MINISTRY OF FOOD AND AGRICULTUREDIRECTORATE OF AGRICULTURAL EXTENSION SERVICES

HANDBOOK ON POST HARVEST

MODULE 4

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OA&A



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POST HARVEST MANAGEMENT

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Introduction

Do you know that?

- Agriculture is the largest source of employment in Ghana
- Agriculture engages about 48.5% of Ghanaians
- Crop farming engages about 95.1% of Ghanaian farmers (GSS 2010) with average farm sizes of 1 - 2 acres
- An average of 30% of farm produce are lost annually as postharvest losses -MOFA
- Ghana loses about GH¢700,000 to inadequate postharvest management – GNA, 2010
- Most farmers are poor meaning most Ghanaians are poor

This handbook is intended to deepen the knowledge of extension personnel in their bid to disseminate to farmers simple advances in post-harvest technology through demonstrations and training. This handbook has been designed as a Facilitator's Guide or Training Manual and may be used for effective dissemination of post harvest technologies to farmers.

The major benefits to the farmer in taking the advice in this manual include;

Less waste and reduced losses
Increased income from the sale of increased quantity and better quality crops
More reliable food supply throughout the year
Better quality food for the family (better nutrition)
Improved transport and marketing arrangements

For clarity and simplification, this manual has been structured into the following topics: harvesting; transport and temporary storage; primary processing; treatment; storage; secondary processing and marketing.

FACT SHEET 1

Post-Harvest Management

Topic 1: Post Harvest and Its Importance

All **activities** that a farmer carries out after the maturity of crops are referred to as **post-harvest management**. These activities are called **post harvesting** activities and include:

1. Harvesting
2. Transportation and temporary storage
3. Primary processing
4. Treatment
5. Storage
6. Secondary processing
7. Marketing

Post-harvest losses of crops in Ghana are estimated to be around **30%,** this means that farmers lose up to 30% of their income. The losses can occur through:

- **Reduced quantity:** crops destroyed by mould or damaged by pests or diseases during storage.
- **Reduced quality**: damaging crops through improper harvesting practices, transportation or any other post-harvest handling.
- **Reduced profits:** reduction in quantity and quality tend to affect sales and this limits the revenue of farmers.

NOTE: In interacting with the farmers encourage and permit them to give examples of how post-harvest losses occur and to share their experiences relating to successes and challenges.

Table 1: Post-harvest activities and how losses occur

Groups	Post-Harvest Activities	How postharvest losses occur
1- Cassava	1. Packing 2. Transportation 3. Peeling 4. Cleaning(washing) 5. Grating 6. Bagging 7. Pressing 8. Packaging(Dough) 9. Marketing 10. Sieving (for Gari) 11. Roasting 12. Packaging 13. Storage 14. Transportation 15. Marketing	• Broken tubers (reduction in quantity) • Tuber falling off whilst being transported • Reduction in quantity/quality • Improper washing • Machine used to grate • Use of inferior bag mat affects quality • Use of sub-standard mat • Spillage • Time material used • Rot during temporary storage
2- Tomato	1. Time of harvesting 2. Gathering and sorting 3. Packaging 4. Transportation 5. Processing and storage 6. Marketing	• Delay in harvesting leads to over ripping which result in rotting • Improper sorting can affect the quality which attracts low price • Poor packaging can lead to damage of the fruits • Poor handling during transport can damage the produce • Inappropriate processing methods and poor storage • Poor marketing results to low income
3- Maize	1. Time of harvesting 2. Transportation of produce 3. Primary storage 4. Dehusking/ sorting 5. Shelling 6. Winnowing 7. Drying 8. Treatment 9. Bagging 10. Storage 11. Routine inspection 12. Marketing	• Untimely harvest leads to poor quality as a result of moldiness and pest attack • Reduction in quantity • Delay in conveyance of the produce leads to losses • Delay in primary storage cause pest infestation and exposure of the produce to vagaries of the weather • Delay in Dehusking and shelling lead to discoloration, moldiness and pests attack • Late winnowing lead to contamination and high pest infestation • Inadequate drying lead to moulds and discoloration • Non treatment lead to pest infestation and loss of market • Delay storage and bagging and routine inspection lead to re infestation of produce reducing market price
4- Yam	13. Harvesting and packing 14. Transportation 15. Storage • Theft • Fire • Rodent 16. marketing	• Bruised lead to fungal attack and rot • Breakage, bruises, heat generation and rot • Loss of produce • Reduction in quality and quantity or total destruction • Rot, reduction by urine and fecal matter • Breakages, theft, bruises and rot

