OF STORAGE METHODS OF COWPEA
IN ADAMAWA STATE, NIGERIA

BY

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DECLARATION

I declare that this work was carried out in its original form by Nweze Mabel Obiageli of the Department of Vocational Education, Federal University of Technology, Yola, Nigeria

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Sign Date

APPROVAL PAGE

This thesis entitled Assessment of Storage Methods of Cowpea in Adamawa State Nigeria by Nweze Mabel Obiageli meets the regulations governing the award of degree in M. Tech. Agricultural Education, Federal University of Technology, Yola and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my husband, Mr. Isaiah Nnabuike Udeh.

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Abstract

This study was designed to assess storage methods of cowpea in Adamawa State which was aimed at identifying the various storage methods, determine problems associated with storing cowpea, determination of the level of utilization of various methods and the most effective methods of storing cowpea. Four research questions and four hypotheses were formulated while the study employed opinion survey. The questionnaire was the instrument used to collect data from farmers and traders. The questionnaire was validated and tested for reliability and the reliability co-efficient was 0.92. The area of study was Adamawa State consisting of 21 local government areas with 4 agricultural zones. The population was made up of all 4,000 farmers and 3,400 traders who store cowpea. Using a stratified random sampling, 100 farmers and 100 traders were drawn. The data collected were analyzed using the mean and standard deviation while to test the hypotheses a t-Test was used at 0.05 level of significance. Findings revealed that all the various methods of storing cowpea were used. There was no significant difference in the level of utilization of the various methods of storing cowpea. Results also revealed that there was no significant difference in the mean scores of farmers 3.82 and traders 3.80 with problems encountered in storing cowpea. Also, there was no significant difference in the mean scores of farmers and traders with the most effective methods of storing cowpea. So the null hypotheses were accepted. Based on the findings, it was recommended that government should establish a central grain storage facilities in the various local government area of the state so as to reduce the losses incurred every season and also farmers should be enlightened about the serious effects of the use of chemicals in storing cowpea.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Cowpea *Vigna unguiculata* (L) Walp belongs to the family fabaceae. It has been cultivated for many centuries in the developing world. The crop is a pan-tropical genus consisting of 170 species with the largest number of species being endemic in Africa (Nwokolo and Smart, 1996). These species are sub-divided into five sub-genera of which three are cultivated species while two are wild species. The cultivated species are *Vigna unguiculata*, *Vigna cylindrical* and *Vigna sesquipedalis*, while the wild species are *Vigna dekindtiana* and *Vigna mehsensis* (Kochlar, 1986).

Raemaekers (2001) reported that Nigeria and Niger produce 850,000 kg/ha and 270,000 kg/ha per annum respectively of world cowpea production. The major areas of production and the estimated quantities of cowpea in Adamawa State are Bazza (Michika local government area), Mugulbu (Mubi South local government area) and Kwagang in Hong local government area (Wilcox, Obanewo and Gbenyi, 2003). They also reported that the least estimated average cowpea production in the state was recorded by Yola North local government area 252 kg/ha, while the highest estimated average production was recorded by Michika local government area 104,715.4 kg/ha.

Most of the cowpea grown in West Africa and in the world is grown for the edible seed (Raemaekers, 2001). The dry seed consist of about 25% protein and 67% carbohydrate. It is therefore a very important source of protein in the

local diet. Raemaekers (2001) states that the green immature cowpea pods may also be eaten as vegetable. The leaf of cowpea is sometimes grown for livestock feed. It may be planted as cover crop in plantation or on fallow land. In addition, the cowpea plant being leguminous, enriches the soil through nitrogen fixation even in very poor soils of pH range of 4.5 – 9.0, organic matter < 0.2% and a sand content of > 85% (Singh and Tarawali, 1996). It is also important in the internal trade in Nigeria where considerable quantities are transported from northern parts to other parts of the country for sale.

During harvesting, the cowpea seeds must be properly dried to reduce the moisture content to about 13 percent or less before storage (Ajibola, 1994). The pods and seeds that are affected by insect pest should be removed during harvest. After harvest, cowpea will go directly to markets or kept in storage and care should be exercised to reduce post harvest losses caused by various physical, biological and mechanical factors (Jada and Ahmed, 2005). The contribution of cereals and legume to food security is limited by deterioration during storage (Gupta, 2006). A crop in storage can also be contaminated by insect pests, molds, rodents and similar organisms that cause damage to stored crops. Agricultural produce is preserved over a period of time to serve as a continuous source of food materials, seeds, merchandise or as a strategic stock (Lale, 2002). The goal of storage is to hold goods until needed for further processing, marketing and/or consumption. The expression connotes the expectation that goods would not just be kept but in the most appropriate conditions for maximum retention of both quantity and quality (Johnson, 2006).

The main purpose in storing cowpea by the farmers and traders is to ensure household food supplies from one season to another and to ensure an even supply of cowpea throughout the year. It is aimed at off-setting the effect of seasonal fluctuations in the supply of cowpea arising from drought, flood and pest attack on crops. It also helps to reduce unnecessary wastage and to provides a form of saving to cover future cash need through sale or barter.

The period of storage of farm produce for whatever purpose ranges from a few days to several months (Harper, 1983). The length of time cowpea can be safely stored will depend on the condition it was harvested and the type of storage method being utilized (Chapman, 2005). According to Johnson (2006), efficiency in storage means that food varieties are available as at when needed with minimum losses in both quality and quantity through keeping the products in the best condition. It is not disputed that losses of food after harvest can often be serious (Tyler, 1999), which may not be unconnected with the fact that greater percentage of what is produced is kept at the farmers level (Appert, 1987 and Jada and Ahmed, 2005). Where there are no storage facilities to carter for the needs of rural population seeds for the next season and to a limited extent as feed for livestock.

The basic objective of good storage is to create the appropriate environmental conditions, which provide sufficient protection to the product to maintain its quality and quantity thus reducing product and financial loss (Schulte, 2004). Haile (2006) stated that the Food and Agriculture Organisation (FAO) estimates that 25% of the world food production is lost at post harvest

level. 10% occur in grains with peaks for some less developed countries reaching 30-50% of the nutritional value of some crops. The main reasons for these losses, especially in developing countries are lack or inadequacy of storage facilities, permitting insects, rodents and birds free access to the produce, the dangerous influence of high humidity or even rain, causing mold growth and poor storage practices. From the moment of harvest until it is eaten, most stored agricultural produce are subject to degradation from a variety of causes (Delima, 2004). These can be attributed to some major causes like infestation of insects, pests and rodents.

The most serious pest of cowpea in the store is bruchid weevil *Callosobruchus maculatus* (William, 1980). He reported that this weevil not only causes direct reduction in dry weight but also reduces cowpea quality and seed viability, making the seed unfit for human consumption as well as for planting. It also reduces the market value. Losses in cowpea attributed to cowpea pests are from 20 percent to almost 100 percent (Singh and Allen (1980). These high losses have contributed immensely to cowpea subsidiary position in the farming system. Singh and Rachie (1985) reported that various insect pest attacking cowpea from field to store which include the following: cowpea aphids, leaf hoppers, foliage beetle, striped foliage beetles, African ball worm, legume pod borer pod borer thrips, coreid bugs and cowpea weevils. Lack of protection during storage and knowledge of varieties that are less susceptible to pest attack contributed to this. However, store condition and the use of less susceptible varieties can upgrade the quality of our stored cowpea, minimizing reduction of

market value and food content (Jackai and Davst, 1991). Insects not only eat significant quantities of grain but decrease the quality by the presence of insect fragment faeces and unnatural odours. Rodents particularly rats and mice, can be serious problem around stored grains and they contaminate the grain with urine, hair, faeces and other debris.

Cowpeas are stored so that they are affordable by the majority of people and at the same time to ensure that farmers and traders of cowpea receive rewarding financial returns during the investment in farming and storage. This study was intended to assess the storage methods of cowpea in Adamawa State.

1.2 Statement of the Problem

The major limiting factors in the production of cowpea in Nigeria mostly in the northern states are due to inadequate storage facilities, inefficient and ineffective storage methods and facilities. These factors are clear evidence in Adamawa State (Wilcox et al, 2003) resulting to the reduced nutritive value and the losses of cowpea every year which is a common syndrome in the state.

Special attention is needed in the area of post harvest processing. (Adamawa State Ministry of Agriculture, 2001). This is because majority of Nigerians that go into post harvest operation are small-scale farmers that account for 90% of the total agricultural output, whereby, they are being faced with challenges such as poverty, literacy, lack of proper tools, modified post-harvest implements and the traditional systems of storage and processing.

These methods and factors in Adamawa State poses a big problem, which could result in food scarcity (Jada and Ahmed, 2005) in the state. This therefore justifies the need to embark on a research on storage methods of cowpea in Adamawa State.

1.3 Purpose of the Study

The purpose of this study was to assess the storage methods of cowpea in Adamawa State. The specific objectives were to:-

i. identify the various storage methods of cowpea in Adamawa State.
ii. determine the problems associated with storing cowpea in Adamawa State.
iii. determine the level of utilization of the various storage methods of cowpea in Adamawa State.
iv. determine the most effective methods of storing cowpea in Adamawa State.

1.4 Research Questions

The following research questions were put forward:-

i. What are the various storage methods of cowpea in Adamawa State?
ii. What are the problems encountered in storing cowpea in Adamawa State?
iii. What is the level of utilization of the various storage methods of cowpea?
iv. What are the most effective methods of storing cowpea?

1.5 Hypotheses

The following hypotheses were tested at the 0.05 level of significance.

Ho_1: There is no significant difference between the mean responses of farmers and traders on the storage methods used.

Ho_2: There is no significant difference between the mean responses of farmers and traders on the problems encountered in storing cowpea.

Ho_3: There is no significant difference between the mean responses of farmers and traders on the level of utilization of the cowpea storage methods.

Ho_4: There is no significant difference between the mean responses of farmers and traders on the most effective methods of storing cowpea.

1.6 Significance of the Study

It is hoped that the results of this study will help the federal, state and local governments to consciously make budgetary plans for the purchase and construction of modern storage facilities seeing the gross benefits derivable from the utilization of modern storage methods. The results of this study will help the farmers and traders of cowpea to identify more storage facilities available to them and will also encourage them to utilize these methods for the benefit of their crops which may easily damaged by insect pest. The results of the study will help the consumers in the sense that when cowpea are stored very well, they will obtain better quality seeds for their consumption and the crop will be available throughout the whole season.

