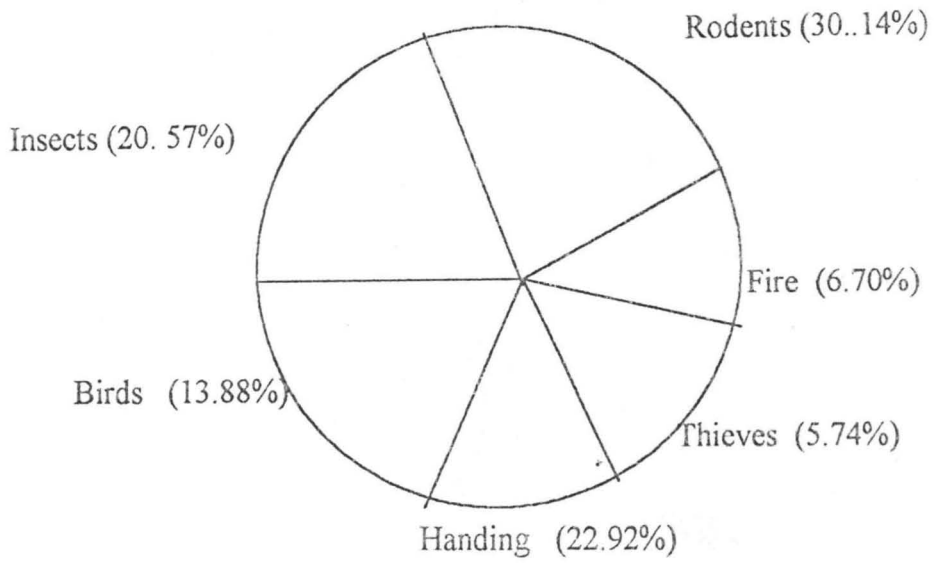


FIG: 22 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN LOCAL GOVERNMENT ADAVI AREA.

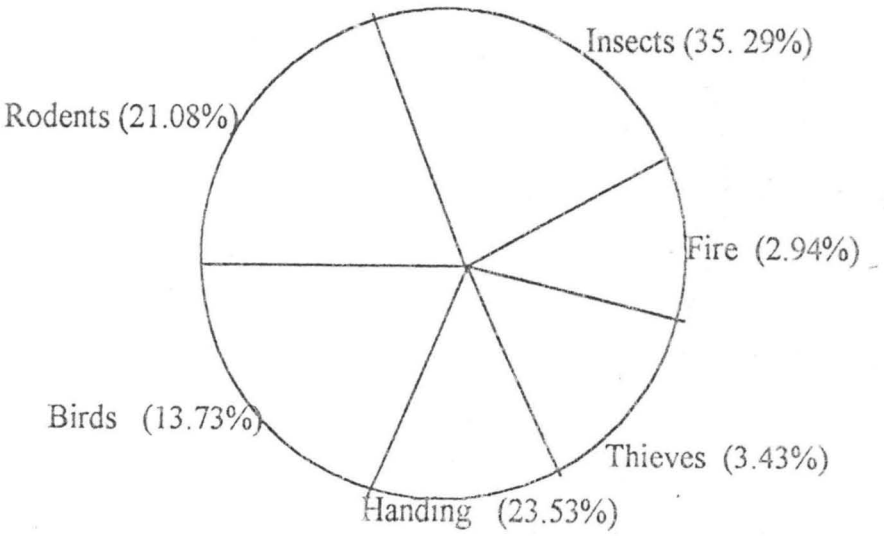


FIG: 23 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN AJAOKUTA LOCAL GOVERNMENT AREA .

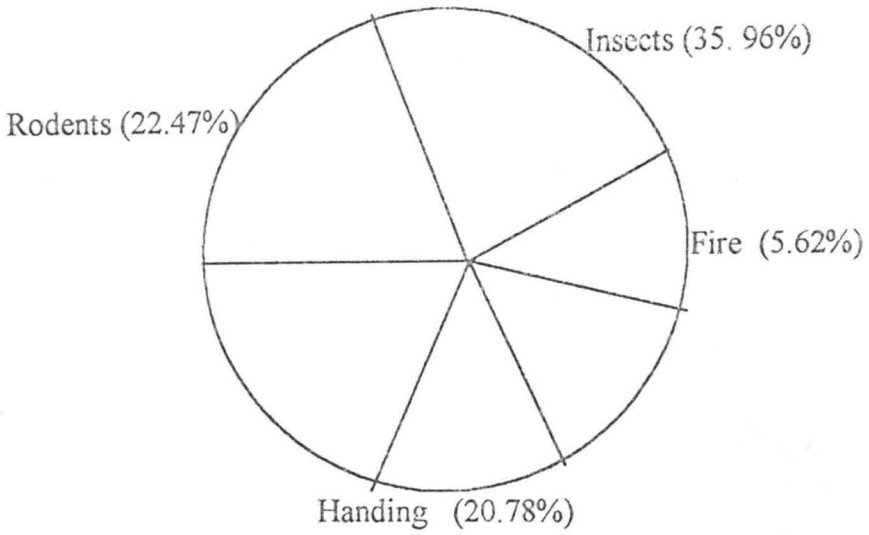


FIG: 24 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN OKENE LOCAL GOVERNMENT AREA.

