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Part 2: Power operated maize sheller

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Rwanda Standards Board

P.O Box 7099 Kigali-Rwanda

KK 15 Rd, 49

Tel. +250 788303492

Toll Free: 3250

E-mail: info@rsb.gov.rw

Website: www.rsb.gov.rw

ePortal: www.portal.rsb.gov.rw

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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 gazettment as Rwanda Standards.

RS 269-2 was prepared by Technical Committee RSB/TC 047 *Steel aluminium and related product*

This second edition cancels and replaces the first edition (RS 269-2:2015), which has been technically revised.

DRS 269 consists of the following parts, under the general title *Agroprocessing machinery — Test methods:*

— *Part 1: Rice thresher*

— *Part 3: Rice mill*

— *Part 4 Heated air mechanical grain dryer*

— *Part 5: Maize mill*

Committee membership

The following organizations were represented on the Technical Committee on Steel aluminium and related (RSB/TC 047) in the preparation of this standard.

University of Rwanda/college of science and technology

University of Rwanda/College of agriculture animal science and veterinary medicine

Kabizu business group

Rwanda Polytechnic/IPRC Kigali

Rwanda Polytechnic/IPRC Ngoma

Rwanda Polytechnic/IPRC Musanze

RWANTECH Boilers

Rwanda Inspectorate and competition authority

Rwanda Institute for Conservation Agriculture

ACER Ltd

Rwanda Standards Board (RSB) – Secretariat

Agricultural machinery — Test methods — Part 2: Power operated maize sheller

1 Scope

This Draft Rwanda Standard specifies the methods of sampling, testing and inspection for power operated maize sheller.

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.

DRS 268-2, *Agroprocessing machines—Specification — Part 2: Power operated maize sheller*

RS 241, *Agricultural machinery — Methods of sampling*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in RS 268-2 and the following apply.

3.1

concave clearance

clearance between cylinder shelling elements and concave component

3.2

corrected capacity

actual capacity of the sheller corrected at 20 % kernel moisture content (wet basis), and 100 % purity

3.3

output capacity

weight of shelled kernel collected per unit of time

3.4

total kernel input

sum of the weight of collected shelled kernels and all the shelling losses

4 General conditions for test and inspection

4.1 Role of manufacturer/dealer

The manufacturer/dealer shall comply with the test procedures of national testing authority.

4.2 Test site conditions

The maize sheller shall be installed on a stable level ground on a site with sufficient working space, and shall be positioned in such a way that the wind cannot blow the maize cobs and other impurities into the clean kernel.

5 Suspension of test

5.1 If during the test run, the machine stops due to breakdown or malfunction so as to affect the machine's performance, the test may be suspended.

5.2 The decision to suspend or to continue the test is at the discretion of the testing authority and concurred by the manufacturer's representative.

6 Test preparation

6.1 Running-in and preliminary adjustments

6.1.1 Before the start of the test, the maize sheller shall have undergone a breaking-in period.

6.1.2 The maize sheller shall be operated at the test site for sufficient duration with and without load.

6.1.3 During the running-in period, the various adjustments of the maize sheller shall be made according to the manufacturer's recommendations.

6.1.4 No other adjustments shall be permitted while the test is ongoing.

6.2 Test materials

The maize to be used in the test shall be prepared in sufficient quantity, using the procedure given in Annex A.

7 Pre-test observation

7.1.1 The specifications claimed by the manufacturer and the physical details given in Annex B shall be verified by the recognized testing authority.

7.1.2 A stable and level surface shall be used as reference plane for verification of dimensional machine specifications.

8 Performance test

8.1 Operation of the maize mill

8.1.1 The maize sheller shall be operated at the recommended speed and feed rate of the manufacturer.

8.1.2 The same feeding rate recommended by the manufacturer shall be maintained during the test run.

8.1.3 After the test-run, the shelling area shall be cleaned and then prepared for the next test trial(s).

8.1.4 This procedure shall be repeated for at least three test trial(s).

9 Test trial

A minimum of two (2) test trials, with duration of at least 15 min per trial, shall be adopted.

10 Sampling

Sampling procedure is given in Annex C.

10.1 Data collection

10.1.1 Duration of test

The duration of each test trial shall start with the feeding of the first sample and ends after the feeding of the last sample. However, all discharge from the different outlets shall be included after the cut-off time.

10.1.2 Noise level

10.1.2.1 The noise emitted by the machine, with or without load, shall be measured using a noise level meter at the location of the operators and baggers.