Source: Compiled by Regional/ District Agricultural Extension Agents

FACT SHEET2

Post-Harvest Management

Topic 2: Harvesting

Harvesting is the removal of matured agricultural products from the farm. Synonyms for harvesting may include the following:

- Reap
- Gather
- Collect
- Bringing
- Hunting
- Trapping
- Fishing
- Cutting

Examples of matured agricultural products include the following:

- Fruits
- Grains
- Tubers
- Fish
- Timber
- Water
- Energy
- Organ

Honey
Palm
wine

Factors that affect harvesting are:

i. Time of maturity

This is very important in order to determine the best time to harvest. Some indicators to look out for in determining crop maturity include: color, size and general appearance of the crop. Other factors that need to be taken into consideration are:

- Risk of **insect infestation**: since they can severely damage the quality and quantity of the yield.
- **Heavy rain** on a maturing crop will cause lodging and encourage mould damage and discoloration.

Economic factors: prices fluctuate during the season and harvesting at a certain time might attract a better price for the crop.

ii. Time of Harvest

Harvesting should be done when the local temperature is at its coolest especially for perishable crops (e.g. **before mid-day and before sun down**). Fruits that are harvested at the appropriate time do have extended shelf life. Fruits can be harvested with minimum damage if done with the appropriate tool and if the appropriate method is used.

iii. Method of Harvesting

Method of harvesting depends mainly on the type of crop but in all cases proper handling practices should be taken to prevent damaging or bruising the crop.

Tools, Equipment and Machines for Harvesting

- Knives
- Machete
- Cutlass
- Hoes
- Mattock
- Axe
- go-to-hell (long-armed sickle)
- Sickle
- Baskets
- Sacks
- Trolleys
- Carts
- Wheel barrows
- Hook and line
- Basket traps
- Scooping nets
- Machines (combine harvesters)

Note: explain that the combined harvester combines many of the listed items above.

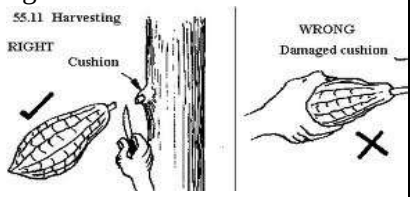
Table 2: Characteristics for unripe, overripe, mould damage, weevil damage and rodent damage

Crop	Unripe grains	Over ripe	Mould damage	Weevil damage	Rodent damage
Maize	- Shriveled - Light in weight - Smaller in size (depending on variety)	- Cracks - Brown and black kennels - Germinate - Insect infested	- Greenish black - Dark brown	- Holes in grain - Light in weight - Powdery - Embryo eaten - Chipped	- Chipped / broken - Broken - Smile - Fecal remains in grains - Holes in sack
Cowpea	- Greenish - Light in weight - Shriveled - Breaks in pods	- Pods shatter - Blackish colour on pods - Perforations on pod - Cracks on grains	- Brownish black - Ash grain color	- Embryo is eaten - Holes in grain - Larvae (whitish substance on the grain) - Reduction in weight - Powdery grain	- Broken grains
Rice	- Greenish - Shriveled - Empty glume (empty paddy) - Light in weight - Small whole grain	- Broken grains - Dark brown - Cracks from paddy - Shatter - Lodge	- Black - Whitish - Smells - Sticky	- Chipped grains - Chuff	- Chuff of paddy in grain - Broken

Source: Compiled by Regional and District Extension Agents in Ghana

Table 3: Postharvest Management in Ghana, Compiled by District/ Regional Extension Agents, 2013

