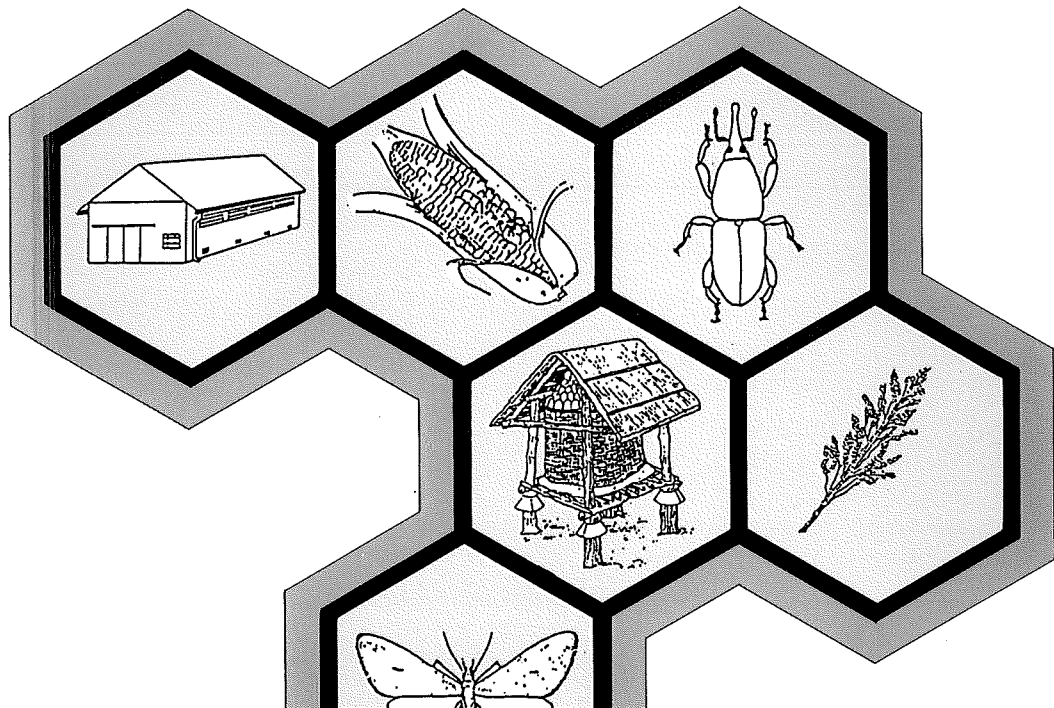




# MANUAL ON THE PREVENTION OF POST-HARVEST GRAIN LOSSES

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THE PREVENTION OF POST-HARVEST GRAIN LOSSES



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## 5 Central Storage

As a result of extensive social and economic changes (e.g. expansion of trade with basic foodstuffs, supplies of food aid, increase in urbanisation), central stores, usually under state control, have grown both in number and importance in all countries.

### 5.1 Storage Facilities

It is quite apparent that a number of the storage facilities set up in tropical and sub-tropical countries are unsuitable for storing goods without a reduction in quality and considerable losses.

Although appropriate warehouse designs have been provided as far as suitable construction material, ventilation facilities and favourable constructional properties are concerned, little use is made of these.

This can be observed even in recently-built stores and has led to the following considerations:

- Easy-to-erect **corrugated iron halls** made of prefabricated parts may be justifiable for short-term storage in case of emergencies. Buildings of this kind are unsuitable for long-term storage due to the poor control of climatic conditions and condensation problems.
- Under arid climate conditions, instant erection **flexible plastic silos** can be used for bag storage of locally produced grain as a part of maintaining security reserves. To avoid condensation problems it is a

precondition that the produce is absolutely dry ( about 10 % moisture content) at the moment of storage.

In the case of supplies of foodstuffs coming from temperate areas or produce with higher moisture content, flexible plastic silos can only be used as emergency stores for a short period as the same problems may be anticipated as for corrugated iron halls.

Fumigation can easily be performed in silos of this kind.