10.1.2.2 The noise, expressed in db(A), shall be measured in accordance with RS 236.

10.1.3 Speed of components

The speed of the shelling cylinder, oscillating screen shaft, fan shaft, prime mover and other rotating components shall be measured using a tachometer.

10.1.4 Fuel consumption

Before the start of each test trial, the fuel tank shall be filled to its capacity and after each test trial, the fuel consumed shall be measured by refilling the tank to the same level using a graduated cylinder measured in L/hr.

10.1.5 Data recording and observations

Record sheet for all data and information during the test is given in Annex D.

11 Laboratory analysis

The laboratory procedures to be followed in the analysis are given in Annex E and the data sheet to be used is given in Annex F.

12 Data analysis

12.1 For uniform result of output due to variation in kernel moisture content and purity, the output capacity shall be corrected at 100 % purity and 20 % moisture content.

12.2 The formula to be used in the calculation of different test parameters are given in Annex G.

13 Test report

The test report shall include the following information:

a) title;

b) summary of result;

c) methods of test;

d) conditions of the machine;

e) description of the machine;

   1) figure 1 – material flow diagram

   2) figure 2 – power transmission system

   3) figure 3 –arrangements of shelling elements on the cylinder

   4) table 1 – machine specifications

f) results of test;

g) table 2 – field performance test data;

h) observations (include pictures); and

i) name and signature of test engineers

Annex A
(normative)

Test materials for power operated maize sheller

A.1 Sample characteristics

Test materials to be used shall have the following characteristics:

a) variety: commonly or locally grown;

b) moisture content: 18 % - 24 %, wet basis; and

c) kernel-ear maize ratio: 0.77 – 0.81.

A.2 Quantity to be supplied

The amount of test material to be supplied shall be sufficient for at least three hour of continuous shelling operation including samples to be used for running-in prior to the actual conduct of test trials.

A.3 Sample preparation

Prepare the sample in such a way that test sample to be used for the running-in and in each test trial shall have identical characteristics in terms of moisture content, variety and date of harvest and cultural management practices such as water management, fertilizer input.

Annex B
(normative)

Specifications of power operated maize sheller

Name of Applicant (or Distributor): _____

Address: _____

Telephone No: _____

Name of Factory/Distributor: _____

Address: _____

General information

Make: _____ Brand/Model: _____

Serial No: _____ Classification: _____

Production date of machine sheller to be tested: _____

Table B 1 — Items to be inspected

Manufacturer's Items	Manufacturer's Specifications	Verification by the testing Agency
B.1 Dimensions and weight of sheller		
B.1.1 Overall length (mm)		
B.1.2 Overall width (mm)		
B.1.3 Overall height (mm)		
B.1.4 Weight of the machine (kg), without engine		
B.2 Crop(s) for which machine is suitable		
B.3 Rated output capacity (kg/h)		
B.4 Recommended cylinder speed (rpm)		
B.5 Engine		
B.5.1 Brand		
B.5.2 Model		
B.5.3 Serial Number		

B.5.4 Make		
B.5.5 Rated power (kW)		
B.5.6 Rated speed (rpm)		
B.5.7 Type		
B.5.8 Weight		
B.5.9 Starting system		
B.5.10 Cooling system		
B.6 Type of power transmission system		
B.6.1 Engine to		
B.6.2 Cylinder shaft to		
B.6.3 Fan shaft to		
B.6.4 Oscillating sieve/screen to		
B.6.5 Others (specify)		
B.7 Shelling Cylinder		
B.7.1 Type		
B.7.2 Size (L x D), mm		
B.7.3 Cylinder teeth		
B.7.3.1 Type		
B.7.3.2 Size		
B.7.3.3 Number/row		
B.7.3.4 No. of rows		
B.7.3.5 Arrangement		
B.7.3.6 Means of attachment		
B.7.3.7 Material		
B.7.3.8 Others		
B.7.4 Material		
B.8 Fan		
B.8.1 Type		
B.8.2 No. of units		
B.8.3 Impeller		
B.8.3.1 Material		
B.8.3.2 Number of blades		
B.9 Oscillating screen		
B.9.1 Dimension (L x W), mm		
B.9.2 Size of perforations, mm		
B.9.3 Length of stroke, mm		
B.9.4 Material		
B.10 Concave component		

