Maize harvesting

Harvesting patterns are almost similar from one region to another. Harvesting is carried out with or without husks. In the northern and central regions, where the climatic conditions offer drying possibilities in the field, and especially on the spot, harvesting is done in baled cobs. In the south, the harvesting method could be different because this is done under specific climatic conditions during the high season (non-dry cobs). The harvest is done in unpadded spikes (baling) and drying continues in the appropriate granaries or cribs

Preparing the harvest

Before starting the harvest, it is necessary to take certain practical measures both inside the house as well as in the field. Among the most important are:

- Plan all harvest-related activities and get an idea of how the grain will be stored (husks, maize cobs or grains) as soon as the maize matures (Figure 1).
- Mobilise and clean containers or bags to be used for harvesting.
- Empty and clean granaries or other structures to accommodate the harvest.
- Ensure that labour is available and that practical arrangements (remuneration and meals) are taken care of.
- Clean storage or pre-storage structures' surroundings in preparation for the harvest.
- Clear and clean drying areas while awaiting the harvest

Maize Harvesting

During harvesting, certain practices are recommended, while others are to be avoided to minimise contamination of maize by certain insects and diseases such as mould.

Recommended Practices

- Harvest maize at full maturity at the moment when the grains are soft, yellowing, shiny
- The maturity of the maize cobs can be tested by checking the condition of the black layer that forms at the base of the grain (where they are attached to the cob). The layer can be observed by removing the grain from the cob and scraping the tip with the nail (Figure 4) as suggested by World Food Program (WFP) and Natural Resources Institute (NRI) in their document "Training Manual for Improving Treatment and Storage of Grains After Harvest."
- Harvesting can be carried out as soon as 75% of the stalks are yellowish, the leaves are slightly yellowish and the maize stands are still upright, because delayed harvesting, although it decreases drying time of grains, has disadvantages such as lodging, parasitic attacks, possible delay in planting the next crop, etc.
- Cut the maize directly at the stem and in the field if it is to be stored as cobs or grains. This makes it possible to reduce infestations and rotting, thus ensuring an efficient sorting and saving time and labour
- When harvesting, it is necessary to isolate infected, mouldy cobs, or those from plants that have already fallen, from other cobs.
- Use clean bags or containers such as specific baskets for collecting maize cobs when harvesting manually from standing crops (Figs 3-5)
- Finish the harvesting in the shortest possible time, especially during the rainy season to prevent the cobs from getting wet. As much as possible, the harvest should be done during the bright and sunny days when the sky is clear.
- Burn the rejected maize cobs or dispose them off in a compost pit away from the production area (Figures 10 and 11).
- If rain catches you during harvesting, cut the stem just below the cob and prevent the water entering the cobs by bending them downwards

Figure 1: Maize field ready to be harvested

Figure 2: Corn harvesting from despathes

Figure 3: Harvesting maize in baskets

Practices to Avoid

- Avoid harvesting maize during the wet season when the moisture content is more than 22%, because it will be extremely difficult to dry it in such a way as to lower the water content sufficiently to keep it in good condition, or being shelled without the risk of being attacked by mould or contaminated by mycotoxins.
- Avoid late harvesting (some of the cobs fall down and this is called lodging) which exposes the maize to attacks and bad weather. In fact, the more the maize cobs are left in the field, the higher the chances of them being damaged by insects or noticing fungi forming around them.
- Avoid mixing healthy and damaged cobs during harvesting, as insect damage is an entry point for fungi, especially aspergillus, which is responsible for maize moulds (Figure 7-8).
- Similarly, separate the cobs from fallen plants.
- Avoid placing harvested cobs on an open ground to prevent damages and contaminations. In fact, the ground contains millions of aspergillus germs which contaminate the cobs once they touch the ground.
- Use the preferred types of bags which allow air circulation at harvest storage. Avoid polythene bags because they lock up humidity and humid conditions inside the bags encourage growth of mushrooms
- Avoid harvesting after the rains or when air humidity is high.
- Avoid damaging the cobs during harvesting and transporting activities.

