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► **To cite this version:**

M. S. Adiaha. Complete Guide to Agricultural Product Processing and Storage. 81 (1), pp.1-52, 2017, WSN 81(1) (2017) 1-52. hal-04608128

**HAL Id: hal-04608128**

**<https://hal.science/hal-04608128>**

Submitted on 12 Jun 2024

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# Complete Guide to Agricultural Product Processing and Storage



*M. S. Adiaha*

2017

Publisher's address:

Scientific Publishing House „DARWIN”

22/12 Adama Mickiewicza Street, 78-520 Złocieniec,

District Drawski, West Pomerania, Poland

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World Scientific News / An International Scientific Journal

<http://www.worldscientificnews.com/>

EISSN 2392-2192

Code of the article in World Scientific News: WSN 81(1) (2017) 1-52



# World Scientific News

WSN 81(1) (2017) 1-52

EISSN 2392-2192

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## **Complete Guide to Agricultural Product Processing and Storage**

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## **TABLE OF CONTENTS**

FOREWORD.....	5
PREFACE.....	5
ABSTRACT & Keywords.....	6
INTRODUCTION .....	7
MATERIALS AND METHODS .....	8
Chapter One.....	9
Chapter Two .....	11
Chapter Three .....	14
Chapter Four .....	50
Reference .....	51

## **FOREWORD**

As part of the effort to combat global food shortages in the face of climate change, then the need for processing and storage of our food crops becomes imperative. The concern about local food wastages has been raised, creating fear that the level of human hunger may be raised if this is not tackle. This book seeks a way locally produced food crops can be preserved, giving practical guide to storage methods using locally available materials. The text seems appropriate for students, agricultural practitioners, researchers and farmers.

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## **PREFACE**

The emergence of the article was informed by the urge to meet the gap between food production and preservation in rural areas with low technology and income. Specifically, the article is intended for users both in-school and out-of-school. The topics treated as encapsulated in the various chapters covered all the major aspects of agricultural produce processing/storage.

**Obio, E. E (PhD in view)**

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**ABSTRACT**

In fighting global food crises, Agricultural product processing and storage plays an important role in food and feed preservation for the continual survival of man. Through the development of modern storage facilities, food crop preservation becomes easy and simple to follow. Rice and oil palm is a selected few agricultural product that will be taken into consideration in the course of this work. The study was conducted in Obubra Local Government Area of Cross River State, Nigeria, Storage experimentations were done at Faculty of Agriculture and Forestry Multipurpose screen house. The study was conducted with the aim to look into processing procedures and find possible solutions to the problems facing the farmers and agricultural machine operators in Agric business. Low level of mechanisation was observed to be high in areas visited during the period of this research.

**Keywords:** Agricultural Storage, Food security, Produce processing, Mechanization

## **INTRODUCTION**

Considering the challenges of increase in human population, low yield due to pest and disease attack on cultivated crops and poor level of mechanized agricultural activities. Then product processing and storage in other to meet these necessities becomes of crucial importance. If we process and store our food crops we make it more durable, attractive and add value to it, this can go a long way in mitigating global food insecurity. Agricultural produce and by-products is an essential demand and means of survival for the world's agro-based industries, as it plays a greater role in almost all aspect of life. Unprocessed raw materials are raw materials for the intermediate industries with processed food/consumables as the finished product. Energy use in Agriculture and food processing is high; hence, mechanization is essential to reduce the level of drudgery especially in the local processing factories and mills. Rice and oil palm processing will be discussed in details during the course of survey.

### **Aims / objectives of the Survey**

- This survey aims at promoting sustainable agricultural management for economic development.
- It seeks to support local food processing, in-other to improve local knowledge on agricultural mechanization.
- The survey seeks to aid food security, this is because food wastage and spoilage can be cut-down through processing.
- Looking at the amount of food produced yearly, this survey on processing will aid in conservation and re-organisation of any agric produce, while contributing in the development and promotion of agricultural activities.
- If greater percentage of our agric produce are processed then, importation of many other foreign processed food will be minimised.
- Since climate change is one of the greatest challenges to our food crop production, processing will aid in adaptation and mitigation, creating new ways in which our food crop can be properly managed.
- The survey can help to enlighten or widen students scope on the knowledge of agricultural product, giving possible recommendations and practical advice to students, farmers and agricultural machine operators.
- Through this survey a student can get an ideal practical inside of different ways of preservation and their advantages and disadvantages as applied in real life.



## **MATERIALS AND METHODS**

### **The Study Location**

“The study was carried out in Obubra, southern Nigeria, location of the Faculty of Agriculture and Forestry, Cross River of Technology(CRUTECH), Nigeria, Obubra is on latitude 6° 06' N and longitude 8° 18' E in the rainforest zone of Nigeria. Obubra is characterized by a mean annual rainfall distribution at 2250 mm – 2500 mm with annual temperature range at 25 – 27 °C” (Adiaha, 2017).

### **Survey Methodology**

Oral interview on agricultural machine usage was carried out. Field trip to different areas where agricultural produce is been processed was undertaken. Practical assessment of educational background of the agric product processing workers, working environment including challenges of the agric processing unit were examined. And consultation of relevant research findings literature was the methods used in collection and collation of data for this investigation.

## **Chapter One**

### **AGRICULTURAL PROCESSING**

#### **Agricultural Product**

In Agriculture, product refers to processed agricultural produce which has been turned into finished goods either for human/animal consumption or for industrial uses.

#### **Processing**

Processing in agriculture involves the biological, physical, mechanical, and biochemical manipulation of agricultural produce in order to preserve it for further use. It involves the series of operations taken to change agricultural products into a consumer-finished product. E.g. is garri.

Agricultural processing involves both scientific and traditional manipulation of agricultural produce so as to make it to be more useful and be able to store them for future uses.

#### **Processing Techniques**

These are some of the different processing techniques involved in processing of Agricultural produce. Here, different machines are used in the processing e.g. hammer mill, roller mill, and bore mill.

##### **➤ The hammer mill**

This is a machine used in processing agricultural produce that are dry. The hammer mill is made of hammer with a roller with pulleys. The blocks contain hammers. As the hammer rotates, the block will rotate as well, then the product will be milled by pressure of the hammer. It is used to mill crops whose moisture content is reduced e.g. rice.

##### **➤ Bore mill**

It has two plates; rough and smooth plates, enclosed inside the structure, in the hopper e.g. is the melon grinder. The surface is enclosed in a structure. The auger pushes the produce into the collection point. It is used to process agricultural material that are wet, oily and dry.

##### **➤ Roller mill**

Consists of two rollers that are cylindrical in shape, connected to pulley or sheath in-between the rollers. There are space in between the two cylinder so that when the rotates they will rotate in two direction and merge the produce into small particles.

### **Why We Process our Food Crops**

- ❖ Processing helps to make food available even during the off-season.
- ❖ When food is processed it taste and look very attractive
- ❖ Processing helps in the durability of food crop products- when food crop is been processed like in dehydration of a food crop, micro-organisms becomes absent thereby preventing spoilage.
- ❖ Processing adds value to the agric produce.
- ❖ Processing helps in producing income to individual and foreign exchange to a country
- ❖ It creates room for commercial agriculture, thereby promoting agricultural activities.
- ❖ If we stand to process our food crop regularly, then more food will be in our food reserve which is an aid in adaptation and mitigation of climate change.
- ❖ Processing provides raw materials for further studies and for industrial uses.
- ❖ Through processing some materials are produced (by-products) which can be used for formulation of animal feed.
- ❖ The science of processing can aids in drugs and medicinal purposes
- ❖ Agric produce processing gives Income to a farmer and improve his standard of living
- ❖ When a country process her food crops then exportation will be high, thereby improving her foreign exchange earning
- ❖ Processing provides employment for individual and the masses
- ❖ Through agric processing of crops like sugarcane bio-fuel and power is produce which is use for generation of farm or industrial power.
- ❖ If a processing factory is sited in a rural area, it creates development of that rural areas.

## Chapter Two

### AGRICULTURAL STORAGE

**Storage:** Is the act of safekeeping of the quantity and quality of an agricultural material so as to prevent them from deterioration for a specific period of time beyond their normal shelf life.

