Post-harvest handling and storage (PHHS) of sorghum — Guidelines
In order to match with technological development and to keep continuous progress in industries, standards are subject to periodic review. Users shall ascertain that they are in possession of the latest edition.
Contents

1 Scope ........................................................................................................................................... 1
2 Normative references ................................................................................................................... 1
3 Terms and definitions .................................................................................................................. 1
4 General guidelines ...................................................................................................................... 2
5 Specific guidelines ....................................................................................................................... 3
  5.1 Pre-harvesting .......................................................................................................................... 3
  5.2 Harvesting ................................................................................................................................. 4
  5.3 Drying of earheads .................................................................................................................... 4
  5.4 Threshing .................................................................................................................................. 5
  5.5 Drying of grain ........................................................................................................................ 5
  5.6 Cleaning and sorting ................................................................................................................. 6
  5.7 Packaging .................................................................................................................................. 6
  5.8 Transportation ........................................................................................................................ 6
  5.9 Storage ...................................................................................................................................... 7
6 Major storage pests and their control measures ......................................................................... 7

Annex A (informative) Major stored grain pests of sorghum and their control measures ............ 8
Annex B (informative) — ................................................................................................................ 12
Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettement as Rwanda Standards.

RS 228 was prepared by Technical Committee RSB/TC 003, Cereals, pulses, legumes and derived products.

In the preparation of this standard, reference was made to the following standard(s):

1) XYZ: Title
2) XYZ: Title

The assistance derived from the above source is hereby acknowledged with thanks.

This second/third/... edition cancels and replaces the first/second/... edition (RS nnn-n: yyyy), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

(The first/second/third/... edition (RS nnn-n: yyyy) has been reaffirmed by the Board on dd-mm-yyyy.)

RS nnn consists of the following parts, under the general title Introductory element — Main element:

— Part n: Part title
— Part [n+1]: Part title
— Part [n+2]: Part title

Committee membership

The following organizations were represented on the Technical Committee on Cereals, pulses, legumes and derived products (RSB/TC 003) in the preparation of this standard.

Paragraph of participants

Rwanda Standards Board (RSB) – Secretariat
Introduction

Sorghum is one of the most important cereal crops in the world and is one of the four major food grains in Rwanda. Besides being a major source of staple food for human beings, it also serves as an important source of fodder, animal feed and industrial raw material.

It was found that there is reduction in weight of ready to consume grain during harvesting operations, farm storage, transport and market storage. For sorghum, the mean post-harvest loss is 2.20 %. This led to the development of standards which provides guidelines on post-harvest handling and storage of sorghum grains.

This standard has been developed to take into account:

a) the needs of the market for the quality sorghum grains;

b) the need to facilitate fair domestic, regional and international trade and prevent technical barriers to trade by establishing a common trading language for crop producers, buyers and sellers;

c) the needs of the producers in gaining knowledge of market standards, conformity assessment and post harvest handling;

d) the need to transport the product in a manner that ensures keeping of quality until it reaches the consumer;

e) the quality and safety parameters of the product should meet before they are put on the market; and

f) the need to promote good agricultural practices that will enhance wider market access, involvement of small-scale traders and hence making farming a viable means of generating income.
Post-harvest handling and storage (PHHS) of sorghum grains — Guidelines

1 Scope

This Draft Rwanda Standard specifies the guidelines for Post-Harvest Handling and Storage (PHHS) of sorghum grains (Sorghum bicolor L. Moench).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

RS EAS 757, Sorghum grain — Specification

RS 231, Guidelines for Storage of Grains and Pulses with practical recommendations

RS 264, Warehouse AND WAREHOUSING FOR STORAGE of BAGGED GRAINS- Requirements

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply

3.1 sorghum grains

grains obtained from the species Sorghum bicolor L. Moench

3.2 harvesting

operation of gathering mature earheads

3.3 drying of earheads

operation during which the harvested earheads are dried to the desired moisture content so as to undergo the next operation of threshing
3.4
threshing
operation of separating the grains from the dried earheads

3.5
winnowing
operation of blowing air through grains in order to remove the chaff

3.6
drying of sorghum grains
operation during which sorghum grains are dried to the safe storage moisture content

3.7
foreign matter
all organic and inorganic material other than sorghum grains, broken kernels, other grains and filth

3.8
moisture content
amount of moisture in the grain expressed as percentage of the total weight of the sample, wet basis

3.9
transportation
process of moving of sorghum from one location to other location during different unit operations of post-harvest handling

3.10
post-harvest losses
measurable quantitative and qualitative loss of sorghum grains occurred during the various post-harvest operations like harvesting, threshing, drying, cleaning, transporting and storage.