Figure 7: Maize attacked by fungi

Figure 8: Maize attack by weevils

Figure 4: Mature maize grains with a black layer beneath the tip (which has been scratched)

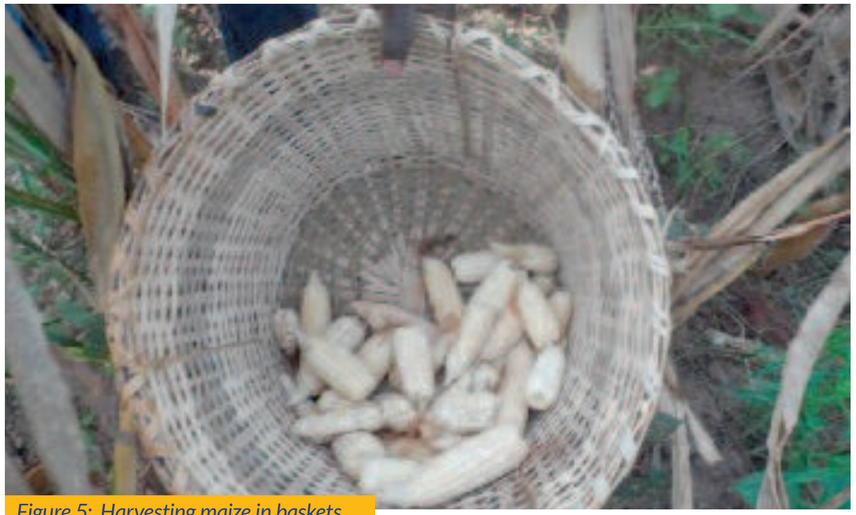

Figure 5: Harvesting maize in baskets

Figure 6: Isolation of damaged cobs

Figure 10 & 11: Rejected maize cobs are sent to the compostbaskets

Figure 9: Heap the maize deposits directly into the ground

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Shelling, sorting and drying of maize

Once maize has been harvested, dehusked and dried, it is shelled by hand threshing or a machine a sheller. Maize grains obtained after must be thoroughly dried to attain the moisture level (12-13%) required for storage. This sheet indicates good grading, shelling and drying practices that allow better grain storage and conservation.

Shelling of maize

Shelling consists of separating the grains from the cob. It is necessary to shell maize after dehusking (recommended in the field), which is the removal of maize from husks.

Usually, shelling is done by threshing maize cobs with a stick in a sack or on the ground in a confined space where all the grains can be recovered. This practice should be avoided because it causes physical damage to grains, which makes them more vulnerable to parasites if certain measures are not taken. Manual and mechanized practices are among those recommended:

Manual shelling

- This is a primary manual method but tedious. It consists of scrubbing two maize cobs against one another or manually shelling them with the hand, one after the other (Figure 1). This method is mostly recommended for seeds and small quantities of maize.
- Another method is the use of small tools made by local craftsmen to accelerate and facilitate shelling.
- Manual methods have the advantage of considerably reducing the breakage rate and offer a possibility of more reliable sorting of grain

Figure 1: Manual shelling

Mechanized shelling

- For mechanized shelling (Figure 2), one needs to pay a service provider who has a sheller. Motorized mechanized shelling reduces time and sometimes does winnowing. To limit breakage during shelling, maize cobs must have a water content within the range of the sheller used.

After shelling, winnowing needs to be done before sorting. Maize that is damaged during shelling should be used within a short time

Figure 2: Aziza maize sheller and winnower

Sorting of maize

The process of sorting consists of separating and removing foreign bodies and damaged grains. It helps in protecting maize from future degradation. Its purpose is to select maize for storage in an intact and good condition. Visual inspection, winnowing and sorting are operations that contribute to this objective. Sorting is carried out at all stages of the maize storage process, from harvest to storage. Even if maize shall be stored in grains, a first selection is essential before shelling. This can be done during harvest or at home.