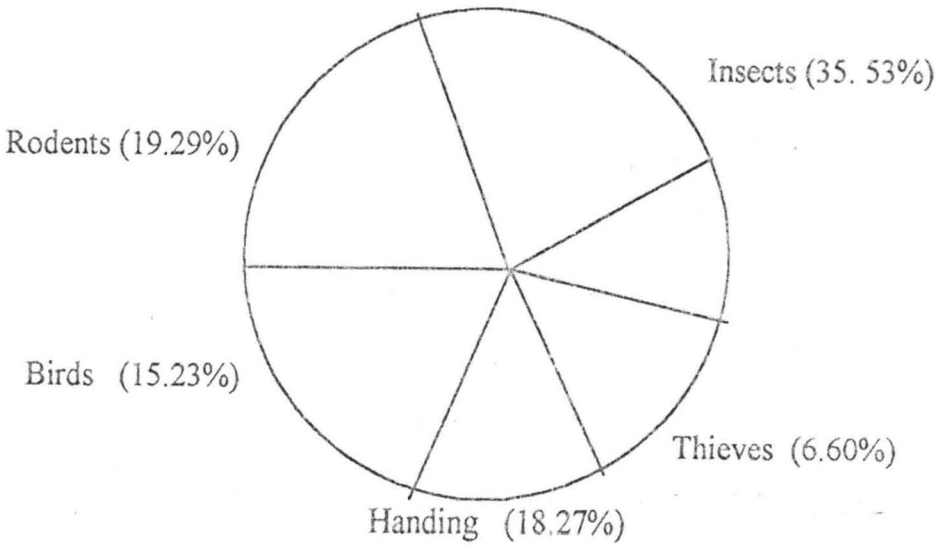


FIG: 25 PERCENTAGE OF GRAIN LOST TO THE AGENT OF LOSSES IN OGORI MAGONGO LOCAL GOVERNMENT AREA .

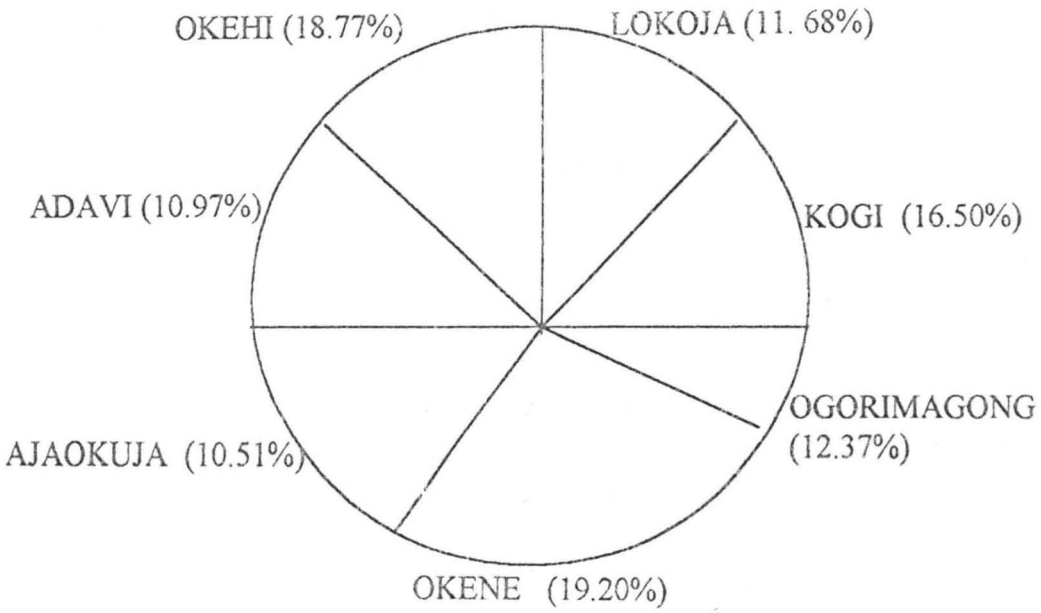


FIG: 26 PERCENTAGE OF GRAIN LOST IN EACH LOCAL GOVERNMENT AREA

CHAPTER FIVE

5:0 CONCLUSION AND RECOMMENDATION.

5:1 CONCLUSION

The study reveals that the three most popular grain crops grown in the state are Maize, Rice and Sorghum and the most predominantly used method of storage is bag or sack storage. It was also observed that insect, rodents and handling problems are the major sources of grain losses in the state.

The current level of grain losses can be reduced if proper measures are put in place by the farmers or grain merchants that store these grains.

5:2 RECOMMENDATION.

It is hereby recommended that:

i. The department should procure its own electronic weighing machine which is not currently available in the department. This will assist greatly in subsequent work that involves taking weight of small samples.

ii. Bags storage should be adopted by grain farmers/ Merchants but the floor of the store or rooms were bags of grain are stored should be made Rodent proof by lining with wire mesh or tin metals sheets.

iii. Bags of grains should be placed on wooden pallets to avoid moisture absorption. And such sack should be lined with polythene bag to create air tight condition.

iv. Only well threshed, cleaned, sorted and graded grains should be stored and strict hygienic conditions should be maintained.

v. Regular repairs of the storage structure should be carried out.

REFERENCES

Adeniji F.A. (1988). *Food preservation and processing, focusing on storage and processing of grains. A paper presented at the first National science and technology week, Borno state chapter, Maiduguri.*

Ajisegiri E.S.A. (1987). *Sorption phenomenon and storage stability of some tropical agricultural grains. Phd thesis, Agric Engineering Dept., University of Ibadan.*

Ajisegiri E.S.A. and Musa J.J. (1988) *grain storage structures method and losses in Kwara State. National Engineering conference series, Vol. 5 No 2 Pg231-236.*

Ajisegiri E.S.A (2002) *post harvest technology Development in Nigeria, 30 years of university of Ibadan. Aluelemhegbe publishers, Ibadan, Nigeria. Pg 57-61*

Birewar B.R. (1990). *Existing on farm grain storage facilities in Nigeria and suggested improvement. Agric. mech. in Asia, Africa and Latin America Vol. 21, No 2 Pg 58 -60*

Gwinner J, Harnisch R. and Musk O. (1990) *manual on the prevention of post harvest grain losses. Hamburg, 1990. Pg 29-35.*

Harris, K.L and Lindbald, C.J. *post harvest grain loss assessment methods,*

American Association of cereal Chemists, Washington Dc. 1978.

