

Post Harvest Handling and Storage FARMER WORKSHOP

Simon J. Costa / FtMA

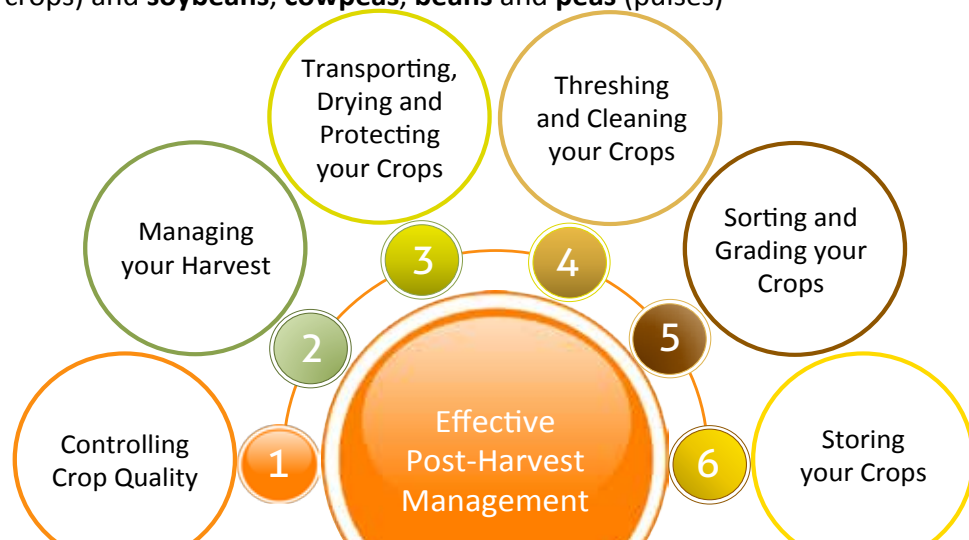


FARMER WORKSHOP NOTES



Intro: Effective Post Harvest Management 1.

Today's training is focused on the **6 principles of good Post-Harvest Management** for traditional staple crops; **maize, sorghum and millet** (cereal crops) and **soybeans, cowpeas, beans and peas** (pulses)



Intro: Effective Post Harvest Management 3.

Discuss incorrect Pre & Post Harvest Practices

1. Incorrect pre-harvest practices
Can infestation of crops begin in the field? How?
2. Contaminated equipment, storages and surroundings
Can infestation of crops start with your equipment/storage?
3. Incorrect preparation of labour
Can this affect harvesting your crop?
4. Incorrect time of harvesting your crop (too early / too late)
Can this result in financial losses?

Intro: Effective Post Harvest Management 2.

Working Group Discussion: Incorrect Pre & Post Harvest Practices



Intro: Effective Post Harvest Management 4.

Discuss incorrect Pre & Post Harvest Practices

5. Incorrect crop transportation and handling
Can crop quality be affected? Can you lose money? How?
6. Incorrect crop drying practices
Can moisture cause problems? How is rotting + mould caused?
7. Incorrect crop storage systems
Can crop quality be affected? Can you lose money? How?
8. Post-harvest crop management
Are good systems and tools important for making money?

Common problems after harvest

- Using wrong equipment to transport crops from the field
- Using wrong equipment to clean and dry crops
- Allowing foreign matter and animals to contaminate the crop
- Allowing different crop varieties to be mixed

All impact on the quality and quantity of your saleable crop

Poor Household Storage

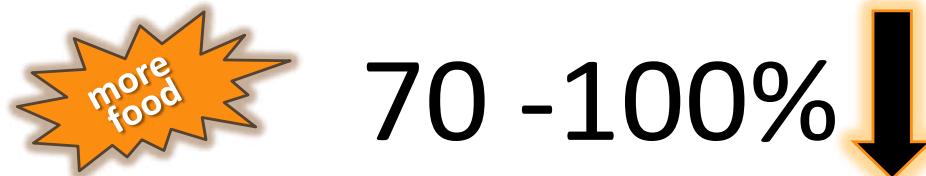
- Using ineffective equipment for household storage of crops
- Being unable to control crop infestation during storage
- Selecting incorrect locations for household storage
- Not protecting food stored for household consumption

Poor Drying Practices

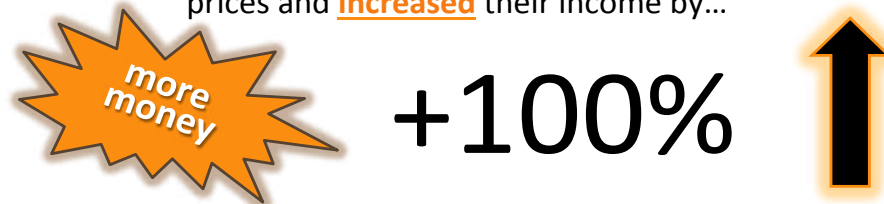
- Allowing crops to be exposed to continuous wetting (causing quality deterioration / mould / infestation of crops)
- Allowing crops to get wet again
- Allowing crops to be exposed to rodents, insects and birds
- Allowing crops to make contact with the soil (which is a major point of contamination for your crops)

The impact of managing correctly:

Farmers following instructions and using the new storage equipment have **reduced** their crop losses by...