- During harvesting, grains damaged due to insect or disease infestation should be removed (Figure 3). This is the first step in reducing infestation levels. Insect-infested grains are not completely covered by husks or they contain moldy grains. It is for this reason that it is advisable to dehusk at harvest.
- In the case of seeds, harvesting on cobs also makes it possible to eliminate the badly fertilized and aberrant cobs through sorting. The grains can be cleaned by hand, winnowing, sieving and / or sorting.
- Before shelling, it is advisable to sort the good cobs (well filled, healthy and grains with no holes) from degraded ones (attacked by rodents, insects, moldy and blemished).
- After shelling and threshing, broken grains should be isolated and consumed within a short period of time as they are more susceptible to insect attack and mold.
- For storage in form of grains, it is advisable that after shelling, maize should be winnowed to separate good

Figure 3: Sorting of shelled maize

grains from bad ones (fig 3). The goal is to keep the grain clean. Sorting is therefore an effective means of reducing infestation levels in stored maize, although the percentage of sorted maize varies widely per farmer and may depend both on the individual's judgment and on the producer's economic situation.

Drying of grains

Moisture is the biggest enemy of maize in stock. At harvest, the grain's water content is about 30 to 35%. At this stage, an organism can still live, breathe and produce heat, water and carbon dioxide. Therefore, the grain should be dried **as soon as possible** after harvest. The purpose of drying is to preserve the quality of the stored maize by reducing its **initial water content to around 12%**, which is the recommended WFP level. Several methods are useful in evaluating the water content of maize. These include the sound produced by grains when broken using teeth, moisture absorption by salt when mixed with the grains in a dry jar, or the use of a moisture meter. The first two methods are much less accurate than the moisture meter.

Figure 4: Drying maize on a liner

Recommended practices

- Drying should be done on a suitable concrete surface (figure 5), sturdy polyethylene or canvas (preferably) to reduce the risk of contamination.
- Use clean concrete drying areas to accelerate drying due to rapid heating. In clear, sunny weather, a 5 × 5 m slab can dry 1 ton of maize in a day and a 10 × 10 m slab can dry up to 4 tons of maize in a day.
- Ensure that the maize layer on the canvas does not go beyond the first joint of the index finger. Otherwise, the grains that are below the surface layer will not dry quickly.
- Dry under the warm midday sun for at least four hours a day until drying is complete (fig 5). The grains dryfaster if they are turned several times during the day.
- Use sun-drying preferably and avoid slow and incomplete drying.
- Pre-dry maize cobs naturally in special granaries or silos-cages or cribs.

Figure 5: Drying maize on a developed area

Practices to avoid

- Avoid any contamination from dust or sand that can reduce the market value of maize.
- Allow maize to cool until evening before putting it in appropriate storage structures.Avoid drying maize in husks since they serve as hiding places for insects.

- Avoid drying maize in the field as it is highly infected and infested with insects and microorganisms.
- Avoid rehydration of maize during drying as it promotes infection with Aspergilus (aflatoxin fungus).

Aflatoxin contamination may increase tenfold in three days if the maize grain is not dried properly.

Do not let pets such as chicken, goats, dogs and cows walk through the maize drying area because they may damage or eat the grains.

Sun-drying steps

Sun-drying is a direct drying method that uses sunlight to reduce the moisture content of maize before storage. It reduces post-harvest losses and provides a better quality dried product or market product

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Storage and preservation of maize still on the cobs in the granaries

Maize may be stored as grains or on the cobs. In regions with two rainy seasons and two dry seasons, long rainy season maize is dried and pre-stored on cobs in granaries made from plant materials, which are constructed according to models adapted to each environment. This data sheet describes how granaries are used for drying, storing and preserving maize on the cobs.