Finally, the results of this study will help the researcher in crop production and horticulture who need such findings for comparative analysis and further studies on cowpea production and will also benefit the researcher as these would ultimately lead to an increase in cowpea production and subsequent food securing in the study area.

1.7 Delimitation

The study was carried out in Adamawa State. All farmers and traders of cowpea in four agricultural zones of Adamawa state were those included in the study. The study was also delimited to assessment of storage methods of cowpea in the state.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

In this chapter, related works to the present study were reviewed under the following sections.

2.1 Conceptual framework of the study

2.2 Various storage methods of cowpea

2.3 Problems encountered in storage cowpea

2.4 Level of utilization of the various storage methods of cowpea

2.5 Effective method to be use for storing cowpea

2.6 Review of related empirical studies

2.7 Summary of the literature reviewed

2.1 Conceptual Framework of the Study

Concept of Assessment

Assessment broadly defined as the execution of a contributive share from each of a group of persons, to be applied toward a common object and computed according to the benefits received. It also includes the procedural steps necessary to compute and collect such a fund or to impose a tax (Chauhan, 1979). According to Ellis (2002), to assess implies a carefully considered opinion, or judgment about something or somebody. Generally, assessment is the process of investigating the value or amount of something, to determine the worth of or to appraise, to judge effectiveness or the extent to which goals have been attained or the types of an out comes realized. Assessment is the practical application of measurement and just as all testing

could be subsumed under assessment, so could all assessment be subsumed under measurement. When a person is assessing something, the person is engaged in the determination of the worth and value of that thing (Anikweze, 2005).

Obioma (1988), defines assessment as the process of using the results obtained from measurement to take relevant decision about a programme being assessed. Anikweze (2005) reported that for us to understand the concept of assessment, let us examine the following hypothetical example. A teacher who has via testing measured the performance of this pupils say in mathematics or any other subject, may want to estimate the average performance to that obtained from some where else or compare the performance of male pupils with those of their female counter parts. This process of carrying out these tasks of comparison constitutes assessment and with assessment we move into evaluation.

Assessment of projects is not left until the project is finally completed. Assessment should start with the project design, planning phase, construction and completion phase. Assessment should be carried out in stages until project is completed (Olaitan, Nwachukwu, Igbo, Onyemachia and Ekong, 1999). The assessor supervised and identifies areas that need remedial instructions. This is noted and corrected.

Concept of Storage

Storage is define as the act of preserving in a safe place, any product or commodity for future use (Lale, 2002). Maunde, Ali and El-Okene (2005) defined

storage as those preservation measures and techniques adequate for holding and keeping in good state, a reasonable quality and quantity of products to be used by people for a period of time. Storage means the phase of the post-harvest system during which the products are kept in such away as to guarantee food security other than during periods of agricultural production (Lucia, 1994). Storage is a component within a farming system, a trading enterprise, or a government policy and may be undertaken because of its contribution to other activities within these broader contents (Food and Agriculture Organization, 1994). Appert (1987) states that the basic objective of good storage is to create the appropriate environmental conditions, which provide sufficient protection to the product to maintain its quality and quantity, thus reducing product and financial loss.

According to Lucia (1994), the main objectives of storage can be summed up as follows:-

1. At the food level, to permit deferred us (on the annual and multi-annual basis) of the agricultural products harvested.
2. At the agricultural level, to ensure availability of seeds for the crop cycles to come.
3. At the agro-industrial level, to guarantee regular and continuous supplies of raw materials for processing industries.
4. At the market level, to balance the supply and demand of agricultural products, thereby stabilizing market prices. In order to attain these

general objectives, it is obviously necessary to adopt measures aimed at preserving the quality and quantity of the stored products overtime.

Hayma (1990) reported that storage losses may occur in many ways.

1. Losses in weight due to insects, rodents or birds eating the grain.
2. Deterioration through fungus growth and rotting.
3. Losses in quality through biting damage, insect and rodent excrement and fungus growth.
4. Loss of motivation in the farmer to grow more, because he is not able to store his harvest or part, thereof in a safe way for any long period of time.
5. Damage to sacks, which causes waste during transportation.
6. Decline in germination capacity of stored seeds.

The concepts of assessment and storage highlighted above are relevant to this study since it seeks to determine the opinions of farmers and middlemen on the desirability of the various approaches used to manage the shall-life of cowpea. Seeking opinions of people on that desirability or effectiveness of structures involves assessment while managing the shall-life of any agricultural produce refers to storage.

2.2 Various Storage Methods of Cowpea

Over the years man developed several methods of storing his crop from traditional local methods of mud barns to the present use of chemicals (Wilcox, et al, 2003).

Traditional storage methods

Traditional storage methods are products of decades, if not centuries of development, perhaps by means of trial and error but certainly as a result of experience of the users and their ancestors (Proctor, 1994). Traditionally, in many tropical countries, the main crop store is a small wicker work hut with thatched roof and floor raised off the ground to about a metre or less (Appert, 1987). According to Proctor, (1994), traditional storage methods at producer level are usually well adopted to both the type of crop for which they are intended and the environment in which they are employed with minimal storage losses. This according to him makes it difficult to interfere with the methods having known that rural communities are very conservation in their attitudes towards changes.

Traditional farm storage methods could be grouped into temporary and long term. Temporary storage methods are quite often associated with the drying of the crop and are primarily intended to serve this purpose. They assume the function of storage, only if the product is kept in place beyond the drying period (Proctor, 1994). Examples of such methods are aerial storage, ground or drying floors and platform. The long term storage methods includes cribs, rhumbu, gourds, calabashes, earthen ware pots, jars, solid walls, underground methods.

Aerial storage methods

Legumes sometimes tied in bundles, which are then suspended from tree branches posts or tight lines inside the house (Kone, 1993). This methods of

storage is not suitable for very small or very large quantities and does not provide protection against the weather (if outside), insects, rodents or thieves.

Storage on the ground or drying floors

Cowpea is exposed to all pests including domestic animals and weather (Wilcox et al, 2003). This method is usually resorted to if the farmers are compelled to attend to some other tasks or lacks means for transporting the cowpea to the homestead.

Platforms

A platform consists essentially of a number of relatively straight poles laid horizontally on series of up-right posts. If the platform is constructed inside a building. It may be raised just 35 – 40cm above the ground to facilitate cleaning and inspection (Jada and Ahmed, 2005), according to them the disadvantage of platform in humid countries is problem of drying and the exposure to pests.

Traditional cribs (Storage Baskets)

Traditional cribs are usually constructed entirely out of locally available plant materials for example reeds (Jada and Ahmed, 2005). The baskets should be raised off the ground on a platform place rodent baffles on the legs of the platform. The cover should be tight and sealed with plaster of the material (Hayma, 1990). The disadvantages of this method is that under prevailing climatic conditions, most of the plant materials have to replaced very often and the produce is exposed to pests attack.

Calabashes, gourds and earthen ware pots

These small capacity containers are mostly used for storing seed and pulse such as cowpeas. They have small opening and could be made hermetic

by sealing the walls inside and out with liquid clay and closing the mouth with stiff clay, cow dung or wooden bung reinforced with cloth (Jada and Ahmed, 2005). The disadvantage of these method is that if the cowpea has moisture content over 12 percent there is problem of mould attack (Kone, 1993). Small or large earthen ware pots of different dimensions are used in some communities to store cowpea and such structures are usually placed in dwelling places (Lale and Ofuya, 2001). The disadvantage of this method is that since they are in dwelling places pest control activities is limited because of its effect on the health of the dweller.

Jars

Jars are large clay receptacles whose shape and capacity vary from place to place. The upper parts is narrow and is closed with a flat stone or a clay lid, which is sealed in position with clay or other suitable material. These structures are generally kept in dwellings, they serve equally for storing seeds and legumes (Hayma, 1990). These structures can remain in good serviceable condition if they are not exposed to the sun.

Rhumbu

The rhumbu, which is also called granaries, are constructed in different designs in Adamawa State (Jada and Ahmed, 2005). They are also referred to as mud silos or clay silos which are usually around or cylindrical in shape, depending on the materials used. The roof is usually made of thatched grass, with generous overhung to protect the mud walls from rain and erosion. Where a side door is not provided or a detachable “cap” is not provided the roof has to be lifted for access to the bin (Kone, 1993). In some areas, people use woven grasses and plastering with clay mud at the back. Whatever material is used the

structure is suspended from direct contact with the ground either with stones or woods. The disadvantages of rhumbu are that sometimes it collapses during the rain and other agents of deterioration (Jada and Ahmed, 2005). Rodents attack is also serious in rhumbu storage methods.

Underground storage

According to Jada and Ahmed (2005) this method is practical in Adamawa State. The method is used in dry regions where the water table does not endanger the contents. The method is conceived for long-term storage and their traditional form varies from one region to region. They are usually cylindrical, spherical or amphoric in shape, but other types are known (proctor, 1994). The disadvantages of this method are construction and digging laborious, storage conditions adversely affect viability and stored grain can only be used for consumption.

Improved traditional storage methods

Various improved storage methods have been developed for the small-scale farmers and traders. Despite these, wide array of improved methods of processing and storage of agricultural produce they are yet to be adopted (Sajo, 2005). These methods are too expensive or unacceptable to some farmers and traders (Schulten, 2004). Similarly, Appert (1987) observed that some technologies are not utilized because of communication difficulties, but some methods of storage are not suitable for adoption on a small scale or home level. The improve methods are improvements made on the existing traditional methods both for the temporary and long-term. The improvements are made with the aim of enhancing the efficacy of the methods. Temporary storage

methods are the least desirable. The aerial storage is improved by suspending the bundles of cowpea in a well ventilated part of the house or above fire place where insects may be deterred and the moisture content of the legume may be reduced (Kone, 1993). Ground or floor storage is less exposed to risk if it is placed on wattle mats or like laid on the ground or floor. Drying floors are improved by making them of concrete. To prevent the movement of moisture through floor of the cowpea, a plastic sheet is placed upon it first (or better embedded in the floor during construction) (Johnson, 2006). Open platform is improved by fitting rodent barriers around the supporting posts. To enable the structure withstand pressures caused by wind uneven loads or even animals leaning against them, the structure is improved when the post are driven at least 60cm into the ground. It could also be improved against termite attack by coating the post with bitumen or used engine oil. The long storage methods have also been improved. The upright poles which support the platform of traditional storage baskets is improved by making the height at least 80cm, coating them with bitumen against termites or used engine oil (IITA, 1989). Improved crib may be constructed of wire netting or local materials such as raffia, bamboo or wood.

