TRAINING MODULE

POST-HARVEST AND GRAIN STORAGE LOSSES

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Somali Agriculture Technical Group (SATG)

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1. Introduction

For centuries, farmers in the Bay Region and elsewhere in the grain-producing areas of Southern Somalia have been following rudimentary grain harvesting and storage practices that carry the double risks of a quantitative loss of their production and exposure to dangerous toxins leading to illness and deaths among the producers and consumers of the grains.

This module is for farmers who wish to learn more about potential grain losses and their causes, as well as some methods for ameliorating these losses. It is important that farmers are aware of the risks they incur by not improving their current grain harvesting, drying, threshing, and above all, storage practices: while the economic loss from the current grain storage practices is painful, the health hazards have even more serious effects.

2. Module Objectives.

By the end of the module participants should:

- be able to identify the main types of grain losses and their origins
- be aware of the most important grain handling risk factors
- recognize the importance of improving grain storage and handling practices
- understand some practices they can adopt to reduce grain losses
- appreciate the economic and health risks associated with aflatoxin contamination
- be familiar with methods to contain aflatoxin contamination

3. Welcome and Introduction

Welcome to the module "Post-harvest and Grain Storage Losses". We'll be discussing the most important types of grain storage losses, why they occur, and how we can avoid them. We'll also be learning about the risks to health and wealth that some traditional grain storage and handling practices present.

The objectives of this module, therefore, are that you will:

- Identify the main types of grain losses and their origins
- Become aware of important grain handling risk factors
- Recognize the importance of improving grain storage and handling practices
- Understand some practices you can adopt to reduce grain losses
- Appreciate the economic and health risks associated with aflatoxin contamination
- Learn methods to contain aflatoxin contamination.

A note about statistics: where estimates of grain loss magnitudes are given for the Bay region, these estimates are based on a single year and may not be representative of overall trends. These figures should therefore be approached with some caution.

4. Post-harvest

In this session we will be discussing post-harvest losses in the Bay region. Post-harvest loss is attributed to harvesting, transportation and drying. The objective of this session is to identify both the problems associated with post-harvest loss and some possible solutions.

4.1 Harvesting:

In the Bay region, farmers estimate that the loss attributed to harvesting ranges from 10-20%. For comparison, FAO estimates losses from field drying and harvesting in eastern and southern Africa at 12%. These losses occur when the sorghum heads are cut and thrown on the ground and are later recollected and kept in heaps for drying. Cracked or broken grains provide an entry point for infestation by insects and molds during storage. Proper post-harvest handling is critical because if it is improperly done, it may result in serious losses.

Solution: An intact grain is critical for successful storing. Damage to grains may happen due to improper application of post-harvest practices such as threshing, drying or transportation; hence ensuring a proper application of post-harvest losses can reduce the damage to grains.

4.2 Transportation:

In the Bay Region, transportation appears to cause the least amount of grain loss for farmers. It is reported that it accounts for 10% grain loss. In contrast, FAO estimates transport loss for maize in Africa at 1 to 2%. Physical damage, grain spilling or grain deterioration will occur, especially if transport is prolonged.

Solution: Proper packing, loading and handling of the crop.

4.3 Drying Losses:

Field drying of grains after the harvest is widely practiced in the Bay region. This is done by stacking bundles of pinnacles in the fields and sun-drying them. This practice has the disadvantage of attracting insects and rodents which attack the grains and cause considerable losses. While preparing grain for storage there are three important practices that should be followed: keep the produce dry, cool and insect free.

The drying periods for sorghum in the Bay region ranges from 0 to 10 and 10 to 30 days adopted by a majority and a minority of farmers. These drying periods are either too short or too long for practical qualitative and economic reasons.

Solution: It is recommended that an average drying period of 20 days should be adopted by farmers in the Bay region. Abrupt or over drying will cause loss of nutrients or germination capacity. Ensuring the appropriate temperature is maintained for the drying period of grains is important, for example, the temperature should not exceed 43 degrees Celsius for cereal seeds and 35 degree Celsius for legumes. Higher temperatures can be used to dry cereals meant for consumption. Once the crop is dried and stored, continuous checking should be done on the stored crop to investigate the moisture content, presence of pests, molds or deteriorating grains.

Storing the grains below 12% moisture content is very important in order to minimize the

unwanted internal moisture created by the stored grain insects such as weevils. However, these insects cannot be eliminated completely without fully sealed silos. There are several reasons why cooler grain temperatures are desirable: seed germination percentage is maintained longer, moisture migration is reduced and insect breeding is reduced.

5. Storage Losses

In this session we will go through storage losses in the Bay region and find solutions to minimize the impact. Storage losses are usually caused by insects, rodents, grain diseases and the moisture in the grain storage system.

