

3 Post-Harvest Losses: Causes, Effects and Counter-measures

Post-harvest losses may occur in the following areas:

- during harvesting
- during transportation
- during drying
- during threshing
- during processing
- during storage

This manual is concerned primarily with losses which occur during storage and which not only result from the effects of moisture, heat and pests.

The following factors are also of importance:

- The previous history of the stored produce as well as the growing conditions before harvesting, any field infestation with pests or fungi or any heat damage which may have occurred during the drying process.
- Genetic differences, i.e. differences specific to certain varieties and species with regard to resistance against storage pests.

3.1 Losses in Quantity

Losses in quantity of the stored produce result from grain being spilt or running out from damaged bags, from theft or from the grain being damaged by pest organisms. Losses in weight may also result from changes in the grain moisture content during the storage period.

It is generally very difficult to calculate just how high the losses are.

- There is no method of calculating losses which is simple, quick, reliable and generally applicable.
- The exact amount of harvested produce is often not known, particularly in small farm storage, so that losses may be registered at a later date but not quantified.
- In the case of infestation with insects, the loss in weight in no way corresponds to the difference in weight before and after infestation. When weighing the produce, left-overs, frass, webbing, pest carcasses and rodent droppings are also weighed. Assuming that these soilings cannot be separated from the produce, the actual losses are higher than those calculated.

3.1.1 Estimating Losses

The most simple method of establishing losses in the store is to record the amounts entering and leaving the store (**weigh-in, weigh-out method**), even though the results achieved using this method are not always satisfactory for the reasons and shortcomings mentioned above.

It is also possible to make use of other methods of estimating losses, out of which the **count and weigh method (C&W)** is fairly easy to apply in small farm storage.

By establishing the number and weight of damaged and undamaged grains of a composite sample (e.g. 1000 grains)

at monthly intervals, changes in the weight of stored produce can be determined over a period of storage.

The loss in weight in % is calculated using the following equation:

$$\frac{(W_u \times N_d) - (W_d \times N_u)}{W_u \times (N_d + N_u)} \times 100 = \% \text{ weight loss}$$

$W_u$  = weight of undamaged grains

$N_u$  = number of undamaged grains

$W_d$  = weight of damaged grains

$N_d$  = number of damaged grains

Shortcomings in this count and weigh method become apparent particularly:

- when there are large variations in grain size
- when grain is so heavily infested, that kernels cannot be counted any more because of complete destruction
- as infestation inside the grains cannot be detected so that attacked grains are classified as "undamaged"

Other applicable methods for the estimation of storage losses are the Thousand Grain Mass Method (TGM) and the Standard Volume Weight Method (SVM) (see Section 3.4).

### 3.2 Losses in Quality

Losses in quality occur in various forms:

- changes in colour
- changes in smell
- changes in taste
- loss in nutritional value
- contamination of stored produce with mycotoxines or pathogenic agents
- loss of germination ability (seeds)

Often several qualitative changes occur at the same time, usually also in connection with weight losses.

Losses in quality are much more difficult to assess than losses in quantity, as they cannot always be easily recognized (e.g. loss in nutritional value).

Additionally in many countries there is a lack of quality standards and quality changes are sometimes assessed differently by individual consumers.

### 3.3 Sources of Losses

#### 3.3.1 Mechanical Damage

##### Causes

- Incorrect harvesting methods
- Poor handling, threshing, shelling, cleaning, sorting, drying
- Bad transport and loading practices (e.g. use of hooks)

### Effects

- Losses in weight
- Losses in quality (germination power, nutritional value)
- Increased vulnerability to infestation from pests, fungi and rodents

### Countermeasures

- Pay attention to maximum temperatures when drying
- Use save techniques in harvesting, transport, processing and storage
- Take care when handling bags
- Repair or replace damaged bags
- Do not use hooks to carry bags
- Repair pallets (e.g. protruding nails!)

#### 3.3.2 Heat

##### Causes

- Unsuitable storage structures (false location, insufficient shade and ventilation facilities, lack of heat insulation)
- Mass reproduction of storage pests and fungi
- Lack of aeration of store
- High moisture content of the grain

##### Effects

- Losses in weight
- Losses in quality (nutritional value, germination power)
- Improved conditions for pest development
- Condensation with subsequent development of fungi

### Countermeasures

- Build suitable storage structures (see Section 5.1.1)
- Create shade for stores or silos (e.g. by means of wide eaves or shading trees)
- Keep temperatures as low as possible (aerate storage facility)
- Conduct treatments for pest control
- Store bags on pallets (aeration)
- Maintain spaces of 1 m around all bag stacks

#### 3.3.3 Moisture

##### Causes

- Insufficient drying before storage
- Effect of high relative humidity
- Constructional faults and damage to the store (unsuitable materials, unsealed floor, walls and roof, holes, gaps, etc.)
- Imbalances in temperature (e.g. day/night) in storage facility with subsequent condensation
- Produce stored on the floor or next to the walls
- Mass reproduction of pests

##### Effects

- Losses in quality
- Losses in weight
- Development of fungi and formation of mycotoxines
- Improved conditions for the development of pests
- Swelling and germination of seeds
- Damage to storage structures

### Countermeasures

- Repair and seal storage facility
- Keep relative humidity as low as possible in storage facility (perform controlled ventilation)
- Store sacks on pallets
- Maintain spaces of 1 m around all bag stacks
- Dry produce sufficiently before storage
- Conduct pest control treatments
- Avoid temperature fluctuations (day/night) in store by means of shade and ventilation, etc.