Traditionally, cowpea farmers use cribs of various types of storing their cowpea pods in the sheath at the village level. These cribs have poor facilities for continuous drying of cowpea. The improved cowpea and maize crib has been developed to solve the problem.

According to Alo and Egwunyenga (1991) there are other indigenous technologies used by most farmers in the state to store their cowpea at room

temperature. Such technologies have been tested and proven to be effective in control of the cowpea storage pest. These include, the use of neem extracts ashes of burnt plants, the use of wood ash *Azadirachta indica,* Tamarin ash *Tamerindus indica* and the use of dried pepper.

Having observed that some improved storage methods are not utilized because of communication difficulties or that they are too expensive, unacceptable or not suitable for adoption on small scale or home level the following storage methods are reviewed.

Hermetic storage

Various devices and structures, differing in size, cost of construction or acquisition, effectiveness and frequency of maintenance are used for storing cowpea (Lale, 2002). However, only a few of these provide the hermetic conditions necessary for adequate cowpea preservation and these comprise the sacks method of storage, metal and plastic drums or containers and silos. Hermetic storage provides better protection of grains and pulse against stored product pests than aerobic storage. The hermetic technique is a simple, flexible technology for pulses and grain storage that does not require the use of synthetic insecticides, it can be practiced on almost any scale as long as the devices to be used are provided. According to Lale (2002), hermetic storage depends on fulfillment of a number of requirements which include storing only dry pluses or grain, making sure that the containers or structures are really air tight, filling the containers as completely as possible, and keeping the containers at uniform cool temperature.

Sacks method of storage

The use of sacks for commercial and domestic cowpea storage is increasingly gaining ground in Adamawa State (Adamawa State Ministry of Agriculture, 2001). Sack method of storage is therefore a viable alternative to produce farmers and traders. The sacks of cowpea for commercial purpose are stored for some time before they are sold. During this period precautions have to be taken to ensure the safety of the cowpea and maintain its quality. The bagged cowpea must be kept off the ground to prevent spoilage by translocation water and or termites. Low platform tarpaulin or plastic sheet may serve this purpose. However, if there is a risk of damage by rodents or other animals, high platform fitted with rodent barrier should be used. Alternatively, the sacks of cowpea should be stored on dunnages or waterproof sheeting away from walls in a rodent proofed barn. Similar conservation measures should be adopted where sacks are used for domestic cowpea storage. Cowpea can be stored in either jute sacks or plastic bags (Hayma, 1990).

Metal or plastic drums

Drums are often used as storage containers in the house and serve notably for the storage of cowpea and other pulses and cereals. Plastic drums are used intact or after having the upper part cut off to facilitate loading and offloading. The advantage of this method is that, if the lid is tight fitting and the drum is completely filled, any insect present will deplete the oxygen in the drum and die (Proctor, 1994). Metal drums can be adopted for domestic storage in a similar way. A removable lid permits easy loading but it is also possible to weld,

half of the lid to the rim of the drum and provide a riveted hinge on the remaining half of the lid so that it alone can be opened if such drums are fitted with a padlock, such a modified drum is more secured. The advantage of this method is that it is inaccessible to rodents, efficient against insect, sealed against entry of water and make excellent cowpea container (Manude et al., 2005). However, the drum should be protected from direct sunshine and other sources of heat to avoid condensation by being located in shaded and well-ventilated places according to the source. Some countries cowpea storage workers, rather than modifying traditional storage methods have developed significantly different storage bins and few of these have been tried in Nigeria (Proctors, 1994), which could be a viable alternative in Adamawa State, few of which are reviewed below.

Silos

These have been erected in Nigeria (Proctor, 1994) holding one kilogramme of cowpea. The silo rests on stone or concrete pillar supporting a reinforced slab 1.5 meters in diameter. The walls are made of stabilized earth brick and are plastered inside and out with cement reinforced with chicken wire mesh. The top is a dome shaped (Hayma, 1990). Metal silos are often regarded as too costly for small-scale storage. Nevertheless, crop storage unit of Federal Department of Agriculture Abuja has successfully introduced small metal silo of 0.4 to 10 kilogrammes capacity at farmers level in Nigeria (Osuji, 1985). Such silos are made of smooth corrugated galvanized metal and are cylindrical in shape with a flat metal bottom. Metal silos are reported to have been used on

farm and villages in Guatemala for over 50 years and in Swaziland on small scale, possibly longer (Proctor, 1994). Even now there is a new construction of silos at Ganye local government area in Adamawa State for storage.

Bins

The crop storage unit of Federal Ministry of Agriculture, Abuja, is introducing the structure into the country. These bins are made of earth or sundried bricks. They are rectangular and have a capacity of 1 to 3 kilogrammes Hayma, 1994). A typical bin has a foundation of bricks, compacted or stabilized earth. A polythene sheet is laid on this, followed by concrete slab floor 10cm thick and roof with a separating layer of plastic sheet between he wall. The plastic protects against moisture and keeps air from entering the stored product provided the tile and outflow opening can be tightly closed.

Storage of cowpea using chemical

In modern methods of storing cowpea, the use of chemicals are found particularly among the traders of cowpea. Chemicals such as actelic 2% dust, 25EC, phostoxin Benzene hexachloride (BHC), lindane are used for storing cowpea (Madsen and Rasmissen, 2006). Fumigants in both liquid and solid form such as carbonide calcium cynide and aluminium phosphide respectively. Phoshine is an excellent fumigant and fairly easy to use in storing cowpea. It is used as a mixture of aluminium phosophide and ammonium carbamate. These are stable if kept in sealed containers, but when exposed to the air they take up water and release phosphine, ammonia and carbondioxide. Phosphine is the only fumigant that will not interfere with germination if the cowpea is to be use for

seeds planting (Madsen and Rasmissen, 2006). He also reported that gaseous ones like hydrogen cyanide and methyl bromide are also used for storing cowpea. The disadvantage of these methods is that if they are not carefully use, they will result to food poisoning and affect the long-term storage life of the seed.

Adedire (2001) reported that various chemicals for example insecticides are supplied in form of dilute dusts which are applied by thoroughly mixing with the cowpea to be protected. According to source, the dusts contain between 0.5% and 4.0% active ingredient and are suitable for use against Bruchudae. Other chemicals can be used in storing the cowpeas especially the surface areas like walls, floors and other surfaces are Pirimiphos-methyl, chlorphyrifos-methyl, iodofenphos or fenitrothion at a rate of 1g a.i/m^2 of surface. The outside of sacks can be sprayed using the above insecticides at 0.5g a.i/m^2 of bag surface subsequently the risk of re-infestation can be reduced by respraying surfaces and bags at intervals of not shorter than eight weeks.

Insecticide residues are often not desirable in cowpeas which are markets through national and international trade bodies (Pest Control in Tropical Grain Legumes (1981). Fumigation is then the most suitable means of disinfecting the produce. According to the source, the most suitable products for fumigation are methyl bromide and phosphine methyl bromide is supplied in cylinders and is applied through tubes and nozzles at a rate of 24g/m^3 for 24 hours. Fumigation can be carried out in gas-tight silos or bins or under impermeable sheets. Only specially trained personnel should carry out fumigations. Smaller quantities of produce can be fumigated by packing it into jute bags with polythene liners into

which is dropped a single pellet of aluminium phosphide fumigant. The bags are then tied closed and left for 4 – 5 days. If kept sealed the plastic liner provides good protection against re-infestation. A major problem associated with the fumigation of cowpeas which enter large-scale trade networks is that the fumigant gas penetrates the seeds and kills larvae inside. If this happens to "windowed" seeds then the seeds remain obvious damaged, even after cooking, and may be unaccepted to the consumer (Centre for Overseas Pest Research,, 1981). In contrast, if seeds are protected by admixed insecticide or inert dusts, the insects are often killed only after emergence from the seeds. The holed seeds on then be easily removed using sorting machinery.

2.3 Problems Encountered in Storing Cowpea

Preserving the fruit of hard agricultural labour has always been the concern of farmers (Kone, 1993). Particularly in the developing countries like Nigeria, which Adamawa State is not an exemption. Post harvest management problem of rural farmers are rooted in the traditional system of storage and processing (Manude et al., 2005). Inadequate and ineffective storage method predisposes food stored to early deterioration and loss of value, this result in serious wastage of food stuff and increased costs to consumers (Payne, 1986). The major problem facing storage of cowpea is the attack of storage pest and vertebrate pests (Adedire, 2001). Storage pest like *Callosobruchus maculatus* (bruchide weevils) affect seriously stored cowpea causing 80% - 100% yield loss (Jada and Aliyara, 1999). Stored cowpea are also said to be attacked by

pathogens (Donli, 2001). According to Igwe (2005), post harvest losses can also occur as a result of lack of agricultural produce and lack of developed market techniques of the farm produce. Agro-climatic conditions affect post-harvest quality and storage characteristics of cowpea, grain, fruits and vegetables (Majunder, 2004).

Another problems of storing cowpea is deterioration of cowpea in storage. According to Pushpamma and Vimala (1994) is bio-deterioration. This deterioration is because of the activity of enzymes present in the seed. The source further advanced that in addition to the weight loss, enhanced bio-deterioration results in an enhanced loss of nutrients and contamination with anti-nutritional factors. Therefore, in populations where most of the dietary needs are derived from cereals and legumes, nutritional impairment in these cowpea during storage will be of great consequence to the health and nutrition of the people.

Mikloda and Joshua (2004) reported that inadequate storage facilities limits the traders and farmers from storing cowpea. Only few of them have access to these storage facilities while others just leave their crop outside and cover. This exposes the cowpea to pest infestation and damage by rain. Again individual production is too small to make modern storage facilities on the farm economic. In addition traditional structures are less difficult to obtain and are likely to be much more acceptable to the farmers given then present environment (Hays, 1975). This, adoption of improves storage techniques, given the technology presently available, implies that to be economic, farmers must store on some organized or co-operative basis in a central store or silo.