Idah. P.A. Lecture Materials *on storage techniques and food management for 2001/2002 session in PGD Agric Engineering, Agric Engineering Dept of Fed. University of Technology Minna*

Igbeka J.C. (1983). *Evaluation of grain storage techniques in Nigeria, AJST Vol. 2, No2 Pg 22-34.*

Kinta, A. A (2003) *Village level crop storage structures in middle belt of Nigeria. A PGD Seminar presentation to Agric Engineering Dept of F.U .T. Minna*

Kogi State hand book, (2001) *vol. II No 1 Pg 2-5.*

Mijinyawa Y. (2002), *Farm structures, Aluelemhegbe publishers, Ibadon Nigeria Pg 31-35*

Sahay K.M, and Singh K.K. *unit operations in Agricultural processing, Vikas publishing house PVT limited,* 1994. Pg 179-183.

Salunkhe D.K, Kadam S.S and Chavan J.K, *post harvest Biotechnology of food Legumes CRC press inc, Boca Raton, Florida,* 1985, Pg 79-85.

Segun O.O (1988) *A study of grain storage structures and losses in Fed capital Territory and Kaduna State. B. Eng. Thesis, Agric Engineering Dept. F.U.T Minna.*

APPENDIX 1: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN KOGI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	151.65	64	9705.6	12.63	426	5350.38	4325.22	490	74308.5	5.82 %
2	155.71	70	11055.41	14.73	450	6624	4431.41	5200	80964	5.47
3	139.31	61	8497.91	12.09	400	4836	3661.91	461	64221.91	5.70
4	89.45	56	5009.20	11.00	288	3168	1841.20	324	28981.8	6.35
5	154.30	77	11881.1	15.04	498	7489.92	4391.18	574	88722.5	7.02

APPENDIX 2: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN LOKOJA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	197.63	86	16996.18	15.45	539	8327.55	625	8668.63	123518.75	7.02
2	118.30	67	7926.1	14.50	413	5988.5	450	1937.6	56784	3.41
3	179.01	87	15573.87	17.40	601	10457.4	658	5116.47	123158.83	4.15
4	144.85	100	14485	15.99	431	6891.69	531	7593.31	76915.35	9.87
5	184.67	84	15512.28	16.28	608	9898.24	692	5614.04	127791.64	4.39

APPENDIX 3: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	166.39	92	16139.83	17.05	420	7161	517	8978.83	86023.63	10.44
2	204	98	19992	17.41	504	87746	602	11217.36	122808	9.13
3	151.13	75	11334.75	13.39	420	5623.8	495	5710.95	74809.35	7.63
4	131.54	82	10786.28	15.30	407	6227.1	489	4559.18	64323.06	7.09
5	91.96	80	7356.86	13.83	367	5075.61	447	2281.19	39266.92	5.9

APPENDIX 4: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	127.69	95	12130.55	19.27	375	7226.25	470	4904.3	600143	8.17
2	169.12	100	16912	19.65	413	8115.45	513	8796.55	86758.56	10.14
3	202.65	88	17833.2	16.66	574	9562.84	662	8270.36	134154.3	6.17
4	81.13	72	5841.36	12.88	243	3056.94	315	2784.42	25555.95	10.90
5	118.57	68	8062.76	11.58	350	4053	418	4009.76	49562.26	8.10

APPENDIX 5: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	162.00	88	14256	16.37	449	7350.13	537	6905.87	86994	7.94
2	203.28	84	17075.52	14.60	608	8876.8	692	8198.72	140669.76	5.83
3	222.12	74	16436.88	13.73	563	7729.99	637	8706.89	141490.44	6.15
4	120.20	75	9015	13.97	397	5546.09	472	3468.91	56734.4	6.11
5	136.25	64	8720	12.06	361	4353.66	425	4366.34	57919	7.54

APPENDIX 6: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN OKENELGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	113.35	73	8274.55	13.93	418	5822.74	491	2451.81	55654.85	4.41
2	180.35	88	15870.8	16.62	415	6897.3	503	8973.5	90716.05	9.98
3	110.20	92	1038.4	16.84	530	8925.2	622	1213.2	68544.4	1.77
4	143.95	65	9343.75	11.33	379	4294.07	444	5049.68	63825	7.91
5	107.94	64	6908.16	12.60	450	5670	514	1238.16	55481.16	2.23

APPENDIX 7: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MAIZE IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	92.30	90	8307	12.62	478	6032.36	428	2274.64	39504.4	5.76
2	224.06	96	21509.76	17.06	576	9826.56	672	11683.2	150568.32	7.76
3	150.37	88	13232.56	15.97	419	6691.43	506	6541.13	76237.59	8.58
4	144.20	88	12112.8	14.77	591	8729.09	675	3383.73	97335	3.48
5	152.80	74	11307.2	14.20	443	6290.6	517	5016.6	789976.35	6.35

Average percentage weight lost for maize in the state using count and weigh method = 6.84%

Where Wu = weight of undamaged grains (g)

Nu = number of undamaged grains

Wd = weight of damaged grains (g)

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu\ (Nd+Nu)} \times 100$ = percent weight lost

APPENDIX 8: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN KOGI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.75	60	525	2.07	210	434.70	90.30	270	2362.5	3.82
2	5.95	63	374.85	2.14	150	321.00	53.85	213	1267.35	4.25
3	9.38	65	609.70	3.12	180	561.60	48.1	245	2298.10	2.09
4	7.49	76	569.24	2.9	175	507.5	61.74	251	1879.99	3.28
5	6.52	68	443.36	2.68	149	399.32	44.04	217	1414.84	3.11