Flexible plastic silos are not suitable as transit stores due to the longer filling procedure and their fragility.

- Assuming that the basic storage requirements are adhered to, the system of **bag storage** in well-designed warehouses is most suitable in tropical or subtropical areas.

This system is easy to manage, cheap, and efficient and well adapted to the existing infrastructure in most countries. It involves little risk in particular as far as long-term storage of security reserves is concerned.

- **Bulk storage** in warehouses and silos is a system whose strengths lie particularly in rapid and labour-saving turnover of produce. The system enables relatively simple and efficient pest control measures and may considerably simplify transport tasks. Costs for bags do not occur.

Examples show that bulk storage in silos can be a well-adapted and practical system wherever turnover of

large amounts of produce has to be made in a short space of time. The transit silos often found in ports are typical of this usage.

The relatively sophisticated bulk storage system demands a high degree of management qualities, in particular with respect to loss prevention as a result of moist grain and condensation problems.

Successful bulk storage in silos requires adequate funds being made available for the relatively high overheads (maintenance, service, energy). In general operating costs are higher for bulk storage than for bag storage.

Setting up silo units demands considerably higher investments and capital costs than for the comparable warehouse capacity for bag storage.

A minimum annual turnover is necessary to justify these investments, thus making silos uneconomical for long-term storage.

In the Federal Republic of Germany, for example, the rough figure for the economic operation of a silo plant is an annual turnover of 13 times.

In developing countries the bulk storage system may gain importance in the long term if the conditions in terms of infrastructure and management permit the introduction of such a system.

- **Open-air storage** is a short-term emergency measure.

The produce must always be stored on pallets in order to avoid any ground moisture being absorbed. Tarpaulins

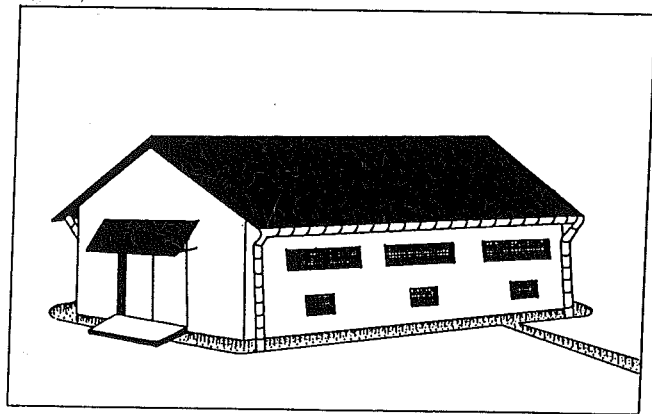
spread on the ground, or concrete platforms, afford also protection, and must be present in any case for fumigation. The stacks also have to be covered with tarpaulins against adverse weather conditions.

A decision in favour of one system or the other must take into account all the pros and cons of the systems and of the conditions in the country in question.

Moreover, storage must be seen only as one element in the entire process of food supply from the producer to the consumer, and any particular storage system must become an integrated, well adapted part of the existing structures.

#### 5.1.1 Instructions for the Construction of Warehouses

As many serious mistakes are made in the construction of medium-sized and large warehouses, instructions are given here for the design of stores which provide optimum conditions for the storage of perishable goods.



#### 5.1.1.1 Siting and Orientation

- A raised site and good drainage  
ensure that there is no stagnant water in the vicinity of stores.
- Setting up the store with its longitudinal side on an East-West axis (less sun radiation on the building) or exposed to the main wind direction  
creates balanced temperature conditions, thus reducing the danger of condensation.
- Firm soil and good road connections  
enable easy delivery and transportation of produce.

#### 5.1.1.2 Roofing

- Eaves overhanging the walls by at least 1 metre  
ensure that the store is kept in the shade and its walls are protected against rain.
- Eaves overhanging by at least 2-3 metres at the doors  
enable vehicles to be loaded and unloaded when it is raining.
- Properly sealed connections from roof to walls  
prevent any insects or birds from entering.
- Insulation under the roof in case of corrugated iron sheets  
reduce the effect of the sun radiation and create better storage temperatures.