**Agricultural storage:** Is any deposit or holding of farm product, fertilizer, grains, feed and other related supplies in facilities or container, often to prevent contamination or for times when production cannot meet demand. It is an important marketing function which involves holding and processing goods from the time they are produced until they are needed for consumption.

**Table 1.** produce and its products

S/N	PRODUCE/ RAW MATERIAL	PRODUCTS	PRESERVATION/STORAGE METHOD
1.	Oil palm	Red oil, kernel oil, soap, body cream, detergent, margarine etc.	The product is preserved in a container for sales/ stored in a warehouse or in silo for further use
2.	Cassava	Garri, cassava cake, starch etc.	Garri is bagged and sole, cassava cake can be pack in a sachet, starch is also pack in a sachet when dehydrated.
3.	Rice	Can rice, livestock feed, brewery beers and some infant food.	Rice can be canned or bagged, livestock feed is bagged after formulation. Infant food is canned. These products can be stored in a warehouse.
4.	Cocoa bean	Drinks, beverages, butter, liquor, chocolate etc.	Drinks are bottled, butter is put in a can, chocolate is put in a sachet. There are all stored in a Silos/warehouse

5.	Rubber/latex	Bart room wears, tyre, tube, shoe soles, boots etc.	Warehouse
6.	Hides and skin	Lathers, drums, Shoe, belt, bags, caps, cloths	warehouse
7.	Vegetables (e.g. water melon, cucumber, okra etc.)	Nutrient drip, drinks, or eaten fresh	They are canned and stored in a warehouse. Nutrient drip comes in sachets.

Source: Survey Field Analysis by Oral interview; Research literature

### **Classification of Storage**

Storage can be classified into:

- Duration of storage
- Size or scale of storage
- Principle of storage

### **Duration of Storage**

This involves time interval taken to preserve agricultural materials for further use as the need arises.

- **Short-term storage** - This involves storing of agric product for a short period of time e.g of crop here is garri.
- **Medium term storage** - This type of storage involves storing of an agric product for a specific period of time not too long.
- **Long term storage** - In long term storage, agric materials are preserved for a longer time.

### **Size or Scale of Storage**

Size of storage is the amount of agric materials preserved at a specific time.

- **Small scale storage** - This method involves the storing of agric products that are of small scale e.g is the storing of small quantity of rice in a jute bag in a warehouse.

- **Medium scale storage** - This is a kind of storage that involves some certain amount of agric products store at a time.
- **Large scale storage**- This involves commercial storage of agricultural product for further use.

### **Principle of Storage**

Principle of storage is divided into:

- Physical storage
- Chemical storage
- Biological storage

## **Chapter Three**

### **FACTORS RESPONSIBLE FOR DETERIORATION IN STORAGE**

These factors must be known and guided against in the design of our storage structures.

#### **1. Bacteria, fungi and yeast**

These are microbes that normally live in the agricultural martial, they cause destruction to agric produce, so we need to stop their action in-other to have our produce safe.

#### **2. Insect and mice**

In designing and construction of storage structures, we need to design and guide against it.

#### **3. Rodents**

#### **4. Birds**

#### **5. Man**

#### **6. Environmental factors**

Environmental factors like humidity and temperature must be guided against when we design our storage structures.

### **PRACTICAL APPLICATION OF STORAGE TECHNIQUES IN OUR FOOD CROP**

#### **➤ Freezers and thawing food**

Freezer temperature should be maintained below 0°F. Food should never be thawed at room temperature, this increases the risk of bacterial and fungal growth and accordingly the risk of food poisoning. Once thawed, food should be used and never refrozen. Frozen food should be thawed using the following methods:

- Microwave oven
- During cooking
- In cold water (place food in watertight, plastic bag; change water every 30 minutes)
- In the refrigerator

Throw out foods that have been warmer than 40 °F for more than 2 hours. If there is any doubt at all about the length of time the food has been defrosted at room temperature, it should be thrown out. Freezing does not destroy microbes present in food. Freezing at 0 °F does inactivate microbes (bacteria, yeasts and

molds). However, once food has been thawed, these microbes can again become active. Microbes in thawed food can multiply to levels that can lead to foodborne illness. Thawed food should be handled according to the same guidelines as perishable fresh food.

Food frozen at 0°F and below is preserved indefinitely. However, the quality of the food will deteriorate if it is frozen over a lengthy period.

➤ **Refrigeration**

It is important to note that safe food storage using refrigeration requires adhering to temperature guidelines:

For safety, it is important to verify the temperature of the refrigerator. Refrigerators should be set to maintain a temperature of 40 °F or below. Some refrigerators have built-in thermometers to measure their internal temperature. For those refrigerators without this feature, keep an appliance thermometer in the refrigerator to monitor the temperature. This can be critical in the event of a power outage. When the power goes back on, if the refrigerator is still 40 °F, the food is safe. Foods held at temperatures above 40 °F for more than 2 hours should not be consumed. Appliance thermometers are specifically designed to provide accuracy at cold temperatures. Be sure refrigerator/freezer doors are closed tightly at all times. Don't open refrigerator/freezer doors more often than necessary and close them as soon as possible.

➤ **Storing oils and fats**

Oils and fats can begin to go rancid quickly when not stored safely. Rancid cooking oils and fats do not often smell rancid until well after they have spoiled. Oxygen, light and heat all contribute to cooking oils becoming rancid. The higher the level of polyunsaturated fat that an oil contains, the faster it spoils. The percentage of polyunsaturated fat in some common cooking oils is: safflower (74%); sunflower (66%); corn (60%); soybean (37%); peanut (32%); canola (29%); olive (8%).

To help preserve oils from rancidification, they should be refrigerated once opened. Opened, refrigerated cooking oils should be used within a few weeks, when some types begin to go rancid. Unopened oils can have a storage life of up to one year, but some types have a shorter shelf-life even when unopened (such as sesame and flaxseed).

## **DRY STORAGE OF FOODS**

Some food crops are stored using dry storing methods. Such crops include:

➤ **Vegetables**

The guidelines vary for safe storage of vegetables under dry conditions (without refrigerating or freezing). This is because different vegetables have



different characteristics, for example, tomatoes contain a lot of water, while root vegetables such as carrots and potatoes contain less. These factors, and many others, affect the amount of time that a vegetable can be kept in dry storage, as well as the temperature needed to preserve its usefulness. The following guideline shows the required dry storage conditions:

- Cool and dry: onion
- Cool and moist: root vegetable, potato, cabbage
- Warm and dry: winter squash, pumpkin, sweet potatoes, dried hot peppers

Many cultures have developed innovative ways of preserving vegetables so that they can be stored for several months between harvest seasons. Techniques include pickling, home canning, food dehydration, or storage in a root cellar.

### ➤ **Grain**

Grain, which includes dry kitchen ingredients such as flour, rice, millet, couscous, cornmeal, and so on, can be stored in rigid sealed containers to prevent moisture contamination or insect or rodent infestation. For kitchen use, glass containers are the most traditional method. During the 20th century plastic containers were introduced for kitchen use. They are now sold in a vast variety of sizes and designs.

Metal cans are used (in the smallest practical grain storage uses closed-top #10 metal cans). Storage in grain sacks is ineffective; mold and pests destroy a 25 kg cloth sack of grain in a year, even if stored off the ground in a dry area. On the ground or damp concrete, grain can spoil in as little as three days, and the grain might have to be dried before it can be milled. Food stored under unsuitable conditions should not be purchased or used because of risk of spoilage. To test whether grain is still good, it can be sprouted. If it sprouts, it is still good, but if not, it should not be eaten. It may take up to a week for grains to sprout. When in doubt about the safety of the food, throw it out as quickly as possible.

### ➤ **Spices and herbs**

Spices and herbs are today often sold prepackaged in a way that is convenient for pantry storage. The packaging has dual purposes of both storing and dispensing the spices or herbs. They are sold in small glass or plastic containers or resealable plastic packaging. When spices or herbs are homegrown or bought in bulk, they can be stored at home in glass or plastic containers. They can be stored for extended periods, in some cases for years. However, after 6 months to a year, spices and herbs will gradually lose their flavour as oils they contain will slowly evaporate during storage.