Choice and preparation of pre-storage structure

The type of granary to be constructed depends on the type of materials available in the area. To construct any type of granary, the following must be taken into account;

- Have the granary built (not on a moving or sloping ground, not under a tree) by a specialist;
- In case the granary exists, it will be necessary to: *Restore the granary's materials by replacing rotten wood, cleaning its surroundings and burning the waste*;
- Sweep inside the granary to remove residues from the old stock that can serve as breeding places for insects;

Figure 1: Plant materials granary

- Dry the cobs after baling so as to reduce the water content of the grains to between 12% and 13%.
- All areas around the granary should always be clean to prevent the stored cobs from becoming contaminated and also avoid fire.

Pre-storage operations and quality of maize to be stored

Before storing maize you need to:

- Remove husks from each cob.
- Disinfect the interior of the granary
- Ensure that the maize to be stored is clean and free of insect infestations, otherwise it must be cleaned and sorted in order to remove all moldy, damaged and perforated grain, as well as insects and also material and foreign bodies (leaves, pebbles, pieces of wood, etc.).
- Do not mix and store maize on cobs harvested in different periods and of different qualities in the same granary.

Figure 3: Granary from Palm tree

Figure 4: Check all wood in the structure

Figure 2 : Granary from Bamboo lofts

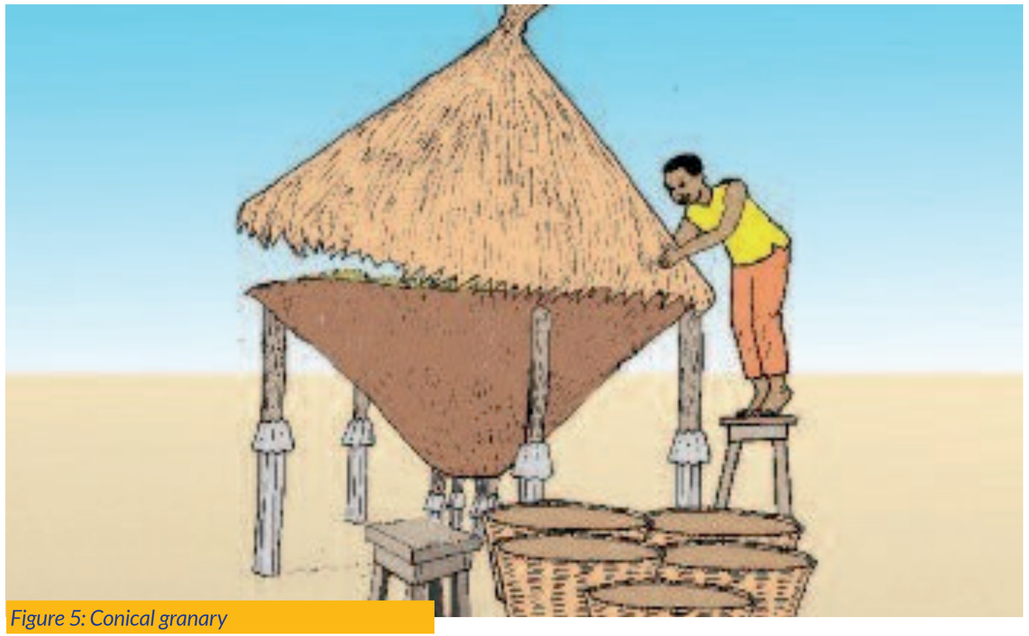

Figure 5: Conical granary

Figure 6: Maize cobs in a conical granary

How to store in the improved conical wooden granary

Once the granary is available, it is necessary to:

- Use granaries that can hold up to 2 tons of maize cobs.
- Avoid putting loose grains in the granary as they clog spaces between maize cobs and hinder air circulation.
- Arrange the sorted maize cobs in the granary, with the lower part facing outwards in successive layers. One layer corresponds to 3 solid basins, i.e. 50 kg.
- In case of long term pre-storage, disinfect maize cobs using insecticides such as Actalm, Actellic super PP or sofagrain at the rate of 50g per 100 kg or any other product authorised and advised by the authorities to avoid insect infestation. Sprinkle half a sachet of insecticide on each layer homogeneously.
- In addition, avoid putting other cereals in the granary that contains maize cobs.
- Note that storage of cobs in this type of granary is pre-storage and should not stay too long (maximum 2 months).