5.1 Insects:

On average, losses due to insects are reported to be in the range of 10-20% of stored grains, but at times may be as high as 30%. In fact, insects cause the highest loss of grain. For example, farmers in Bardale district reported that the loss due to pests is more than 50% of their harvest per year. The most common insect in the grain stores in the Bay Region are *sitophilus ssp*, *sitotroga cerealla*, termites and cockroaches. In comparison, in the Kenyan highlands, total losses due to pests were estimated at 57%, with a greater share of this damage resulting from insects than diseases. In Namibia, the bush cricket (*Acanthopolus discoidalis*) alone has been responsible for up to 30% losses in pearl millet production.

These insect pests inflict their damage on stored products mainly by direct feeding. The damage created by insects on the grain can affect the farmers because their grain may lose value for marketing, consumption or planting.

Solution: The development of insects is limited by temperatures below 15 degree Celsius, and by moistures below 9 degrees Celsius, and by moistures below 13 percent for cereal grains. The application of pesticides can be an effective solution to reduce insect pests; however, pesticides can carry health hazards.

5.2 Rodents:

Stored grain losses due to rodents are estimated at between 10 and 20%. Some of these rodents not only feed on and damage the stored grain, but they also cause indirect grain loss by opening holes outside the underground store which allows water to penetrate and cause extensive damage to the remaining stored grains. The damage caused by rodents is not limited to eating the stored grains but they also contaminate the grains by their urine and hair.

Solution: Drums and bins (including recycled oil drums) have been found to be efficient, not costly and cost effective as farmer storage containers mainly used for grain protection. The salient features of the drums are that they are inaccessible to rodents, efficient against insects and sealed against water entry, all qualities that make them excellent grain containers.

5.3 Diseases:

Fungi are the most common micro-organisms which affect the grains. Initially, they appear as

spore, and then spread into individual grains whenever they find a favorable environment such as high moisture conditions. A negative chain reaction starts when the mouldy grain produces the fungi known as *Aspergillus Flavus* and *Fulsarium Maniliforme*. These in turn, produce dangerous toxins known as aflatoxin and *Zearlenone* which render the grain unfit for human consumption. Once small concentrations of the toxins enter the human blood cells they become carcinogenic and, at higher concentrations, they become highly toxic and deadly. Every effort should therefore be made so that a mouldy atmosphere does not develop in the pits.

Aflatoxin can occur at both pre and post-harvest stages. Post-harvest contamination may occur if crop drying is not done properly and during storage of the cereals as well as if water enters the storage facility or mould invasion of stored commodities is facilitated by mould infestation. The crops with the highest risk of Aflatoxin contamination are the cereals, peanuts and cottonseeds.

Solution: Reducing the amount of humidity by ensuring that the products are dried sufficiently after harvest, that insect pests don't penetrate through the grain storages as this increases the humidity, and that proper storing technique is followed so as to avoid contact with rain water or humidity condensation.

5.4 Moisture:

Depending on the district, farmers in the Bay region reported that stored grain losses to moisture are substantial and range from 10 to 30%. Losses caused by moisture also varied depending on the source of the moisture. The most common source of moisture includes the following;

- Flooding due to excessive rainfall
- Underground moisture
- Improper drying of grain before storage

Daily and seasonal temperature changes near the storage pit walls set up air movements that carry moisture to the coolest parts of the grain. During harvesting, pockets of high moisture grain or inclusion of green leaf material with the grain can affect quality of all the grain in storage as it allows moisture movement.

Solution: Lining the inner wall of the pits with cement, so as to avoid moisture movement into the grain storage. Eliminating the factors influencing the degree of humidity in the store. These can be: a high moisture content in the product if it has not sufficiently dried after harvest, infestation with insect pests that results in hot spots and increased humidity, or improper storing technique that allows for contact with rain water or humidity condensation.

6. Post-storage losses: threshing

A final source of grain losses occurs after storage, specifically during threshing.

Threshing appears to have a considerable impact on post harvest losses. Although farmers in various districts in Bay region reported a minimum of 10% and a maximum of 20% loss, it is safe to estimate that on average, threshing accounts for at least 15% grain loss for the region as a whole. This contrasts with overall FAO estimates for loss due to threshing in Africa: for maize, these are 2 to 5%.

The most common threshing method in the Bay region is the use of pestle and mortar (Kal iyo moye) for threshing the sorghum heads.

Studies indicate that threshed sorghum grains are more susceptible to *sitophilus oryzae* than unthreshed grains. Another potential problem is posed by modern maize varieties: while maize is traditionally stored in its shucks, with modern varieties the shucks are removed for storage. In this case, proper care should be taken and insect repellents or antifeedants should be applied.

