

**KENYA STANDARD**

**DKS 2783:2018**

ICS



**Warehousing and storage of roots and tubers —Requirements**

## **DKS 2783:2018**

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Kenya Agricultural & Livestock Research Organization  
International Potato Center  
National Potato Council of Kenya  
Kenya Industrial Research & Development Institute  
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PUBLIC REVIEW DRAFT

# **Warehousing and storage of roots and tubers —Requirements**

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## Foreword

This Kenya Standard was prepared by the Tubers and Tuber Products Technical Committee under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

Warehouses and stores are intended for the storage and physical protection of roots and tubers from adverse weather conditions, prevention of the entry of pests as well as provision of security. They also include materials and equipment required for inspection and proper handling of tubers and storage pest control.

The structure should be properly built to provide good storage conditions, easy access and safe working conditions, and should not provide harbourage for pests.

In general, the condition of roots and tubers change slowly while in storage; the extent of any change depends on ambient conditions at harvest, handling and storage. Changes in moisture content and temperature are limited to the periphery of a bulk or to the outer bags of a stack, unless the storage period is prolonged or the root/tuber is adequately ventilated.

Heavy infestations of insects, however, may cause a rise in temperature in the root or tuber mass, possibly due to the development of fungi. Ideally, the warehouse should permit some control of temperature and humidity, to keep the tubers cool, dry and at a uniform temperature as much as possible.

The objective of this standard is to provide guidance to the industry regarding appropriate storage of roots and tubers in order to reduce on the level of post-harvest losses incurred in these commodities.

This standard as well will be invaluable in promoting the Structured Trading Systems (STS) in the region to promote both regional and International trade in roots and tubers. The standard will play a major role in the implementation of the Warehouse Receipt System (WRS) and the Commodity Exchange in the region.

During the preparation of this standard, reference was made to the following documents:

KS ISO 2165 Ware potatoes - Guide to storage

KS 2657:2016 Warehouse and warehousing for bagged storage of cereals and pulses —Requirements

Acknowledgement is hereby made for the assistance derived from these sources.



## Warehousing and storage of roots and tubers — Requirements

### 1 Scope

This Kenya Standard covers the location, structural, facility, safety and management requirements for a warehouse storing roots and tubers either bagged, in crates or in bulk.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

KS EAS 778, *Fresh bitter Cassava-Specification*

KS EAS 748, *Fresh potato tuber (ware potato tuber) – Specification*

KS EAS 771, *Fresh sweet potatoes- Specification*

KS EAS 776, *Production and handling of fresh cassava - Code of practice*

KS EAS 775, *Production and handling of fresh ware potatoes- Code of practice*

KS 2077, *Seed potato - Specification.*

### 3 Terms and definitions

For the purpose of this standard, the following terms and definitions shall apply.

#### 3.1 Warehouse

Structure for storage of roots and tubers meant for trade, exchange and food security

#### 3.2 Roots

Underground part of a plant conveying water and nutrients to the rest of the plant and consumed as food.

#### 3.3 Tubers

A much thickened, fleshy part of an underground stem, serving as a food reserve and bearing buds from which new plants arise.

#### 3.5 Pallet (spacers)

Wooden, plastic or any other suitable frames used on concrete floors for stacking bags or crates to prevent direct contact between the roots and tubers and the floor

#### 3.6 Competent authority

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Any person or organization that has the legally delegated or invested authority, capacity, or power to perform a designated function

### **3.7 Warehousing**

Performance of administrative and physical functions associated with storage of roots and tubers. These functions include cleaning and maintenance of a warehouse, inspection, drying, screening, sorting and grading of roots and tubers, stacking, pests prevention and control, records keeping and any other activity necessary to store roots and tubers safely.

## **4 Location**

- 4.1 The location of a warehouse shall be authorized by competent authority (ies).
- 4.2 The site shall be located at relatively high elevation to avoid water logging and safe from natural flooding calamities.
- 4.3 The orientation of the warehouse shall be such that radiant heat gain from the sun is minimal.
- 4.4 The warehouse shall be accessible by road.
- 4.5 The warehouse shall have facilities such as clean water, power supply, handling and communication facilities.
- 4.6 The warehouse shall be secured
- 4.6 Warehouse shall not be located near the site for waste disposal and surroundings shall be kept clear of vegetation and rubbish.
- 4.7 The warehouse shall not be near any facility where the danger of fire is constantly present
- 4.8 Warehouses shall not be located near busy public facilities such as schools, or hospitals. Existing warehouses near public facilities shall take necessary measures to mitigate the effects of their operations.
- 4.9 There should be ample space to facilitate movement and parking of transport.
- 4.10 The warehouse for storing roots and tubers should be constructed with care to avoid cross contamination of pests and diseases between ware and seed potatoes.