2.4 Level of Utilization of the Various Storage Methods

The utilization of aerial storage method of cowpea is low because it is not suitable to store large quantities of cowpea and does not provide protection against insects, rodents or thieves if kept outside (Kone, 1993). Storage of cowpea on the ground or drying floor is not highly utilized in Adamawa State. According to Wilcox, et al. (2003), this method exposed cowpeas to all pests, attack, domestic animals. There is low utilization of calabashes, gourds and earthen ware ports in storing cowpea (Kone, 1993). This is because if the cowpea have moisture content over 12 percent there is mould attack thereby leading to spoilage of crop. The utilization of underground storage method is also low because of its disadvantages of affecting viability of stored cowpea and can also acquire a fermented smell after long storage inspection of cowpea is difficult (Proctor, 1994). A *rhumbu* is a specially built structure made from a mixture of dry grass and clay. Rhumbu storage method is moderately utilized in Adamawa State in storing cowpea mostly by rural farmers (Jada and Ahmed, 2005).

According to Hayma (1990), in recent time, the utilization of cowpea storage in bags is high. Cowpeas are stored in jute or plastic bags which carry varying numbers of tiny holes of different size and placed inside the house. The bags provide different levels of protection of stored cowpea (Hayma, 1990). Stacked on pallets, pallets are wooden structure varying in size. The bags should always be stacked carefully and neatly such that there is adequate circulation of air through the sacks to dry and cool the crop (Lale, 2002). Wilcox

et al (2003), reported that about 86% of respondents remarked that unshelled cowpea were stored in bags in Adamawa State. The utilization of plastic bags in storing cowpea in Adamawa State is high because plastic bags provide a good means preserving cowpea already carrying weevils eggs (Alder, 1998). Cowpeas are put into polyethylene sacks and then sealed after hermetically. Sometimes, the bags are sealed after dosing with a recommended fumigant such a methyl bromide or aluminium phosphide which will protect the cowpea from attack of insect pest (Alder, 1998). While 14% indicated that cowpea were stored in air-tight plastic container in Adamawa State (Wilcox et al, 2003). Air-tight containers such as plastic drums, metal drums and jerry cans are highly utilized in storing cowpeas either by farmers or traders (Appert, 1981). The use of these storage bins especially metal drums is gaining popularity, various plastic containers of much smaller capacities are highly used in homes or villages for storing cowpea (Osuji, 1985). Earthen silos is highly utilized in storing cowpea in rural areas because it gives better protection against insects pest attack while the storage in metal silos is not highly used because most of the farmers and traders cannot afford it. The farmers level of utilization of chemical methods of storing cowpea is low.

2.5 Effective Methods of Storing Cowpea

IITA (1992), reported that farmers have not identify efficient storage methods of cowpea. Effective storage is therefore, essential for household food security. Effective methods of storage can give farmers and traders huge

benefits (Adamawa Agricultural Development Programme, 1996). According to Wilcox et al (2003), estimated that about 96% of the respondents in Adamawa State stored shelled cowpea in metal drums which is one of the effective method to be use for storing cowpea. This is because it can possible combat insects without using insecticides and sealed against entry of water.

Hayma (1990), states that improved storage system like agricultural silos and bins constructed of aluminium galvanized steel or reinforced concrete are commonly used to store large quantities of cereals and legumes such as cowpea. These are also one of effective methods to be use for storing cowpea. According to Hayma, (1990) storing cowpeas in jars are effective method if they are not exposed to the sun, they can remain in good service condition

2.6 Review of Related Empirical Studies

Empirical studies have not been found, which focus specifically on the storage methods of cowpea chosen for the research being conducted at the same time. The following study that relates to the present study is reported below. For instance a research carried out by Kone (1993) examined on a traditional grain storage methods. The traditional improved and alternative storage technology at farmer village level are reviewed. Data collected were analyzed using descriptive statistics mean, standard deviation and z-test using least significant difference. The finding shows that the small metal silos, the USAID silo, sacks and metal or plastic drums were to be used in storing grains because of their advantages of reducing looses in storage, affordability and

durability. In a study conducted by Mueke (1985), the researcher assessed the best storing variety of cowpea that will minimize infestation by stored pest to reduce economic losses. The susceptibility of six (6) cowpea varieties grown in northern Nigeria to this pest was examined. The data collected were subjected to the analysis of variance. The finding shows that cowpea weevil burchid can damage store cowpea within a period of 2 – 3 months to a powdery level and local white variety was more susceptible at a moisture content of 11 – 12% and relative humidity of 75% with the temperature of 32C.

Hays (1975) conducted a research on the storage of cereal grains in three villages of Zaria province, northern Nigeria. He found that in the northern states of Nigeria Giles has identified six different storage methods which are dried earth granaries, granaries made of plant materials, underground stores, in hut-storage, pot storage and occasionally modern silos. In assessing storage methods with emphasis on improving the situation, one has to determine the following:-

1. what methods are used to store crops
2. how successful these methods are at minimum losses and
3. what are the costs of these methods.

Data were taken and analyzed using descriptive statistic of mean, standard deviation and z-test. It was observed that only the dried earth granaries called rhumbu an in hut storage methods were found in the three Zaria villages as storage methods used for millet and sorghum.

A research by Magaji (1992) in Yola Adamawa State aimed at controlling the cowpea storage weevil on stored cowpea. Storage weevil *Callosebruchus*

maculatus, causes a yield loss of up to 80 percent if not rotted. The use of ash from Tamarin, *Tamarindus indica* was used. The experiment was carried out with five treatments and five replications in which various quantities of tamarine ash powder were used. Data were taken and analyzed using analysis of variance (ANOVA) and the means were compared using the least significant difference. Cowpea storage weevil has been recognized by peasant farmers, but good research on the method and quantity of the ash applied as well as the type of plant to be used has kept the technology out of the farmers reach.

In another study on an analysis of price fluctuation of cowpea in Maiduguri metropolitan. Undiandeye (2004) carried out this research, she founds out that quite a number of problems have been identified by cowpea farmers and traders in storing and marketing of cowpea. Some of these problems includes:

1. Poor storage facilities by storing at time of harvest
2. Inadequate facilities for storage limits the farmers and traders from storing the commodity.
3. High cost of transportation
4. Adulteration of produce
5. Lack of information about production and marketing.

The data collected were analyzed using descriptive statistics, budgeting technique and production function analysis. The study was found out that there was in fluctuation in prices of cowpea in the study area.

2.7 Summary of Related Literature Reviewed

In the review of literature, six basic themes have been stated and discussed as follows : Conceptual framework of the study, various storage methods of cowpea such as traditional, improved traditional, alternative storage technology and chemical storage methods. The problems encountered in storing cowpea like inadequate and ineffective storage methods which result loss of value to insect pest attack (Adedire, 2001). The level of utilization of aerial, ground or drying floor calabashes, gourd and earthen ware pot were low, while the use of sacks storage methods, plastic and metal drums and silos were high. The effective storage methods of cowpea that are to be use includes jars, metal drums, bins and silos.

Finally, it could be seen in the related literature review shows that efforts are been made towards the improvement of storage methods of agricultural products which is geared towards increasing productivity, and marketing of cowpea. This study is aimed at assessing the storage methods of cowpea.

CHAPTER THREE

METHODOLOGY

This chapter explains the methodology and materials that were used in the conduct of the research. It covers, research design, area of the study, population of the study, samples and sampling techniques, instrument used for data collection, validity of the instruments, reliability of the instrument, methods of data collection and method of data analysis.

3.1 Research Design

The research design for this study was opinion survey. In a survey, data are collected about a population by using questionnaire or interview. According to Thomas (1992), a survey is a procedure in which information is collected systematically about a set of cases, such as people, organizations, objects among others. According to Osuala (2005), a survey research studies both large and small populations by selecting and studying samples chosen from populations to discover the relative incidence, distribution and interrelations of sociological and psychological variables.

3.2 Area of the Study

The area of the study was Adamawa State of Nigeria. The state has a total land area of 42,159 square kilometers. It is bounded by Taraba State in the South, Borno State in the North, Gombe State in the West and Cameroun Republic in the East. It lies between latitude 7º and 11º North of the equator and

between longitude 11º and 14º East of the Greenwich meridian (Adebayo and Tukur, 1999). (The Appendix A) has twenty-one local government areas. The state has a total of four agricultural zones as follows: North West, North East, South West and Central zones (Wilcox, et al., 2003). The main crops grown are cowpea, groundnuts, maize rice, sorghum and millet.

3.3 Population of the Study

The population of this study comprised four thousand (4,000) farmers and three thousand four hundred (3,400) traders who store cowpea in four Agricultural Zones of Adamawa State.

3.4 Sample and Sampling Technique

Adamawa State has 21 local government area. In the cause of this study, Yola North and Yola south were merged as one local government considering size and proximity having a total of 20 local government. The four agricultural zones in the state coincidentally covers the 21 local governments within the state. A random sampling of 100 farmers and 100 traders of cowpea were used totaling of 200 respondents for the study.

3.5 Instrument for Data Collection

The instrument for data collection for this study was questionnaire that sought information from both literate and illiterate farmers and traders on the assessment of storage methods of cowpea in Adamawa State. The instrument

(Appendix B) has sections A, B, C, D and E. Section A of the instrument seeks information on respondents biography. Section B, C, D and E, four (4) scales instrument were used as follows: Section B, seeks information to collect data on the various storage methods, of cowpea in the study area. It had rating scale with: strongly agree (SA) – 4, agree (A) – 3, disagree (D) – 2 and strongly disagree (SD) – 1.

Section C, seeks information to collect data on the problems encountered in storing cowpea which also have a rating scale with strongly agree (SA) – 4, agree (A) – 3, disagree (D) – 2 and strongly disagree (SD) – 1. Section D, enquires about the level of utilization of the various storage methods of cowpea and was rated thus: Highly utilized (HU) – 4, Utilized (U) – 3, Moderately utilized (MU) – 2, and not utilized (NU – 1.

Section E, seeks information to collect data on the effective method to be use for storing cowpea in the study area which also rated as follows: Very effective (VE) – 4, Effective (E) – 3, Moderately effective (ME) – 2, and not effective (NE) – 1. The assigned values recorded against each item on the questionnaire were added in relation to the number of respondents that agree with each option.

Validation of the Instrument

The instrument was subjected to face validation because face validity according to Uzoagulu (1998) judges the appropriate use of the questionnaire items to the topic under research. The validation for this study were three experts

in Vocational Education Department who and three experts in Crop Production and Horticulture Department Federal University of Technology, Yola who checked the appropriateness of the questionnaire items.