B.10.1 Overall diameter, mm		
B.10.2 Clearance		
B.10.2.1Maximum, mm		
B.10.2.2Minimum, mm		
B.10.3 Material		
B.11 Hopper (if available)		
B.11.1 Location		
B.11.2 Material		
B.11.3 Feature		
B.12 Feeding Table (if available)		
B.12.1 Dimensions (L x W), mm		
B.12.2 Height from the ground (mm)		
B.12.3 Orientation		
B.12.4 Mode of attachment		
B.12.5 Material		
B.13 Transport device		
B.13.1 Type		
B.13.2 Size		
B.14 Safety device(s), if any		
B.15 Discharge device		
B.16 Labour requirement		
B.17 Adjustment(s)		
B.18 Other special features		

Annex C
(normative)

Sampling and measurements for test material

C.1 Sampling from different outlets

C.1.1 During each test trial, samples shall be collected from the different outlets to be analyzed in the laboratory for losses, purity and kernel quality.

C.1.2 The minimum amount of samples to be taken shall be twice as much as what is needed for a particular analysis.

C.1.3 The excess sample shall be used for reference purposes or for an eventual second check in case of review. The sampling procedures shall be undertaken at the following sheller outlets:

a) main kernel outlet – Using a plastic bag or an appropriate container, collect three or more samples of approximately 0.5 kg each from the outlet.

b) maize-cob outlet – In the collection of sample in this outlet, use a rectangular box shaped nylon catch with a dimension of 1.5 m x 1.5 m x 0.5 m open at one end of the small side. Three samples shall be collected from this outlet for a minimum duration of five (5) sec per collection. Separate the free maize kernel mixed with the cob and the kernels that are still attached to the cob. Put them in separate containers and label them as separation loss and unshelled loss, respectively.

c) fan outlet – During the test, three samples shall be taken from the fan outlet for a duration of at least 15 sec per collection by using a nylon net with a dimension of 1.5 m x 1.0 m held by two persons at both ends. These samples shall be placed in appropriate containers and labelled as blower loss.

C.2 Collection of scattered maize kernels

C.2.1 For testing purposes, scattered maize kernels shall be gathered since these maize kernels are part of the total maize kernel input. Spread canvas sheets to the shelling floor area to catch these maize kernels after each trial. Placed the collected maize kernels in appropriate containers and label them as scattered maize kernels.

C.2.2 Provisions shall be provided for the collection scattered maize kernels with maximum distance of 1.0 m away from the base of the machine.

C.3 Handling of samples

All samples to be taken to the laboratory shall be placed in appropriate containers and properly labelled. If the samples are not to be immediately analyzed they should be air-dried and if necessary, treat samples with chemicals such as insecticide in order to prevent the samples from possible damage. If the sample is to be used for determining moisture content, it must be kept in dry and airtight containers.

C.4 Other measurements required during the test run

C.4.1 Data shall be taken for the following:

a) speed of rotating components;

b) air velocity; and

c) noise level at the location of the operators and baggers.

C.4.2 For each data, there shall be a minimum of five observations. These shall be taken without and with load. Before taking data, it should be ensured that the feed rate, speed and other functional characteristics have stabilized. The time of sampling shall be properly space during the whole duration of the test trials. For air velocity, measurement shall be taken in at least six measuring points. The test engineer shall decide on the location of the measuring points that can provide him with a good estimate of the fan's air velocity.

C.5 Measurement of fuel consumption

To get the amount of fuel consumed, the tank shall be filled to full capacity before the test. After the test, fill the tank with measured fuel to the same level before the test. When filling up the tank, careful attention shall be paid to keep the tank horizontal and not to leave empty space in the tank.

Annex D
(normative)

Performance test data sheet

Test Trial No:_____ Date: _____

Test Engineers:_____ Location: _____

Test Specimen:_____

Table D 1 — Items to be inspected

Items	Trial			
	1	2	3	Average
D.1 Crop Condition				
D.1.1 Kind/Variety				
D.1.2 Days after harvest				
D.1.3 Moisture content (%)				
D.1.4 Size of ear maize				
D.1.4.1 Length (mm)				
D.1.4.2 Diameter (mm)				
D.1.5 Kernel-ear maize ratio				
D.2 Performance test				
D.2.1 Speed of components (rpm)				
D.2.1.1 Primemover				
D.2.1.1.1 Without load				
D.2.1.1.2 With load				
D.2.1.2 Shelling cylinder shaft				
D.2.1.2.1 Without load				
D.2.1.2.2 With load				
D.2.1.3 Fan shaft				
D.2.1.3.1 Without load				
D.2.1.3.2 With load				
D.2.1.4 Oscillating screen shaft				
D.2.1.4.1 Without load				
D.2.1.4.2 With load				
D.2.2 Fan air velocity (m/sec)				
D.2.2.1 Without load				