Farmers reducing quality and quantity losses achieved higher prices and **increased** their income by...





At the end of Topic 1 you will understand:



- The definition of 'high quality' crops
- What is a grain grade? (cereal and legume standard?)
- Ways to prevent your crops being broken, dirty and infested
- Things that affect the quality and value of your crops?

What does 'high quality crops' mean?

- High quality crops are safe for human consumption
- High quality crops conform to a standard (grade) that is suitable for sale (local, regional or international markets)
- High quality crops are **not dirty**, they are **not broken**, they are **not insect** or **pest damaged**, they are **not mouldy**, they are **not discoloured**
- High quality crops receive more money!

Learn what grade is required by your customer

- It is important to know what quality your customer wants. You must discuss this with your customer (eg: Traders and Farmer Organizers)
- Request samples so you understand what quality is acceptable
- See Grain Standard (p66)



beans



Topic 1: Controlling Crop Quality

13.

Always keep your Grains, Beans and Seeds clean

1. Remove all foreign matter

Remove **organic** waste (e.g. cob cores, tassels, hulls, shells, other types of grain etc) and **inorganic** waste (e.g. stones, dust) and **filth** (e.g. rodent dropping, dead insects)



maize



soybeans



Topic 1: Controlling Crop Quality

15.



maize

4. Prevent rodent damage.

Rodents cause major damage to harvested crops. They also carry serious diseases that cause sickness to humans and animals. Understand how you can prevent rodents from touching your crops.



maize



soybeans

5. Mould damage to crops.

Poor handling and drying of grain and beans attracts mould, which causes discolouration, poisoning (aflatoxin contamination) and loss of crops. Mould can be prevented.



Topic 1: Controlling Crop Quality

14.



maize



soybeans

2. Prevent broken grain and beans.

Most broken grain comes from poor handling and processing practices (shelling, threshing, cleaning, sorting). Understand how to prevent breaking grain and beans.



maize



soybeans

3. Avoid insect and pest damage.

Insects feed on the grain and beans, lay eggs and contaminate the storage area. Understand ways to prevent your crops being attacked.



Topic 1: Controlling Crop Quality

16.



maize



sorghum

6. Discoloured grain.

Grain and bean discolouration is caused by fluctuating temperatures during storage. How can this be controlled? (eg: storage units must never be placed in direct sunlight)



7. Grain with an unusual smell.

Inadequate drying, contamination or storage near fertilisers and chemicals can cause grain to smell badly.

These quality issues reduce crop quality and crop quantity (less money + more sickness)



Topic 1: Controlling Crop Quality

17.



maize



maize

Good management improves crop quality



Topic 1: Controlling Crop Quality

19.

Why is crop quality important?

- Farmers producing high quality grains & beans earn more money
- Farmers with low crop losses can earn even more money
- Buyers pay more for consistent and better quality crops
- Large buyers are only interested in purchasing in bulk (farmers who aggregate quality grains & beans have a big advantage)



Topic 1: Controlling Crop Quality

18.



cowpeas



cowpeas



beans



beans



Topic 1: Controlling Crop Quality

20.

Important points to remember



- It is important to understand the quality your customers want you to supply
- High quality crops conforms to a standard
- High quality crops are **not dirty**, they are **not broken**, they are **not insect** or **pest damaged**, they are **not mouldy**, they are **not discoloured**
- There is a strong financial incentive for farmers to produce high quality grain and beans
- Collective marketing with Farmer Organisations is a good way of organising higher prices for supplying high quality grain and beans



At the end of Topic 2 you will understand:



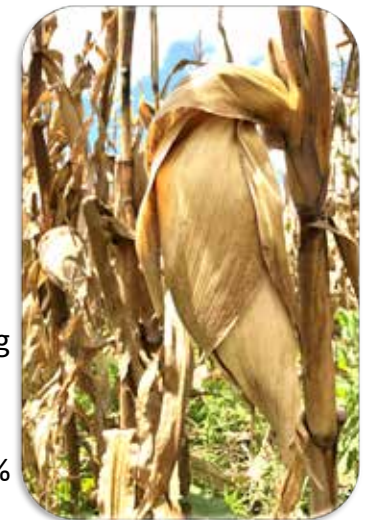
- How to prepare before harvest
- Knowing the right time to harvest a crop
- The dangers of field pre-drying
- The dangers of field infestation
- Precautions to take during harvest