## **5 Structural requirements**

### **5.1 General**

- 5.1.1 The construction and building materials shall conform to the National Building Regulations and relevant standards.
- 5.1.2 The material shall be durable, nontoxic, wind and water tight
- 5.1.3 The structural materials used for construction of warehouse should assist to regulate internal temperature and humidity.



## **5.2 Foundation**

The foundations shall be of adequate strength to take the weight of the structure and of the roots and tubers under storage.

## **5.3 Floor**

**5.3.1** The floor shall be adequately strong and capable of withstanding heavy loads and vibrations.

**5.3.2** The floor shall be elevated or constructed higher than the existing ground.

**5.3.3** The floor shall be easy to clean and not slippery.

**5.3.4** The floor shall be free from cracks where moisture from the ground may affect the stored roots and Tubers

**5.3.5** General warehouse space may be floored with appropriate flooring to carry wheel loads and withstand the friction from abrasion generated by the continual use of hard rubber and steel-wheeled forklift and trucks where necessary.

## **5.4 Walls**

**5.4.1** The internal surfaces of the walls shall be smooth and free from projections to eliminate dust-laden surfaces, facilitate cleaning of the store and avoid interference with other operations.

**5.4.2** The junction between walls and roof shall be well sealed in order to prevent birds and rodents from accessing the store rooms while providing adequate ventilation.

## **5.5 Roofs**

**5.5.1** Roof design shall be in a way that facilitates pest control and other stock management procedures.

**5.5.2** Internal pillars supporting roof frames should be avoided as much as practicable.

**5.5.3** Roofs shall be provided with the necessary lateral and vertical wind brace to resist forces due to strong winds and earthquakes.

**5.5.5** The inclination of the roofs shall be sufficient to drain rainwater quickly, taking into account that the water may be forced up by the wind.

**5.5.6** Roofs shall be watertight and gulleys kept clear of debris and leaves.

**5.5.7** The roofs shall be a good thermal insulator, not affected by condensation, and give protection against attack by pests and moulds.

**5.5.8** The roofs shall be designed so as not to provide harbourage for birds, bats, insects, mites and rodents. An internal ceiling is not advised, as it may provide harbourage for predators.

**5.5.9** All drain pipes from roof gutters shall be external, well fitted and shall have mesh baffles fitted inside their lower open ends.

## **5.6 Doors**

- 5.6.1 The door shall fit tightly for insect and pests control and fumigation.
- 5.6.2 The door shall be made or reinforced with rodent or pest resistant material
- 5.6.3 The door shall be provided with a secure locking system.
- 5.6.4 The size of the entrance shall depend on loading and unloading operations.

## **5.7 Ventilation**

- 5.7.1 Vents shall be provided near the floor level in the wall, at the top of the walls near the grid line. A suitable meshed ventilation duct should be placed in each gable so that warm air accumulating under the roof can escape.
- 5.7.2 Ventilation openings shall be fitted on the outside with anti-bird grills and on the inside with insect screens, which will deter entry of birds, rodents and insects.
- 5.7.3 In addition to natural ventilation, exhaust and fans may be introduced for forced ventilation.
- 5.7.4 Windows should be kept to a minimum or avoided. They should be left open as little as possible. Windows shall be protected by mesh grills to keep birds out when the windows are open.

## **5.8 Illuminations temperatures and relative humidity,**

5.8.1 The lighting should be maintained according to the requirements of specific root and tuber crops

- a) Ware potato, shall be maintained in darkness
- b) Seed potato store should be maintained under diffused light

5.8.2 Artificial lighting is preferable for the interior of the warehouse

### **5.8.3 Temperature and relative humidity**

5.8.3.1 Roots and tubers shall be stored at a temperature of about 5°C to 20°C. And a relative humidity of above 85%

5.8.3.2 Sweetpotatoes should not be stored at temperatures below 10°C

## **5.9 Fence**

- 5.9.1 The site shall be secured against the unauthorized entry of persons and animals.
- 5.9.2 Gates shall be adequate for their purpose and wide enough to allow easy vehicle access.

## **6 Facility requirements**

Where annex rooms are present, they shall be separate from the roots/tubers storage areas and may include the facilities for reception, offices, laboratory, equipment and chemical store, toilets and urinals, changing room and showers.

### 6.1 Office space and related facilities

The office space shall be:

- a) easily accessible for staff and other visitors;
- b) clearly signposted;
- c) well aerated;
- d) safe and unobstructed; and
- e) clean, naturally well-lit and suitably furnished.