APPENDIX 9: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN LOKOJA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.75	70	612.5	2.88	194	558.72	53.78	264	2310	2.33
2	6.95	73	507.35	2.67	170	453.9	53.45	243	1688.85	3.16
3	9.75	65	633.75	2.70	214	577.8	55.95	279	2720.25	2.06
4	8.80	67	589.6	2.77	176	487.52	102.08	243	2138.40	4.77
5	820	66	541.2	3.30	145	478.5	62.70	211	1730.2	3.62

APPENDIX 10: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.50	60	510	2.02	210	424.20	85.8	270	2295.	3.74
2	7.34	68	499.12	2.82	150	423	76.12	218	1600.12	4.76
3	6.05	63	381.15	2.14	154	329.56	51.59	217	1312.85	3.92
4	7.75	70	542.50	2.88	167	480.96	61.54	237	1836.75	3.35
5	8.00	65	520	2.70	145	391.50	128.50	210	1680	7.65

APPENDIX 11: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.98	63	502.74	2.41	170	409.7	93.04	233	1859.34	5.00
2	8.70	65	565.50	2.57	200	514	51.5	265	2305.50	2.23
3	7.40	68	503.2	2.60	150	390	113.2	218	1613.2	7.02
4	6.51	70	455.7	2.68	147	393.96	61.74	217	1412.67	4.37
5	7.01	66	462.66	2.13	175	372.75	89.91	241	1689.41	5.32

APPENDIX 12: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.67	65	563.55	2.75	176	484	79.55	241	2089.47	3.81
2	6.85	72	493.20	2.69	145	390.05	1031.5	217	1486.45	6.94
3	9.72	69	670.68	2.61	221	576.81	93.87	290	2818.8	3.33
4	8.57	68	582.76	2.86	167	477.62	105.14	235	2013.95	5.22
5	6.98	65	453.70	2.72	154	418.88	34.82	219	1528.62	2.28

APPENDIX 13: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN OKENE LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.13	77	549.01	2.80	167	467.6	81.41	244	1739.72	4.68
2	6.90	74	510.6	2.70	174	469.8	40.80	248	1711.20	2.38
3	7.82	67	523.94	2.67	170	453.9	70.04	237	1853.38	3.78
4	8.60	66	567.60	2.80	176	492.8	74.8	242	2081.20	3.60
5	7.50	63	472.5	2.14	175	374.5	98	238	1785	5.49

APPENDIX 14: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR SORGHUM IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.01	67	536.67	2.75	145	398.75	137.92	212	1698.12	8.12
2	7.45	66	491.70	2.87	154	441.98	49.72	220	1639.00	3.03
3	7.35	65	477.75	2.70	150	405.00	72.75	215	1580.25	4.60
4	7.28	73	531.44	2.67	149	397.83	133.61	222	1616.16	8.27
5	7.81	70	546.70	2.88	167	480.96	65.74	237	1850.97	3.55

Average percentage weight lost for sorghum in the state using count and weigh method = 4.26%

Where Wu = weight of undamaged grains (g)

Nu = number of undamaged grains

Wd = weight of damaged grains (g)

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu\ (Nd+Nu)} \times 100$ = percent weight lost

APPENDIX 15: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN KOGI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.60	110	836	1.55	396	613.80	222.20	506	3845.60	5.78
2	8.43	123	1036.89	1.85	440	814	222.89	563	4746.09	4.69
3	5.60	98	548.80	1.60	285	456	92.80	383	2144.80	4.33
4	5.08	95	482.60	1.45	275	398.75	83.85	370	1879.60	4.46
5	6.20	97	601.40	1.57	320	502.4	99.00	417	2585.4	3.83

APPENDIX 16: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN LOKOJA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	12.60	233	2935.80	4.00	650	2600	335.80	883	11125.80	3.02
2	15.50	245	3797.50	3.91	800	3128	669.50	1045	16197.5	4.13
3	12.15	190	2308.50	3.20	627	2006.40	302.10	817	9926.55	3.04
4	11.20	200	2240.00	3.25	578	4878.50	361.50	778	8713.6	4.15
5	12.65	198	25004.70	3.06	653	1998018	506.52	851	10765.15	4.71

APPENDIX 17: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.50	112	840	1.55	387	599.85	240.15	499	3742.50	6.42
2	8.43	132	1112.76	2.00	435	870.00	242.76	567	4779.81	5.08
3	5.43	97	526.71	1.60	280	448.00	78.71	377	2047.11	3.84
4	5.40	95	513	1.54	277	426.58	86.42	372	2008.80	4.30
5	6.18	97	599.46	1.60	319	510.40	89.06		2298.96	3.84

APPENDIX 18: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.53	121	1032.13	2.05	440	902	130.13	561	4785.33	2.72
2	5.43	98	532.14	1.56	280	436.8	95.34	378	2052.54	4.64
3	11.95	190	2270.50	3.24	617	1999.08	271.42	807	9643.65	2.81
4	12.60	197	2482.20	3.28	650	2132	350.20	847	10672.20	3.28
5	8.62	120	1034.40	2.05	445	912.25	122.15	565	4870.30	2.51

APPENDIX 19: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	12.01	190	2281.90	3.09	620	1915.8	366.10	810	9728.10	3.76
2	8.49	135	1146.15	2.23	438	978.74	169.41	573	4864.77	3.48
3	12.59	197	2480.23	3.28	650	2132.00	348.23	847	10663.73	3.27
4	15.11	240	3626.40	3.82	780	2979.60	646.8	1020	15412.2	4.19
5	8.39	132	1107.48	2.12	433	917.96	189.52	565	4740.35	3.99

APPENDIX 20: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.50	110	825	1.55	390	604.50	220.50	500	3750	5.88
2	7.81	132	1030.92	2.05	403	826.15	204.77	535	4178.35	4.90
3	5.62	98	550.76	1.51	290	437.9	112.86	388	2180.56	5.18
4	6.20	97	601.4	1.47	320	470.4	131	417	2585.40	5.07
5	5.33	95	506.35	1.55	275	426.25	80.10	370	1972.10	4.06