#### 3.3.4 Insect Pests

##### Causes of infestation

- Cross infestation from neighbouring lots or stores
- Migration from waste or rubbish
- Hiding places in stores (cracks, fissures)
- Use of infested bags
- Introduction of infested lots

##### Effects

- Losses in weight
- Losses in quality (impurities such as droppings, cocoons and parts of insects, reduction of nutritional value, reduction in germination ability)
- Increase of temperature and moisture

### Countermeasures

- Clean the store daily
- Keep the temperature and relative humidity as low as possible (perform controlled ventilation)
- Ensure that produce is dry before storing
- Prevent pest introduction by checking for infestation before storing
- Prevent any pest infiltration by sealing the store (windows, doors, ventilation facilities; e.g. with the use of insect gauze)
- Repair any damage to the store
- Store old and new lots separately
- Remove infested cobs, panicles or pods before storage
- Clean empty bags thoroughly and fumigate if necessary
- Perform pest control treatments
- Rotate stocks - 'first in - first out'
- Pay attention to the time of harvest
- Choose resistant varieties
- Keep means of transportation clean

#### 3.3.5 Microorganisms

##### Causes of infestation

- High moisture content of stored produce
- High relative humidity in store
- Condensation
- Humidity and moisture produced by insects

### Effects

- Loss of weight (mould)
- Loss of quality (smell, taste, colour, nutritional value, germination power)
- Formation of mycotoxines
- Further increase in temperature and moisture
- Further condensation

### Countermeasures

- Dry produce sufficiently before storage
- Keep relative humidity as low as possible in storage facility (perform controlled ventilation)
- Store bags on pallets
- Maintain spaces of 1 m around all stacks
- Conduct pest control treatments

### 3.3.6 Rodents

#### Causes of infestation

- Penetration through badly closing doors, windows, ventilation openings, holes
- Lack of barriers
- Lack of hygiene in store and surrounding area (possible hiding and breeding places)

#### Effects

- Loss of weight
- High losses in quality due to contamination of produce with faeces and urine

- Contamination of produce with pathogenic agents (typhoid, rabies, hepatitis, plague, etc.)
- Damage of material and facilities (bags, doors, electric cables)

#### Countermeasures

- Prevent entry of rodents by sealing store rat-proof
- Keep store and surrounding area clean
- Place traps
- Carry out rodent control measures

### 3.3.7 Birds

#### Causes of infestation

- Open or broken doors, windows, ventilation openings or roofs

#### Effects

- Losses in weight
- Damage to bags
- Contamination of stored produce with droppings and pathogenic agents

#### Countermeasures

- Bird-proof stores (carry out repair work, fit grilles or nets)
- Remove any nests of granivore birds from the store and surrounding area

### 3.4 Further Literature

- Anonymous. 1985. Prevention of Post-Harvest Food Losses, FAO, Rome, 121 pp.
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- Pantenius, C.U. 1988. Etat des pertes dans les systèmes de stockage du maïs au niveau des petites paysans de la région maritime du Togo, GTZ, Hamburg, 83 pp.
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- Reed, C. 1986. Characteristics and limitations of methods to estimate losses in stored grain, Special Report No. 16, Kansas State University, Food and Feed Grain Institute, Manhattan, Kansas, 23 pp.

### 4 Farm and Village Level Storage

#### 4.1 Farm Storage Methods

Farmers traditionally store their grain in an unthreshed state. This is first because they often do not have the time to thresh the grain after harvesting, and secondly because they rely on the lower susceptibility of grain stored in husks to infestation from pests.

The storage period on farm level generally lasts 6 to 12 months.

After harvesting, the grain is kept in a variety of different traditional storage containers which are in general perfectly adapted to the existing social, economic and climatic conditions and require only locally available materials.

Two basic forms of small farm storage can be distinguished: open and closed storage systems.

##### 4.1.1 Open Storage Systems

In unfavourable hot and humid climatic conditions almost only open storage systems are used because the stored produce is still moist when it is put into storage.

Platforms resting on wooden stakes are very widespread, on which cobs or panicles are stacked in layers. A straw roof affords protection against the rain.