Reliability of the Instrument

To establish the reliability of the instrument, Cronbach Alpha method was used to measure the internal consistency of the instrument. Cronbach formula is given as:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\Sigma S_1^2}{S_t^2}\right]$$

where α = the coefficient alpha reliability estimate

K = number of test items

Σ = sum of

S_1^2 = variance of each test item

S_t^2 = variance of the total test

This method is appropriate for establishing reliability of an instrument such as questionnaire (Ugodulunwa and Ugwuanyi, 1999). A Cronbach Alpha coefficient (a) according to Uzoagulu (1998), is approximately the average of all the possible split-half correlations and thus it measures the consistency of all items, globally and individually. The means score of the responses of farmers and traders was used to calculate the reliability coefficient of correlation. The calculation yielded reliability co-efficient of 0.92.

Method of Data Collection

The questionnaire was administered in four zones by the researcher and ten trained personnel. A 100% return rate of the questionnaire was achieved.

Method of Data Analysis

Data generated using the research questionnaire was subjected to both descriptive statistics of mean and standard deviation. While the t-Test was employed to test the hypotheses at 0.05 level of significance. The formula for t-Test is:

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where X_1 and X_2 are means of first and second group

S_1^2 and S_2^2 are variance of the first and second group.

n_1 and n_2 are sample size of the first and second group (Uzoagulu, 1998).

It has been accepted that in samples less than 30, t-Test is considered appropriate for data analysis.

Decision Rule

The range for each numerical value of response category was used to take decisions for research questions one and two which had a four point scale with a range of 1- 4, the mean was 2.5 and it was adopted as cut off point. This means that any item that had a mean of 2.5 and above was seen as a good storage methods or as being the problems encountered in storing cowpea. On

the other hand, research questions three and four even though on a four point scale had a range of 0 – 4 with mean of 2.5 which was also adopted as the cut off points. This means that any item that had a mean of 2.5 and above was considered as utilized or effective storage method of cowpea. The decision rule for the null hypotheses was when calculated values were less than the critical value, the null hypothesis was accepted.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

This chapter presents the results obtained in this study as well as the analysis of data carried out. This was carried out in accordance with the research questions formulated for this study.

4.1 Results

Research Question 1

What are the various storage methods of cowpea in Adamawa State?

Responses of farmers and traders to Section A of the research questionnaire was used to answer this research question. Table 1 presents the responses of traders and farmers to the research question.

Table 1: Mean Responses of Farmers and Traders on the Storage Methods of Cowpea in Adamawa State

S/No	Items	Farmers		Traders		Grand Mean	Remarks
		Mean	Std. Dev	Mean	Std. Dev		
1	Aerial is used to store cowpea in my area	3.64	1.29	3.50	1.33	3.57	Agree
2	Ground or drying floors is used to store cowpea in my area	2.25	1.31	2.20	1.29	2.23	Disagree
3	Platform is used to store cowpea in my area	2.27	1.37	2.16	1.37	2.22	Disagree
4	Traditional cribs is used to store cowpea in my area	3.47	1.28	3.54	1.26	3.51	Agree
5	Calabashes and gourds is used to store cowpea in my area	3.79	1.27	3.57	1.37	3.68	Agree
6	Earthenware pots is used to store cowpea in my area	2.35	1.34	2.38	1.34	2.37	Disagree
7	Jars is used to store cowpea in my area	3.61	1.22	3.47	1.45	3.54	Agree
8	Underground (air tight) is used to store cowpea in my area	2.72	1.42	2.19	1.37	2.17	Disagree
9	Rhumbu (air tight) is used to store cowpea in my area	3.61	1.05	3.86	1.18	3.74	Agree
10	Jute sacks (air tight) is used to store cowpea in my area	2.24	1.35	2.07	1.38	2.16	Disagree
11	Plastic bags (air tight) is used to store cowpea in my area	3.93	1.31	3.59	1.35	3.76	Agree
12	Metal drums (air tight) is used to store cowpea in my area	3.72	1.36	3.62	1.45	3.67	Agree
13	Plastic drums (air tight) is used to store cowpea in my area	2.38	1.30	2.28	1.42	2.33	Disagree
14	Jerry cans (air tight) is used to store cowpea in my area	2.40	1.40	2.08	1.33	2.24	Disagree
15	Tins (air tight) is used to store cowpea in my area	2.17	1.38	2.23	1.38	2.10	Disagree
16	Bins is used to store cowpea in my area	2.29	1.36	2.24	1.32	2.52	Disagree
17	Silos (air tight) is used to store cowpea in my area	2.26	1.35	2.12	1.44	2.19	Disagree
18	Chemical storage methods is used to store cowpea in my area	4.13	1.05	4.16	1.05	4.15	Agree

Table 1 shows that the traders and farmers used as respondents in this study disagreed that almost all the methods listed in Table 1 are used in their area in storing cowpea. The result obtained showed that mean response value obtained for farmers ranged between 2.17 and 4.13. The lowest mean response value of 2.17 was recorded for the use of tins (airtight) in storing cowpea in the area while the highest mean response value of 4.13 was recorded for the use of chemical storage. These values were observed to be higher than the limit of 2.5 set in this study. Standard deviation values recorded for farmers' responses presented in Table 1 ranged between 1.05 and 1.40. These values indicated that the farmers are cohesive in their responses to the research questionnaire.

Similarly, for traders, the mean response value recorded ranged between 2.24 and 4.16. Table 1 shows that the lowest mean response value of 2.24 was recorded for the use of bin in storing cowpea in the area while the highest mean response value of 4.16 was recorded for the use of chemical storage. These values were also observed to be higher than the limit of 2.5. Moreover, standard deviation values recorded for traders' responses presented in Table 1 ranged between 1.05 and 1.45. These values indicated that the traders are cohesive in their responses to the research questionnaire.

The grand mean recorded for responses to the various methods of storage used for cowpea in the study area revealed that respondent indicated disagreement to more than half of the methods listed in Table 1. The values recorded ranged from 2.52 recorded for bin to 4.15 recorded for chemical storage.

Research Question 2

What are the problems encountered in storing cowpea in Adamawa State?

Responses of farmers and traders to Section C of the research questionnaire were used to answer this research question. Table 2 presents the responses of traders and farmers to the research question.

Table 2: Mean Responses of Farmers and Traders on the Problems encountered in storing cowpea in Adamawa State

S/N	Problems	Farmers		Traders		Grand Mean	Remarks
		Mean	Std. Dev	Mean	Std. Dev		
1	The use of chemical in storing cowpea has some adverse effects on human consumption	3.89	1.05	3.72	1.27	3.81	Agree
2	Inadequate storage facilities affects the production of cowpea in Adamawa state	4.07	1.12	4.04	1.11	4.06	Agree
3	Underground storage method of cowpea is associated with many problems	3.52	1.22	3.63	1.27	3.58	Agree
4	Weevil is the commonly identified insect pest that affect stored cowpea	4.15	0.97	4.07	1.12	4.11	Agree
5	Bruchid weevil is the most serious insect pest affect stored cowpea	4.01	1.16	3.79	1.27	3.90	Agree
6	Many farmers and traders do not grow and store cowpea in large quantity because of poor storage facilities and high level of wastage	3.77	1.18	3.77	1.18	3.77	Agree
7	Early and late harvest of cowpea affects its storage in the study area	3.74	1.13	3.66	1.25	3.70	Agree
8	Lack of pesticides is a problem in cowpea storage	3.99	1.17	3.99	1.04	3.99	Agree
9	Lack of credit facility is a problem in cowpea storage	3.23	1.41	3.49	1.40	3.63	Agree

Table 2 shows that the traders and farmers used as respondents unanimously agreed that the factors listed in Table 2 are problems facing storage of cowpea in the study area. The result obtained showed that mean response value obtained for farmers ranged between 3.23 and 4.15. The lowest mean response value of 3.23 was recorded for lack of credit facility is a problem in cowpea storage while the highest mean response value of 4.15 was recorded for the statement that weevils are the commonly identified pests that affect stored

cowpea. These values were observed to be higher than the limit of 2.5 set in this study. Standard deviation values recorded for farmers' responses presented in Table 2 ranged between 0.97 and 1.41. These values indicated that the farmers are cohesive in their responses to the research questionnaire.

Similarly, for traders, the mean response value recorded ranged between 3.49 and 4.07. The table shows that the lowest mean response value of 3.49 was recorded for lack of credit facilities while the highest mean response value of 4.07 was recorded for the occurrence of weevil as the most common insect pest affecting cowpea storage. These values were also observed to be higher than the limit of 3.5. Moreover, standard deviation values recorded for traders' responses presented in Table 1 ranged between 1.04 and 1.40. These values indicated that the traders are cohesive in their responses to the research questionnaire.

The grand mean recorded for responses to the various problems affecting storage of cowpea in the study area revealed that there is a general agreement to all the methods listed in Table 2. The values recorded ranged from 3.63 recorded for lack of credit facilities to 4.11 recorded for the occurrence of weevils as the commonly identified insect pest that affect stored cowpea.

Research Question 3

What is the level of utilization of the various storage methods of cowpea?

Responses of farmers and traders to Section D of the research questionnaire were used to answer this research question. Table 3 presents the responses of traders and farmers to the research question.

Table 3: Mean Responses of Farmers and Traders on the Level of utilization of various storage methods of cowpea in Adamawa State

S/N	Method	Farmers		Traders		Grand Mean	Remarks
		Mean	Std. Dev	Mean	Std. Dev		
1	Aerial	2.62	1.38	2.54	1.28	2.58	Utilized
2	Ground or drying	2.37	1.26	2.71	1.38	2.54	Utilized
3	Platform	2.74	1.24	2.82	1.19	2.78	Utilized
4	Traditional cribs	2.34	1.41	2.23	1.29	2.29	Utilized
5	Calabashes and gourds	2.28	1.22	2.37	1.32	2.33	Not Utilized
6	Earthenware pots	2.82	1.33	2.86	1.34	2.84	Utilized
7	Jars	3.31	1.36	3.19	1.39	3.25	Utilized
8	Underground (air tight)	2.73	1.43	2.72	1.36	2.73	Utilized
9	Rhumbu (air tight)	3.81	1.20	3.76	1.23	3.79	Utilized
10	Jute sacks (air tight)	2.76	1.33	3.27	1.38	3.02	Utilized
11	Plastic bags (air tight)	3.74	1.25	3.78	1.28	3.76	Utilized
12	Metal drums (air tight)	3.82	1.24	3.93	1.30	3.88	Utilized
13	Plastic drums (air tight)	3.55	1.30	3.77	1.18	3.66	Utilized
14	Jerry cans (air tight)	3.49	1.43	3.33	1.41	3.41	Utilized
15	Tins (air tight)	2.78	1.40	2.75	1.40	2.77	Utilized
16	Bins	2.55	1.38	2.59	1.36	2.57	Utilized
17	Silos (air tight)	3.23	1.38	3.52	1.37	3.38	Utilized
18	Chemical storage methods	3.66	1.39	3.73	1.33	3.70	Utilized

Table 3 shows that the traders and farmers were unanimous in their responses about the level of utilization of the various storage methods listed in Table 3. The result obtained from farmers showed that apart from the use of calabashes and gourds, the ground or drying, other methods which include aerial, plastic drum, jerry can were highly utilized. The use of calabashes and gourds, and ground or drying recorded mean responses of 2.28 and 2.37 respectively. Mean responses recorded for other methods ranged between 2.55

and 3.82. These values were observed to be higher than the limit of 2.5 set in this study. Standard deviation values recorded for farmers' responses presented in Table 3 ranged between 1.20 and 1.43. These values indicated that the farmers are cohesive in their responses to the research questionnaire.