Preparation before the harvest

- *Are you ready for harvest?* Is the equipment you need for harvest and post-harvest activities ready and in good repair?
- Have you disinfected your drying areas and drying equipment?
- Have you removed old grain and dirt from harvesting tools, carts, wheel barrows, bags and baskets? (*Mixing old and fresh grain will contaminate the fresh grain. Insects and their eggs remain active on your equipment and in your storage area for long periods of time.*)
- Do you have enough storage space? Are your storage units correctly positioned?
- Do you have enough labour to harvest and transport your crop
- Does your crop calendar indicate when the important post-harvest activities must happen

Knowing the right time to harvest your maize

- Maize is mature when the plant is a light brown colour and the cob begin to droop downwards
- When maize reaches physiological maturity, the moisture content in the kernels can be as high as 35%
- For this reason, before proceeding to harvest, your maize should be left standing in the field
- The optimum time to harvest is when moisture content of maize is about 17-20%



maize

Knowing the right time to harvest your beans

- Beans are harvested when the pods turn yellow (for eating fresh) or completely dry (for storage purposes)
- Beans should only be harvested when moisture content is 15%
- Early morning (before dew evaporates) is the best time to harvest
- Temporary moisture on the pods will prevent shattering (when pods are too dry they split when being uprooted)
- Late harvesting can result in crop loss from over exposure to sun or rotting due to rain



beans

Field pre-drying can be dangerous.

- Crops left in the field too long can be damaged by pests (birds and rodents), bad weather (rain and humidity) and insects
- Fungal infection can spread when drying crops are rained upon
- The risk of aflatoxins increase if harvest is delayed after maturity
- Watch your field everyday. Field drying is important, but be careful about leaving your crop too long before harvesting



sorghum



soybeans



maize

Cowpeas at maturity...

- Pods are a light brown colour
- Pods make a rattling sound when you shake them
- Pods are brittle and can be crushed between your fingers



cowpeas



Soybeans at maturity...

- Plant leaves become dry and brittle
- Pods are a light brown colour
- Pods make a rattling sound when you shake them
- Seeds inside are difficult to bite



soybeans



sorghum

Sorghum matures...

- from the top of the head and progresses to the base
- Mature grain is hard to penetrate when pinching the bottom of the kernel between your fingernails
- A good sign is a black spot at the base of the kernel

Pre-Harvest Infestation

- There are many field insect pests and diseases in East Africa
- Many of the same insects that attack grain in storage, infest grain in the field. A major problem for maize is the weevil that chews a small hole in the kernel and lays an egg in the open cavity. Borers, Cutworms and Army worms all attack maize plants in the field
- Beans and Cowpeas also suffer from weevil, bruchid and thrip activity
- Field sorghum can be attacked by shootflies, midge and stem borers
- Sucking bugs are the major soybean pests. They feed on pods and soft growing plant parts. While feeding, their toxins kill the pods/seeds causing necrosis (death of the plant). Pod borers and stink bugs are also problems

Pre-Harvest Infestation



Precautions to take during harvest

- Choosing the right weather is very important for harvesting crops
- It is better to harvest your maize in dry sunny weather
- Staple crops are best harvested when the plants are dry, otherwise you can more easily spread disease between wet plants
- Also, piles of damp cobs, pods or seeds are very difficult to dry
- For maize, if your harvest is delayed due to wet weather, reduce water from entering your cobs by turning tips downwards (break the stalks of the plants so they point down)



Precautions to take during harvest



NEVER allow your crop to come into contact with the soil

- Soil is a major point of contamination for your crop
- Place your harvested crop on clean mats or directly into bags, to avoid contact with the soil



Important points to remember:



- Make sure you are well prepared before the harvest, with the necessary labour, equipment and storage facilities (clean and ready)
- Know when your crops are ready for harvest
- If possible, only harvest in dry weather
- Know the correct moisture content when to harvest (maize and sorghum 18-20%, beans and cowpeas 14-16%, soybeans and peas 13-15%)
- Field pre-drying can be dangerous. Be careful and watch everyday for bird and insect activity
- NEVER allow your crops to come into contact with the soil



At the end of Topic 3 you will understand:



- How grain should be transported to your house
- The importance of knowing your crop’s moisture content
- How to sun dry grain using plastic sheets
- Essential precautions for drying your crops
- When the moisture content is low enough to store crops



Transporting grain to the house

- Transport your harvest to the storage area as soon as possible
- Physical damage and crop spilling will occur if transport is delayed
- Check equipment before using. Reused bags and baskets may be damaged during loading or unloading, causing leakage of crops during transport
- Transportation by bag, basket, barrow, bicycle or cart are all OK, but **always protect your crops** from pests, spillage and touching the soil



Measuring Moisture Content

- Knowing the moisture content of maize, sorghum, soybeans, cowpeas, beans and peas is the most important factor in safely storing these crops
- Farmers must understand how the moisture content changes when crops are harvested and during storage (and the impact of this change)

Late rains can lead to fungus producing spores which affect grain quality. When infected grain is harvested with healthy grain, it reduces grain quality, causes yield loss and lower prices to farmers





Why dry crops after harvest?