Spices and herbs can be preserved in vinegar for short periods of up to a month, creating a flavoured vinegar.

Alternative methods for preserving herbs include freezing in water or unsalted butter. Herbs can be chopped and added to water in an ice cube tray.

After freezing, the ice cubes are emptied into a plastic freezer bag for storing in the freezer. Herbs also can be stirred into a bowl with unsalted butter, then spread on wax paper and rolled into a cylinder shape. The wax paper roll containing the butter and herbs is then stored in a freezer, and can be cut off in the desired amount for cooking. Using either of these techniques, the herbs should be used within a year.

➤ **Meat**

Unpreserved meat has only a relatively short life in storage. Perishable meats should be refrigerated, frozen, dried promptly or cured. Storage of fresh meats is a complex discipline that affects the costs, storage life and eating quality of the meat, and the appropriate techniques vary with the kind of meat and the particular requirements. For example, dry ageing techniques are sometimes used to tenderize gourmet meats by hanging them in carefully controlled environments for up to 21 days, while game animals of various kinds may be hung after shooting. Details depend on personal tastes and local traditions. Modern techniques of preparing meat for storage vary with the type of meat and special requirements of tenderness, flavour, hygiene, and economy.

Semi-dried meats like salamis and country style hams are processed first with salt, smoke, sugar, acid, or other "cures" then hung in cool dry storage for extended periods, sometimes exceeding a year. Some of the materials added during the curing of meats serve to reduce the risks of food poisoning from anaerobic bacteria such as species of *Clostridium* that release botulinum toxin that can cause botulism. Typical ingredients of curing agents that inhibit anaerobic bacteria include nitrates and nitrites. Such salts are dangerously poisonous in their own right and must be added in carefully controlled quantities and according to proper techniques. Their proper use has however saved many lives and much food spoilage.

Like the semi-dried meats, most salted, smoked, and simply-dried meats of different kinds that once were staples in particular regions, now are largely luxury snacks or garnishes; examples include jerky, biltong, and varieties of pemmican, but ham and bacon for instance, still are staples in many communities.

➤ **Fish and shellfish**

It is unsafe to store fish or shellfish without preservation.

➤ **Food rotation**

Food rotation is important to preserve freshness. When food is rotated, the food that has been in storage the longest is used first. As food is used, new food is added to the pantry to replace it; the essential rationale is to use the oldest food as soon as possible so that nothing is in storage too long and becomes unsafe to eat. Labelling food with paper labels on the storage container, marking the date

that the container is placed in storage, can make this practise simpler. The best way to rotate food storage is to prepare meals with stored food on a daily basis.

## **COMMERCIAL FOOD STORAGE**

### **Commercial storage:**

This involves the use of large storage equipment and facilities for storage of agricultural products for man and industrial uses. It is of great importance since it make food available to consumers even during the off- season.



**Figure. 1.** Diagram of silo: a commercial storage equipment, the silos is connected to a grain elevator on a farm

Source: Google image

## **GRAIN STORAGE**

### **➤ Where can we store grain and beans?**

Grain and beans are stored in tall grain elevators, almost always at a rail head near the point of production. The grain is shipped to a final user in hopper cars. Grains can be irradiated at the point of production to suppress mold and

insects. Threshing and drying can be performed in the field, and transport is nearly sterile and in large containers that effectively suppresses pest access, which eliminates the need for irradiation. At any given time. Fresh fruits and vegetables are sometimes packed in plastic packages and cups for fresh premium markets, or placed in large plastic tubs for sauce and soup processors. Fruits and vegetables are usually refrigerated at the earliest possible moment, and even so have a shelf life of two weeks or less.

➤ **Building for grain storage**

**Things to consider when deciding whether a given building would be a good choice for storing grain:**

**Sanitation.** Can you get the building clean enough for grain storage? If the building previously contained manure, ag chemicals, or petroleum products, can you completely remove these materials and their odors so that grain will not be physically contaminated or pick up odors that would result in down grading?

Also, take a look at the way the building is constructed and try to **determine whether you can keep birds and rodents away from the grain.** Wall strength. Dry grain exerts high pressure on walls, and unless the building was specifically designed to withstand the pressure of grain or some other granular product, it will need to be reinforced. If the building was designed and erected by an agric building company, you might ask the company if a “grain package” is available.

Or you could consider hiring an engineering consultant to design building modifications for you. Another option would be to set freestanding bulk heads inside the building to keep grain away from the walls. Extension doesn't currently have plans for do-it-yourself bulk heads, but some local contractors or building materials suppliers might be able to build them for you. Some farmers avoid the wall-pressure problem by buying metal grain bin rings (without floors or roofs), and setting the rings inside the building.

Finally, you could accept reduced storage capacity and just place grain in the center of the building in sloping piles that do not touch the walls. Capacity. When you are trying to decide whether it is worth using an existing building for grain storage, make sure you **estimate how many bushels can be stored.** It is disappointing to find how few bushels can actually be stored in some flat buildings, especially when buildings have low ceilings or when grain is not piled against the sidewalls. To estimate capacity, calculate the volume of the planned grain pile in cubic feet and then multiply by 0.8 bushels per cubic foot, or divide by 1.25 cubic feet per bushel to get volume bushels.

## **GRAIN DRYING AND GRAIN STORAGE MANAGEMENT**

The storability of grain depends on the grain quality, moisture content, and temperature. Grain moisture content must decrease as grain temperature increases to safely store grain. For example, the allowable storage time of 22 percent moisture corn is about 190 days at 30 degrees, 60 days at 40 degrees, and only 30 days at 50 degrees. Therefore, as stored grain temperature increases the grain moisture content must decrease for safe storage.

Stored grain temperature increases in the spring due to outdoor temperatures increasing and solar heat gain on the bin. There is more than twice as much heat gain from solar energy on the south wall of a bin in early spring (raining season) as there will be during the summer (dry season).

Immature grain and grain with damage to the seed coat is more prone to storage problems, so the grain should be stored at a lower moisture content than normal. Also, stored grain should be monitored more closely to detect any storage problems early. Grain temperature and moisture content should be checked every two weeks during the spring and summer. Grain should also be examined for insect infestations.

Corn needs to be dried to 13% moisture for summer storage to prevent spoilage. Soybeans should be dried to 11%, wheat to 13%, barley to 12% and oil sunflower to 8% for summer storage.

Check the moisture content of stored grain to determine if it needs to be dried. Remember to verify that the moisture content measured by the meter has been adjusted for grain temperature. In addition, remember that moisture measurements of grain at temperatures below about 40 degrees are not accurate. Verify the accuracy of the measurement, by warming the grain sample to room temperature in a sealed plastic bag before measuring the moisture content.

Grain temperature should be kept cool during spring and summer. Periodically run aeration fans to keep the grain temperature below 40 degrees during the spring.

Grain storage molds will grow and grain spoilage will occur in grain bags unless the grain is dry. Grain in the bags will be at average outdoor temperatures, so grain will deteriorate rapidly as outdoor temperatures increase, unless it is at recommended summer storage moisture contents.

Corn at moisture contents exceeding 20% should be dried in a high temperature dryer because there is potential for corn field molds to continue to grow at moisture contents exceeding about 20% when grain temperature increases above about 40 degrees. For natural air-drying, assure that the airflow rate supplied by the fan is at least 1.0 cfm/bu. and the initial corn moisture does not exceed 20%. Start drying when outside air temperature averages about 40 degrees. Below that temperature, the moisture holding capacity of the air is so small that very little drying occurs.

An airflow rate of at least 1.0 cfm/bu. is recommended to natural air dry up to 16% moisture soybeans. The expected drying time with this airflow rate will be about 50 days. The allowable storage time for 18% moisture soybeans is only about 40 days at 50 degrees, so a minimum airflow rate of 1.5 cfm/bu. is recommended to natural air dry 18% moisture soybeans.