APPENDIX 21: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR MILLET IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	11.62	230	2672.6	3.67	600	2202	470.6	830	9644.60	4.88
2	14.92	241	3595.72	3.88	770	2987.6	608.12	1011	15084.12	4.03
3	12.60	197	2482.20	3.12	650	2028	454.20	847	10672.20	4.26
4	7.40	110	814.00	1.75	380	665	149	490	3626.00	4.11
5	7.40	120	888.00	1.99	382	760.18	127.82	402	2974.80	4.30

Average percentage weight lost for MILLET in the state using count and weigh method = 4.20%

Where Wu = weight of undamaged grains (g)

Nu = number of undamaged grains

Wd = weight of damaged grains (g)

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu\ (Nd+Nu)} \times 100$ = percent weight lost

APPENDIX 22: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN KOGI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	10.25	118	1209.50	1.95	497	469.15	240.35	615	6303.75	3.81
2	7.38	132	974.16	2.65	330	874.50	99.66	462	3409.56	2.92
3	8.91	188	1675.08	3.10	478	1481.80	193.28	666	5934.06	3.26
4	7.66	144	1103.04	2.88	344	990.72	112.32	488	3738.80	3.00
5	8.75	168	1470.00	2.74	470	1287.80	182.20	638	5582.50	3.28

APPENDIX 23: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN LOKOJA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	8.70	165	1435.50	2.63	467	1228.21	207.29	632	5498.40	3.77
2	7.40	128	947.20	2.48	331	820.88	126.32	459	3396.60	3.72
3	8.97	187	1677.39	3.03	487	1475.61	201.78	674	6045.78	3.34
4	10.30	120	1236.00	1.99	490	975.10	260.90	610	6283.00	4.15
5	7.57	140	1059.80	2.68	341	913.88	145.92	481	3641.17	4.00

APPENDIX 24: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	7.75	145	1123.75	2.91	346	1006.86	116.89	491	3805.25	3.07
2	8.65	170	1470.50	2.64	469	1238.16	232.34	639	5527.35	4.20
3	7.27	130	945.10	2.43	331	804.33	140.77	461	3351.47	4.20
4	8.79	178	1564.62	2.73	478	1304.94	259.68	656	5766.24	4.50
5	8.71	169	1471.99	2.57	472	1213.04	257.95	641	5583.11	4.60

APPENDIX 25: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.53	177	1509.81	2.92	475	1387	122.81	652	5561.56	2.21
2	8.76	171	1497.96	2.83	471	1332.93	165.03	642	5623.92	2.93
3	8.67	164	1421.88	2.64	476	1256.64	165.24	640	5548.80	2.98
4	7.28	118	859.04	2.32	328	760.96	98.08	446	3246.88	3.02
5	7.18	130	933.40	2.61	320	835.20	98.20	450	3231.00	3.04

APPENDIX 26: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	8.67	170	1473.90	2.69	469	1261.61	212.29	639	5540.13	3.83
2	8.73	178	1553.94	2.69	475	1277.75	276.19	653	5700.69	4.84
3	8.91	186	1657.26	3.05	485	1479.25	178.01	671	5978.61	2.98
4	8.58	168	1441.44	2.61	467	1218.87	222.57	635	5448.30	4.09
5	8.70	165	1435.50	2.33	473	1102.09	333.41	638	5550.60	6.01

APPENDIX 27: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN OKENE LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	8.67	177	1534.59	2.68	470	1259.60	274.99	647	5609.49	4.90
2	8.67	170	1473.90	2.75	468	1287	186.90	638	5531.46	3.38
3	8.59	169	1451.71	2.64	471	1243.44	208.27	640	5497.60	3.79
4	8.65	173	1496.45	2.70	469	1266.3	230.15	642	5553.30	4.14
5	8.69	165	1433.85	2.76	457	1261.32	172.53	622	5405.18	3.19

APPENDIX 28: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR RICE IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	8.75	172	1505	2.79	490	1367.10	137.90	662	5792.50	2.38
2	8.68	168	1458.24	2.65	476	1261.40	196.84	644	5589.92	3.52
3	8.62	171	1474.02	2.80	471	1318.80	155.22	642	5534.04	2.80
4	8.65	170	1470.50	2.70	469	1266.30	204.20	639	5527.35	3.69
5	8.55	165	1410.75	2.56	467	1195.52	215.23	632	5403.60	3.98

Average percentage weight lost for RICE in the state using count and weigh method = 3.64%

Where

Wu = weight of undamaged grains

Nu = number of undamaged grains

Wd = weight of damaged grains

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu\ (Nd+Nu)} \times 100$ = percent weight lost

APPENDIX 29: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN KOGI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	71.60	63	4510.8	8.34	380	3169.20	1341.60	443	31718.80	4.23
2	83.68	70	5857.60	13.07	410	5358.70	498.90	480	40166.40	1.24
3	49.45	56	2769.20	9.63	250	2407.50	361.17	306	15131.70	2.49
4	62.10	77	4781.70	13.10	320	4192	589.70	397	24653.70	2.39
5	36.27	67	2430.09	9.35	219	2047.65	382.44	286	10373.22	3.69

APPENDIX 30: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN LOKOJALGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	34.38	56	1925.28	9.82	180	1767.60	157.68	236	8113.68	1.94
2	69.21	65	4498.65	8.80	368	3238.40	1260.25	433	29967.93	4.21
3	70.60	62	4377.20	9.82	370	3633.40	743.80	432	30499.20	2.44
4	37.10	71	2634.10	11.09	220	2439.80	194.30	291	10796.10	1.80
5	49.02	57	2794.14	9.60	247	2371.20	422.94	304	14902.08	2.84