- The greatest enemy of crops is moisture
- High moisture content causes mould to grow
- Mould creates rot, contamination and spoilage of crops
- Moulds also produce **afatoxins** (causing cancer and **death**)
- Drying after harvest is critical for reducing moisture and also reducing **pest infestation**:
 - Storage insects like weevils become more active and multiply more quickly in a warm, moist environment
 - Storage insects produce heat and add more moisture, which increases more mould growth



Do you dry maize with or without the husk?



maize

Only remove husks from the maize cob if:

- rapid drying is needed
- there is no risk of cobs being wet from rain
- the cobs will be shelled within 3 months



How crops are dried

Cereals and pulses are usually dried in the sun

- Pulses (**soybeans, cowpeas, beans and peas**) are normally left in their pods
- Cereals (**sorghum and millet**) are usually left on the seed head.
- Cereal (maize) is dried on the cob, but after shelling, it needs further drying (to 13%) before being sold or stored



drying beans



drying sorghum



Where to do the drying?

- A plastic sheet (tarpaulin) must **ALWAYS** be used
- A special drying crib can also be used for some crops
- **Never** place drying grain in direct contact with the ground





drying maize



drying soybeans



drying maize



drying beans



Precautions when drying

1. Make sure the crop layer is not too deep

- Spread cobs, kernels, pods or seed heads in a single layer
- If drying loose grain, beans or seeds, the grain should be spread in a layer no deeper than 5 cm (less than half a finger deep)



Using plastic sheets

- Plastic sheets are important for stopping your crops becoming dirty and contaminated during the drying process
- Place a large, clean plastic sheet (tarpaulin) on the ground
- Ensure no sharp objects are below the sheet that can tear it
- Plastic sheets are also very good when rain begins. Your crop can be quickly covered and uncovered
- This will protect your crop from becoming wet and mouldy



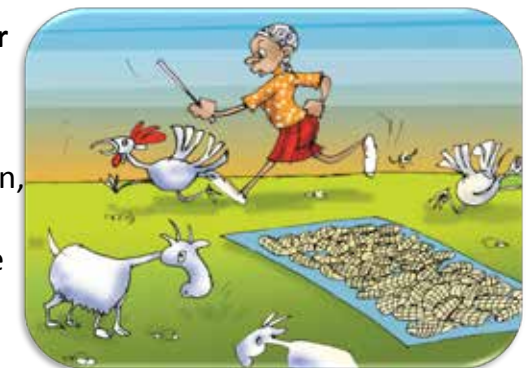
Precautions when drying

2. Turn your crop regularly to improve drying

- Turn your grain, beans or seeds every hour using your hands, a rake or other suitable tools. Turning and stirring the grain makes sure that all parts of the grain are dried evenly by the sun and air

3. Keep animals away from your crop when drying

- Keep farm animals away
- Do not allow grain to be eaten, damaged, or contaminated
Fence the area around where grain is being dried





Precautions when drying

4. Cover your crop if it is going to rain

- Do not let your crop get wet
- Always be around when grain, beans and seeds are being dried
- Option 1. Have a second sheet ready to cover your crop; or
- Option 2. Be ready to quickly move your crop to one side and fold the sheet over the top



Do not let your crop get wet again



Precautions when drying

6. Always be sure your crop is covered at night

- Moisture in the night air will cause your crop to be wet
- Always cover your crop at night
- Option 1. Use a second sheet to cover your crop. Weigh down the edges with wood or rocks
- Option 2. Push all the grain to one half of the plastic sheet and fold the remaining plastic over. Weigh down the edges with wood or rocks



Precautions when drying

5. Turn your crop over on the plastic sheet every 2 hours

- When your grain, beans or seeds have been drying for two hours, push them all to one side of the plastic sheet
- Allow the uncovered area to dry for 5 minutes
- After 5 minutes, push all the grain to the other half of the plastic sheet (the area will now be dry)
- Now allow the other side of the sheet to dry for 5 minutes, before re-spreading the grain across the entire plastic sheet



A farmer must know when their crop is dry enough for safe storage

The moisture content of maize, sorghum, beans, cowpeas, soybeans and peas **must all be 13% or below before storage**