4 General guidelines
Throughout the whole process of PHHS the following shall be considered:

a) the products being handled shall comply with RS EAS 757
b) hygiene conditions shall be maintained throughout the whole process of PHHS;

c) materials and equipment used shall comply with the requirements of relevant standards;

d) chemicals and their use shall comply with relevant standards and regulations; and

e) measures shall be taken to prevent attacks by pests, moulds and rodents throughout the PHHS process (for the control of pest refer to Annex A).

5 Specific guidelines

5.1 Pre-harvesting

. Pre-harvesting should consider the following:

a) prior to the harvest, it is important that farmers are already prepared for their postharvest activities and they should ensure that:

1) the equipment needed for their harvest and postharvest activities is available and in good working condition;

2) the place of important activities like drying and threshing has been identified;

3) there shall be sufficient storage space for the crop;

4) the grain stores and food grade packaging materials have been thoroughly cleaned

5) the residues of the old harvest (last season’s crop) has been removed from all cracks and crevices and disposed in a hygienic manner;

b) farmers should ensure the timely harvest of the sorghum crop to avoid losses and the following should be considered:

1) the time of harvesting can be identified by the change of colour of the plant from green to yellow showing the maturity of grains;

2) not to wait for stalks and leaves to completely dry because they remain green in most of the hybrid and composite varieties; and

3) sorghum cultivated for obtaining kernels (grains) shall be harvested when the kernels are physiologically matured with 15-20% of moisture content;

c) farmers can collect a grain from the earhead in the field itself and test the hardness, size, shape and maturity of the grain inside the earhead and decide the time of harvesting;

d) pest infestation shall be avoided prior to harvesting; and
e) protecting the grains in the field from birds should be controlled, when sorghum is in the stage of ready to harvest.

5.2 Harvesting

Harvesting activity shall be done as follows:

f) the sorghum ear heads shall be cut at the stalk;

g) harvesting before maturity means a low milling recovery and also a higher proportion of immature seeds, high percentage of broken kernels, poor grain quality and more chances of disease attack during storage of grain;

h) delay in harvesting results in grain loss and cracking of sorghum kernels and expose the crop to insects, rodents, birds and pests attack;

a) harvesting during wet weather conditions shall be avoided;

b) harvesting should be done by adopting proper method and avoid missing of earheads;

c) the harvested crop shall be carried in a sack to the drying yard without much transportation loss;

d) the harvested material shall be protected from rain and excessive dew by covering;

e) the harvested sorghum should be kept separately for each variety, to get true to type variety (grains);

f) harvesting at too much dried sorghum crop leads to more field and transportation losses and shall be avoided;

g) the contact of the earthead with soil should be avoided as it can be source of contamination or attack by insects; and

h) Harvested sorghum crop should be transported immediately to the drying yard.

5.3 Drying of earheads

Drying of earheads shall be done as follows:

a) drying of the earheads should be done immediately after harvesting;

b) if there is a delay in drying, earheads should be kept under shade with plenty of aeration to avoid heating of the earheads;

c) for rapid and safe drying the following should be considered:

1) a single layer of thin bed drying of earheads should be used; and
2) the earheads should be regularly turned for uniformity of drying;

d) for better sanitation, clean concrete floor or brick floor or tarpaulin shall be used to dry the earheads/sorghum grain;

e) care shall be taken to protect the earheads from soil contamination, cyclonic wind and rain or dew;

f) where heated air is used to dry the earheads, temperature and drying time shall be synchronized so that they do not result in adverse effect on the nutritional composition and quality of the grains in its intended use;

g) The air heated drying machine shall comply with relevant standards;

h) any source of contamination and pest infestation shall be avoided during drying; and

i) hygienic practices shall be followed during drying.

5.4 Threshing

Threshing shall be done as follows:

j) the machine used for threshing shall comply with relevant standards

k) threshing may be done by manual methods or by power operated multi crop thresher for large quantities;

l) techniques that cause damage to the grains such as severe beating with sticks shall be avoided to prevent the damage of grains;

m) when power operated threshers are used, the clearance between the concave and cylinder should be adjusted so that the percentage of broken grains shall be avoided;

n) power operated thresher should have operator safety arrangements like the belt and pulley guard as per the relevant standards;

o) threshing machine shall not be a source of contamination such as rust, paint, grease

5.5 Drying of sorghum grains

The following shall be considered in drying of grains:

a) the drying of the grains should be done immediately after threshing;

b) the sorghum grains shall be dried to 13.5 % of moisture content prior to packaging and storing;

c) the drying area (concrete floor, tarpaulin) shall be clean and not be a source of contamination to the grains; and
d) where heated air is used to dry the grains, temperature and drying time shall be synchronized so that they do not result in adverse effect on the nutritional composition and quality of the grains in its intended use

5.6 Cleaning

Cleaning may be done manually or by using machine:

a) when power operated cleaning machine is used, care should be taken by adjusting the fan speed to reduce the loss of grain in the chaffy outlet;

b) the grains shall be aspirated to remove all the straws, chaff and leafy vegetative matter;

c) defective (mouldy, discoloured, shrivelled, rotten, broken, insect damaged, etc) grains shall be minimized

d) grading shall be in accordance with RS EAS 757.

