STRUCTURED GRAIN TRADING SYSTEMS IN AFRICA

TRAINING MODULE - 2

Post-Harvest Management on the Farm
Module 2: POST-HARVEST MANAGEMENT ON THE FARM

Introduction to the Module

The Structured Trading System’s Course is designed for Cereal Traders who bulk and aggregate grain from smallholder farmers for delivery to organized markets. For example, this could be for international export or food aid where high quality grain is required, for local consumption where reasonable but not such high quality is demanded, or for animal feed that requires only relatively low quality.

In a formal grain market, cereals and grain pulses are bought and sold according to specific quality grades; these are usually determined by national or regional authorities. When seeking to purchase grain, a buyer will usually specify a particular quality grade in order to meet a particular end-use.

Most farmers now produce at least a small surplus for sale; the money obtained being used to improve their standard of living. The level of income depends not only on the quantity of crop sold but also on its quality. Hence, it is essential that farmers handle and keep their crops in the best possible condition until they are sold.

In this module on **Post-Harvest Management on the Farm** the learner will cover the following:

- What constitutes Post-Harvest Management
- Why Produce Good Quality Grain?
- How to Maintain Grain Quality.
- Threshing the Grain Carefully.
- Drying the Grain Properly.
- Quality Standards for Grain.
- Correct Grain Storage
- Transporting the Grain

The Module is estimated to take 2 hours and 50 minutes. However, depending on the methodology used, it may take longer depending on the level of understanding of participants.
# POST-HARVEST MANAGEMENT ON THE FARM

## Module Summary

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<td>3. Why Produce Good Quality Grain?</td>
<td>Discussion of participants’</td>
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<td>4. How to Maintain Grain Quality.</td>
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<td>5. Threshing the Grain Carefully.</td>
<td>Presentation, Discussion and Exercises</td>
<td>Participants Handout 6: Maize Shellers</td>
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<td>9. Transporting the Grain</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>2 hours 50 mins.</strong></td>
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### 1. Welcome and Introduction
*(Presentation by the Facilitator: 15 minutes)*

Welcome to the Module **Post-Harvest Management on the Farm**.

**Rationale for Post-Harvest management**

Although in many parts of Africa certain crops can be produced throughout the year, the major food crops such as cereal grains and tubers, including potatoes, are normally seasonal crops. Consequently the food produced in one harvest period, which may last for only a few weeks, must be stored for gradual consumption until the next harvest, and seed must be held for the next season’s crop.

In addition, in a market that is not controlled, the value of any surplus crop tends to rise during the off-season period, provided that it is in a marketable condition.

Therefore the principal aim of any storage system must be to maintain the crop in prime condition for as long as possible. The storage and handling methods should minimize losses, but must also be appropriate in relation to other factors, such as economies of scale, labor cost and availability, building costs and machinery cost.

The objectives of this module, therefore, are that you will be able to improve your understanding of the relationship between quality and the market demands which will subsequently inform the margins you can charge to enable your Output Marketing business to make a profit and what requires to be done to improve the benefits to your business, by understanding:

1. What constitutes Post-Harvest Management of Grain?
2. What are Produce preparation and packaging costs
3. Why Produce Quality Grain
4. How to maintain Grain Quality
5. Threshing the Grain Carefully
6. Drying the Grain Properly

| Have participants introduce themselves to each other (If this has not been done during Module 1). |
| List Participants’ points on a flipchart, entitled “Expectations”. Refer back to the list of problems and expectations throughout the Module when relevant. |
| Distribute Participants Handout 1: Module Objectives. |
2. Post-Harvest Management on the Farm
   (Presentation by the Facilitator: 15 minutes)

Members of the Iganga Adult Literacy Group in eastern Uganda used to shell their maize by beating the cobs with sticks. This was hard work and took a long time, so the group had to delay it while they planted the next crop. The sticks also broke plenty of kernels, which buyers did not like: they offered a low price for the group’s output.