Insulating material does, however, have the danger of being an ideal hiding place for pests and also makes it more difficult to maintain good storage hygiene.

- Aluminium sheets or fiber concrete roofing do not become as hot as corrugated iron and create better storage temperatures.
- Gutters linked to a drainage system prevent the outer walls and the foundation becoming wet in case of rain.

#### 5.1.1.3 Flooring

- A floor at a height of 1 m above the ground with a ramp prevents ground moisture to penetrate the store, protects the walls and doors from being damaged by vehicles and simplifies loading and unloading of trucks.
- A vapour barrier stops ground moisture from rising. A suitable method is to insert polyethylene foil of at least 0.2 mm thickness, or a 5 cm layer of bitumen in the floor and in the first 25 cm of the walls.
- A smooth surface without any cracks or holes is easy to clean and does not afford insects any place to hide.
- A concrete floor hard enough to bear the load expected prevents cracks.

#### 5.1.1.4 Walls

- A smooth surface without any cracks either inside or out affords no hiding-places for pests. Even the smallest of holes must be filled in.
- A white, water-resistant and, if possible, plastifying outer coat of paint reflects the sun radiation and prevents penetration by moisture.
- Roof-bearing pillars integrated into the walls facilitate storage hygiene.
- Corrugated iron walls are unsuitable due to temperature variations inside the store.

#### 5.1.1.5 Doors

- One door at each gable end is normally sufficient.
- Tight-sealing hinged doors prevent rodents from entering. Sliding doors always leave a gap between door and wall. A gap of 6 mm is sufficient to enable a mouse to enter. Roll-up doors rust and often become defect when older.
- Metal doors are most resistant against any damage by rodents. Wooden doors should be fitted at the bottom with a panel of sheet steel of half a metre in height.

#### 5.1.1.6 Ventilation Openings

- Ventilation openings with flaps which can be regulated enable controlled ventilation and the evacuation of heat from the store.

Ventilation openings should have a size of:  
0.5 m<sup>2</sup>/100 m<sup>2</sup> storage area for incoming air (lower ventilation openings) and  
1.5 m<sup>2</sup>/100 m<sup>2</sup> storage area for outgoing air (upper ventilation openings).

The lower ventilation openings should be situated approx. 1/2 metre above the floor, the upper ones approx. 1/2 metre below the roof on both sides of the store.

- Tightly-sealing ventilation openings permit fogging with insecticides.
- Wire gauze and grilles in the ventilation openings prevent insects, rodents and birds from entering.
- Roofing over the ventilation openings prevents any penetration by rainwater.

#### 5.1.1.7 General Constructional Features

- Not more than four corners and a simple and effective spatial design without any more angles, pillars, beams, windows or doors than necessary  
make work and especially cleaning easier and make it more difficult for pests to enter or find a hiding place.

- Offices and sanitary facilities which are separate from the warehouse  
enable fumigation and pest control measures to take place without any danger to staff.
- Pesticides, fertilizers and other material which are stored separately  
prevent any damaging effect on the stored produce and improve storage hygiene.

#### 5.2 Store Management

The proper management of the store is the task of the storekeeper.

##### 5.2.1 The Storekeeper's Job

The storekeeper is responsible:

- for the maintenance of the warehouse (small repairs) and its equipment (fumigation sheets, spraying equipment, etc.)
- for the correct handling and storage of the commodities and the products for pest control
- for the performance of any measures necessary to maintain the quality of the stored produce (hygiene measures, application of insecticides, fumigation, rodent control, controlled ventilation)
- for the correct use of chemical products and the safety of the staff

- for regular controls of the storage facilities and the stored produce
- for keeping correct records of all movements of stored produce and of all activities in the store including stack cards
- for giving support and guidance to the staff under his supervision
- for writing regular reports for his superiors.