For traders, the trend observed was slightly different. Apart from the use of calabashes and gourds which recorded mean response value of 2.37, other methods recorded mean response values which ranged from 2.54 to 3.78. These values were also observed to be higher than the limit of 2.5. Moreover, standard deviation values recorded for traders' responses presented in Table 1 ranged between 1.18 and 1.41. These values indicated that the traders are cohesive in their responses to the research questionnaire.

The grand mean recorded for the level of utilization of the various storage methods listed in Table 3, only calabashes and gourds was rarely used. Other storage methods were either moderately utilized or highly utilized. Grand mean recorded for utilized methods ranged from 2.54 to 3.88. The best utilized method is the use of metal drum (airtight) with a mean response value of 3.88.

Research Question 4

What are the most effective methods of storing cowpea?

Responses of farmers and traders to Section E of the research questionnaire were used to answer this research question. Table 4 presents the responses of traders and farmers to the research question.

Table 4: Mean Responses of Farmers and Traders on Effective Storage Methods of Cowpea in Adamawa State

S/N	Method	Farmers		Traders		Grand Mean	Remarks
		Mean	Std. Dev	Mean	Std. Dev		
1	Aerial	2.71	1.39	2.94	1.36	2.83	Effective
2	Ground or drying	2.57	1.23	2.57	1.27	2.57	Effective
3	Platform	2.72	1.33	2.48	1.29	2.60	Effective
4	Traditional cribs	2.58	1.25	2.59	1.33	2.59	Effective
5	Calabashes and gourds	2.43	1.34	2.45	1.38	2.49	Not Effective
6	Earthenware pots	2.90	1.41	2.90	1.41	2.90	Effective
7	Jars	3.44	1.31	3.28	1.42	3.36	Effective
8	Underground (air tight)	2.54	1.37	2.91	1.36	2.73	Effective
9	Rhumbu (air tight)	3.77	1.18	3.33	1.38	3.55	Effective
10	Jute sacks (air tight)	3.02	1.30	2.54	1.37	2.78	Effective
11	Plastic bags (air tight)	3.31	1.37	3.22	1.40	3.27	Effective
12	Metal drums (air tight)	3.84	1.36	3.82	1.24	3.83	Effective
13	Plastic drums (air tight)	3.74	1.18	3.23	1.41	3.49	Effective
14	Jerry cans (air tight)	3.49	1.37	3.23	1.38	3.36	Effective
15	Tins (air tight)	2.77	1.42	2.43	1.34	2.60	Effective
16	Bins	3.13	1.41	3.06	1.38	3.10	Effective
17	Silos (air tight)	3.84	1.29	3.69	1.35	3.77	Effective
18	Chemical storage methods	3.75	1.38	3.77	1.34	3.76	Effective

Table 4 shows that the traders and farmers were unanimous in their responses about the most effective method of storing cowpea in Adamawa State. The result obtained from farmers showed that apart from the use of calabashes and gourds, they rated other methods of storage as effective. Mean responses recorded for other methods ranged between 2.54 and 3.84. These values were observed to be higher than the limit of 2.5 set in this study. Standard deviation values recorded for farmers' responses presented in Table 4 ranged between 1.18 and 1.42. These values indicated that the farmers are cohesive in their responses to the research questionnaire.

For traders, the trend observed was slightly different. Apart from the use of tins (airtight) and platform which recorded mean response value of 2.43 and 2.48 respectively, other methods recorded mean response values which ranged from

2.54 to 3.82. These values were also observed to be higher than the limit of 2.5. Moreover, standard deviation values recorded for traders' responses presented in Table 4 ranged between 1.24 and 1.42. These values indicated that the traders are cohesive in their responses to the research questionnaire.

The grand mean recorded for effective methods of cowpea storage listed in Table 5 showed that only calabashes and gourds was rated as ineffective. Other storage methods were rated as effective as indicated by the mean response values in the range of 2.57 to 3.83 recorded for the storage methods. Metal drum (airtight) was rated as the most effective (mean response = 3.83) while ground or drying was rated as the least effective method (mean response = 2.57).

4.2 Testing of Hypotheses

Null Hypothesis 1

There is no significant difference between the mean responses of farmers and traders on storage methods used.

To test this hypothesis mean responses of farmers and traders presented in Table 1 was subjected to analysis by Students t-Test. The summary of the analysis is presented in Table 5.

Table 5: Summary of Analysis of Responses of Farmers and Traders to Methods of Storage of Cowpea in Adamawa State

Respondents	Mean	Variance	Df	t-cal	t-critical
Farmers	3.39	0.17	17	1.76	2.11
Traders	3.23	0.15			

Table 5 showed that the t- critical value of 2.11 recorded for the analysis is greater than the t-calculated value of 1.76 recorded. Subjecting this to the decision rule that the null hypothesis is accepted if the computed t-value is lesser than the critical t-value, Null Hypothesis 1 is accepted for this study. This translates to mean that there is no significant difference in the opinions of the farmers and traders about cowpea storage methods in Adamawa state.

Null Hypothesis 2

There is no significant difference between the mean responses of farmers and traders on problems encountered in storing cowpea.

To test this hypothesis, mean responses of farmers and traders presented in Table 2 was subjected to analysis by Students t-Test. The summary of the analysis is presented in Table 6.

Table 6: Summary of Analysis of Responses of Farmers and Traders to Methods of Storage of Cowpea in Adamawa State

Respondents	Mean	Variance	Df	t-cal	t-critical
Farmers	3.82	0.09	9	0.49	2.11
Traders	3.80	0.04			

Table 6 showed that the t- critical value of 2.11 recorded for the analysis is greater than the t-calculated value of 0.49 recorded. Subjecting this to the decision rule stated earlier, Null Hypothesis 2 is accepted for this study. This translates to mean that there is no significant difference in the opinions of the farmers and traders about problems encountered in storing cowpea.

Null Hypothesis 3

There is no significant difference between the mean responses of farmers and traders on the level of utilization of cowpea storage methods.

To test this hypothesis, mean responses of farmers and traders presented in Table 3 was subjected to analysis by Students t-Test. The summary of the analysis is presented in Table 7.

Table 7: Summary of analysis of responses of farmers and traders on the level of utilization of cowpea storage methods in Adamawa State

Respondents	Mean	Variance	Df	t-cal	t-critical
Farmers	3.07	0.26	17	1.72	2.11
Traders	3.14	0.26			

Table 7 showed that the t- critical value of 2.11 recorded for the analysis is greater than the t-calculated value of 1.72 recorded. Subjecting this to the decision rule stated earlier, Null Hypothesis 3 is accepted for this study. This translates to mean that there is no significant difference in the opinions of the farmers and traders about the level of utilization of cowpea storage methods in Adamawa state.

Null Hypothesis 4

There is no significant difference between the mean response of farmers and traders on the most effective methods of storing cowpea.

To test this hypothesis, mean responses of farmers and traders presented in Table 4 was subjected to analysis by Students t-Test. The summary of the analysis is presented in Table 8.

Table 8: Summary of analysis of responses of farmers and traders to most effective methods of storing cowpea in Adamawa State

Respondents	Mean	Variance	df	t-cal	t-critical
Farmers	3.14	0.26			
Traders	3.03	0.20	17	1.99	2.11

Table 8 showed that the t- critical value of 2.11 recorded for the analysis is greater than the t-calculated value of 1.99 recorded. Subjecting this to the decision rule stated earlier, Null Hypothesis 4 is accepted for this study. This translates to mean that there is no significant difference in the opinions of the farmers and traders about the most effective ways of storing cowpea in Adamawa state.

4.3 Discussions

Based on the analysis carried out in this study, it was discovered that aerial, use of jar, rhumbu, plastics, bags, metal drums were used for storage of cowpea in Adamawa state. However, the responses obtained showed that there are preferences in the selection of the methods used. Specifically, responses from both farmers and traders showed that there is high preference for the use of chemical storage method than any other storage method. It was also discovered that the use of metal drum (air tight), plastic bags (air tight), rhumbu (air tight), calabashes, and jars were also common among the traders and farmers. Other methods that were relatively common include the use of jute sacks, earthenware pots, traditional cribs, platforms, aerial, and ground floor drying. These findings are in agreement with the report of Hallie (2006) who reported that similar methods were used in the study of sorghum and chickpea in Eritrea. Moreover,

Igwe (2005) highlighted majority of the methods listed in this study as part of the common methods of grain storage in Adamawa state.

Moreover, problems encountered in storing cowpea in Adamawa state identified in this study are not significantly ($P < 0.05$) different from what Igwe (2005) and Hayma (1990) documented. Factors which include adverse effect of chemicals on human, inadequate storage facilities, preponderance of weevil infestation, associated problems with ground storage, lack of access to pesticide adequate supply, and lack of credit facilities. Similarly, related factors have been identified as militating against storage of cereals in Zaria by Hays (1975). Reports by Harper (1983), and Jackai and Davst (1991) also corroborate the findings that these factors affect storage of cereals (including cowpea) in Africa generally.

The level of utilization of the various identified storage methods were also sought in this study. It was specifically indicated by farmers and traders that the level of utilization of chemical storage, plastic drums, metal drums, plastic bags and rhumbu higher compared to other storage methods. Other methods with considerable level of utilization as discovered in this study include jars, jute sacks, jerry cans, and silos. The use of chemical method in grains storage as a predominant grain storage method was reported by Igwe (2005) and Hayma (1990). Moreover, the findings of this study are not significantly different from the report of other researchers including Haile (2006), Gupta (2006) and FAO (1994).