? But how do you know when the moisture content is



- Option 1: 'Salt and Bottle' test; or
- Option 2: Use a moisture meter



'Salt & Bottle' to test moisture content is 13%



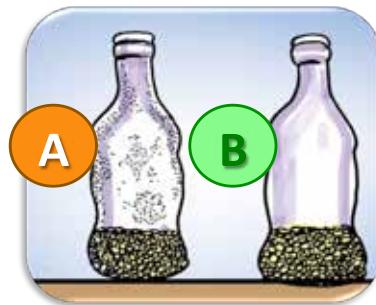
Q. There is something wrong with this image? What is the mistake? **X**



'Salt & Bottle' to test moisture content is 13%



1. Use clean dry glass bottle with a cap
2. Use common salt
- salt must be dry.
3. Fill one third of dry bottle with grain
- use dry spoon and dry funnel
- do not use hands.
4. Add 2 tablespoons of salt
- use a dry spoon
5. Close bottle tightly with its cap



6. Shake bottle strongly for 1 minute
8. Leave the bottle to rest for 15 minutes

8. If salt sticks to the bottle (**Bottle A**), the moisture content is above 13% and **the grain is not ready for storing**
9. If the salt does not stick to the bottle (**Bottle B**), the moisture is below 13% and **the grain is ready for storage**



Using Technology

- If possible, use a moisture meter to test the moisture content of your crop
- This equipment will provide the most accurate information to decide if your crop is ready for storage
- Check with your Farmer Organizer or Aggregator if they can provide you with access to a moisture meter





Protecting Crops from Contamination

- Aflatoxin is a poison produced by fungi
- Aflatoxin is extremely harmful to humans and animals
- Soil and insects are the major cause of spreading infections that cause the fungi
- Contamination is usually very difficult to see
- The more insects on your crop, the higher the risk of contamination
- As fungi grows, they release poisons which cause sickness and death



Aflatoxin spores on maize cob



- Contamination of grain can cause sickness...
- Contamination of grain can also cause death!



Protecting Crops from Contamination

- When crops are not stored correctly they provide a perfect environment for fungus growth



Fungi is very happy (and multiplies rapidly) when moisture content is high and storage temperature is above 20°C.



Fungi is unhappy (and dies) when moisture content is low and crops are in good storage conditions

New storage technologies will stop fungal growth and insect activity



Important points to remember



- Crops must be dried in the sun on a plastic sheet
- Never allow the drying the crop to come into contact with the soil. Keep animals away
- Drying crops must be covered before rain and always covered at night
- Moisture content must be $\leq 13\%$ before storage
- Use 'salt & bottle' to test moisture content
- Protect your crops from contamination
- Soil & insects are major cause of contamination



At the end of Topic 4 and Topic 5 you will understand:



- The precautions needed to avoid damage to your grain during threshing/shelling
- The correct way to thresh beans, sorghum, soybeans & maize
- The importance of cleaning grain before storage
- Different Grading Standards

How to thresh grain

- Threshing (or shelling) separates the grain from the seed heads, panicles, cobs or pods
- It is important to minimize grain damage during threshing by:
 - Avoiding techniques that crush or damage grain
 - Not threshing grain that is too moist (soft) or too brittle (dry)
 - Not threshing grain when the moisture content is above 16%



soybeans

How to thresh staple crops

- Beans, sorghum, soybeans and millet seed heads can be beaten against a threshing platform. *Do not do this with maize*
- Threshing can also be done by beating dried pods with a small stick. Using a small stick will prevent the loss of grain
- Beating with big sticks will damage your grain causing 5-10% loss
- Beans and sorghum kernels are very easily damaged



sorghum



beans

Note: Crops threshed on bare ground are easily attacked by insects and contaminated by mold, foreign matter and cause loss due to scattering

How to shell maize

- Maize cobs can be shelled using bare hands, wooden or metal hand-shellers, pedal operated shellers or motor-driven shellers
- *You must never beat your maize with a stick*
- Beating maize will cause broken grain. Broken grain increases exposure to contamination and aflatoxin poisons
- Broken grain reduces the quality and value of your crop

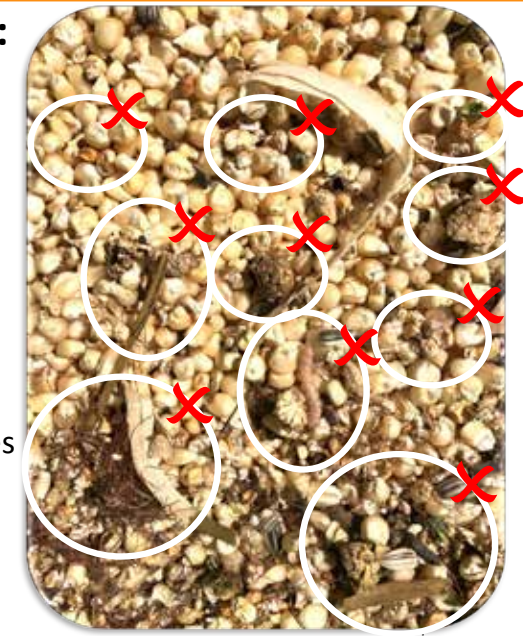


- Winnowing is the process of removing chaff, dust, stones and other foreign materials from your grains before sale or before family consumption



Cleaning crops manually:

- Winnowing or Sieving will remove many impurities, but
 - Hand sorting is required to remove damaged, broken, diseased, discoloured and mouldy grain
 - Hand sorting is also required to remove insects and grains of other varieties





Topic 5: Sorting & Grading your Crops

65.