For the job description of a storekeeper see section 5.2.3.2

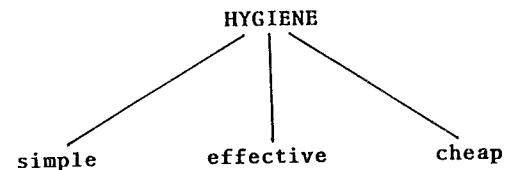
### 5.2.2 Storage Hygiene

Preventive measures with regard to storage hygiene are of decisive importance in maintaining the quality of the stored produce and avoiding losses.

By the term storage hygiene, we mean the use of all technical measures without the application of chemicals.

Perfect storage hygiene is the basic prerequisite for successful storage and for the effectiveness of all on-going measures, such as the use of insecticides or fumigants.

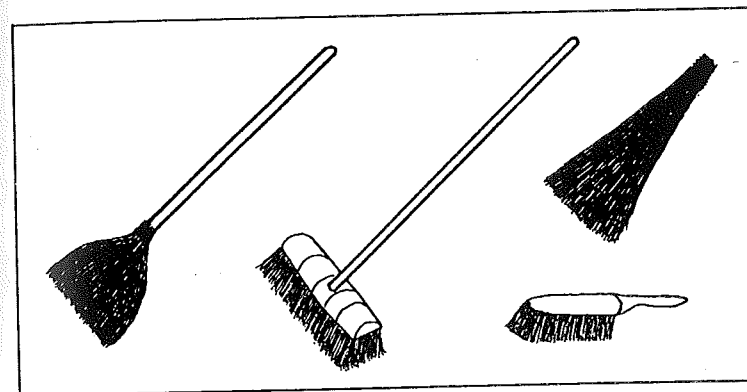
All hygiene measures are very simple, particularly effective and cheap, and can thus be performed by any storekeeper with little effort.



Hygiene requires knowledge, attentiveness, diligence, surveillance, responsibility and thoroughness on the part of the storekeeper.

A few basic principles determine the success of storage:

Always keep the store and its surroundings clean: the broom is the most effective and economic instrument in storage!



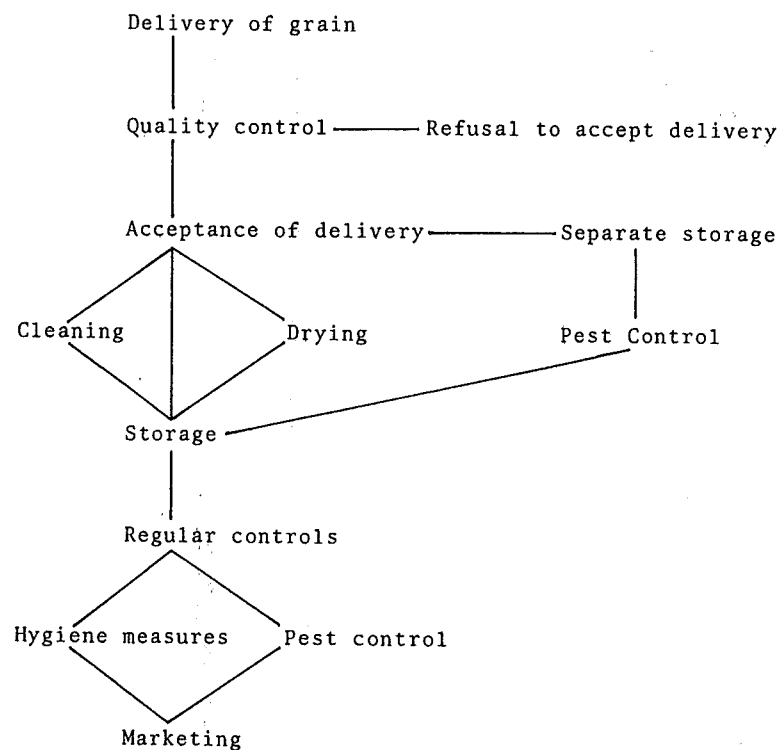
Always keep grain cool and dry!

Always keep the store in good condition!