The discovery in this study that the most effective storage method for cowpea is silos is not surprising. This is because earlier studies (Igwe, 2005 and FAO, 1994) have reported that the use of silos in grain storage is still very predominant in Northern Nigeria. Hays (1975) also reported that the use of silos is preferred in Northern Nigeria due to its temperate climatic conditions.

However, the use of chemicals in storage of cowpea was rated very close to silos. This could be attributed to the recent development in technology which has led to the discovery of a number of chemicals with grain protectant and insecticidal properties.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter gave a summary of the statement of problems, procedure used in the study and major findings of the study. Also conclusion and recommendations based on the findings of the study were presented with implications of the study and suggestions for further studies.

5.1 Restatement of the Problem

Major challenges affecting cowpea production in Adamawa state have been identified to include inadequate and inappropriate storage methods and storage pest's infestation. These problems are mostly obvious during storage. Cowpea yields are reducing every year and the quality or viability of seeds is on the decline every year. Adamawa State Ministry of Agriculture (2001) observed that one aspect of the state's agricultural sector which needs special attention is the postharvest processing and storage of food crops in particular.

Food crop production in Adamawa State has maintained an upward trend over the years and the postharvest techniques needed to contend with this increase has been neglected due to insufficient funds, obsolete facilities and other related factors (Jada and Ahmed, 2005). This situation has led farmers to devise various storage methods for cowpea in the state. This research attempts to identify the various storage methods used in the storing cowpea in the state, the level of utilization of some classical storage methods, problems affecting utilization of storage techniques and the way forward.

5.2 Summary of Procedure used for the Study

This study was an opinion survey research which sought for the opinion of farmers and traders pertaining to the assessment of cowpea storage methods used in Adamawa State. The specific objectives of the study include the identification of the various storage methods in Adamawa state, determination of the level of utilization of the methods and determination of the most effective method of cowpea in Adamawa State.

The study area was Adamawa State comprising of 21 Local Government Areas divided into four Agricultural zones. The population for the study was made up of all 4000 cowpea farmers and 3400 cowpea traders in the State. Stratified random sampling of 25 farmers and 25 traders of cowpea in each zone were used for selecting samples for the study. A sample of 100 farmers and 100 traders of cowpea totaling 200 respondents for the study.

Four research questions were formulated for the study. These were used to formulate four research hypotheses which were tested at 0.05 level of significance in the study. The instrument for data collection was the structured questionnaire developed by the researcher and validated by three experts in Vocational Education Department and three experts from Crop Production and Horticulture Departments of the Federal University of Technology, Yola. The reliability study conducted for the research instrument showed that it is highly reliable. Data collected after the administration of the questionnaire were subjected to both inferential and descriptive statistics. Descriptive statistics of

mean and standard deviation and inferential statistics of student's t-test were used in this study.

5.3 Summary of Major Findings

Based on the analysis carried out in this study, the following are the main findings of this study:

1. Cowpea storage methods used in Adamawa state as identified by this study include chemical storage, the use of metal drum (air tight), plastic bags (air tight), rhumbu (air tight), calabashes, and jars. Other methods that were relatively common include the use of jute sacks, earthenware pots, and traditional cribs.
2. Major problems encountered in storing cowpea in Adamawa state, among others, include adverse effect of chemicals on human, inadequate storage facilities, preponderance of weevil infestation, associated problems with ground storage, lack of access to pesticide adequate supply, and lack of credit facilities.
3. The level of utilization of chemical storage, plastic drums, metal drums, plastic bags and rhumbu higher compared to other storage methods.
4. The most effective way of storing cowpea according to the results obtained in this study is the use of silos. However, the use of chemicals was rated very closely to silos.

5.4 Implications of the Findings

Findings of this study have some important implications for Federal and State Ministry of Agriculture, farmers, and traders of cowpea. The implication of

this study to the Federal and State Ministry of Agriculture is in the area of budgetary allocations and planning. The construction and provision of modern storage facilities by the government will be required to ameliorate the existing storage problem in the state.

Supervision of farming and storage activities by qualified extension workers will be needed to help farmers deal with several bottlenecks they do encounter during storage processes. This could be done in form of educating farmers on modern storage techniques and the use of modern storage facilities. Implication for farmers and traders include that they are required cooperate with government agriculture departments and be positively disposed to the utilization of modern techniques as provided by the government. Farmers should be encouraged to use the hermetic systems of storage as available options open to farmers (drums, tins, jerricanes, silos), that gave less incidence of pest destruction.

5.5 Conclusion

This study has identified the various storage methods of cowpea in Adamawa state and the level of utilization of the various methods. Moreover, problems encountered in storing cowpea were also identified. Conclusively, this study discovered that farmers and traders in Adamawa State utilize cowpea storage methods that are adapted to the weather condition in the state and that are readily accessible to them. This is because the several problems militating against effective deployment of various cowpea storage methods discovered in

this study place a limitation on the flexibility of the farmers and traders in choosing which storage method to use.

Hence, farmers and traders use storage methods that they are able to afford and that could best suit them in relation to their compelling circumstances. A good indication of this fact is the discovery that though both farmers and traders rated chemical storage method very high, its level of utilization is second in ranking to the use of silos. This is because some of these chemicals are not readily available and some of the available ones are expensive and unaffordable to the farmers and traders.

Though the use of silos in grain storage is as old as man and despite the availability of modern storage techniques due to improved technology, this study discovered that most of the farmers and traders in Adamawa still use this method in cowpea storage. This further buttresses the effect of the various problems highlighted in this study. The reason for this may not be far fetched as the new improved storage methods may likely require more funds to procure compared to silos, and farmers lack access to bank loan facilities that could help them acquire these technologies. The implication is that they continue to use the old storage methods. This could also be a reasons for the persistent incidences of postharvest losses recorded in the area.

In conclusion, this study has revealed the various sides to the choice and utilization of cowpea storage methods in Adamawa state. It is based on the foregoing that this study makes certain recommendation that are believed to be able to help farmers and traders in relation to choice and utilization of cowpea storage methods in Adamawa state.

5.6 Recommendations

Based on the findings of this study, the following are recommended:

1. Farmers should be enlightened about the hazardous effects of the use of chemicals in preserving cowpea.
2. Government should intensify efforts towards food security programme which should be extended to the local government of the state
3. Research into the use of ethnobotanicals in the prevention of stored cowpea infestation by weevils should be carried out.
4. Looking at the economic value of cowpea in North Eastern Nigeria and the adaptability of the crop to the climatic condition of the region, it is recommended that credit facilities should be made available to more farmers either through the Fadama Project of the Federal Government or through the Microfinance Banks.
5. This research should be replicated in other states of Nigeria so as to expose the national view of the problem of cowpea storage in Nigeria.

5.7 Limitations of the Study

In the course of carrying out this study, the researcher encountered the following limitations:

1. Language barrier between the researcher and the farmers who could not communicate in English Language. Moreover, interpreters used were also not able to interpret accurately word spoken in English.
2. Financial constraints prevented the researcher from covering the whole study area. This explains why some selected locations from the four agricultural zones were used in the study.

5.8 Suggestions for Further Study

There is need to replicate this study in other parts of the country to determine how the problem will correlate with the present study in other to help in generalizing the findings. There is need to find out those various storage methods of cereals, pulses and other crops used in other locations. The following studies are suggested:

1. Storage problems in cowpea production in Plateau State
2. Effect of seed storage systems in Taraba State.
3. The storage methods of three varieties of groundnut in Borno State.

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APPENDIX A

APPENDIX B

Department of Vocational Edu.
Federal University of Tech.
Yola

June 2008

Sir/Madam,

REQUEST FOR ASSISTANCE TO VALIDATE RESEARCH INSTRUMENT

Title of the Study: **Assessment of Storage Methods of Cowpea in Adamawa State.**

The attached is the research questionnaire designed to collect the data needed for analysis. As an expert in the area, please you are requested to:

1. Check whether the instrument contains all the aspects of the subject that should be included in the questionnaire
2. Compare the sample of the items with the content, if the sample of the items cover all aspects of the content.
3. Ascertains the language and clarity of questionnaire items.
4. Assess the appropriateness of the instrument to sample needful information form farmers and traders (middlemen).

To make the instrument a more valid one, you may wish to make recommendations, make additions or both. Also attached to the research questionnaire is a copy of the specific objectives, research questions and hypotheses for the study.

Thank you.

Yours sincerely,

Signed
NWEZE MABEL O.

APPENDIX C

Department of Vocational Edu.
Federal University of Tech.
Yola

June 2008

Dear Respondent,

I am a Postgraduate student of the above institution carrying out a research on the “Assessment of Storage Methods of Cowpea in Adamawa State.

I therefore solicit for your help to answer the questionnaire overleaf.

Your contribution will be of great help to the success of this project.

Thank you for your cooperation.

Yours faithfully,

Nweze Mabel O.

QUESTIONNAIRE ON ASSESSMENT OF STORAGE METHODS OF COWPEA FOR FRAMERS AND TRADERS

This questionnaire is designed to elicit your responses on the assessment of storage methods of cowpea. Kindly respond to the items by ticking the appropriate column that best expressed your opinion, disposition or view. All information supplied will be treated confidentially and shall only be used for the purpose of this research.

SECTION A: PERSONAL DATA

1. (a) Farmer ( ) (b) Trader (middlemen) ( )

2. Location:_____

SECTION B: Storage Methods

In this section a number of storage methods are provided. Indicate with a tick in the box below. The rating scale: Strongly Agree (SA); Agree (A); Disagree (D) and Strongly Disagree (SD).

S/N	Storage Methods	SA	A	D	SD
1.	Aerial is use to store cowpea in my area				
2.	Ground or drying floors is use to store cowpea in my area				
3.	Platform is use to store cowpea in my area				
4.	Traditional cribs is use to store cowpea in my area				
5.	Calabashes and gourds is use to store cowpea in my area				
6.	Earthen ware pots is use to store cowpea in my area				
7.	Jars is use to store cowpea in my area				
8.	Underground is use to store cowpea in my area				
9.	Rhumbu (air tight) is use to store cowpea in my area				
10.	Jute sacks (air tight) is use to store cowpea in my area				
11.	Plastic bags (air tight) is use to store cowpea in my area				
12.	Metal drums (air tight) is use to store cowpea in my area				
13.	Plastic drums (air tight) is use to store cowpea in my area				
14.	Jerry cans (air tight) is use to store cowpea in my area				

15.	Tins (air tight) is use to store cowpea in my area				
16.	Bins is use to store cowpea in my area				
17.	Silos (air tight) is use to store cowpea in my area				
18.	Chemical storage methods is use to store cowpea in my area				

SECTION C: The Problems Encountered in Storing Cowpea

S/N		SA	A	D	SD
19.	The use of chemical in storing cowpea has some adverse effects on human consumption.				
20.	Inadequate storage facilities affects the production of cowpea in Adamawa State.				
21.	Underground storage method of cowpea is associated with many problems.				
22.	Weevil is the commonly identified insect pest that attack stored cowpea.				
23.	Bruchid weevil is the most serious insect pest that affect stored cowpea.				
24.	Many farmers and traders do not grow and store cowpea in large quantity because of poor storage facilities and high level of wastage.				
25.	Early and late harvest of cowpea affects its storage in study area.				
26.	Lack of pesticides is a problem in cowpea storage.				
27.	Lack of credit facility is a problem in cowpea storage.				