Sorting your crop

- The appearance of your maize, sorghum, beans, cowpeas, soybeans and peas is very important to the price you receive for your crop
- Careful sorting of your crop is very important. It may be time consuming, but it improves your crop quality, grade and price
- Dry crops are graded in terms of grading regulations and the price paid is adjusted according to the quality of the product
- Crops are graded as Grade 1, Grade 2, and Grade 3
- **Example:** Grade 1 beans must be of a particular form, size, colour and free of any musty or unacceptable odour. All discoloured, broken and split beans must be removed. All stones, sticks, dirt and insects must be removed



Topic 5: Grading your Crops

67.

example: East Africa Grade Standards for Beans

	GRADE 1	GRADE 2	GRADE 3
Foreign Matter (stones, sticks and dirt)	0.5%	0.75%	1.0%
Filth (animal droppings)	0.1%	0.1%	0.1%
Live Infestations	0%	0%	0%
Other Bean Varieties	0.5%	1.0%	1.5%
Total Defective Beans	2.0%	3.5%	5.5%

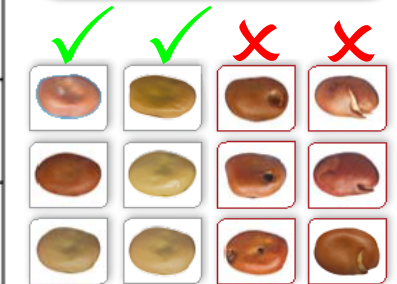


Topic 5: Grading your Crops

66.

example: East Africa Grade Standards for Beans

	GRADE 1	GRADE 2	GRADE 3
Moisture Content	13%	13%	13%
Discoloured Beans	1.0%	1.0%	1.0%
Pest Damaged Beans	1.0%	2.0%	3.0%
Broken Beans	1.0%	2.0%	3.0%
Heat Damaged Beans	0.1%	0.2%	0.5%



Topics 4 + 5: Threshing, Cleaning & Grading crops

68.

Important points to remember



- Minimize grain damage by only threshing grain below 16% moisture content and using a method that does not crush or damage your grain
- Use a small stick for threshing beans, sorghum and soybeans. Do not use a stick for maize
- Use winnowing, sieving and handpicking to improve grain quality before storage
- Understand different Grading Standards and buyer expectations for all crops



At the end of Topic 6 you will understand:



- The problem with traditional storage
- How to provide good grain storage on your farm
- What is hermetic storage?
- How to select the correct type of storage
- How to keep grain bags in the house

Problems with traditional storage



Polypropylene, Jute or Sisal bags



Traditional Storage Granaries



All are highly vulnerable to insects, rodents, moulds and moisture related issues



Have you ever seen this storage?



Traditional Storage (open weave bags) and Granaries cannot protect your crops

- Grain stored for over 2 weeks in open-weave bags and granaries and are at **high risk** of insect, rodent and weather related damage
- Farmers using traditional storage methods can **expect to lose 30%** of their crop (even more if they store for longer periods)
- To avoid crop losses, farmers should store their grain in hermetic (air-tight) storage units

1-2-3 of Good Storage

1. Your crop must first be cleaned and dried correctly
2. Your crop must be stored at the correct moisture content ($\leq 13\%$)
3. You must decide how much crop you will store for a short time and how much you will store for a longer time. This will affect the type of storage equipment you should be using

13%

- Short-term (less than 1 month before sale or consumption)

Hermetic storage optional

- Medium to long-term (2-12 months storage)

Hermetic storage is not optional

Insect-Free Storage (Hermetic)



Protect your crops for storage periods of +3 months

- Insect-free storage is definitely possible
- Using hermetic storage is very effective for grain quality and reducing grain loss
- When closed correctly insects cannot enter and attack your crop
- When closed correctly insects inside will die within hours

Using Air Tight (hermetic) Storage Units

- Airtight storage can mean sealed **plastic bags**, sealed **plastic silos** or sealed **metal silos**
- Airtight storage provides excellent insect control and also stops the grain from reabsorbing moisture from humid outside air
- When closed, the oxygen in the storage unit quickly expires (oxygen is used by grain respiration and any insects trapped inside)
- All insects will die quickly without oxygen and water
- All moulds and fungi die quickly without oxygen and water