5.2.3 Measures to Maintain the Quality of the Stored Produce

5.2.3.1 Influence on the Part of the Storekeeper

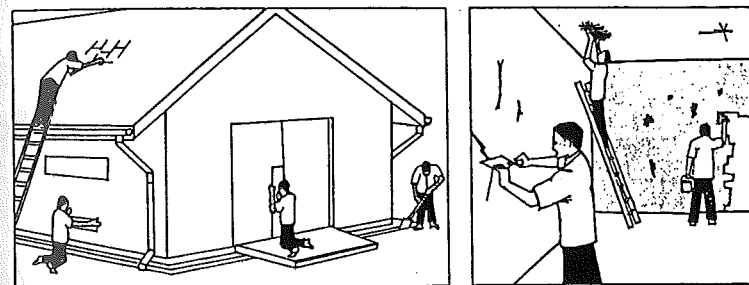
From the delivery of the produce to the end of the storage period, the storekeeper has to make decisions and initiate actions with the aim of keeping the produce in good condition.



5.2.3.2 Activities to Prevent Losses in Storage

Note before storage:

- Check the storage conditions using the store check list provided in Section 5.2.5.4 and deal with any faults you discover!
- Ensure that any damage to the warehouse is repaired (roof: leaks; walls and floor: cracks and crevices; doors: gaps; ventilation openings: damaged gauze and grilles, broken glass)!

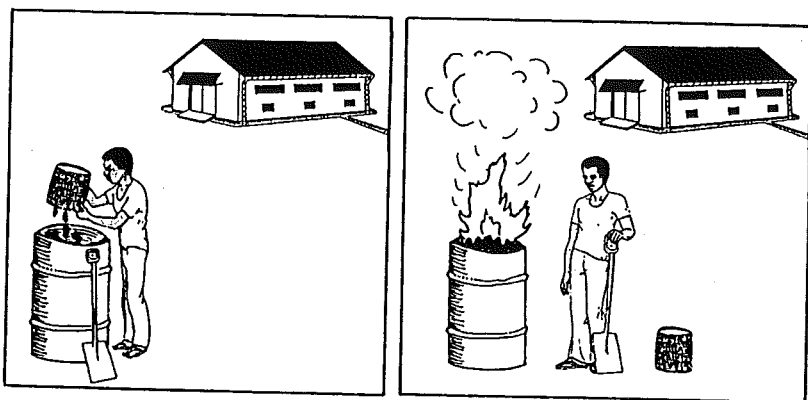


- Thoroughly clean the store's floors, walls, roof, doors and ventilation openings!
- Clean the area surrounding the store and remove any left-overs of grain, rubbish, birds' nests, grass and bushes within a minimum of 5 m of the store so as not to give pests any shelter or the chance to develop!





- Collect rubbish in a bin (e.g. old oil drum)! Dispose of it immediately by burning or, in case of non-inflammable material, by burying!



- Repair any damaged pallets (pay particular attention to nails sticking out)!
- Treat the empty store, if necessary, and all pallets with a contact insecticide (see Chapter 8)!

- Draw up a storage plan for each store!

Note before accepting delivery:

- Carry out quality control! Check every bag if possible! For large amounts, follow the instructions for taking samples (see Section 5.2.4.3)!
- Check the smell and the appearance of the produce delivered!
- Measure the moisture content of the produce from individual bags of any particular vehicle (see Section 5.2.4.3)!

If the moisture content is too high, ensure further drying or refuse to accept delivery!

- Check whether the produce is infested by taking samples (see Section 5.2.4.3)! Pay particular attention to cracks and gaps in vehicles where insects may hide!

If the produce is infested, ensure it is stored separately (quarantine) and treated in order to prevent the pests infesting uncontaminated produce. In case of heavy infestation refuse to accept delivery!

- Check the degree of impurity!

If the degree of impurity is too high, have the produce cleaned or refuse to accept delivery!