Then the group had the opportunity to rent a motorized thresher. This let them shell their maize much faster, resulted in fewer broken grains, and made it possible for them to sort the grain. They moved the grain to a warehouse and got a receipt for it. The group presented this to the bank, which accepted it as collateral for a loan to buy the inputs they needed for the next season.

At the warehouse, the manager found that the grain from the Iganga group was of excellent quality. He did not have to reject any. When the group came to sell, they were able to get a premium price.

Discuss the Iganga AL Group Case Study.

Distribute Participants Handout 2:

Distribute Participants Handout 3:
Structured trade depends on having good-quality grain that conforms to certain minimum standards. Good postharvest management is vital for this. This Module focuses on what farmers and small-scale cooperatives can do to maintain grain quality. It covers the six steps listed in Box 3, from harvest until the grain leaves the farm or cooperative store.

The standards themselves are covered in Module 3.

3. **Why Produce Good Quality Grain?**
*(Presentation and Discussion: 40 minutes)*
WHY PRODUCE GOOD-QUALITY GRAIN?

Producing good-quality grain brings many benefits:

- Farmers can sell their grain to different buyers and get a higher price for it.
- Traders, transporters and others in the grain trade can handle more grain and sell it to new markets, such as regional and international buyers. This leads to better business for all.

Traders may buy poor-quality grain from farmers at a low price, and then dry it and sieve it to remove broken grain and foreign matter so it conforms to grade requirements. But this reconditioning costs money and leads to substantial losses of grain. The result: less grain on the market, at a higher price.

Instead, it is better for farmers to produce good-quality grain that does not need reconditioning. This benefits everyone: no reconditioning costs and lower losses mean more grain on the market and lower prices for consumers.

Even if postharvest management is done well, grain will not remain at the same quality indefinitely. Its quality will decline naturally, even if there is no damage from pests or it is stored at the right moisture level.

A particular quality of grain has a shelf-life, during which it will probably retain its grade (see Module 3). But after this period, it is likely to drop a grade.

People experienced in grain storage usually know the expected shelf-life of each grain type, depending on its starting grade and the conditions under which it is stored. For example, in the warehouse receipt system in Uganda, Grade-1 maize is given a shelf-life of one year in a bag store, or four months in a bulk store.
4. **How to Maintain Grain Quality.**

*(Group work, Discussion by participants: 20 minutes).*

- Cereals like maize, sorghum and millet have a black layer just below the tip of the grain (Figure 5). This can be seen if the tip is removed.
- Maize cobs start to droop downwards (though not in all varieties).
- Bean pods turn from green to yellowish.

Figure 5. The black layer that forms at physiological maturity just below the tip of a maize grain. This shows that the grain is ready for harvest.

Grain should be harvested when the weather is warm and sunny (Figure 6). Otherwise it may be difficult to dry the grain fully. If maize is ready for harvest but the weather is wet, farmers can twist the stems to turn the cobs downward. This stops water from accumulating in the cobs.

The cobs, seed heads, pods, etc. must be kept off the ground to avoid contamination with soil. It is best to put the crop in sacks or clean containers.

In some places, harvesting starts with cutting the stems and stacking them into piles called "stooks". These are left to dry further before the grain is removed. This is generally not recommended: it may lead to more grain losses, and the grain may get wet if it rains.

The harvest should be taken out of the field as soon as possible, using lean, dry containers that do not let it spill out. It should be kept out of the rain and away from dirt and pests until it can be dried.

Distribute Participant Handout 3.

Elicit responses.

Distribute Participants' Handout 4.
Figure 4. Planting the right varieties and growing a healthy crop are the first steps to market success. Photo: Herbert Kirunda.

Traders and others can advise farmers on how to supply grain that fulfils their requirements. Here are some tips they can pass on to farmers.

**Planting the right varieties**

The first step is to ensure a good harvest. This is not strictly part of the postharvest chain, but the choice of crop variety and how it is grown affect the quality after harvest.

Farmers should plant certified seed varieties that are best suited to the agro-ecological zone, and they should take into account the local conditions (climate, soil, irrigation, fertilizer).