## **METHOD OF STORAGE**

The following are the different method of storage:

- a) Improved grain storage (for small scale and large scale storage)
- b) Underground storage structure
- c) Surface storage structure (bag and bulk storage)
- d) Commercial storage (silos, steel, tower silos, bag silos etc)
- e) Warehousing
- f) Rhombus, cribs, barns and raffles
- g) Canning

## **Surface Storage Structures**

Food grains in a ground surface structure can be stored two (2) ways –bag or bulk storage

### ➤ **Bag storage**

- a) Each bag contains a definite quantity, which can be bought, sold or dispatched without difficulty;
- b) Bags are easier to load or unload.
- c) It is easier to keep separate lots with identification marks on the bags.
- d) The bags which are identified as infested on inspection can be removed and treated easily; and
- e) The problem of sweating of grains does not arise because the surface of the bag is exposed to the atmosphere

### ➤ **Bulk or loose storage**

- ❖ The exposed peripheral surface area per unit weight of grain is less. Consequently, the danger of damage from external sources is reduced; and
- ❖ Pest infestation is less because of almost airtight condition in the deeper layers.

## **IMPROVED GRAIN STORAGE STRUCTURES**

For small-scale storage

➤ **Pau bin**

This is a galvanised metal iron structure. It has capacity ranges from 1.5 to 15 quintals. Designed by Punjab agricultural university.

➤ **Pusa bin**

This is a storage structure is made of mud or bricks with a polythene film embedded within the walls.

➤ **Hapur tekka**

It is cylindrical rubberised cloth structure supported by bamboo poles on a metal tube base, and has a small hole in the bottom through which grain can be removed. For large scale storage.

## **THE UNDERGROUND STORAGE STRUCTURES**

In underground storage, a portion of a ground may be dugout and line with water proofing materials. Then used for storing agricultural produce. Here, structures similar to a well with sides plastered with cow dung is constructed. They may also be lined with stones or sand and cement. They may be circular or rectangular in shape. The capacity varies with the size of the structure in mind. Underground storage may also make use of underground tanks.

### **Advantages underground storage structures**

- ❖ They are safer from threats from various external sources of damage, such as theft, rain or wind.
- ❖ They space can temporarily be utilized for some other purposes with minor adjustment and;
- ❖ They are easier to fill up owing to the factor of gravity.

➤ **Silo storage**

Silo is a structure for storing bulk materials. Silos are used in agriculture to store grain (like in grain elevators) or fermented feed known as silage. Silos are more commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust. Three types of silos are in widespread use today: tower silos, bunker silos, and bag silos.

➤ **Forage silo usage**

### **Forage harvesting**

The harvester contains a drum-shaped series of cutting knives which shear the fibrous plant material into small pieces no more than an inch long, to

facilitate mechanized blowing and transport via augers. The finely chopped plant material is then blown by the harvester into a forage wagon which contains an automatic unloading system

➤ **CAP storage (cover and plinth)**

It involves the construction of brick pillars to a height of 14 from the ground, with grooves into which wooden crates are fixed for the stacking of bags of food grains. The structure can be fabricated in less than 3weeks. It is an economical way of storage on a large scale.

➤ **Chemical storage**

This is the use of some less toxic chemical like preservatives to keep the food product in a good state so it can be kept for some period of time. The product is protected against quantitative and qualitative loses by the use of such method of preservation as are necessary.

➤ **Use of Warehousing**

Warehouses are large house or hall that has a storage structures. It is especially constructed for the protection of the quantity and quality of processed agricultural products.

**Financing**

Warehouses meet the financial needs of the person who stores the product. Nationalized banks advanced credit on the security of the warehouse receipt issued for stored products to the ex-tent of 75 to 80% of their value.

**WHY WE MAKE USE OF A WAREHOUSE IN STORING OUR AGRIC PRODUCS**

➤ **Stabilization of price**

Warehouses help in price stabilization of agricultural commodities by checking the tendency to making post-harvest sales among the farmers.

➤ **Provision of financing**

Warehousing creates a financing strength for individuals who stores the product. Nationalised banks advanced credit on the security of the warehouse receipt issued for stored products to the extent of 75 to 80% of their value. These



in summary stand a chance of creating tangible financial support for dealers and farmer even during off-season and famine.

➤ **Market intelligence**

Warehouses also offer the facility of market information to persons who hold their produce in them.

**ESTABLISHING OF A WAREHOUSE**

Warehousing serves a lot of purposes. Hence, its establishment is guided:

- By Acts-the warehouses work under the respective warehousing acts passed by central or state government
- By eligibility- any person may store notified commodities in a warehouse on agreeing to pay the specified charges.
- By warehouse receipt (warrant)-this is warrant/receipt issued by the warehouse manager/owner to the person storing his produce with them.
- Use of chemicals- the produce accepted at the warehouse is preserved scientifically and protected against rodents, insect and pest and other infestation.
- Financing-the warehouse receipt serves as a collateral security for the purpose of getting credit
- Delivery of produce- the warehouse receipt has to be surrendered to the warehouse owner before the withdrawal of the goods.

➤ **Types of warehouse**

**On the basis of ownership**

- Private warehouse
- Public warehouse
- Bonded warehouse

**On the basis of type of commodity stored**

- General warehouse
- Special commodity warehouse
- Refrigerated warehouse

**STORAGE METHODS**

**a) Traditional drying/storage systems**

Many farmers continue to store their produce in the drying place. Often the roof or the eaves are still full with maize even after the produce has dried. Such practices are not correct grain storage techniques. In order to dry grain warm, dry moving air is required. However we have seen that in storage grain should be cool, not warm.

Furthermore, if the drying air can pass around the grain kernels, then insects and rats can enter as well. Therefore it is best to transfer the clean, dry grain to a cool, dry place where rats and insects cannot follow. It is now time to look at some grain storage models which have been recommended for tropical farmers.

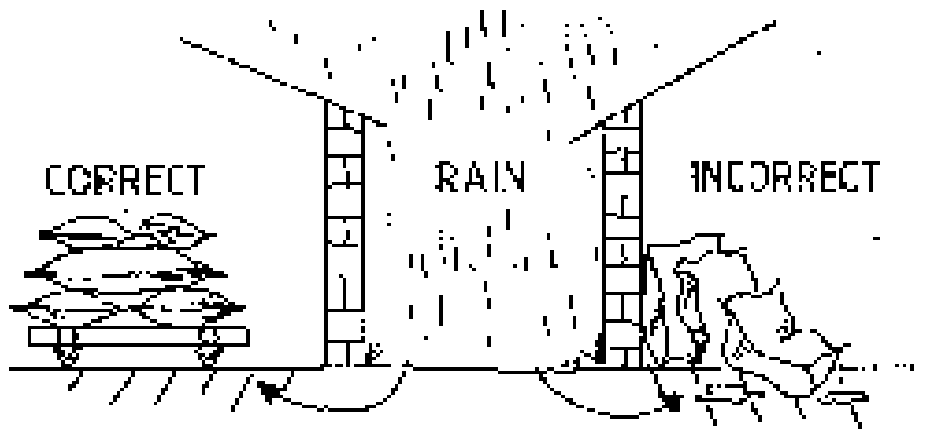
### **b) Drying Cribs**

Many agricultural books say that the drying crib can also be used for a storage barn. However, it is too dangerous to leave the grain exposed to insects, birds, and other pests. After the grain is dry it should be moved to a better storage place.

### **c) Bag Storage**

This is a very popular form of storage. Transportation of the grain is done in the same jute bag, the bags are easy to handle and the jute bag allows you to store different grains in the same room. The following principles should be kept:

- The storage room should be clean and free of all insects. Holes should be repaired.
- All old bags should be washed, shook out, and placed in the sun to dry to drive away any insects still in the sack.
- The bags of produce should be neatly stacked on wooden racks called dunnages away from the walls and off the floor. Grain bags should never lie on the floor or rest against the wall (see the Figure below). Water from the floor and ground can enter into the bags and cause spoilage.
- The bags should be regularly checked for any problems



**Figure 2.** Sacks should never rest directly on the ground or against walls

The main disadvantage of jute bag storage is that the bag does not provide protection against rat or insect attack. Other measures must be taken to control these pests.