Plastic (hermetic) Storage bags

- Each bag can store 90-100kg
- Multi-layers restrict oxygen and water vapour movement
- Hermetic Storage Bags are placed inside an outer bag to protect the hermetic internal bag against damage
- Hermetic Storage bags are re-usable



Plastic (hermetic) Storage bags

- Must never be stored in direct sunlight
- Must never be stored on the ground
- Must be kept away from internal walls
- Must be closed carefully (tied twice) to avoid any oxygen entering the bag
- Can be used for all traditional staple crops; **maize, sorghum, millet, beans, soybeans, cowpeas, and peas**



Fumigation of grain with phosphine is **not required** with air-tight hermetic storage bags

Plastic (hermetic) Storage bags



With secure locking mechanism

- Available in 1 size; 500lt capacity
- Should be filled completely with clean dry grain to displace as much air as possible before closure
- Must never be stored in direct sunlight
- Must never be stored on the ground
- Must be kept away from internal walls

Fumigation of grain with phosphine is **not required** for plastic silos

When used correctly, hermetic storage units can reduce your post-harvest crop losses to 0%



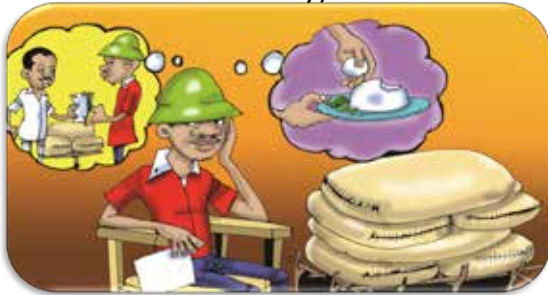
Potentially 30, 60, 100% crop loss during storage



Potentially 0% crop loss during storage

How much to keep? How much to sell?

- It is important to keep enough grain on your farm to feed your family until the next harvest
- Purchasing grain in the months after harvest can be very expensive; so money is saved by keeping enough in storage
- Good hermetic storage will protect your grain for household consumption and also allow you to decide on the best time to sell your grain (to make the most money)



Importance of Aggregation Centers

- Large buyers are only interested in purchasing bulk amounts of grain
- Large buyers will not collect bags from individual farmers
- **Aggregation centers (collecting quality grain) have a big advantage in achieving better prices for farmers**
- A good aggregation center provides safe storage, accurate weighing scales, accurate moisture meters and good record keeping
- After calculating the family consumption needs, a farmer can keep their surplus crops at home in hermetic storage or take their surplus crops to an aggregation center for bulk selling
- Farmers must discuss minimum volumes and quality standards and price with the aggregator or offtaker before their crops are collected

- Calculating the correct amount of food to keep for **Family Consumption** is a very important responsibility
- Farmers must carefully plan how much of their crop to keep for consumption and how much crop to sell
- Example for calculating your total family maize requirements is:



1. Estimate the amount of maize consumed daily by one person
2. Add up the total number of people in your home
3. Individual requirement X number of people X 7 days = Weekly Amount
4. Weekly Amount X 52 => **Family Consumption per Year**

Example: For a family of 8 people

$0.65\text{Kgs per day} \times 8 \text{ people} = 5.2\text{kg maize}$

$5.2\text{kgs} \times 7 \text{ days} \times 52 \text{ weeks} = 1892.8\text{kg maize}$

Yearly Family Consumption = 1900kg (38 x 50kg maize bags)

Important points to remember



- All grain must be stored clean and at a safe moisture content ($\leq 13\%$).
- Airtight storage provides excellent insect control and prevents the grain from reabsorbing moisture from humid outside air.
- **Airtight storage must NEVER be in direct sun-light, NEVER close to a cooking fire, NEVER stored directly on the ground and NEVER touching internal walls**
- Farmers must carefully plan how much of their crop to keep for consumption and how much to sell (keeping crops can save big money)
- Aggregation centers give farmers the opportunity to receive higher prices for their crops

Conclusion: Top 10 Key Messages

85.

1. **Be prepared.** All equipment needed for harvest and post-harvest activities must be ready and in good condition before your harvest begins.
2. Be careful with field drying. **Monitor crop maturity** indicators and ensure you harvest on time. Not too early. Not too late.
3. **Safely transport** grains to your homestead immediately after harvest to avoid destruction by pests, animals, theft, and rain.

Conclusion: Top 10 Key Messages

86.

4. Never allow your crops to be in **contact with the soil**. Use tarpaulins or special drying cribs to dry your crops.
5. **Threshing** should be done using appropriate methods and only when grains have a moisture content of below 16% (to not damage crops)
6. **Careful sorting** of your crop will improve crop quality and price. Hermetic storage units are not magic; what you put in, is what you get out.