They should also bear in mind what varieties buyers prefer.

Some varieties experience bigger problems after harvest than others. For example, high-yielding hybrids are often more susceptible to insect storage pests.
**Growing a healthy crop**

It is important to keep the crop healthy while it is growing by providing fertilizer and irrigation, and controlling weeds, pests and diseases. A healthy crop produces good-quality grain. Farmers may apply various pesticides to control pests, diseases and weeds in their crops. Pesticides may also be used after the harvest: during storage, transport, distribution and processing of grains and grain products.

Pesticide residues in the grain may damage consumers’ health. Safe levels of pesticides residues, also called maximum residue limits, are set by national food safety authorities. For the East African Community, they are based on the limits for different food products set by the Joint FAO/WHO Codex Alimentarius Commission (Codex). These are posted on the Codex Pesticides Residues in Food Online Database, www.codexalimentarius.net/pestres/data/index.html?lang=en.

To keep residues to acceptable levels, farmers and grain stores should use only the pesticides approved for a given crop by the national authorities. It is important to follow the manufacturers’ instructions on applying the pesticides, including the stage and time of application on the crop, and the time between application and harvest.
Harvesting at the right time and in the right way

Harvesting either too early or too late can result in poor-quality grain and losses. Harvesting too early means the grain will be immature and underweight. Harvest too late, and pests may attack it, or it may be stolen.

The right time to harvest is when the growing process has finished, i.e., when the grain has reached physiological maturity.

- The plant will change colour from green to light brown or yellowish, and the grain will have a moisture content of 20–30%.
- Cereals like maize, sorghum and millet have a black layer just below the tip of the grain (Figure 5). This can be seen if the tip is removed.
- Maize cobs start to droop downwards (though not in all varieties).
- Bean pods turn from green to yellowish.

![Black layer](image)

*Figure 5. The black layer that forms at physiological maturity just below the tip of a maize grain. This shows that the grain is ready for harvest.*

Grain should be harvested when the weather is warm and sunny (Figure 6). Otherwise it may be difficult to dry the grain fully. If maize is ready for harvest but the weather is wet, farmers can twist the stems to turn the cobs downward. This stops water from accumulating in the cobs.

The cobs, seed heads, pods, etc. must be kept off the ground to avoid contamination with soil. It is best to put the crop in sacks or clean containers.

In some places, harvesting starts with cutting the stems and stacking them into piles called “stooks”. These are left to dry further before the grain is removed. This is generally not recommended: it may lead to more grain losses, and the grain may get wet if it rains.
Figure 6. Mature cereal grain should be harvested on a sunny day and put on a mat or in sacks.

The harvest should be taken out of the field as soon as possible, using clean, dry containers that do not let it spill out. It should be kept out of the rain and away from dirt and pests until it can be dried.
5. **Threshing the Grain Carefully.**

*Group work, Discussion by participants: 60 minutes*

**THRESHING THE GRAIN CAREFULLY**

Threshing frees the grain from the cob, seed head or pod. For smallholders who must do it by hand, this job takes time and is hard work. For maize, threshing is sometimes called “shelling”.

The most common method of threshing by hand is to beat the crop with sticks.

But this breaks a lot of the grain and so lowers the quality.

For maize, the husk has to be removed before threshing. When doing this farmers should separate out any cobs that are damaged or infested by insects, and make sure they are consumed or destroyed quickly. If they do not do this, the bad grain will be mixed with good, and the overall quality will be lower.

Instead of beating the cobs, it is better to shell them by hand or use a simple manual Sheller (Figure 7).

Machine threshing is much quicker and produces better-quality grain with fewer broken grains than threshing by beating with sticks. Because the threshing is done sooner, the grain has less chance to deteriorate. Threshing machines are expensive, so farmers often either rent one or get together as a group to buy one.