SECTION D: Level of Utilization of the Various Storage Methods of Cowpea

Indicate the level of utilization of the following methods of storing cowpea. The rating scale: Highly Utilized (HU); Utilized (U); Moderately Utilized (MU); and Not Utilized (NU).

S/N		HU	U	MU	NU
28.	Aerial				
29.	Ground or drying				
30.	Platform				
31.	Traditional cribs				
32.	Calabashes and gourds				

33.	Earthen ware pots				
34.	Jars				
35.	Underground (air tight)				
36.	Rhumbu (air tight)				
37.	Jute sacks (air tight)				
38.	Plastic bags (air tight)				
39.	Metal drums (air tight)				
40.	Plastic drums (air tight)				
41.	Jerry cans (air tight)				
42.	Tins (air tight)				
43.	Bins				
44.	Silos (air tight)				
45.	Chemical storage methods				

SECTION E: The effective methods used in Storing Cowpea

Indicate rate of effective methods used in storing cowpea by you. Very Effective (VE); Effective (E); Moderately Effective (ME) and Not Effective (NE).

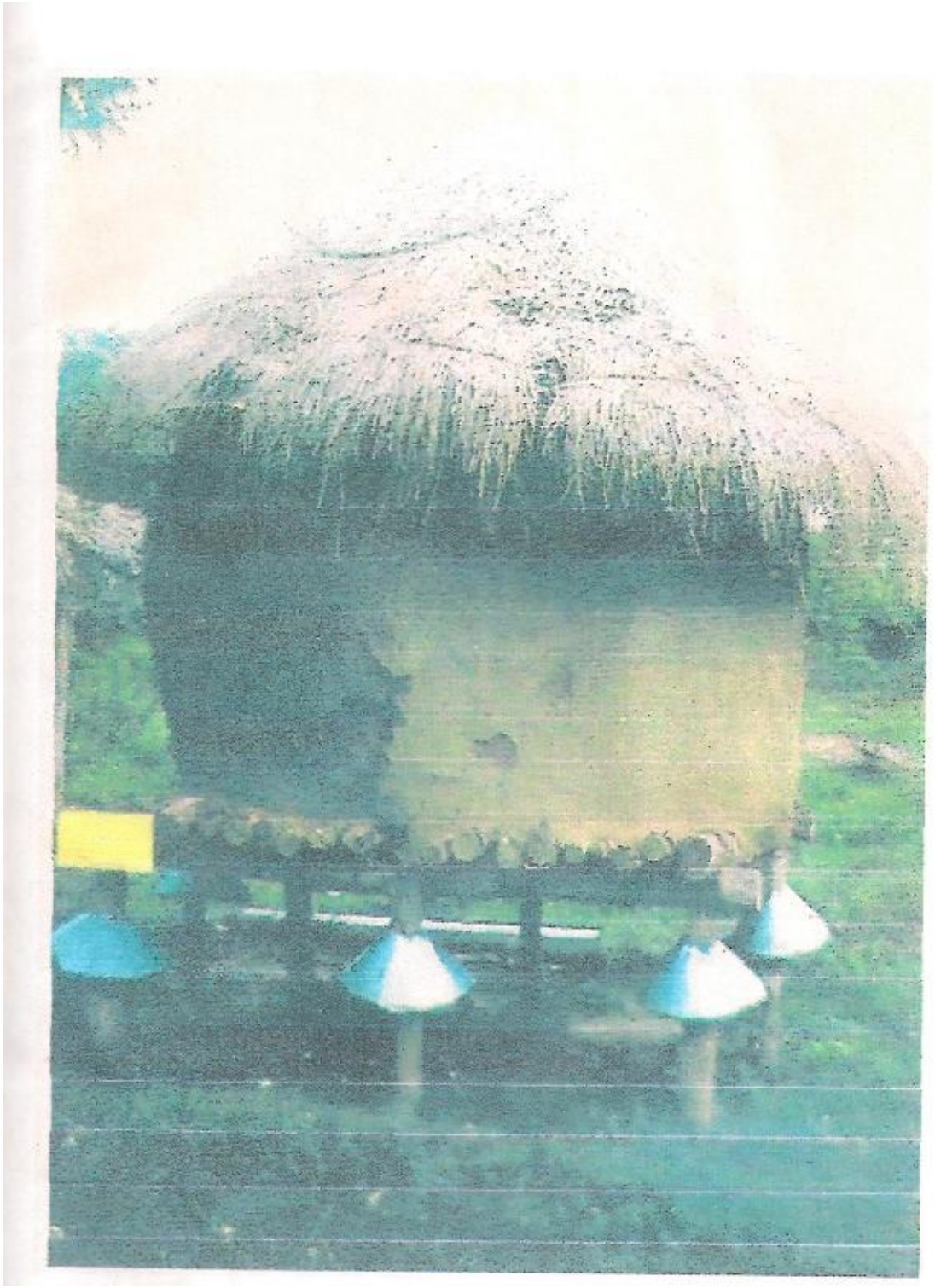
S/N		VE	E	ME	NE
46.	Aerial				
47.	Ground or drying				
48.	Platform				
49.	Traditional cribs				
50.	Calabashes and gourds				
51.	Earthen ware pots				
52.	Jars				
53.	Underground (air tight)				
54.	Rhumbu (air tight)				
55.	Jute sacks (air tight)				
56.	Plastic bags (air tight)				
57.	Metal drums (air tight)				
58.	Plastic drums (air tight)				
59.	Jerry cans (air tight)				
60.	Tins (air tight)				
61.	Bins				
62.	Silos (air tight)				
63.	Chemical storage methods				

APPENDIX D

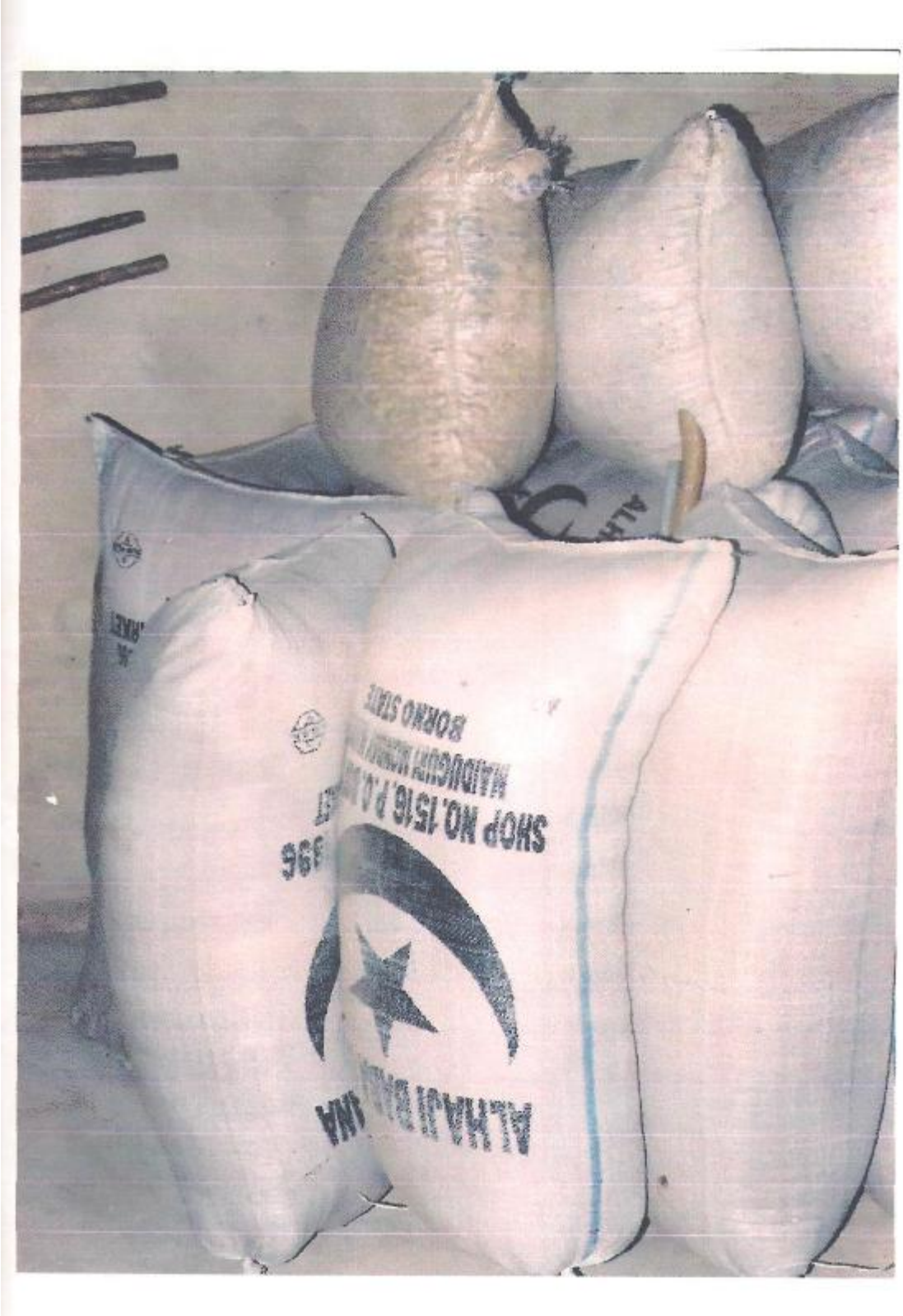
Aerial storage method

Improved traditional crib

Improved crib



Improved local Rhumbu



Hermetic storage method (Jute sack)

Hermetic storage method (Drum)