#### **d) Bamboo Boxes**

The box is constructed entirely of raffia bamboo sticks and bamboo rope (see the Figure below). The floor of the box is raised off the ground so that water cannot rise up from the ground and enter the box. The bottom of the walls are often packed with mud soil to discourage rats. The box has either a zinc/grass roof or is placed under the eaves of the house to keep the rain off the box. Once the grain is well dried and cleaned it is placed in the box and a tight fitting bamboo cover closes the box. An average box is one meter long, one meter high and one meter wide - it can hold more than 300 kilos of maize on the cob. A well constructed box can last for more than 5 years (Google e-book, 2001).

Once it is well closed insects and rats cannot enter the box. However, the grain must be checked regularly for an increase in insect population 'from the eggs and insects which were carried in with the maize from the drying place. Inside the box it will be dry, cool, and dark. The box should be well cleaned at the beginning and end of each storage season. Insecticide can be used with this method of storage.



**Figure 3.** Bamboo Box

**e) Drums (Air Tight Storage)**

A very good, but more expensive method is to use old oil drums. The drums should be well cleaned. All holes should be repaired and sealed properly with sodden.

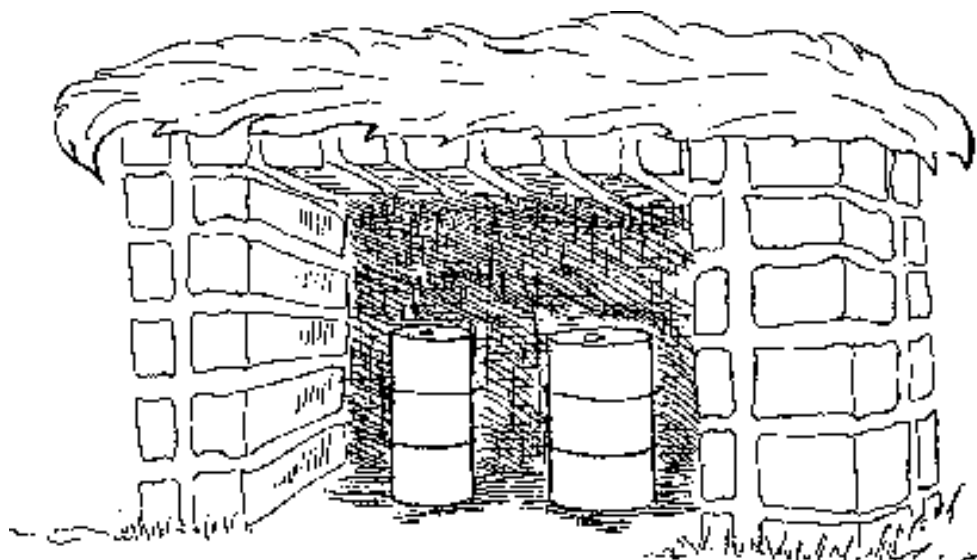
Only very dry grain can be placed inside the drum; if it is too wet the moisture cannot come out and the grain can spoil. Once the dry grain is inside, the drum mouth should be sealed with wax or grease to stop air from entering. Very soon any insects inside should stop breathing and die because all the air is finished. Care must be taken to make certain that the drum is well sealed.

Finally, it is also very important to keep the drum out of the sun, in a cool place. Otherwise the hot sun hitting the metal drum will make the grain very hot. The grain will sweat and respire faster. This also can cause spoilage. Therefore, always keep the drum under a shelter. An oil drum can hold almost 300 kilos of maize.

**f) Others**

Baskets, tins, and empty calabashes can also be used to store grain. Just ensure that the grains and the containers are clean and free of insects. Keep the container in a clean, cool, dry place. Baskets, tins' end calabashes are small and

are ideal for seed storage. However, for large amounts of grain bigger containers are needed.



**Figure 4.** Metals drums must be put out of the sun. Good storage places are cool, dry, and dark.

## **TUBER STORAGE**

There are so many different types of tuber stores which are used locally throughout Africa that to talk about them all would be impossible. Here are three methods which are fairly common. Most other stores use the same principles.

### **a) The Yam Bam**

This store is a small simple building with a thatched roof: zinc roofs are sometimes too hot. The walls can be of any construction: wood plank, bamboo, etc. Mud blocks or mud packed walls are preferred because they keep the inside of the barn much cooler. The floor should be raised off the ground about 30 cm. This allows air to pass all through the barn. The floor can be made of bamboo or wood.

There should be small spaces in the walls or under the eaves to let the air pass freely through the barn. Tubers are generally spread evenly on the floor. Make certain that the barn is filled carefully so that the tubers are not damaged.

An improved method using the same store is to build bamboo racks or shelves along the walls of the store. The tubers are then placed on the racks. The racks or shelves should be constructed at 60 cm (2 feet) intervals along the side

of each wall. This way each wall would have about four racks attached to it, all spaced 60 cm from each other.

Yams, cocoyams, and potatoes would store well in this manner. The tubers would not be piled up on top of each other. They would not be touching each other. Disease could not spread. The room is cool and dry and the sun cannot enter. Furthermore, air can pass all around the tubers to keep them cool. The tubers can be easily inspected for insect or disease problems as they are not piled on top of each other. The barn can be locked at night to discourage thieves.

### **b) Clamps or Tuber Pits**

This method is used mostly for potatoes. It does not seem to be as successful with yams.

A shallow hole is dug in a shady, cool place. The hole is then lined with sand. Grass, leaves, and sticks are then packed over the sand. The tubers are then carefully placed in the hole and covered with ashes or sand. Grass and banana leaves are then placed over the filled pit. A small sun/rain shelter of bamboo and thatch is built over the clamp. One must make certain that the drainage is good so that water does not fill the pit and spoil the tubers.

This method keeps the tubers cool, dry, and dark. However, there is no ventilation. If heating takes place the heat cannot escape. Instead it will build up inside the pit and could cause spoilage. It is also difficult to inspect the tubers for storage problems. Termites could bother the pit if they are a problem in your area. The wood ashes sometimes discourage them.

### **c) Box or Basket Storage**

Tubers, especially the potato, can be gently packed into baskets or boxes and then stored in a cool, dry place in the house. Sometimes it is good to pack the tubers with wood shavings, sand, or wood ashes. This not only cushions the tubers, but it also stops the spread of fungus diseases.

Make certain that the box has a few holes in it so that air can circulate. A basket should have a loose weave. The major difficulty is that the tubers cannot be easily inspected. The area is small, not too many tubers can fit into a box or basket.

## **GOOD STORAGE REQUIREMENT**

- ❖ Any given storage system must be easy for maintenance and management.
- ❖ A good storage must be prevented from moisture and excessive air current.
- ❖ A good storage system must be the one that can enable free access in terms of regular check to access the state of the product.

- ❖ Any stored agric produce must be protected from pest, rodent and birds by allowing proper storage hygiene and maintenance.
- ❖ The store method and facility must give ease of loading and offloading as the need arises. This is to create accessibility of the product.
- ❖ For a long term storage like in the case of grains adequate measures must be taken to ensure that the structures properly constructed and manage.

## **MAIN PURPOSE/IMPORTANCE OF AGRICULTURAL STORAGE**

The purpose of any storage facility is to provide safe storage condition for the produce or product in question in order to prevent losses that may be cause by an adverse weather conditions, moisture content, rodent, birds, insect and microorganism like fungi, bacteria and mould. Hence:

- ❖ Storage of harvested and processed plant and animal food products for distribution to consumers
- ❖ Enabling a better balanced diet throughout the year
- ❖ Reducing kitchen waste by preserving unused or uneaten food for later use
- ❖ Preserving pantry food, such as spices or dry ingredients like rice and flour, for eventual use in cooking
- ❖ Preparedness for catastrophes, emergencies and periods of food scarcity or famine
- ❖ Religious reasons (Example: LDS Church leaders instruct church members to store food)
- ❖ Protection from animals or theft
- ❖ Storage protects the quality of perishable and semi-perishable product from deterioration.
- ❖ It helps in the stabilization of prices by adjusting demand and supply.
- ❖ Storage provides employment and income through price advantage.
- ❖ Storage is necessary for some period for performance of other marketing function.
- ❖ The storage of goods, therefore, from the time of production to the time of consumption, ensures a continuous flow of goods in the market.