Group	Time of maturity	Time of harvesting	Harvesting method	Tools used
Cassava E.g. Afisiafi, BankyeHemma, Sika Ampong,	• When flowering varieties have well matured seeds • Swelling and cracking of the soil around the base of the plant • Formation of matured by some varieties, e.g. 'Bosom ensia' • Very brown and woody stem	6-9 months Major season Aug. to Sept (for the 6months variety) Nov – Dec (9 months) Minor season 5 month variety (Jan –March) 9 month variety (April-May) Note: cassava harvesters are ideal when crops are planted on ridges.	• Coppice to about 30cm and uproot • Coppice loosen the soil around the plant and uproot • Coppice attach harvester and shake and uproot tubers • Irrigate and uproot	Cutlass , hoe, earth chisel, cassava harvester (not common)
Plantain	Signs of maturity: • Rounded shape of hands • Blossom tips of fingers withers and turns black • Colour of finger turns from light green to deep green • Usually matures 3 months after flowering (Apentu), and 4-5 months (Apem)	• Jun/ July • Aug / Sept. This is the period when it is common on the market • The skin also becomes turgid Most leaves on the stem except apical one dries up	• By cutting the fruit bearing plant /stem approximately mid-section to bring the bunch down and cut	Cutlass ; machete
Oranges	• High brix (sugar /acid level using the Refracto meter • Light yellow green to dark green skin • Fruit size also increases	• Early in the morning • Late afternoon • October –March • May –July	• Hand picking / plucking into sacks using sticks with fork at the end	Stick/sack
Maize: Akposoe Obatanpa Panar53	85-120days Dried tassel Brownish silkHusk	• 3-4months		Cutlass By hand Combine harvester
Tomato	Yellowing of the	• Early in the	Manual	Hand

Group	Time of maturity	Time of harvesting	Harvesting method	Tools used
	skin (80-100)day	morning and late in the evening		
Pineapple Varieties in the district – MD2, Smooth cayenne; sugar loaf	• From flowering: For export 135 days (sea fright) Non-export 150 days • Brix (sugar content) –device is Refractometer 135 days 7-8 months (export) 150 days 10-12 units (non-export) • Fruit colour ¼ of fruit yellow (Export) ½ of fruit is yellow (non-export) Note: the colouration begins from the stalk (bottom) upwards	• It is an all year round crop Flower induction to ripen (chemical used for flowering – calcium carbide)	• Cut fruit stalk , do not detach at point of the attachment The cut is done with the stalk on fruit to avoid entering point for pathogens	Sharp knife
Yam: Kplendzo, Puna	When 40% of the leaves turn yellow 4-6 months when flowers begin to grow on the stem and leaves become dark green Total harvesting is when leaves becomes dried up	Nov-April July – Sept Nov – April	Dig and uproot -do- -do-	Hoes and cutlass Earth chisel -do-
Cocoa	When the pod is yellow. When the pod is green it is  too early, when the pod is brownish it is too late for harvesting.	The main harvesting season is from October to December	You have to cut the pod off the stem or branch (don't pull off). Low-hanging pods are harvested with a machete/cutlass and high-hanging pods are harvested with a go-to-hell 	Cutlass, go-to-hell

FACT SHEET 3

Post-Harvest Management

Topic 3: Transportation and Temporary Storage

In general, farmers can do two things when harvesting:

1. Harvest a little, which is then transported to a temporary storage area.
2. Harvest all crops and leave it on the field to be transported later.

Disadvantages of leaving the crop on the field for a long time can lead to:

- Insect infestation.
- Mould.
- Eaten by rodents or other mammals.
- With perishable crops, **field heat** may cause a decrease in quality as soon as the fruit is harvested.

Therefore it is best to **store properly or transport as soon as possible** to a storage facility. This can be done by either hiring **additional labor** to transport the crop to store as quickly as possible, or to construct a **temporary storage on site** to enable the crop to continue to dry. For perishable crops the solution may be to have **cooling units close to the farms**, which may be owned by an individual farmer or owned by a **farmer based organization.**

When transporting, it is necessary to treat the crops carefully because:

- **Improper handling** can decrease quality.
- Over loading and the use of inappropriate containers causes **Compression injury and bruising.**

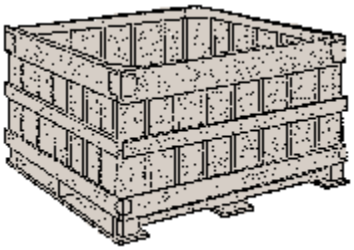
Reduction in temperature to the **optimum temperature** for storage will enhance quality maintenance during transportation and storage. With perishable crops it is advisable to use refrigerated trucks in transporting produce to the storage facility or market.