Monitoring the maize cobs stock

In order to guarantee a good quality stock, it is very important to monitor stored maize during the storage period. It is therefore necessary to:

- Inspect the stock status at least once every 15 days and ensure that weevils are not present. If yes, destock and dry again.
- Avoid storing newly harvested maize on an old stock in the granary.
- Avoid placing other wooden objects like hoes next to the granary.
- Clean (rake, sweep and burn leaves) regularly around the granary.
- If the storage phase of cobs lasts longer than three months, it is useful to carry out a maintenance treatment. This maintenance treatment simply consists of sprinkling one or two sachets of insecticide on the external surface of the stock.
- Avoid tying ropes on the granary for drying clothes as this reduces contact between the granary and insects, rats and other animals.

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Storage and preservation of maize grains in improved earthen granaries

After shelling, winnowing and sorting, and drying, maize cobs can be stored in bags or a metal silo for long-term storage or stored in improved earthen granaries. This type of granary is found much more in the north of Benin, where it serves not only to preserve maize grain but also sorghum. The base is used as a chicken coop for domestic poultry. This leaflet describes best practices for storage and storing maize grain in this type of granary.

Quality of the maize to be stored

Before storing maize, you must:

- Ensure that maize is free from impurities; otherwise, proceed with cleaning and sorting to remove mouldy, damaged, perforated kernels and also foreign bodies and other matter (leaves, pebbles, insects, etc.).
- Ensure that the grains are dry. If not dry, reduce the moisture content to between 12% and 13% (well-dried grain makes a cracking noise when broken by teeth).
- Proceed, in case of long-term storage, to disinfect the grains by preservatives in order to avoid infestation of the stock by insects.

Earthen granaries

This type of granary is an improvement of the traditional earthen granary which is often on the ground or on reeds (Fig. 1). The closed improved earthen granary (Fig. 2) comprises three parts: the body of the granary whose interior is generally partitioned into 2 to accommodate different commodities (Fig. 3) and equipped with two safety valves, which enable sampling; the lower part of the barn serves as a chicken coop and the roof consists of a lid in the form of a slab and a straw roof.

The Improvements

1. the chicken coop under the granary - fig.5
2. stone basement (wooden front) - fig.5
3. partitioning (storage for 2cereals) - fig.3
4. valves (one in each compartment)
5. slab cover - fig.2

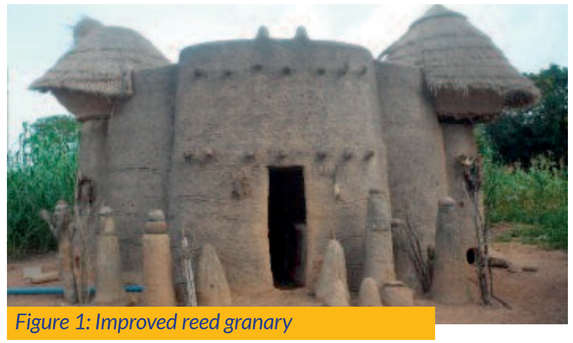

Figure 1: Improved reed granary

Conditions of good storage and preservation of maize in the earthen granary

- Whatever the type of granary, first clean and disinfect it from the inside.
- The granary must not be cracked and should be protected with straws against severe weather.
- The outside, i.e. all around the structure must be clean and dry. It must be cleaned regularly.
- The granary and covers must be in good condition.
- For a long shelf-life, preservatives that are authorised and recommended by the Ministry of Agriculture (Fig. 4).may be used:
- Each compartment in the granary must contain clean maize cobs free from any infection or infestation.
- After removing an amount of maize from a compartment, you must not fill it up with another amount of maize.
- After removing a portion of stock from a compartment, close the door tightly.