*Figure 7. Some manual maize Shellers.*
### 6. Drying the Grain Properly

*(Group work, Discussion by participants: 30 minutes)*

#### DRYING THE GRAIN PROPERLY

The grain may be dried in the sun, in racks or cribs, or using a mechanical dryer.

**☞ Sun-drying.** This is the cheapest way to dry grain. The most common method for smallholders is to spread it out on a plastic sheet or tarpaulin, in a layer no more than 3 cm deep, and leave it exposed to the sun. It should be turned with a rake every hour. Every two hours, all the grain should be moved to one side of the sheet to allow any moisture on the sheet to evaporate. After 5 minutes, the process is repeated for the other half of the sheet, after which the grain is spread out again across the whole sheet.

Chickens and other animals must be kept away to stop them from eating the grain or making it dirty. The grain should be covered at night and when it rains.

**☞ Drying on racks or in cribs.** Grain can also be dried on racks or in a crib.

A crib is a long, thin structure (Figure 8) that air can pass through easily. It should be positioned at right angles to the prevailing wind to improve the ventilation. Cribs are usually used for unthreshed grain such as maize cobs (with or without the husk), sorghum or millet heads. They may be kept in the crib for some months. If the sides of the cribs are covered to prevent rain from getting in, they can also be used to store sacks of grain.

**☞ Mechanical drying.** Mechanical dryers use a fire (or other source of heat) and fans to dry the grain. They are used in large-scale commercial operations.
The grain must be dried quickly to a safe moisture level, below which mould cannot grow (Box 4).

Figure 8. A drying crib: long and thin to allow good ventilation.

Figure 9. Experienced storage operators can tell if the grain is dry enough for storage by listening to the sound when it is poured. Photo: Herbert Kirunda

Good drying reduces microbial activity, especially of moulds that may produce mycotoxins (such as aflatoxin). It also hardens the grains, making it more difficult for insects and other pests to damage them.

7. **Quality Standards for Grain.**
   *(Presentations and Discussions: 60 minutes)*
**CLEANING THE GRAIN WELL**

Before storing the grain, farmers should clean it to remove as much foreign matter as possible. They can do this by winnowing it (letting it drop from a height and allowing the wind to blow away lighter impurities such as chaff or leaves), or by using a sieve (or handpicking) to remove heavier impurities such as stones.

Some threshing machines clean the grain at the same time as threshing it.

8. **Correct Grain Storage**  
* (Participants’ questions, Presentation: 15 minutes)

**CORRECT STORAGE**

For structured grain trading, the grain must be well stored, probably in commercial facilities, fairly soon after harvest. However, this will not always be possible, and farmers may keep grain for many months before moving it into a commercial facility or releasing it onto the market. In addition, many farmers also wish to store some of their output for their own use. So good farm storage is important to maintain grain quality for the market and for home consumption. Farmers should be reliably informed about how to store their produce well. See the list of Resources at the end of this publication for information on how they can do this.

For grain that will be marketed, the most common choice for storage is an open-weave sack made of jute, sisal or polypropylene. Open-weave bags should be put on pallets to lift them up off the floor, and the pallets should be kept away from the walls (Figure 11). Insects can get into open-weave bags easily, so the grain inside will become infested after about 3 months unless properly treated.

<table>
<thead>
<tr>
<th>Clean up</th>
<th>Participants Handout 9:</th>
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<td>8. Correct Grain Storage</td>
<td>Participants Handout 10:</td>
</tr>
<tr>
<td>CORRECT STORAGE</td>
<td>Participants Handout 11:</td>
</tr>
</tbody>
</table>
If the grain has to be stored for longer periods (especially for home consumption), other types of store such as bins, silos (Figure 12), drums and fully sealed bags may be more suitable.

9. **Transporting the Grain**  
*Participants’ questions, Presentation: 15 minutes*

**TRANSPORTING THE GRAIN**

The farmer may sell the grain to a trader, take it to a cooperative or community warehouse, or deliver it to a commercial warehouse. On its journey, the grain may be moved by truck several times. In doing this, these precautions should be followed:

- The vehicle should be clean and dry and have no sharp edges that might tear the sacks.
- The sacks should be loaded carefully into the vehicle and counted. If they are taken out of a warehouse the storekeeper should sign a release form for this number of sacks.
- The weight capacity of the vehicle should not be exceeded.
- There must be a tarpaulin to cover the sacks in case it rains.