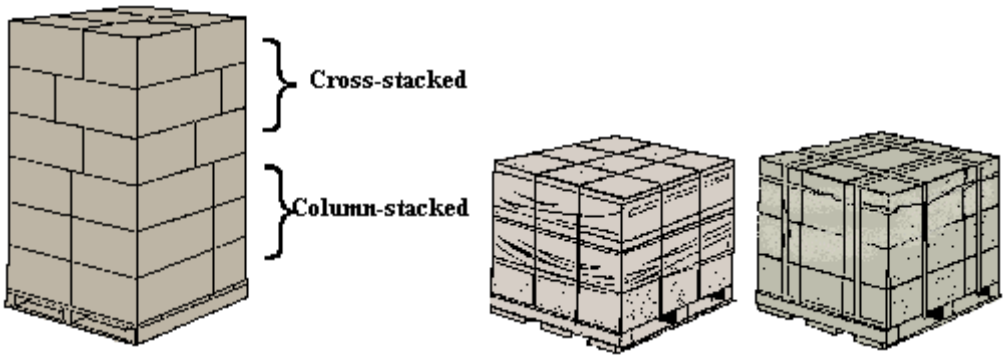
Refrigerated Truck

Samples of Packing Cases for Transporting Perishables

Packing Boxes

Pallet Bin





Source: http://www.bae.ncsu.edu/programs/extension/publicat/postharv/ag-414-8/index.html

FACT SHEET 4

Post-Harvest Management

Topic 4: Primary Processing

Primary processing is an action done directly after harvesting to change the state of the raw produce. This is done to reduce insect and mould infestation before storage. Some examples of Primary processes are:

1. **Dehusking**: removal of the sheath (or outer leaves) from the cob.
2. **Shelling**: removal of grains or kernels from the cob.
3. **Threshing**: removal of paddy rice from the panicles.
4. **Cleaning and sorting**: removal of foreign matter and damaged crops, brushing to remove soil and dust.
5. **Drying**: to avoid germination and mould growth.
6. **Curing**: process that allows injured parts of the produce to heal and for the produce to acquire certain properties.

1. Dehusking

Dehusking is the **removal of the sheath** from the cob. This process can be done **manually** or mechanically with a **combine harvester**. Dehusking can be carried out on the field when the crop is being harvested.

2. Shelling

Shelling is the **removal of grains or kernels** from the cob. Some farmers may put the grains on the cobs or panicles in bags and beat it with a stick.

The approved methods are hand shelling and mechanized shelling. **Manual shelling** can be aided by the use of hand **Sheller(s)**. Hand Shellers could be made of **wood or metal**, which are equally efficient.

Hand Sheller

Mechanical Sheller

3. Threshing

Threshing is the **removal of paddy rice from the panicles**. Threshing should be done immediately after harvest using either mechanical or manual means. Manually, the panicles are beaten with sticks using communal labor. This often results in broken grains, which leads to poor quality rice after milling. Threshing should always be done on mats or sheets to avoid losses due to spillage and to avoid contamination with soil and other foreign matter. It is better to use a machine to thresh the rice.

Manually threshing

Threshing machine

4. Cleaning and Sorting

Cleaning and sorting is the **removal of foreign matter and damaged crops**.

In **perishable crops**, cleaning may involve trimming stems at the base of the fruit, removing any damaged or unsightly leaves from the crop, and gently dry brushing the fruit surface to remove dirt and dust. Damaged, bruised, diseased, and insect damaged fruits should also be discarded.

In **durable crops**, cleaning may involve winnowing to remove dust and soil, chaff, dead or live insects, seed coats, part of stems, leaves and weed seeds.