Monitoring stored maize

Monitoring of stored maize during the storage period is very important in order to ensure a good stock quality.

Therefore, it is necessary to:

- Avoid putting newly harvested maize onto the old stock in the granary.
- Check the granary from time to time to see if there are any cracks or other defects to be repaired.
- Open the granary by the cover slightly and also take

Figure 2: Improved Traditional attic Granary

Figure 3: Partitioning

Figure4: Recommended pesticides

Figure 5: Comparison of the old and new granary

Figure 6: Disinfection of the grains

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Management of maize storage

Once maize has dried and stored in polypropylene bags or PICS bags, storage in a store or storage place should follow certain rules. The purpose of this Factsheet is to provide guidelines for proper management of stored maize.
In the context of warehousing or storage credit, stock management is very important.

Some precautions to facilitate stock management

For storing in stores, ensure that enough space is available for storing the new crop and that the store is thoroughly cleaned and rehabilitated before the new harvest. In the store, grains can be stored in polypropylene bags, PICS bags as well as in metal silos. The following rules must be generally observed

Storage of bags

- The bags must be placed on pallets (fig. 1) to ensure good air circulation in between the pallets and within the wharehouse;
- The bags must not touch either the sides of the wall, the roof or any structure of the store;
- A pathway of at least 50 cm should be left between the sides of the wall and the stock to facilitate inspection and treatment. This pathway must be at least 1 m between the store's main entrance and the stocks;
- The bags must be stacked well in a particular manner (fig 2). The stock should be stable and easy to count;
- The pallets must be strong to support the weight;
- In a given batch, bags must be of the same type;
- Pallets should be placed at a distance from the walls with pathways to facilitate movement during storage, inspection and destocking;
- Store full bags at a lower height than windows;
- Leave a space of at least 0.5 cm between the roof and top of the stacks.

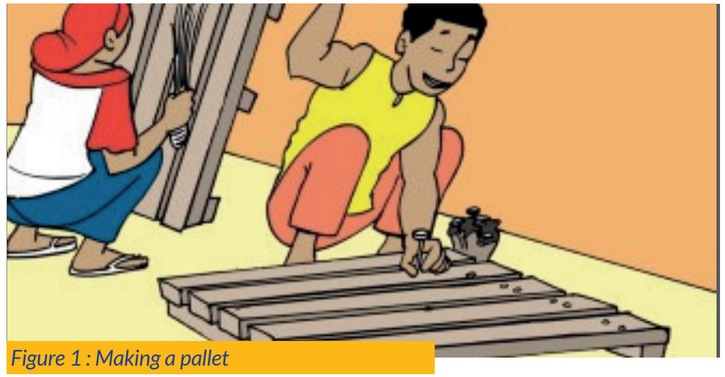

Figure 1 : Making a pallet

Conditions and maintenance of the store

- The store must have ventilators on the walls in the direction of wind to ensure good ventilation;
- Clean the surroundings of the store and place baits for rodents;
- Set up a firewall around the store's fence;
- Have a store whose (smooth) roof and walls are totally waterproof

Stock management

- If it is a community store, it is important:
  1. that the stock manager gets appropriate training in advance;
  2. to keep producers informed of the quality of grain to bring;
  3. to check the grain quality of each bag using a sampling probe and reject it if it does not meet the standards.
- Stock management must be rigorous: quality and quantity control at the time of storage.
- Take measures to prevent theft.
- Management of stock entails costs which must be projected and discussed at the beginning of the operation. Various partners must have a contract on how these costs shall be met, especially in the case of warrantage.
- If necessary, the warehousekeeper must carry out the necessary treatments (sorting, phytosanitary treatments, etc.). He/She must also record entries and issue delivery notes or warrants to depositors, which certify the type of product stored, quantity, date, etc.