5.7 Packaging

Sorghum grains shall be packaged according the following:

a) sorghum grains shall be packaged in clean and;

b) sorghum grains shall be packed in food grade packaging materials which will safeguard the hygienic, nutritional, and organoleptic qualities of the products;

c) each package shall contain sorghum grains of the same type and of the same grade designation;

d) each container shall be securely closed

5.8 Transportation

Transportation of sorghum grains shall consider the following:

a) the grains may be transported in vehicle itself (bulk) or in transportable container then the vehicle and container shall be clean, dry and free from undesirable odours and infestation;

b) sorghum grain should be handled and transported in such a way so that they remain well protected from sun, rain or other sources of excessive heat, objectionable odour and from any type of cross infestation;

c) if the vehicle is not fully enclosed, it should have a covering such as tarpaulin to keep out of the rain or any form of water;

d) transported grains should be well ventilated with dry air to remove moisture resulting from respiration of the grains and to prevent moisture condensation; and

e) transportation of sorghum grains with chemicals and products in liquid form shall be avoided.
5.9 Storage

Storage facility and management should be in such ways that preserve the safety and quality of sorghum grains and shall comply with RS 231 and RS 264.

6 Major storage pests and their control measures

Measures should be taken to control insect infestation using either physical, chemical, mechanical or biological means or combinations of these methods. The prevalent storage pest and their control measures are given in Annex A.
Annex A  
(informative)

Major stored grain pests of sorghum and their control measures

<table>
<thead>
<tr>
<th>Name of pest and figure of pest</th>
<th>Damage</th>
<th>Control measures</th>
</tr>
</thead>
</table>
| 1. Rice weevil  
*Sitophilus oryzae* (Linn.) | Adults and larvae both bore into grains and feed on the grain. | Two types of treatments are followed to control infestation.  
**A. Prophylactic treatment:**  
Use following insecticide to prevent infestation in godown and stock of sorghum  
1. *Malathion* (50% EC):  
Mix 1 litre in 100 litre of water. Use 3 litre prepared solution per 100 square meter area. Spray every 15 days interval.  
2. *DDVP* (76% EC):  
Mix 1 litre in 150 litre of water. Use 3 litre prepared solution per 100 square meter area. Do not spray on stock. Spray on walls and floors of the go down as and when required or once in a |
| 2. Lesser grain borer  
*Rhizopertha dominica* (fabr.) | Beetles and larvae both penetrate the grain and feed. Sometimes, larvae feed on the waste flour produced by the adults. Heavy infestation makes the grain warm and moist, which leads to mould formation. | |

©RSB 2019 - All rights reserved
3. Deltamethrin (2.5/WP):
Mix 1 kg. in 25 litre of water. Use 3 litre prepared solution per 100 square meter area. Spray on gunny bags after 3 months’ interval.

B) Curative treatment:
Use following fumigation insecticide to control infested stock/go down of sorghum in airtight condition.

1. Aluminium Phosphine:
For stack fumigation use 3 tablets / tonne and put polythene cover on infected stock. For godown fumigation, use 120 - 140 tablets per 100 cubic meter area and keep godown structure airtight and closed for 7 days.

3. Khapra beetle
*Trogoderma granarium*
Larvae is a very serious stored pest but the beetle itself does not damage. First the larvae feed germ portion and later other parts of the grains.

4. Saw-toothed grain beetle
*Oryzaephilus surinamensis* (Linn.)
Both beetle and larvae feed broken grains and damaged grains of other insects. They are usually found as a secondary pest together with other grain pests.
### 5. Red rust flour beetle

*Tribolium castaneum*

Beetle and larvae both do not cause damage to whole grain but feed on broken and damaged grains produced by milling and handling or infested/damaged grains of other insects.

![Red rust flour beetle image](image)

### 6. Rice moth

*Corcyra cephalonica*

Larvae feed broken and processed sorghum. Larvae produce dense webbings. Whole grain kernels are bound into lumps.

![Rice moth image](image)

### 7. Rodents

Rodents eat whole grains, broken grains, flour etc. They spill more grains than they consume. Rodents also contaminate sorghum by hair, urine and feces, which cause diseases like cholera, food poisoning, ringworm, rabies etc. They also damage the storage structures and other accessories of storage like wire and cable etc.

#### Rat cage:

Different types of rat cages are available in the market. Caught rats can be killed by dipping into water.

#### Poison baits:

Anti-coagulant pesticide like Zinc Phosphide is mixed with bread or any other food stuff used as bait. Keep baits for a week.

#### Rat burrow fumigation:

Put tablets of Aluminum Phosphide in each hole and
| burrow and block that hole by mud mixture to make it airtight |  |  |
Annex B  
(informative)
Bibliography

[1]