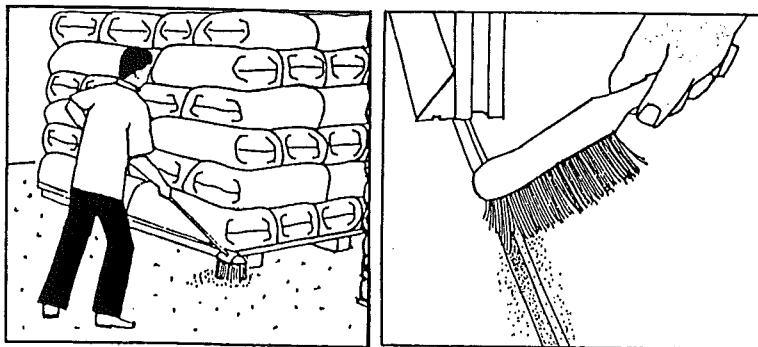
**Note when storing:**

- Avoid infested produce coming into contact with uncontaminated produce!
- Handle the bags carefully in order to avoid any damage! Do not use bag hooks!
- Make sure that any damaged bags are replaced and/or repaired!
- Make sure that the bags are stacked correctly and safely on pallets (see Section 5.2.4.1)!

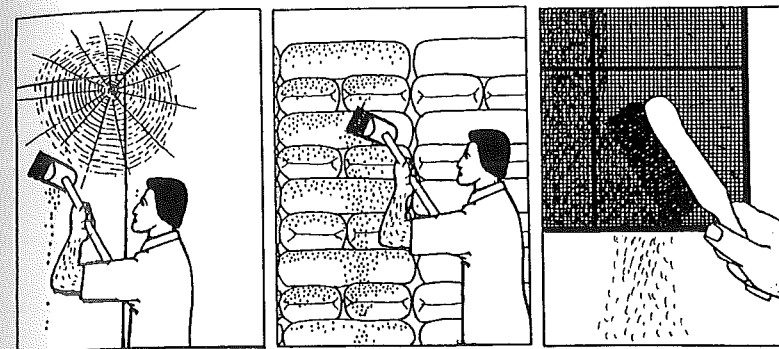
**Note during storage:**

**Daily:**

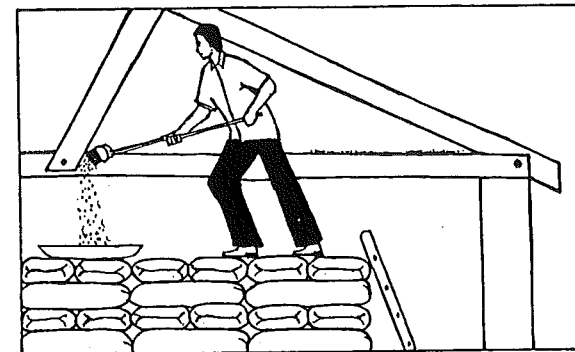
- Sweep the floor of the store! Pay particular attention to corners and edges where dirt and pests may gather!



- Clean the walls, the ventilation openings including the gauze and grilles and the stacks of bags!

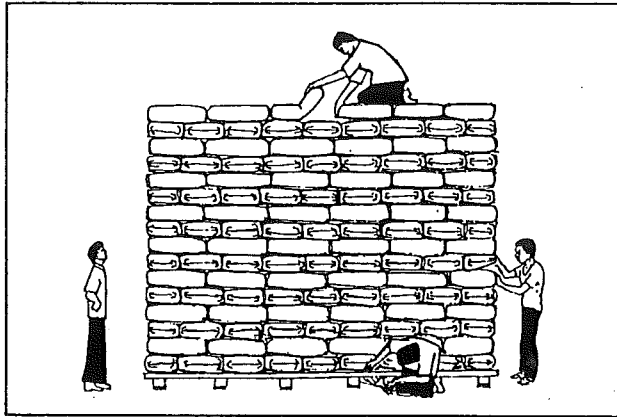


- Brush the roof beams as insects may hide and survive there!