Practice to avoid

- Avoid poorly designed stores that are generally badly ventilated and moist, and which provide no protection against rodents.
- Avoid mixing grains or bags of different origins without ensuring their quality (fig. 3).
- Do not pile up bags inside the store in a disorderly manner. Avoid leaving them on the floor and along the walls.
- Do not leave fallen grains inside and around the store as they inevitable attractinsects and rodents. Lack of hygiene contributes to contamination and infestation of the stock.

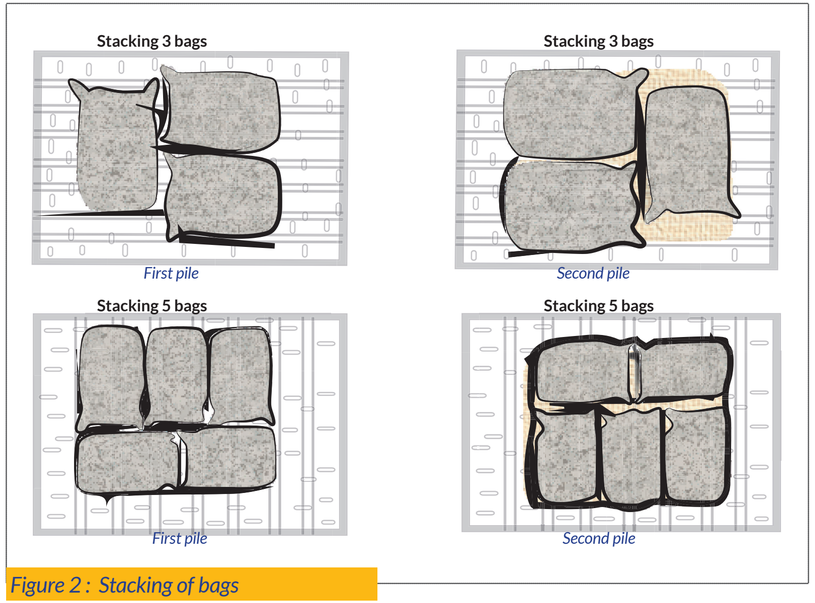

Figure 2 : Stacking of bags

Figure 3 : Good bags next to infested ones in a store

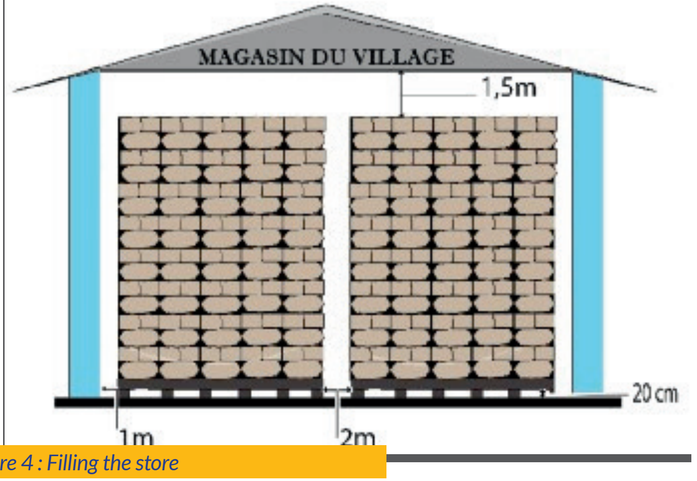

Figure 4 : Filling the store

Stock inspection

Storage inspection, which consists of a thorough assessment of all internal and external parts of the storage structure and its contents. It also takes into account sampling and phytosanitary analysis.