### 6.2 Toilets and urinals

**6.2.1** The floor of the toilets and urinals shall be non-absorbent, washable and non-slip materials.

**6.2.2** The wall shall be constructed from non-absorbent, light coloured material, up to a height of 2 m, smooth, without crevices and shall be easy to clean and disinfect.

**6.2.3** The toilets and urinals shall be furnished with hand washing facilities.

**6.2.4** Toilets shall not be constructed in the warehouse operation area

**6.2.5** For commercial warehouses, the number of toilets shall be adequate for the number of employees. The number of toilets may be determined using Table 1.

**Table 1 — Number of toilets and urinals in Warehouse and warehousing for storage of roots and tubers**

SL No	Number of employees	Number of toilets and urinals
i)	1 – 15	1
ii)	16 – 35	2
iii)	36 – 55	3
iv)	56 – 80	4
v)	81 – 110	5
vi)	111 – 150	6
NOTE Over 150 employees, one additional fixture for each additional 40 employees.		

### 6.3 Changing rooms and showers

**6.3.1** Commercial warehouse shall provide suitable changing rooms furnished with labelled lockers.

**6.3.2** All cleaning materials shall be provided.

#### **6.4 Equipment store**

**6.4.1** Equipment such as for fumigation, sampling, cleaning may be provided in the warehouse. Such equipment shall be appropriately stored and separate from the roots and tubers storage and chemical storage areas.

**6.4.2** The floor shall be easy to clean and not slippery.

**6.4.3** The equipment store shall be secured

#### **6.5 Chemical store**

**6.5.1** Chemicals such as pesticide, rodenticides, fumigants may be stored at the warehouse. Such chemicals shall be stored in a separate room under lock and key.

**6.5.2** Chemicals shall be clearly labelled for easy identification.

**6.5.3** The floor shall be easy to clean and not slippery.

**6.5.4** The chemical store shall be secured

**6.5.5** Chemical store shall be clearly identified as such.

#### **6.6 Laboratory**

**6.6.1** The warehouse may be provided with laboratory for internal control.

**6.6.2** The laboratory shall have facilities to undertake basic tests such as moisture content, organoleptic test and grading.

**6.6.3** The laboratory shall have sufficient area for staff, reagents, equipment, and testing operations . These equipment may include but not limited to moisture meters, grading racks, weighing balance.

**6.6.4** The floor and the walls shall be easy to clean and not slippery.

**6.6.5** The laboratory shall be secured

**6.6.6** The testing area shall be sufficiently lit.

### **7 Safety requirements**

**7.1** Warning signs or boards shall be fixed in hazardous/dangerous areas such as chemical storage, wet floor, laboratories

**7.2** Firefighting equipment in working condition (fire extinguishers, fire hydrants) shall be provided and be installed in a conspicuous and accessible location.

**7.3** There shall be provisions for first aid facility placed in a conspicuous and accessible location. .

**7.4** Safety signs, fire exits and assembly points, eyewash and emergency shower stations, shall be indicated.

## **8.0 Harvest and post-harvest handling practices**

### **8.1 Harvesting**

8.1.1 Roots and tubers for storage shall be harvested after attaining specified product maturity

### **8.2 Curing**

**8.2.1** The roots and tubers meant for storage shall be cured after cut back of above foliage for a specified period to allow development of a thick enough skin to avoid peeling off and rotting.

**8.2.2** Harvesting shall be done on a dry day and gently not to puncture, pierce or bruise the roots and tubers.

**8.2.3** Freshly harvested roots and tubers shall be stored in a dry and cool place for the skin to cure for longer keeping.

**8.2.4** After curing excess soil clinging to roots and tubers may be brushed off, packaged in the correct materials followed by storage in a cool, dry, and dark place while observing the specific ideal temperature and humidity requirements

### **8.3 Proper packaging and handling**

**8.3.1** Roots and tubers shall be packaged in bags or crates in accordance with recommended practices to protect the produce from damage during handling, transport and storage. Strong, uniformly sized, well ventilated and easy to clean packages should be used for ease of stacking, handling, stocking in quantity, weighing and economical use of transport.

## **8.4 Loading, Transportation and Unloading**

### **8.4.1 Loading**

**8.4.1.1** Roots and tubers packaged in bags, crates or bulk shall be loaded in stacks or gently placed to recommended height not to damage underlying fresh produce into a transport vessel

### **8.4.2 Transportation**

**8.4.2.1** Roots and tubers shall be transported in clean covered or closed vessel to avoid airborne contaminants, water and direct sunlight likely to negatively affect the produce.