## **PROBLEMS ASSOCIATED WITH STORAGE AND PROCESSING FACILLITIES**

During storage care should be taken based on the following points:

- a. **Poor maintenance**-Storage equipment and facilities should be maintained by regularly accessing its parts and its nature of operation.

- b. **Produce/crop requirement**-As each crop has a specific method or temperature of storage, then precaution is to be taken to maintain it for proper storage.
- c. **Technical know-how**-skill personnel should be employed to operate machines and equipment so as to meet the demand of each machine and its working operations.
- d. **Inadequate power supply**-Perishable c crops like tomato, pepper etc. needs continuous power supply in other to keep it safe and fit for human consumption, therefore an effort should be made to make farm power available to meet this requirement
- e. **Inadequate/lack of spare parts**-some storage facilities may be so complex that during break down its parts may be so expensive or difficult to replace thereby crating a room for storage failure.
- f. **Marketing**- it is essential to market out stored food product after storage, this promote hygiene and safe the produce from spoilage, because excessive storage may give room to pest and disease attack.

## **PROJECT UNDERTAKEN IN THE SURVEY**

The following projects were undertaken during the studying of this survey

### **CONSTRUCTION OF A LOCAL EVAPORATIVE COOLERS**

#### **Introduction**

As post-harvest losses is still a major issue for farmers, lack of electricity and poverty in Nigeria, processing of perishable agricultural produce becomes a very big problem.

As population increases, there is need to increase food production without much effort on how what has been produced in excess are stored.

Locally constructed Evaporative coolers are not very expensive to produce and can be used for the preservation of vegetables.

#### **EVAPORATIVE COOLING**

When water evaporates from the surface of a body, that surface becomes much cooler because it requires heat to change the liquid into vapour. Evaporative cooling, therefore, works by evaporating water into air-steam. The chilling effect that is felt when you come out of a swimming pool and a breeze blows across your body best illustrate this principle (evaporative cooling). The more moisture that is present in the air, the less the chilling effect because the less the evaporation of water. Also the less moisture that is present in the air,



the more the chilling effect because the more the evaporation of water from the surface of the body (Liberty et al., 2013)

## **MATERIALS AND METHODS**

**Construction Of Hygrometer:-** 2 hygrometer was constructed.



**Figure 5.** Locally constructed Hygrometer

### **Materials**

- Two (2) thermometer for each hygrometer
- Plywood, hard wood, wick and bottle.

### **Procedure**

- Cut the wood into  $30 \times 5$ cm
- Cut 2 plywood and cover one side
- Bore 2 holes on the upper and lower parts of the hygrometer
- The hole should be 1cm apart

- Nail 2 of the board on each side of the wood such that the wood having holes are located first and second followed lastly by the wood without holes.
- Insert 2 thermometers on the holes and make one of the thermometer wet bulb by fixing a wick on the bulb and inserting the wick in the bottle containing water.
- Put one of the hygrometer in the trolley and the other one outside the cooler for recording of ambient temperatures (both dry and wet bulbs).

## **CONSTRUCTION OF THE EVAPORATIVE COOLER**

**Materials:-** jute bag, trolley, hygrometer and weighing balance.



**Figure 6.** Locally Constructed Evaporative Cooler For Agric Produce Storage

## **Procedures**

- Soak the jute bag in clean water and wipe off excess water
- Wrap the jute bag round the trolley such that no part of it is exposed.
- Put freshly harvested and weighed vegetables (100g) into the second chamber of the cooler. The vegetables are fluted pumpkin, water leaf and garden egg (egg plant).
- Also, put one hygrometer into the second chamber of the cooler.
- Finally, place the entire arrangement in the greenhouse.

## **RESULTS AND DISCUSSION**

The readings must be taken and recorded for 7 days and summary made in tables. The vegetables should be weighed 6am and 6pm daily while the both wet and dry bulb temperatures are to be taken every 2 hours from 6am to 6pm daily.

From the table, the weight of the vegetables may reduced but those kept in Ambient condition may reduced considerably compared to the weight of vegetables stored in cooler condition, this shows the effectiveness of the evaporative cooler in the preservation of vegetables compared to the Ambient condition.

## **CONCLUSION / RECOMMENDATION**

Locally constructed evaporative cooler has proved to be efficient or effective in the preservation of fresh agricultural produce like vegetables up to 7days without spoilage. I therefore, recommend that locally constructed cooler should be use for the preservation of fresh agricultural produce like vegetables since it can preserve for days and also easy and cheap to construct and the maintenance cost is low.

## **CASSAVA PROCESSING AND PRODUCT**

### **Materials and Method**

- **Kitchen knife:** The knife was use to remove (pill ) off the skin of the cassava
- **Basin:** It is used to put the pilled cassava
- **Water:** For washing the cassava
- **Hammer mill:** Used to grind the cassava into tiny particle
- **Sack bags:** After grinding , the product I put into a sack bage
- **Screw hand press:** It is used to compressed the grinded cassava to get the water out in other for it to ferment.
- **Sifter:** Used to separate the shaft from the main product meant for frying.

- **Basins:** After the separation the product is put into a basin
- **Carpet:** Used for placing the product
- **Turning stick:** Used to turn the product while on fire to avoid it getting burnt
- **Frying pot:** Used to fry the garri
- **Firewood:** For fuel hood
- **Bowel:** to place the fried garri
- **Palm oil:** Added to the fired garri to get the needed colour
- **Fuel/engine:** Fuel is put into an engine in other to generate power if the process is to be done mechanically.

## **Results and Discussion**

- The heat required for cassava processing is moderate. High heat may cause the product to get burnt and lead to wastage.
- Fermentation must be properly done to avoid hydrocyanide acid contamination in the product.
- The drudgery involves in manual processing can be cut-down through the use of more mechanized machines and equipment's
- Cassava can processed into many useful product, therefore it is advisable to take care during the processing of the produce.

### ***Conclusion/ Recommendation***

- Processing of garri is one of the aid in global food security, hence garri should be produce since the cost of processing is pocket friendly.
- I therefore, recommend that locally processing of cassava into garri since the procedures involves a straight and simple way and easy to follow

## **RICE PROCESSING AND PRODUCTS**

### **Materials and Methods**

- ❖ **Manual thresher:** Thresher threshes the rice immediately it is brought from the farm after sun-drying.
- ❖ **Boiling drum:** Fire is set under it to parboil the rice
- ❖ **Buckets:** Buckets is used to put the rice after removing it from the heat source.
- ❖ **Galloons:** Galloons are used to get water to fill the drum with water for subsequent parboiling.
- ❖ **Firewood:** Firewood is used to generate heat to the rice for it to parboil adequately.

- ❖ **Bushel:** A bushel in rice processing has a dual function. First it serves as a container for filling of rice will milling. Secondly it serves as the medium for measuring and selling of rice.
- ❖ **Basins:** Used in getting water or used for putting parboiled rice
- ❖ **Hullers:** Used for hulling (milling ) the rice
- ❖ **Water:** water is very essential during rice processing, because it helps to reduce the tenderness in the rice and makes it strong for milling.
- ❖ **Carpet:** Carpet is used for sun drying the rice before milling, also used to place the milled rice or sales.
- ❖ **Rakes:** Rakes is used for turning the sun-dried rice to ensure proper drying.
- ❖ **Broom:** Broom is used to gather the rice grains together
- ❖ **Polishing machine:** this machine gives rice a nice face by polishing it immediately after milling.
- ❖ **Sack bags:** Sack bags are used to bag rice after milling. Sack bag can also be used in bagging paddy rice after parboiling.
- ❖ **Diesel/engine:** Diesel is used to power a milling machine so as to provide power for the milling process
- ❖ **Bowel turner:** It is used to turns the rice during preparation for boiling.