Solution: if threshing is carried on plastic sheets or liners, fewer grain will be lost or spoilt. A large plastic sheet should be set below the mortar in order to catch any overspill from the threshing process

7. What is aflatoxin?

In this session we will be introducing aflatoxin and highlighting its harmful effects on humans and on sorghum. In the next sections, we will move on to discussing risk factors and solutions.

Many agricultural commodities are vulnerable to attack from a group of fungi that produce toxic metabolites called mycotoxins. Among these mycotoxins, aflatoxins have assumed significance due to their harmful effects on human beings, poultry and livestock. Two species of fungus, *Aspergillus flavus* (predominant in Asia and Africa) and *Aspergillus parasiticus* (mostly found in the Americas), produce aflatoxins on various food products. One of the most dangerous aflatoxins finds its way into the milk systems of animals which have consumed contaminated feed (usually groundnut cake or haulms with small pods). This is called aflatoxin M1.

7.1 What are the effects of aflatoxin on humans and livestock?

• Aflatoxin is carcinogenic and can cause liver and other cancers in humans.
• It is synergistic with hepatitis viruses B and C.
• It lowers the body's normal immune response to invasion by foreign substances.
• It impairs growth in children, notably in Africa, and causes childhood cirrhosis in India.
• In Kenya in 2005, over 100 people died and several hundreds became ill after consuming aflatoxin-contaminated maize.
• In poultry and livestock, aflatoxin can cause feed refusal, loss of weight, reduced egg production and contamination of milk.

7.2 What are the effects of aflatoxin on sorghum?

• It causes marked deterioration in grain quality because of fungal growth. Contaminated grains are then unfit for the markets or for consumption.
• It causes decay in both seeds and non-emerged seedlings and leads to aflaroot disease.

8. Factors contributing to contamination in sorghum

We will now examine which are the risk factors which contribute to aflatoxin contamination of sorghum. This will help us to determine which crops and which areas will be especially vulnerable. Risk factors will be present in both the pre-harvest and post-harvest period.

8.1 Pre-harvest

• Presence of the A. flavus fungus in soil and air. This infection of sorghum, which occurs at every stage from preharvest to storage, causes aflatoxin production in the kernels.
• Use of susceptible cultivars.
• End-of-season moisture stress to the crop for more than 20 days.
• Mean soil temperatures of 28-31 ^{0}C.
• Mechanical injury to the grain.
• Insect damage to grain by grain damaging insect.
• Death caused by diseases at grain maturity stage.

8.2 Post-harvest

• Harvesting an overly mature crop.
• Mechanical damage to the grain at the time of harvest.
• Stacking the harvest when grain moisture is more than 10% or under high humidity conditions.
• Damage to the grain by insects during storage.
• Storing grain when the grain moisture content is high (high moisture content coupled with optimum temperature level of 28 ^{0}C to 31 ^{0}C is conducive for the fungus to grow.
• Drying grain in direct contact with the soil after harvest

8.3 Food products particularly vulnerable to aflatoxin contamination include:

• **Cereals:** maize, sorghum, pearl millet, rice, wheat
• **Oilseeds:** groundnut, soybean, sunflower, cotton
• **Spices:** chilli, black pepper, turmeric, coriander and ginger
• **Nuts:** almond, pistachio, walnut, coconut
• **Milk** and milk products

9. How can aflatoxin be contained?

Finally we will examine some ways in which we can reduce aflatoxin risk. Again, there are risk-mitigating steps to be taken both before and after the harvest.

9.1 Pre-harvest

• Use aflatoxin-resistant sorghum varieties.

• Apply farm yard manure/compost @ 5-10 tons/ha.
• Maintain optimal plant population in the field.
• Avoid end- of- season drought by planting the crop early in the season.
• Remove dead plants from the field before harvest.
• Harvest the crop at the right maturity.

9.2 Post-harvest

• At harvest, avoid mechanical damage to the grain
• Dry the harvested produce thoroughly after harvesting the crop for 15 to 20 days.
• Dry the produce until the grain moisture is below 12%.
• Ensure proper hygiene in the storage pit (cleaning the storage pit to ensure that residue from previous crop does not become the source of contamination for the new grain harvested).
• When using mechanical threshers, use appropriate sieves based on grain size so that immature grains are blown off.
• Remove mechanical- and insect-damaged grains.
• Do not mix diseased heads with the non-diseased heads.
• Prevent insect damage to the pods in storage.
• Remove all immature, damaged and diseased grains prior to storing grain.

10. Review of Module

Let's review what we've learnt about grain storage losses. What have you learnt today? What changes are you going to make to the way you store and handle grain?

Points to remember:

- Poor grain storage and post-harvest practices can be dangerous to health as well as wealth, particularly if there is a risk of aflatoxin contamination.
- Grain losses can occur at all stages of the grain preparation process: harvest, post-harvest, storage, and post-storage.
- Grain should always be kept cool, dry, and insect-free.

Thank you for participating!