### **8.4.3 Unloading**

**8.4.3.1** The roots and tubers shall be unloaded for storage with avoidance of stepping on the fresh produce and rough handling likely to cause bruises while ensuring placement of the unloaded produce on pallets.

## **8.5 Management of post-harvest pests & diseases**

- 8.5.1** Roots and tubers harvested from a clean crop field shall be stored in properly cleaned, disinfected and dry stores, they shall be gently handled to avoid bruising and regular inspection shall be conducted to isolate and dispose any rotting material.

## **9 Management requirements**

### **9.1 Cleaning and maintenance**

- 9.1.1** The buildings, equipment, utensils and all other physical facilities of the establishment, including drains, shall be maintained in good orderly working condition.
- 9.1.2** The store shall be cleaned and treated prior to any storage operation.
- 9.1.3** The store and environment of the warehouse shall be kept clean and shall be disinfected regularly to prevent insects, rodents and mites infestation.
- 9.1.4** Waste from sorting and screening shall be disposed in such way that does not cause contamination, harbour rodents and Pests or generate obnoxious smell.
- 9.1.5** Waste from the warehouse shall be collected and disposed in environment friendly manner.
- 9.1.6** Changing facilities and toilets shall be kept clean.

### **9.2 Inspection**

- 9.2.1** Inspection operations shall be carried out in a clean and sanitary manner. Only clean, sound product shall be stored.
- 9.2.2** The general appearance of the products shall be observed during the process of unloading; if the Roots or tubers are moist, injured, insect infested, insect damaged, or contain an unusual amount of dirt, debris or other foreign material.
- 9.2.3** If the observations from organoleptic analysis do not allow taking the decision, a sample from the suspected lots shall be taken and accurate tests conducted before any acceptance of the lot.

### **9.3 Loading and unloading**

- 9.3.1** Loading and unloading may be done mechanically or manually.
- 9.3.2** If manual loading and unloading is used, the floor should be 1-m above the ground to permit easy loading or unloading into trucks at the sides of the warehouse.
- 9.3.3** Loading and unloading shall not take place in open area when it is raining. A canopy should be constructed over every entry door to allow continuous loading and unloading even when it rains.

### **9.4 Provision of spacers**

- 9.4.1** The spacers (pallets) shall be used to avoid the sacks being in direct contact with the ground.

- 9.4.2** Spacers should be standard pallets, of manageable size, and therefore easy to lift. spacers shall be treated with pesticides and stacked neatly when not in use.

## **9.5 Stacking**

While deciding the whereabouts of bag or crate stacks the following shall be considered:

- a) Bags or crates of roots or tubers in each lot shall be stacked in basic patterns of cluster formation so that bags or crates can be easily counted, and quality maintained;
- b) The bag or crates stack shall be arranged in a manner that allows inspection and fumigation
- c) When using jute or sisal bags, the bag stack can be built to around 8 layers, any higher than that there is a risk to stability and it is difficult for storage worker
- d) Different commodities, different consignments (new and old) should be placed in different stacks i.e. separated in batches based also on the time of their reception in store, as far as the available space will allow.

## **9.6 Pests prevention and control**

**9.6.1** Pests can be prevented and controlled by:

- a) keeping roots or tubers below the temperature or the humidity necessary for increase in pest numbers (for example drying, aerated storage, refrigerated storage);
- b) spraying the floors and walls with pesticides;
- c) dusting of roots and tubers by pesticides; and
- d) fumigation.

**9.6.2** Where control is by fumigation, the following provisions shall apply:

- a) fumigants shall only be used by properly trained and authorized persons, who know the hazards and the necessary safety precautions.
- b) there shall be no human habitations within 100 m of the planned fumigation; if there are, the arrangements shall be made for people to be relocated during the treatment.
- c) fumigated piles shall be kept closed and warning signs displayed until the gas concentration goes below the levels which do not cause any adverse effect to the workers.
- d) the stacks shall be well sheeted and there shall be no store imperfections, including but not limited to cracks in the floor, unfilled floor joints and roof leaks, which might jeopardize the success of the fumigation.
- e) at the end of the fumigation, warehouse shall be aerated carefully to minimize hazards.

## **9.7 Record keeping**

Warehouse shall keep records of:

- a) origin, history of and volume of each lot of roots or tubers
- b) Dates of receipt and batch number.
- c) laboratory tests carried out;
- d) names of chemicals used for pest control;
- e) fumigation detailing the fumigant used, the date and method of fumigation, person or company;
- f) names of employees and training undertaken;
- g) authorization by Environmental agency;
- h) servicing and calibration of all equipment;
- i) cleaning; and
- j) pest control detailing the pesticide used, the date and method of spray/dusting, person or company.



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