APPENDIX 31: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	36.17	75	2712.75	12.17	205	2494.85	217.90	280	10127.60	2.15
2	36.31	73	2650.63	11.27	220	2479.40	171.23	293	10638.83	1.61
3	35.03	65	2276.95	8.72	215	1874.80	402.15	280	9808.40	4.10
4	36.91	68	2509.88	9.40	210	1974.	535.88	278	10260.98	5.22
5	34.78	70	2434.60	11.08	198	2193.84	240.76	268	9321.04	2.58

APPENDIX 32: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	34.01	75	2550.75	12.90	180	2322	228.75	255	8672.55	2.64
2	36.08	76	2742.08	13.01	200	2602	140.08	276	9958.08	1.41
3	34.50	71	2449.50	11.28	197	2222.16	227.34	268	9246.00	2.46
4	36.17	69	2495.73	8.99	217	1950.83	544.90	286	10344.62	5.27
5	36.93	73	2695.89	8.42	213	1793.46	902.43	286	10561.98	8.54

APPENDIX 33: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	70.75	62	4386.50	8.72	378	3296.16	1090.34	440	31130.00	3,50
2	82.86	73	6048.78	13.01	398	5177.98	870.80	471	39027.06	2.23
3	44.54	65	2895.10	9.63	250	2407.5	487.60	315	14030.10	3.48
4	61.35	77	4723.95	12.90	317	4089.30	634.65	394	24171.90	2.63
5	60.97	75	4572.75	12.88	291	3748.08	824.67	366	22315.02	3.70

APPENDIX 34: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN OKENE LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	82.89	72	5968.08	13.00	389	5057	911.08	461	38212.29	2.38
2	36.75	68	2499.00	8.91	223	1986.93	512.07	291	10694.25	4.79
3	36.00	76	2736	13.00	199	2587	149	275	2900	1.51
4	35.05	74	2593.70	10.37	215	2229.55	364.15	289	10129.45	3.59
5	46.38	71	3292.	8.89	274	2425.86	857.12	345	16001.10	5.36

APPENDIX 35: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR COWPEA IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu(Nd+Nu)} \times 100$
1	82.17	70	5751.90	9.91	400	3964	1787.90	470	38619.90	4.63
2	69.75	56	3906	6.77	386	2613.22	1292.78	442	30829.50	4.19
3	36.97	68	2513.96	9.40	215	2021	492.96	283	10462.51	4.71
4	36.13	76	2745.88	10.09	219	2209.71	536.17	295	10658.35	5.03
5	81.19	73	5926.87	12.98	387	5023.26	903.61	460	3734.40	2.42

Average percentage weight lost for COWPEA in the state using count and weigh method = 3.36%

Where

Wu = weight of undamaged grains

Nu = number of undamaged grains

Wd = weight of damaged grains

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu(Nd+Nu)} \times 100$ = percent weight lost

APPENDIX 36: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{\text{WuxNd-WdxNd}}{\text{Wu (Nd+Nu)}} \times 100$
1	96.33	120	11559.60	32.30	276	5914.80	2644.80	396	38146.68	6.93
2	72.69	99	7196.31	25.60	232	5939.20	1257.11	331	24060.39	5.22
3	71.21	95	6764.95	27.85	212	5904.20	860.75	307	21861.47	3.94
4	78.21	108	8446.68	26.08	240	6259.20	2187.48	348	27217.08	8.04
5	86.96	93	8087.28	22.14	250	5535	2552.28	343	29827.28	8.56

APPENDIX 37: PERCENT WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN LOKOJA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{\text{WuxNd-WdxNd}}{\text{Wu (Nd+Nu)}} \times 100$
1	70.12	97	6801.64	19.82	200	3964	2837.64	297	20825.64	13.63
2	88.68	70	6207.60	14.78	260	3842.80	2364.80	330	29264.40	8.08
3	71.10	110	7821.00	26.08	210	5476.80	2344.20	320	22752	10.30
4	71.89	90	6470.10	25.95	241	5553.30	916.80	304	218554.56	4.20
5	71.98	100	7198.00	26.02	219	5698.38	149.62	319	22961.62	6.53

APPENDIX 38: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN OKEHI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	96.21	118	11352.78	32.03	267	8552.01	2800.77	385	37040.85	7.56
2	71.70	98	7026.60	25.15	223	5608.45	1418.15	321	23015.70	6.16
3	78.21	108	8446.68	26.71	237	6330.27	2116.41	345	26982.45	7.84
4	70.98	110	7807.80	26.02	215	5594.30	2213.50	325	23068.50	9.60
5	88.78	70	6214.60	14.87	261	3881.07	2333.53	331	29386.18	7.94

APPENDIX 39: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN ADAVI LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	72.19	95	6858.05	25.50	238	6069	789.05	333	24039.27	3.28
2	70.90	93	6593.70	22.41	232	5199.12	1394.58	325	23042.50	6.05
3	87.98	70	6158.60	14.87	258	3836.46	2322.14	328	28857.44	8.05
4	69.97	97	6787.09	18.99	209	3968.91	2818.18	306	21410.82	13.16
5	70.85	98	6943.30	25.51	213	5433.63	1509.67	311	22034.35	6.85

APPENDIX 40: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN AJAOKUTA LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	82.89	110	9117.90	26.08	250	6520.00	2597.90	360	29840.40	8.71
2	88.00	96	8448.00	19.72	260	5127.20	3320.80	356	31328.00	10.60
3	78.31	107	8379.17	26.01	242	6294.42	2084.75	349	27330.19	7.63
4	73.72	99	7298.28	25.70	235	6039.50	1258.78	334	24622.48	5.11
5	70.21	97	6810.37	19.28	197	3798.16	3012.21	294	20641.74	14.60