It is necessary to:

- Inspect the structure weekly to see if there are any signs of attacks.
- Lift some bags (fig. 5) to check their external appearance and smell to see if the maize is not getting spoilt. It is also necessary to check between the bags to
- Inspect the store to detect presence of insects and their movement in the afternoon at around 16:00. Using your ears, listen to sounds of insects eating grain and use a torch to inspect the dark areas of the store
- Check the stability of stacks of bags.
- Take time to climb over the stored bags to see if there are any moisture stains (fig. 5) on the bags due to the rain penetration, for example.
- Look carefully to see if there is no problem with the roof, no cracks in the walls and no safety problems.
- Using a probe (fig.6), collect grains from a sample of bags to check their quality. This practice is not possible with PICS bags. According to the World Food Program (WFP), the number of bags from which a sample is taken is the square root of the total number of bags. On bags chosen randomly from the store, the sampling will be done at the top, middle and bottom.
- Search in the sample for damage, larvae, pupae and adult insects
- Take the earliest palliative measures necessary to reduce losses after observing signs of infestation, attacks and moisture.
- Also look for traces of rodents and damage.

Some hygienic decisions to take

- Remove from the batch and return bags whose contents have holes, insects or moldy grains in excess.
- Bags with small holes can be mended with adhesive tape.
- Replenish bait, insect or rodent traps if necessary.
- Keep the store clean or clean it if necessary.
- Open the store weekly to facilitate ventilation.

Destocking the store

- It is advisable to empty the contents of a PICS bag or barrel after it has been opened. This is because once air gets in, it will allow any dormant pests to come back to life and start feeding. However, in the case where removal of maize is mandatory to take care of family needs, bags must be correctly closed (fig. 7) by observing the following steps:
  1. Press the bag containing maize to remove the air from it and then tie the neck tightly with a rope or wire.
  2. Twist the top end of the neck remaining above the knot and bend it down.
  3. Firmly fasten the twisted and curved tip together.
- When removal concerns the entire bags, the first in, first out (FIFO in English) rule must be observed.
- The warehouse keeper must record stock removal in a register and on receipt or warrant specifying the type of product, quantity, date, and any other useful information.

Figure 5 : Inspection of bags & pallets

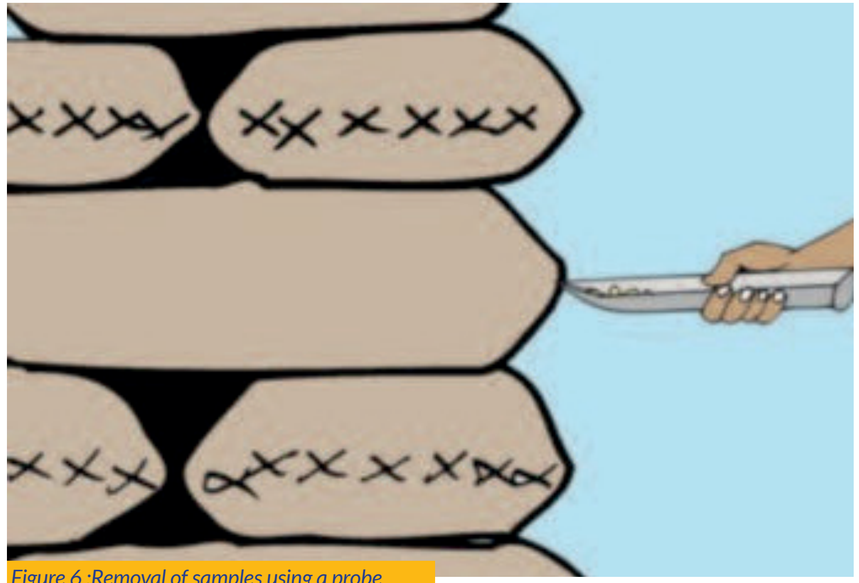

Figure 6 :Removal of samples using a probe

Figure 7 : A poorly tied ICS bag (left) and well tied one to the right

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