### **Results and Discussion**

- Energy is required to mill a parboiled rice. power required may be 250 volt or 350volt depending on the type of machine used.
- From threshing to milling requires outmost care, hence the manner of parboiling gives the rice a nice appearance.
- During drying proper turning is essential to crate room for evenly dying of the produce.
- Rice can be processed into many agric consumables like in beer from brewery

### **Conclusion / Recommendation**

- Processing of rice is one of the aid in global food security.
- Rice is widely consume throughout the world, hence it production is very vital to human existence. I therefore, recommend that rice processing should be supported by many and modern machines should be used to avoid drudgery

## **OIL PALM PROCESSING AND PRODUCT**

### **Materials Used for Oil Palm Processing**

- **Sterilized steam:** After harvesting the oil palm bunch is put into steam to aid the fruit from falling-off from its bunch.
- **Axe:** axe can also be used to remove the fruit from the bunch, this is by cutting the bunch into pieces
- **Chunk knife:** Chunk knife is also used in removal of the fruits from the bunch
- **Basket:** The fruit can be packed into the basket ready for boiling.
- **Boiling drum:** The drum is used to boiled the fruit, here some quantity of water is put into the drum with the fruit inside it.
- **Water:** Water is essential, we use water to boil the fruit
- **Digester:** Immediately after boiling the fruit is put into digester for it to be pound
- **Miller:** the fruit is transferred into a miller for milling
- **Screw hand press:** Used manually to compress the already pounded material for water-oil collection
- **Hand press:** Hand press is also used manually to press the pounded materials
- **Filter:** Filtering is essential for frying and preservation
- **Galloons:** Oils are stored in galloons or in drums
- **Basins:** some residues of oil left are put in a basin for further processing or for soda soap formulation.

### ***Results and Discussion***

- Energy is also required to mill a water-oil into finish oil power required may be 250 volt or 350volt depending on the type of machine used for power generation.
- From sorting to boiling care is needed to enable production of quality oil.
- Frying is done to keep the shelf-life of the oil longer and discourage microbes entrance.

### **Conclusion / Recommendation**

- Oil palm production is one of the leading agricultural products, hence its processing is of great importance to man and His industries.
- Palm fruit can be produce into many other product like kernel oil, soap, detergent etc. Hence care is needed to ensure it safe and guided processing.
-

Table 2. Practical Study Under-Taken In Rice Mill.

2.	1.	S/N	
Obina Mills	Bob Loko Rice Mill	NAME OF UNIT	
Black stone and Hauler. Uses 230 Volt of power	Pecking machine. Uses 250 Volt of power	TYPES OF MACHINE AND CAPACITY	
2000 bushels. This also depends on the available rice in the mill	1500 bushels depending on quantity of brought for milling in a day.	QTY OF RICE MILL PER DAY	
3	2	SKILL	NO OF WORKER PER UNIT
1	1	UNSKILL	
0	1	D	LEVEL OF EDUCATION OF WORKERS
3	1	C*	
1	1	IFE	
Personal savings and family support	Agric loan by Federal Government	SOURCE OF INCOME BEFORE ESTABLISHMENT	
“We appeal for government loan, so we can buy more equipment and modern milling machine”	Lack of worker, Loan form Government, provision of more modern machine	PROBLEMS AND SOLUTIONS	
41	32	MAN/HOUR REQUIREMENT FOR DAILY MILLING	

	3.
<b>TOTAL</b>	Oba Rice Mills
	HR machine. It uses 300 Volt of power.
	4000 bushels. This depends on the season and customers available.
11	6
3	1
2	1
7	3
4	2
	Agric Loan by state Government of Abia State.
	“Lack of power, water, insecurity of our goods. We need more equipment.”
<b>121 MHR</b>	48

N/B; D = Degree , C\* = Certificate/College, IFE = Informal Education.

**Table 3.** Practical Study Under-Taken In Oil Palm Mill



2.	1.	S/N	
John Ubong Mills	Oba Oil Mills, Ofatura.	<b>NAME OF UNIT</b>	
Compact presser/miller . It is connected to a diesel engine which uses 200 Volt of power	Goyum Screw Press. Connected to electric motor which uses 250 Volt of power	<b>TYPES OF MACHINE AND CAPACITY</b>	
5-8 drums in a day. This depends on harvest or customer who bring palms for milling.	10 drums of oil in a day. “This depends on how many fruit we harvest.”	<b>QTY OF RICE MILL PER DAY</b>	
2	3	<b>SKILL</b>	<b>NO OF WORKER PER UNIT</b>
1	0	<b>UNSKILL</b>	
0	0	<b>D</b>	<b>LEVEL OF EDUCATION OF WORKERS</b>
2	3	<b>C</b>	
1	0	<b>IFE</b>	
Personal savings and support from family members and friends.	“Semi-industrial loan by Microfinance Bank, Abia State.	<b>SOURCE OF INCOME BEFORE ESTABLISHMENT</b>	
“We need more machine so we can mill more oil” Government should provide machinery.	“We need water and more equipment” Governmental loan.	<b>PROBLEMS AND SOLUTIONS</b>	
39	42	<b>MAN/HOUR REQUIREMENT FOR DAILY MILLING</b>	

3.	Obong-Ette Oil Mill, Ofatura	HR oil automatic digester/miller. The machine uses 300 Volt of power	11-15 drums daily. "My 15 drums in a day is only when there is NEPA light"	4	1	1	2	1	"Cross River Agric Scheme Loan For Young Entrepreneur, and family support.	"I will like the Government to provide water and give me more loan so I can buy more equipment and I need steady power to run this business effectively."	51
<b>TOTAL</b>				9	2	1	7	2			<b>132 MHR</b>

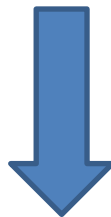
**STAGES OF PROCESSING IN RICE AND OIL MILL**

These is a series of processes involved in the processing of some agric produce like rice and oil palm. This study was conducted at Ofudua Community for (rice milling) and Ofatura Community for (oil milling) in Obubra Local Government Area .

**FLOW CHART FOR RICE PROCESSING RICE (*Oryza sativa*)**

(Harvest, sun-dry then) **start** ———> **THRESHING**

This is the process of loosening the edible part of cereal grain (or other crop) from the scaly, inedible chaff that surrounds it. It was done manually by use of hands flail.



**WINNOWER**

This is the act of separating grain from chaff, stalk. This process helps in the removal of weevil or other pest in the grain.



**PARBOILING**

This is the partial boiling of the rice as the first in cooking process. This was done with used of boiling drum. It is done to reduce breakage of robe and rice during milling.



**HULLING**

This is the removal of husk from the grain.



**BOILING**

It is the rapid vaporization of a liquid which occurs when a liquid is heated to its boiling point.



**SUN DRYING**

This is the process of drying the boiled rice for about 8 to 10 hours in order to prepare it for polishing and processing.



### **POLISHING**

This involves the use of specially designed machines to remove the husks and other layers covering the grains. Polishing involves the removal of the rice bran which is very proteinous and rich in vitamins.



### **PACKAGING**

Packaging is the science, art and technology of enclosing or protecting products for storage, distribution, sale and use. This was done with industrial bushel, basin and bags.



**End** —————> **STORAGE**

This is the commercial enterprise of storing goods and material stored in ware

## **FLOW CHART FOR OIL PALM PROCESSING**

### **OIL PALM (*Elaeis guineensis*)**

(After harvesting) **Start** —————> **STERILIZATION**

Sterilization helps to soften the fruits, remove pathogens and inhibit the action of lipolytic enzyme. Inactivates the lases and prevent build up of free fatty acids (FFA).

## **FUNCTIONS**

- ❖ It softens the oil palm fruit so as to facilitate easy removal of the mesocarp.
- ❖ It helps in pathogens that accompany the fruit from the field to the mill.
- ❖ It helps to inhibit the enzyme that is contain inside (lypolytic enzyme)



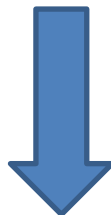
### **STRIPPING**

Stripping is the removal of fruits from sterilized or quartered bunches.