D.2.2.2 With load				
D.2.3 Noise level [db(A)]				
D.2.3.1 Feeder				
D.2.3.1.1 Without load				
D.2.3.1.2 With load				
D.2.3.2 Bagger				
D.2.3.2.1 Without load				
D.2.3.2.2 With load				
D.2.4 Shelling time (min)				
D.2.5 Shelled kernel (kg)				
D.2.6 Shelling capacity (kg/h)				
D.2.7 Fuel time (min)				
D.2.8 Fuel consumed (L)				
D.2.9 Fuel consumption (L/h)				

D.3.1 Observations

D.3.1.1 Ease of transporting the machine

_____

_____

D.3.1.2 Adjustments such as belt tensions, clearance, air velocity and others

_____

_____

D.3.1.3 Safety features

_____

_____

D.3.1.4 Ease of cleaning the concave and cylinder

_____

_____

D.3.1.5 Ease of cleaning the fan component

_____

_____

D.3.1.6 Labour requirement

_____

_____

D.3.1.7 Failure or abnormalities that may be observed on the sheller or its component parts during and after the shelling operation.

_____

_____

D.3.18 Others

_____

_____

Annex E
(normative)

Laboratory analysis

E.1 Measurement of ear maize dimensions

This shall be taken using at least ten representative samples of ear maize and measure the length and diameter.

E.2 Measurement of kernel-ear maize ratio

E.2.1 In measuring the kernel-ear maize ratio, take at least ten representative samples of ear maize.

E.2.2 Take the weight of each ear maize and manually shelled the kernels.

E.2.3 Determine the weight of the kernel for each ear maize then compute for the kernel-ear maize ratio.

E.3 Determination of Purity

E.3.1 Take three 500 g samples from the main maize kernel outlet.

E.3.2 Clean the maize kernels to remove the impurities and other foreign matters, the clean maize kernel shall be weighed and recorded.

E.3.3 The percent purity is calculated using the formula in Annex G.

E.4 Determination of losses

E.4.1 Blower loss

E.4.1.1 Three samples shall be taken from the fan outlet to collect the maize kernels mixed with impurities.

E.4.1.2 Each sample shall be cleaned and weighed.

E.4.1.3 The total weight of the clean maize kernels and the total time of collection shall be recorded for the computation of blower loss (see Annex G).

E.4.2 Separation loss

E.4.2.1 Three samples shall be taken at the cob outlet to collect loose maize kernels mixed with the cob.

E.4.2.2 The total time of collection of the three samples shall be taken and recorded for the computation of separation loss (see G).

E.4.3 Unshelled loss

E.4.3.1 Unshelled kernels collected at the cob outlet shall be hand shelled and weighed.

E.4.3.2 The total weight and time of collection shall be taken and recorded for the computation of unshelled loss (see Annex G).

E.4.4 Scattering loss

Kernels scattered around the sheller with a maximum distance of 1.0 m away from the base of the machine, shall be collected after each trial, cleaned and weighed for the determination of scattering loss. (see Annex G).

E.5 Determination of net percent cracked kernels

E.5.1 Three samples each from manually shelled and machine shelled maize kernels shall be taken for analysis. Each sample consists of 100 maize kernels.

E.5.2 These maize kernels shall be inspected for the presence of fissures.

E.5.3 The net percent cracked kernels shall be taken as the difference between the values obtained from the manual and machine shelled kernel samples (see Annex G).

E.6 Determination of percent mechanically damaged kernels

E.6.1 Three samples from machine shelled kernels shall be taken for analysis.

E.6.2 Each sample shall consist of 100 g.

E.6.3 Separate those kernels that were broken or crushed and weigh.

E.6.4 Compute for the percent broken kernels (see Annex G).