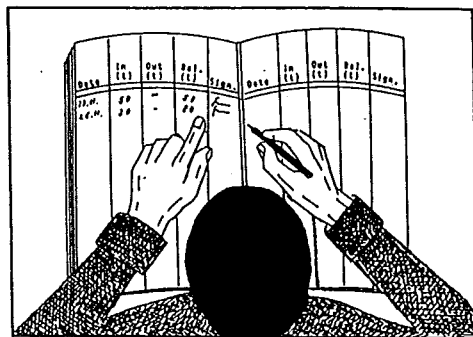


- Clean equipment after use in order to remove grain left over in inaccessible places!
- Dispose of any waste immediately after cleaning by burning or burying it!
- Check the store for damage and ensure reparation immediately!

- Look for the presence of any flying or crawling insects



- Check for traces of rodents or birds!
- Carry out controlled ventilation (see Section 5.2.4.2)!
- Make sure that the store records are kept up-to-date!



#### Weekly:

- Take samples of every lot and check:
  - the moisture content of the produce
  - the presence of pests in the stored produce by sieving the samples!
- Check the temperature of the stored produce in the stacks of bags using a grain thermometer!

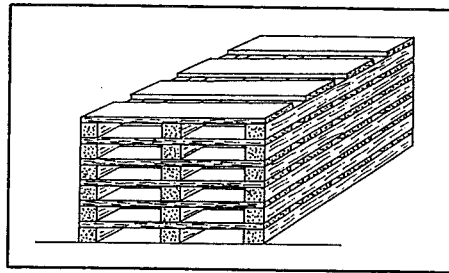
#### Monthly:

- Clean the area surrounding the store and remove any herbs!
- Draw up a monthly report and send it to your superiors!

#### **General Principles of Storage**

- Only accept delivery of sufficiently dry, uninfested and well cleaned produce!
- For foodstuffs:
  - Ensure for rotation of the produce in store according to the "first in - first out" principle in order to prevent overstorage!
- For seeds:
  - Remove any lots which are below the prescribed standard of germination capacity and make other use of them!

- If the germination capacity is in accordance with the prescribed standard, first supply the lot with the lowest germination capacity! The higher the germination capacity of any lot, the longer it can be stored as seed.
- Remove any waste from processing (by-products such as from cleaning seeds) immediately! If by-products have to remain in the store, treat them as any other stored produce. Otherwise they will be a constant source of infestation!
- Stack empty bags on pallets with a distance of 1 m to walls. Fumigate empty bags after use!
- Stack unused pallets tidily and treat them with contact insecticide before and after use!



- Store equipment and chemicals in separate stores!
  - Remove any junk from stores!
- A job description, such as in the form of a poster, in the storekeeper's office and signed reminds him of his tasks and duties.

# JOB DESCRIPTION

LOCATION:  
STOREKEEPER:  
SIGNATURE:

<b>JOB DESCRIPTION</b>	<b>WEEKLY</b>		<b>MONTHLY</b>		<b>IN GENERAL</b>
	MEASURE THE MOISTURE CONTENT OF EACH LOT	CHECK FOR UNUSUALLY HIGH GRAIN TEMPERATURES	PREPARE A MONTHLY REPORT	PRACTISE STOCK ROTATION FIRST IN FIRST OUT	
	TAKE A REPRESENTATIVE SAMPLE OF EACH LOT	CHECK EACH SAMPLE FOR LIVING INSECTS	CLEAR THE SURROUNDINGS OF THE STORE FROM - WASTE - TRASH - PLANTS	USE STACK CARDS	
	OPERATE THE VENTS FOR CONTROLLED AERATION	CHECK FOR RODENTS AND BIRDS	KEEP THE STOCK JOURNALS UP-TO-DATE	STACK THE BAGS PROPERLY YES  NO	
	BURN OR BURY WASTE	CHECK FOR CRAWLING INSECTS	CHECK FOR DAMAGE TO THE STORE AND REPAIR AT ONCE	KEEP SPACE OF 1m AROUND THE STACKS 	
	CLEAN THE FLOOR -HALLS -DOORS -VENTS	CHECK FOR FLYING INSECTS	MAINTAIN EQUIPMENT AND MATERIAL	USE PALLETES YES  NO	
	SPRAY IN TIME FUMIGATE IN TIME CONTROL RODENTS IN TIME				