10. **Review of Module in Conclusion**  
*Participants’ questions, Presentation: 15 minutes*
IN CONCLUSION
Farmers have to use the right postharvest methods for the grain to be at a grade needed by a structured grain market. But these methods cannot be considered in isolation from the farmers’ situation.
Postharvest practices must be sustainable. The costs must be justified by higher prices and lower losses. Warehouse operators and traders can recommend sustainable, cost-effective ways to reduce postharvest losses that give farmers an incentive to improve their practices.

An important aim of better postharvest management is to reduce grain losses. For more information on postharvest grain losses in sub-Saharan Africa, see the African Postharvest Losses Information System (Box 6).

Distribute Participants Handout 12:
Distribute Participants Handout 13:
## Module Objectives

Participants will be able to appreciate **Post-Harvest Management on the Farm** by:

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<td>1</td>
<td>To Understand The Importance of Post-Harvest Management on and off the Farm,</td>
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<tr>
<td>2</td>
<td>To Know How to Advise Smallholder Farmers on the Production of Quality Grain.</td>
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<tr>
<td>3</td>
<td>To Know How to Maintain Quality Grains.</td>
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<td>4</td>
<td>Apply Correct Grain Storage to Ensure Quality.</td>
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## Box 3. From Harvest to Transport off the Farm

### FROM HARVEST TO TRANSPORT OFF THE FARM

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<th>Step</th>
<th>Description</th>
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<tr>
<td><strong>1. Planting the Right Varieties</strong></td>
<td>• Planting varieties that grow well and that the market wants</td>
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</table>
| **2. Growing a Healthy Crop**                                        | • Providing fertilizer and irrigation  
• Controlling pests, weeds and diseases                                         |
| **3. Harvesting at the Right Time and in the Right Way**             | • Bringing in the crop at the right time  
• Avoiding bad weather  
• Avoiding contamination with soil                                        |
| **4. Threshing the Grain Carefully**                                 | • Enabling grain/cob selection  
• Reducing the space required for storage  
  (threshed maize takes up less space than cobs)  
• Reducing grain susceptibility to pests                                  |
| **5. Drying the Grain Properly**                                     | • Retaining maximum quality of crop  
• Reducing moisture for safe storage  
• Conforming to grade specifications                                         |
| **6. Cleaning the Grain Well**                                       | • Removing foreign matter  
• Improving storability  
• Increasing purity and market value                                           |
| **7. Correct Storage**                                               | • Keeping the grain dry and free of pests until it can be taken to the warehouse                                                             |
| **8. Transporting the Grain**                                        | • Transporting safely to the warehouse                                                                                                       |
Figure 3. Structured Trade relies on good-quality grain that conforms to certain Standards.

Photo: Herbert Kirunda.
Figure 4. Planting the right varieties and growing a healthy crop are the first steps to market success.  
*Photo: Herbert Kirunda.*

Figure 5. The black layer that forms at physiological maturity just below the tip of a maize grain. This shows that the grain is ready for harvest.
Figure 6. Mature cereal grain should be harvested on a sunny day and put on a mat or in sacks.
Figure 7. Some Manual Maize Shellers.

Hand Held Sheller

Mechanical Sheller
METHODS OF DRYING GRAIN

Figure 8. A drying crib: long and thin to allow good ventilation.