Winnowing is blowing air through the grains to remove chaff (often done by pouring the grains from a height to another bowl on the ground).

5. Drying

There are basically 2 ways of drying:

a. Sun drying
b. Forced air drying

a. Sun Drying

Sun drying could be done on platforms, clean cemented floors (patios), on plastic sheets or on tarpaulins. The grains are laid on clean surfaces every day, especially when sunny. The depth of grain should not be more than 5cm and grain must be **stirred frequently** to allow for even drying.

b. Forced air drying

Mechanical dryers – fans that blow hot air through the grains – are also used for drying. The drying is done in batches or in a continuous flow manner.

In order to store crops safely, the moisture content should be **reduced** to a level below that which encourages **germination and mould growth**. The moisture content in most cases is **12% for food grains and 13-15% for seed**.

A **moisture meter** is used to determine the moisture content accurately.

Two simple ways to determine whether grain is dry for storage:

1. In the **hand dipping test**, the outstretched hand is pushed deeply into a bag of the grain. If the grain is dry enough, it is possible to push the hand downward to the elbow level or further.
2. In the **biting test**, the dry grain will split into two or more parts with a cracking sound whereas the wet grain will just crush with a dull sound.

6. Curing

Curing is the process that **allows injured produce to heal itself.**

In yams, the process of curing uses energy that is gained from processing starch stored in the tuber. Curing also helps to toughen the skin of the produce, which prevents easy bruising and infection.

FACT SHEET 5

Post-Harvest Management

Topic 5: Treatment of Agricultural Produce

Introduction

Insect pests will reduce the quality of the produce and negatively affect the profit margin of the farmer if appropriate steps are not taken to control them. The insecticide chosen may be in the form of a dust or liquid.

Treatment Against Insects

Treatment against these pests can be done in several ways.
These are:

- Chemical
- Biological
- Physical
- Hermetic

Therefore it becomes important to identify the type of insect before treatment.

i. **Chemical insecticides** are formulated either as dusts or liquids.
ii. **Biological control** is done using biological agents such as other insects to control the pest.
iii. **Physical control** is completed by using the appropriate inactive material to control the pest. This material may be wood ash, sand or oil. This method controls the pest by physically weakening its movement, which eventually leads to death.
iv. **Hermetic treatment** is where the grains are kept in an airtight container to deprive the insects of oxygen.
v. Other forms of treatment may include using some plant parts like neem leaves and other roots.
vi. Most insects, such as the common store weevil, *Sitophilusspp*, are controlled by organo-phosphorus insecticides.
vii. The Larger Grain Borer (LGB), *Prostephanustruncatus*, is only vulnerable to synthetic pyrethroids.
viii. So the identification of the insect in storage is very important for effective control. In a situation where both insects are found in the same store (as is very often the case), a "cocktail" of an organo-pyrethroid is the most effective treatment.

Dust Application

The recommended dust is a safe insecticide that is mixed with the dry crop. The manufacturer's instructions will have to be followed very carefully to achieve the best protection.

Liquid Application

This is the application of safe liquid insecticide which protects the grains for a period of 3-6 months.

Fumigation

Another form of insect control is fumigation

Biological Control

Biological control is the use of a living organism to control pests.

Insect Control Methods

Insect control methods used by the farmers can be location specific and may vary from one geographical location to the other.

Treatment against Rodents

Rodents are a nuisance and can cause great financial losses to farmers and should always be controlled. Rodents cause damage by eating and contaminating the produce with their urine and droppings.

Methods of Controlling Rodents

The most effective method of control is to strictly keep storage hygienic.

- Storage areas are to be kept clean and any weeds around stores should be cut and burnt.
- Some farmers use cats in the control of rodents but this has been found to be ineffective as the cats may even be a source of contamination in the store.
- Due to the toxicity of rodenticides to humans, it is always recommended that their use as bait or poison be performed by qualified personnel.

The extension officer must find out the following and give advice to their farmers:

- How do farmers control rodents in their stores?
- Is the method effective?
- Let farmers describe how the stores are kept clean.