APPENDIX 41: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGHT METHOD FOR GROUNDNUT IN OKENE LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)} \times 100$
1	78.41	108	8468.28	26.52	239	6338.28	2130.00	347	27208.27	7.83
2	96.57	117	11298.69	31.95	276	8818.20	2480.49	393	37952.01	6.54
3	88.10	106	9338.60	19.62	261	5120.82	4217.78	367	32332.70	13.05
4	87.19	97	8457.43	18.89	257	4854.73	3602.70	354	30865.26	11.67
5	86.97	93	8088.21	21.65	241	5217.65	2870.56	334	29047.98	9.88

APPENDIX 42: PERCENTAGE WEIGHT LOST USING COUNT AND WEIGH METHOD FOR GROUNDNUT IN OGORI MAGONGO LGA

S/NO	Wu	Nd	WuxNd	Wd	Nu	WdXNu	(WuxNd)-(WdxNu)	Nu+Nd	Wu(Nd+Nu)	$\frac{WuxNd-WdxNd}{Wu\ (Nd+Nu)}100$
11	88.86	112	9952.32	26.18	263	6885.34	3066.98	375	33322.50	9.20
22	78.31	107	8379.17	26.01	241	6268.41	2110.76	348	27251.88	7.75
33	71.10	110	7821.00	26.89	210	5646.90	2174.10	320	22752.00	9.56
44	72.08	100	7208.00	26.03	223	5804.69	1403.31	323	23281.84	6.03
55	71.85	98	7041.30	25.75	231	5948.25	1093.05	329	23638.65	4.62

Average percentage weight lost for GROUNDNUT in the state using count and weigh method = 8.13%

Where

Wu = weight ofundamaged grains (g)

Nu = number of undamaged grains

Wd = weight of damaged grains (g)

Nd = number of damaged grains

and $\frac{(WuxNd)-(WdxNd)}{Wu\ (Nd+Nu)} \times 100$ = percent weight lost

QUESTIONNAIRE ON GRAIN STORAGE METHODS & STRUCTURES IN KOGI STATE.

A Basic information

i. Name: Adamu Salihu

ii. Sex: male

iii. Age: 35

iv. Name of town or village (in reference to a known land mark): K/K

v. L.G.A. where farm is located: Kogi

vi. Marital status: Married ☑ 1 Single ☐ 2 Tick ☐

vii. No. of children <4 5 6 7 8 >8
1 ☑ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐

viii. No of dependents <4 5 6 7 8 >8
1 ☑ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐

ix. Educational qualification None Pri. Sec. Tertiary others
1 ☐ 2 ☐ 3 ☑ 4 ☐ _____

x. Major occupation: c/servant

xi. Other occupations (please specify) farming

xii. Residential address: Opposite LG model Sec. Sch. up hill, K/Kaufe.

B Farm Cultivation:

i. No. of hectare cultivate <2ha 3-5 5-7 7-9 >9ha
☑ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

ii. Methods of farming Manual ☐ 1 Use of Tractor ☑ 2 Both ☑ 3

iii. Major grains predominantly cultivated in your area

Maize [✓] 1

Millet [✓] 2 G/Corn [✓] 3 Rice [✓] 4

G/Nut [✓] 5 Cowpea [ ] 6 Others (please specify)

iv. Estimated quality of grains produced per year quantity

50kg/100kg/bags

1 Maize 10 bags (10kg)

2 Millet .....

3 G/Corn .....

4 Rice 15 bags

5 G/Nut .....

6 Cowpea .....

7 Others. .....

v. Major grains which you market:

Maize [✓] 1 Millet [ ] 2 G/Corn [ ] 3 Rice [✓] 4 G/Nut [ ] 5 Cowpea [ ] Others. -

vi. Quantity marketed (50kg/100kg/bags)

Grains	No. of bags	Cost per bag
1. Rice (paddy)	10	₦2800
2. maize	7	₦2700
3.		
4.		
5.		

C. Processing

i. Method of processing grains

	Machine	Local	Both
a. Dehusking	[ ]	[✓]	[ ]
b. Shelling	[ ]	[✓]	[ ]
c. Cleaning	[ ]	[✓]	[ ]
d. Grading	[ ]	[ ]	[ ]

ii. In what form do you store your grains:

Name of grain/crops	Processed	unprocessed
Maize	1 ☑	☐ 2
Millet	1 ☐	☐ 2
G/Corn	1 ☐	☐ 2
Rice	1 ☐	☑ 2
G/Nut	1 ☐	☐ 2
Cowpea	1 ☐	☐ 2
Others (please specify)	1 ☐	☐ 2

iii. Which of the following operations do you carry out before storage.

Threshing ☑ 1 Shelling ☐ 2 Cleaning ☑ 3 Sorting ☐ 4 Drying ☑ 5

Packaging ☐ 6

iv. Estimate the effect of the following on the viability of the grains produced by you.

	High >60%	Medium 40-59%	low <40%
Moisture content	☐ 1	☑ 2	☐ 3
Temperature	☐ 1	☑ 2	☐ 3
Humidity	☑ 1	☐ 2	☐ 3
Pest	☐ 1	☑ 2	☐ 3
Fungal	☐ 1	☐ 2	☑ 3

v Uses of these grains (please indicate with percentage)

		Quantity (50/100kg/bags)	Percentage
Human consumption	☑	1 8 bags	.....
Animal consumption	☐	2	.....
Selling	☑	3 17 bags	.....
Seeding	☑	4	.....
Exportation	☐	5	.....
Industrial usage	☐	6	.....

Others (please state type) .....

D. Storage methods 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:

		Estimated capacity (50/100kg/Bags)
Calabash	☐	1.....
Clay-pots	☐	2.....
Polythene bags	☐	3.....
Air Tight Container	☐	4.....
Platform	☐	5.....
Drums	☐	6.....
Hanging	☐	7.....
Others (pls. Specify)	☐	8.....

iii. Indicate which of following you practice:-

			Capacity (50/100kg/Bags)
Sack	1	☑	.....
Drums	2	☐	.....
Cribs	3	☐	.....
Granary	4	☐	.....
Rhumbu	5	☐	.....
Room	6	☑	.....
Basket	7	☐	.....
Pit	8	☐	.....