Conclusion: Top 10 Key Messages

87.

7. High moisture content leads to high humidity within the storage unit (creating fungal development.) Use the salt and bottle method to ensure **moisture content is $\leq 13\%$** prior to storage.
8. Air-tight storage units provide excellent insect control but must be used correctly for safe and long term storage of crops.
9. **Fumigation** with chemical tablets is not needed when using air-tight storage units and should be avoided.
10. Carefully prepare your crops before storage. Using hermetic storage units, you can **protect your crop from insects, pests, mould and moisture**. Beans, cowpeas, groundnuts and maize usually sell for higher prices months after the harvest.

Conclusion: Questions

88.

Questions please:



Conclusion: Top 10 Key Messages

89.

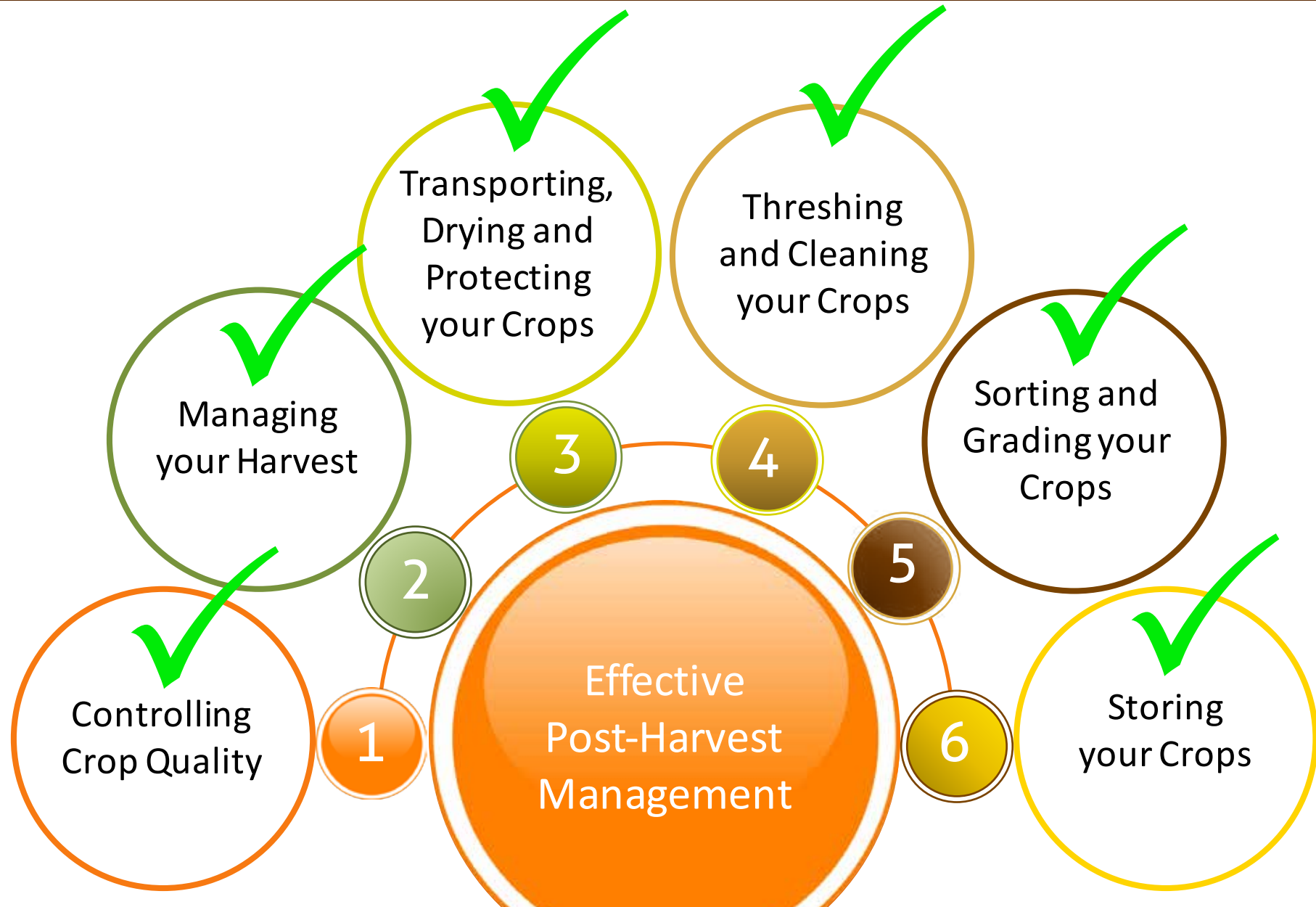
Traditional Storage Problems



Hermetic Storage Benefits



6 principles of good Post-Harvest Management



FARMER WORKSHOP NOTES