FACT SHEET 6

Post-Harvest Management

Topic 6: Storage

Several factors affect the quality and quantity of produce during storage, including weather, insect pests and rodents. It is therefore important to have appropriate storage for harvested produce.

***Storage Structures**

There are various types of storage structures. Some of the storage structures are discussed below:

1. Warehousing
2. Bulk storage
3. Pack houses and cooling units

1. Warehousing

Good warehouses are constructed with **hollow cement blocks** and are roofed with **corrugated iron sheets**. The construction should allow for sufficient **ventilation** and all ventilation points should be covered with **wire mesh** to prevent entry of insects and bird pests.

Some use **pro-cocoons** (airtight semi-transparent material that prevent the entry of insects and other pests) to store their crops.

2. Bulk Storage

Grains can be stored in bulk as in silos.

3. Pack Houses and Cooling Units

Perishable crops can be stored for a few days in pack houses and cooling units. In **pack houses** the fruits are cleaned, waxed, sorted, graded and packaged.

Cooling units are structures in which the temperature is reduced for storage of perishable crops.

* Give examples where appropriate.

FACT SHEET7

Post-Harvest Management

Topic 7: Secondary Processing

Secondary processing involves a range of techniques that are used to **preserve** produce to make it available at other times of the year, to keep it longer and to reduce waste. Some of the processes are:

- Milling
- Par- boiling
- Chipping
- Making of puree, powder
- Packaging
- Baking
- Frying
- Cooking
- Extruding
- Blending
- Fermenting
- Roasting
- Packaging
- Marketing

The high quality standard requirement of the Ghana Standard Authority, Food and Drugs Authority and the international community makes it important to pay attention to the following among others in secondary processing, especially when targeting the export market:

Use stainless steel, plastic or edible woods for parts of equipment that come into contact with all products which are produced for human consumption.
Ensure that no foreign materials such as stones, sand, wood chippings, dead insects, coins, jewels, bottles find their way into the final products.
As much as possible, avoid the use of bare hands in handling food products, especially food items such as salads, which are consumed directly.
Ensure the use of proper working gears and the covering of hairs, mouths and using nose masks.

1. Paddy Milling

Milling is the process of going from paddy to white rice.

Polishing of brown rice removes vitamins B and E and so to conserve some of these vitamins, it is best to **par-boil** the paddy beforehand.

There are 2 main types of **milling systems** in the country:

1. Engelbert steel huller mills: the paddy is dehusked and polished in a single operation
2. Rubber roll mills:
   - The operation is done separately as the roller only removes the husks.
   - The rubber roll mill may have aspirators, de-stoners and graders and therefore may give better products.

2. Par-boiling

Par-boiling involves **soaking** of paddy in **warm water** overnight, steaming and drying before milling. The process is undertaken to **reduce broken rice** when milled due to temperature stress in the grain.

3. Chipping

The production of chips is the simplest way of obtaining a product from roots (cassava) and tubers (yam), plantain, which will have a longer shelf life and can be stored. Processes involved in chipping are:

- Peeling
- Washing
- Cutting
- Drying

4. Preparation of puree, paste and powder

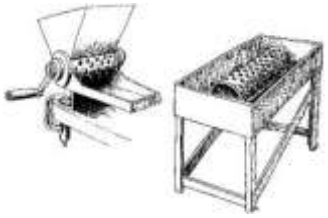
To prepare **paste**, ripe and undamaged fruits are selected. The fruits are par-boiled for 5 minutes to soften them and pressed in any appropriate press, which leaves behind the skin and the seeds.

To obtain a **puree**, the resulting pulp is boiled until a third of the volume is left. It is then salted to required taste.

In the preparation of **powde**r, the fruit is blanched and immediately put in cold water which allows for easy removal of the skin. It is then cut into slices and properly dried. The dried product is milled and stored.

5. Gari Processing

To **prevent wastage and spoilage** of fresh cassava, and to produce an improved product for long-term storage, cassava is processed into **gari or cassava grits**. Cassava is also processed in High Quality Cassava Flour (HQCF) for industrial use.



6. Packaging

Packaging is another important step to **maintain product integrity and prevent spoilage**.