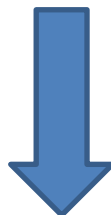
### **SEPERATION/SORTING**

This method involve the keeping aside of the fruits from the chaff, done manually by hand picking.



### **BOILING**

Boiling is done to soften the fruit that is the mesocarp for digestion.



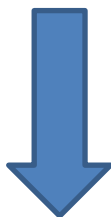
### **DIGESTION**

This is the process of releasing the palm oil in the fruit through the rupture or break down of the beaming cells.



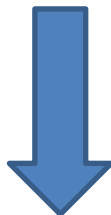
### **MILLING**

This is the pounding of sterilized fruit for the purpose of separating the mesocarp from the kernels (de-pulping). After the separation, the mesocarp is pounded until no streak of coloured outer skin is distinguishable anymore.



### **PRESSING**

The pounded mass in this process is then loaded into a press for the extraction of the oil. There are different types of presses. The screw hand press was manually used



### **CLARIFICATION**

The main point here is to separate the oil from its entrained impurities. The fluid coming out from the press is a mixture of palm oil, water, cell debris, fibrous materials and non oily solids. The extracted crude oil is clarified by boiling/skimming. It is more effective by used of hand screw press or hydraulic press.

### **FUNCTIONS**

- ❖ It reduces free fatty acid (FFA)
- ❖ It determine the quality of the oil



## **PACKAGING**

Packaging is the science, art and technology of enclosing or protecting products for storage, distribution, sale and use. It was packed by 25litres, 20litres, 10litres rubbers each respectively.



**End** —————> **STORAGE**

In this process, the oil thus refined is stored in drums, tankers, tin or bottles and ready for sale. All stored in his suitable ambient temperature put in a warehouse.

## **PROCEDURE**

- ❖ The longer the storage, the wider the increase of FFA.
- ❖ The shorter the storage, the lower the increase of FFA.
- ❖ The lower the content of the FFA, the higher the quality of the oil.
- ❖ The higher the content of the FFA. The lower the quality of the oil.

## **Some benefits/product from oil palm**

- ❖ Oil palm produces two distinct oils called palm oil and palm kernel both of which are important in world trade used in the industries. .
- ❖ It serves as medicinal purpose for pharmaceutical industries.
- ❖ Palm fruit contains about 56% oil (25% to a fresh fruit bunch which is edible with no toxins.
- ❖ palm gives the highest yield of oil per unit area compared to any other crop cash or agric crops.

## **RICE PARBOILING SYSTEMS**

### ➤ **One way parboiling:**

In one way boiling, rice is only boiled once and milled. This method boiling is only be used when the rice is to be used for a specific purpose. Its requires expiatory technique for it to be successful.

### ➤ **Two way parboiling**

Here, rice is boiled in the evening for about 1 hour 30 minute then fire (heat) is redrawn. The following morning heat is applied for about 1 hour before drying can take place.

## **RICE MILLING SYSTEM**

In recent times a rice milling system can be a simple one or two step process, or a multi stage processes:

### **A one step milling process,**

Here, husk and bran removal are done in one pass and milled or while rice is produced directly out of paddy.

### **A two step process,**

Removing of husk and removal of bran are done separately and brown rice is produced as an intermediate product.

### **Multi stage milling system,**

Multi stage milling is classified into village and commercial mills. Hence an ideal milling process, this will result in the following fractions: 20% husk, 8-12% bran depending on the milling process and 68-72% milled rice or white rice depending on the variety. Total milled rice contains whole grain, or head rice and breakage is limited.

## **RICE MILLER**

Rice miller has three (3) important chambers:

- Hauler
- Grinder
- Filter

### **Description of the miller**

Power is generated to the miller through some machines like the black stone machine. The miller machine has 2 belt located at the opposite side. The one at the left hand side i.e. the **conveyor belt** is connected to the grinder down to the



filter which helps to rotate and mill the rice while the other belt at the right hand side is connected from the grinder to the engine which generates power for the miller to carry out its operation.

## **RICE MILLING MACHINE**

It is the power source of the miller; it is connected to a pipe and is a 2 stroke engine with a capacity of 20 to 30 horse power. It consists of the following compartments:

### **Compartments of a rice milling hauler**

- a) One compartment helps in milling of the rice
- b) Another compartment helps in separating the chaffs by winnowing it.

## **THE ENGINE**

**Engine drum:** This is where lubricant rest the oil here helps to lubricate the whole system and increase the rate of rotation to avoid tear and wear and possible breakdown of the system.

**Cooling systems:** it has two systems attach to it i.e. one for carrying water from the tank or drum to the milling engine to cool it while operating and the other to reduce or remove heat from the milling engine while operating. The cooling system helps to maintain the smooth operation of the engine to avoid breakdown and damage.

## **WHY DO WE MILL RICE?**

Rice milling is a crucial and very important step in processing of rice. The basic objectives of a rice milling system is to remove the husk and the bran layers and produce an edible clean rice, white rice kernel that is sufficiently milled and free of impurities. Depending on the requirement of the customer, the rice should have a minimum of broken kernels. But if modern and sophisticated equipment is used breakage is greatly minimized.

## **USES OF RICE BY-PRODUCT**

### **Rice husk uses:**

- Some good foam are make from rice husk
- Husk is used for preparation of livestock fodder
- Some good quality card board papers are made from rice husks

- Rice husk is used as fertilizer material since it is rich in potassium and little of phosphorus nutrient elements.
- Used as manure in farms
- Some mat, sacks and particle board are made from rice husk.

## **Chapter Four**

### **GENERAL RESULTS AND DISCUSSION**

When Agricultural produce like fruits and vegetables are exposed to high temperatures during post-harvest it leads to loss of value and quality, hence in areas with low technology and low income like Obubra where the survey was carried-out, evaporative cooling is thereby recommended. This view agrees with the research findings of Liberty *et al.* (2013) whose report presented evaporative cooling as effective for preservation of Agricultural produce, and further stating epileptic power supply and low income of farmers in the rural communities' as factors makes refrigeration expensive and unaffordable when compared to the technology of evaporative cooler. Low temperature has been reported to be capable of reducing the rate of respiration, as well as reducing growth of spoilage micro-organisms (Rouraa *et al.*, 2000; Watada *et al.*, 1996).

The research on this project was done on the 17<sup>th</sup> of October, 2014. I went to each processing center very early in the morning to assist the owners (farmers) and spent quality time with them in-order to get proper information and documentation.

Hence;

- The research on rice operations takes a total of 121 man/hour requirement with skilled labour calculated into 11 and 3 for unskilled labour.
- The research study for oil palm operations takes a total of 132 man-hours requirement with skilled labour calculated into 9 and 2 for unskilled labour.

#### **Notable observations**

During the course of this project I observed that- there are different level of mechanization which include low level and high level mechanization. Therefore,

The level of mechanization in the study of rice, oil palm agricultural product is low and mostly manually operations is done and its mechanized level is about 12% in areas visited within obubra L.G.A.

The problem here is that, the manual method of operations requires greater man-hours to deliver fast and efficient work to meet the customers demand.

#### **GENERAL CONCLUSION / RECOMMENDATION**

As challenges of food insecurity and climate change hits the globe, it is imperative for proper agricultural processing and storage, strong need for further preservation of our food crop is essential for continual existence of man, his livestock and industries.

Agricultural product provides raw materials for industry workers while industry in turn provides finished goods (consumables, tools and equipment's) used in agriculture. With the low level of agricultural mechanization in Obubra L.G.A where agricultural operations are still done manually and locally, meanwhile this manual farming and processing operations serves as means of providing food for the local human economy and feed for livestock consumption. Then the need to upgrade the level of mechanization in this locality becomes necessary. With these level of drudgery experience while in the field with the farmers, I strongly recommend the use of modern mechanized equipment and facilities for agricultural product processing and storage. This will not only make the work easy but also boost the financial strength of the farmers and also enhance global food security.

Machine such as modern thresher, seed winnower machine including automatic oil miller plant can be donated by the Federal government to boost agricultural practices in rural areas such as Obubra Local Government area of Cross River State, Nigeria.

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( Received 24 June 2017; accepted 20 July 2017 )