Others (pls. Specify) .....

iv. Indicate which of the following you practice:

Commercial silo	Warehouses
1 ☐	2 ☑

v. What type of Silo do you use (state the capacity)?

Concrete	Metal	Wood	Composite	Burnt bricks
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Tons/Kg: ....

vi. What is the quantity of grains stored by you?

Name of grains	Quantity (50/100kg/Bags)
Maize	6 bags
Millet	.....
G/Corn	.....
Rice	13 bags
G/Nut	.....
Cowpea	.....

vii. Duration of storage.

< 3month	3-6 months	6-12months	12-24months
1 ☐	2 ☐	3 ☑	4 ☐

viii. Changes noticed and price of produce after storage.

Name of grains	Change in Colour	Change in smell	change in taste	Mould & rot
Maize	☑ 1	☑ 2	☐ 3	☑ 4
Price /Kg after.	₦20/kg	₦20/kg	-----	₦10/kg
Millet	☐ 1	☐ 2	☐ 3	☐ 4
Price /Kg	----	-----	------	---------
G/Corn	☐ 1	☐ 2	☐ 3	☐ 4
Price /Kg	----	-----	------	---------
Rice	☑ 1	☑ 2	☐ 3	☐ 4
Price /Kg	₦50/kg	₦30	------	---------

G/nut	☐ 1	☐ 2	☐ 3	☐ 4	
Price /Kg	----	-----	------	----------	
Cowpea	☐ 1	☐ 2	☐ 3	☐ 4	
Price /Kg	----	-----	------	----------	

ix. Quantity of grains damaged due to agents of storage losses:

S/No	Name of grains	No. of bags	No. of bags damaged due to					
			Rodents	Insects	Mould	Fire	Thieves	Others
1	Maize	6	3kg	1.5kg	—			
2	Millet	/						
3	G/Corn	/						
4	Rice	12	5kg	1kg				
5	G/nut							
6	Cowpea							
7	Others							

x. Which of the following method of storage lo you use?

	Rhumbu bags	hanging pit	silo	warehouse	Cribs platform
Maize	1 ☐ 2 ☑	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
Millet	1 ☐ 2 ☐	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
G/Corn	1 ☐ 2 ☐	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
Rice	1 ☐ 2 ☑	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
G/Nut	1 ☐ 2 ☐	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
Cowpea	1 ☐ 2 ☐	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐
Others	1 ☐ 2 ☐	3 ☐ 4 ☐	5 ☐	6 ☐	7 ☐ 8 ☐

xi. Quantity of grains lost/ damaged per method of storage.

S/N	Name of grain	No. of bag	No of bags damaged /lost due to the following							Qty
			Rhumbu	Bags	Hanging	Pit	Basket	Crib	Silo	
1	Maize		—	2 kg	—					
2	Millet		—	—						
3	G/Corn		—							
4	Rice		—	0.5kg						
5	G/Nut									
6	Cowpea									

xii. Do you maintain the existing storage structure?

Yes No ✓

xiii If yes, specify the cost N.....

xiv. Do you build new structures every season for different grains to be stored?

Yes No ✓ Use old ones

xv. If no, how often do you build?

Annually Bi-annual Tri-annual others (pls. Specify) ✓

(Anytime the old one is faulty).

xvi. Do you apply Chemical to your storage structures?

Yes No ✓

xvii. If yes, what type?

1 Zinc phosphide
2 Arserious Oxide
3 Thallium Sulphate
4 Acettalic
5 Phostoxin
6 Coopex

PART TWO. (TO BE FILLED BY STATE ADP/MIN OF AGRIC AND LOCAL GOVT. DEPARTMENT.

A. FARM HOLDINGS:

i. What is the total No. of farming families in the State? .....

ii. Total Area of land farmed in the State 274,580 ha .....

iii. Average farm holding/farming family?.....

iv. Production (yields tons/year) in the last 5yrs.....

METRIC TONNES (~~000~~)

Crop	1999 $\times 10^3$	2000 $\times 10^3$	2001 $\times 10^3$	2002	2003	2004
Maize	~~251.566 157.03~~	245.80	234.00	240.85	250.00	
Millet	~~24.025~~	23.70	22.60	20.00	16.45	
G/Corn	80.071	45.00	43.00	50.00	51.00	
Rice	113.295	102.50	86.00	80.00	77.73	
G/nut	40.335	41.00	36.00	35.71	32.75	
Cowpea	31.718	32.00	33.00	30.00	32.00	
Others (Pls. Specify) Benisfed	NIA	NIA	—	—	—	

B STORAGE METHODS & STRUCTURES:

v. Which of these are common storage structures used by farmers in the State? (Please Tick)

		Average capacity (50/100kg/Bags pls specify)
Calabash	☐	☐
Drums	☐	☐
Sacks	☐	☐
Cribs	☐	☐
Rhumbu	☐	☐

Store ☐ ☐

Basket ☐ ☐

Silo ☐ ☐

Warehouse ☐ ☐

vi. Market prices in the last 5yrs.

Crop	Average price/kg (N)					2004
	1999	2000	2001	2002	2003	32.0
Maize	17.87	14.53	38.00	45.64	32.14	38.34
Millet	23.41	17.64	34.54	44.70	36.78	36.4
G/Corn	22.54	18.60	41.59	45.41	35.71	88.64
Rice	59.70	43.06	70.45	80.95	63.83	85.39
G/Nut	64.80 (S) 41.21 (U)	59.46 (S) 32.22 (U)	72.24 (S) 62.40 (U)	97.07 (S) 71.91 (Un)	83.20 (S) 71.72 (Un)	45.85
Cowpea	36.69	36.83	58.71	66.20	59.20	67.9
Others Benisead	71.29	47.31	46.75	53.03	76.05	88.64