Figure 9. Experienced storage operators can tell if the grain is dry enough for storage by listening to the sound when it is poured. Photo: Herbert Kirunda
Advantages of Better Quality Grain
### Box 4. MOISTURE CONTENTS NORMALLY RECOMMENDED IN EASTERN AND SOUTHERN AFRICA

<table>
<thead>
<tr>
<th>Crop</th>
<th>Moisture Content (%)</th>
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<tbody>
<tr>
<td>Maize</td>
<td>13.5%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>13.5%</td>
</tr>
<tr>
<td>Beans</td>
<td>14.0%</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>7.5%</td>
</tr>
<tr>
<td>Sunflower seed</td>
<td>9.0%</td>
</tr>
</tbody>
</table>
Box 5. CHECKING THE MOISTURE CONTENT OF THRESHED GRAIN - CEREALS

Experienced farmers use several ways to check whether it is fully dried:

- Bite it to check how hard it is.
- Take a handful and listen as the grains drop (Figure 9).
- For beans that are dried in the pod, shake the pod and listen to the sound.

**Salt method**

Dry salt will absorb moisture from grain. This principle can be used to determine whether a cereal grain sample has moisture content of above or below 15%. The method uses the following:

- A clean, dry glass bottle of about 750 ml capacity, with a cap that makes it airtight
- A cup of common salt.
- 250–350 g of the grain to be tested
- Transporting safely to the warehouse

The salt must first be dried by spreading it out on some plastic sheeting in the hot sun and leaving it for at least 3–4 hours until it is hard. It should be turned at intervals during this time. It can also be dried in an oven. The dry salt should be placed in a sealed container until it is ready for use.

The grain is tested by putting it into the bottle (which should be about one third full) and adding 2–3 tablespoons (20–30g) of dry salt. The bottle should be closed tightly with the cap, shaken vigorously for 1 minute to mix the salt and grain, and then left for 15 minutes.
If the salt sticks to the side of the bottle, the moisture content of the grain is above about 15% and is not safe for storage. If the salt does not stick to the bottle, the moisture content is below 15% and the grain is safe for storage.

**Moisture meter**

Moisture meters (Figure 10) are quick, portable, simple to use and fairly accurate. They may be used routinely, for example, when grain is delivered to a grain store. They cost several hundred dollars, so would normally be used only at warehouses and by farmers’ groups that handle a lot of grain.

![Figure 10. An example of a moisture meter](image)

Moisture meters must be calibrated before use to make sure they are accurate. Most modern meters allow calibration data to be programmed into them so they read moisture content directly. Many automatically adjust the reading to take into account the temperature of the sample (which can affect the reading). The manufacturer may calibrate the meter, but such meters should be checked regularly to make sure they are still accurate. After calibration, a meter may be accurate to within ± 0.2% of the actual moisture content. Generally speaking, meters are accurate to within ± 0.5% in the middle of the moisture range (12% to 17% moisture content for cereals). Outside this range they are less accurate.
**STORAGE FACILITIES**

*Figure 11. In the house, sacks should be stored on pallets, away from walls. Check regularly for any problems.*

*Figure 12. To store grain at home in bulk, it should be put in a silo or other container.*

*Source: WFP standards*
APHLIS: THE AFRICAN POSTHARVEST LOSSES INFORMATION SYSTEM

APHLIS (www.aphlis.net) is a source of information on post-harvest losses of cereal grains in sub-Saharan Africa. It gives estimates of weight losses in tables and interactive maps, using information from a network of local experts from each country in Eastern and Southern Africa. It also offers tips on reducing post-harvest losses.

APHLIS also has a downloadable calculator that enables practitioners to make their own estimates of post-harvest losses.
## POST-HARVEST MANAGEMENT ON THE FARM

### SUMMARY

**SITUATION:**
Ensure proper Post-Harvest Management

**ACTION:**
- Structured trade depends on having good-quality grain that conforms to certain minimum standards. Good post-harvest management is vital for this.
- Producing good-quality grain brings many benefits:
  - Farmers can sell their grain to different buyers and get a higher price for it.
  - Traders, transporters and others in the grain trade can handle more grain and sell it to new markets, such as regional and international buyers. This leads to better business for all.
- Farmers have to use the right post-harvest methods for the grain to be at a grade needed by a structured grain market. But these methods cannot be considered in isolation from the farmers’ situation.