Annex F
(normative)

Laboratory grain analysis data sheet

Machine tested: _____ Analyzed by: _____

Date of test: _____ Date Analyzed:_____

F.1 Crop conditions

Table F.1 — Moisture content, (% w.b)

Sample No.	Initial weight	Final weight	Moisture content%
Average			

Table F 2 — Kernel-ear maize ratio

Sample No.	Weight of ear Maize (g)	Weight of kernel (g)	Kernel-ear maize ratio
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Average			

F.2 Kernel-ear maize ratio

Initial weight of samples (uncleaned) = 500 g

Table F 3 — Purity determination

Items	Trail 1				Trail 2				Trail 3				Gen Avg
	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	
Cleaned (g)													
Purity (%)													

Table F 4 — Loss determination

Trial No.		Blower loss		Separation loss		Unshelled loss		Scattering loss	
		Sample wt (g)	Total (Kg)	Sample wt (g)	Total (Kg)	Sample wt (g)	Total (Kg)	Sample wt (g)	Total (Kg)
Average									
1	a								
	b								
	c								
Average									
2.	a								
	b								
	c								
Average									
3.	a								
	b								
	c								
Average									
Gen. average									

Table F 5 — Shelling efficiency/recovery determination

Trial No.	Blower loss		Separation loss		Unshelled loss		Scattering loss		Total	
	Wt	%	wt	%	wt	%	wt	%	Output (kg)	Input (kg)
1										
2										
3										
Average										

Annex G
(normative)

Formula used during calculations and testing

1 Kernel-ear corn ratio (R_e)

$$R_e = \frac{W_k}{W_e}$$

where:

W_k is the weight of kernel, g
W_e is the weight of the ear corn, g

2 Fuel consumption (F_C), L/h

$$F_c = \frac{F_l}{T_o}$$

where:

F_l is the amount of fuel consumed, L
T_O is the time of operation, h

3 Capacity

a) Actual capacity (C_a), kg/h

$$C_a = \frac{W_c}{T_o}$$

where:

W_C is the weight of shelled kernel, kg
T_O is the duration of operation, h

b) Corrected capacity (C_C), kg/h (at 100% purity, 20% moisture content)

$$C_c = \frac{100 - MC_o}{100 - MC_m} \times P \times C_o$$

where:

C_C is the corrected capacity, kg/h
C_O is the actual capacity, kg/h
MC_O is the observed moisture content, %
MC_m is the kernel moisture content, at 20%
P is the kernel purity, %

4 Purity (P), %

$$P = \frac{W_c}{W_u} x\,100$$

where:

W_u is the weight of uncleaned kernel, g
W_C is the weight of cleaned kernel, g

5 Losses

5.1 Summation of all losses (L_t), kg

$$L_t = \text{Blower loss} + \text{Separation loss} + \text{Unshelled loss} + \text{Scattering loss}$$

5.2 Blower loss (B_l)

a) Amount

$$B_l, kg = \frac{\text{Weight of blown clean kernel, kg}}{\text{Duration of collection, h}} \text{ x duration of operation, h}$$

b) Percentage

$$B_l, \% = \frac{\text{Blower loss, kg}}{\text{Cleaned shelled kernel, kg} + \text{Summation of all losses, kg}} \text{ x } 100$$

5.3 Separation Loss (S_l)

a) Amount

$$S_l, kg = \frac{\text{Weight of separated clean kernel, kg}}{\text{Duration of collection, h}} \text{ x duration of operation, h}$$

b) Percentage

$$S_l, \% = \frac{\text{Separation loss, kg}}{\text{Cleaned shelled kernel, kg} + \text{Summation of all losses, kg}} \text{ x } 100$$

5.4 Unshelled Loss (U_l)

a) Amount

$$U_l, kg = \frac{\text{Weight of unshelled clean kernel, kg}}{\text{Duration of collection, h}} \text{ x duration of operation, h}$$

b) Percentage

$$U_l, \% = \frac{\text{Unshelled loss, kg}}{\text{Cleaned shelled kernel, kg} + \text{Summation of all losses, kg}} \text{ x } 100$$

5.5 Scattering loss ($S_c l$), %

$$S_c l, \% = \frac{\text{Weight of clean scattered kernels, kg}}{\text{Cleaned shelled kernel kg} + \text{Summation of all losses, kg}} \text{ x } 100$$

5 Shelling Efficiency (S_e) , %

$$S_c, \% = \frac{\text{Clean shelled kernel , kg + Blower loss kg + Separation loss, kg + Scattering loss, kg}}{\text{Clean shelled kernel, kg + Summation of all losses, kg}} \times 100$$

or

= 100% - Unshelled loss (%)

7 Shelling Recovery (S_r), %

$$S_r, \% = \frac{\text{Clean shelled kernels, kg}}{\text{Cleaned shelled kernel, kg + Summation of all losses, kg}} \times 100$$

8 Cracked kernel (C_g), %

$$C_g = \frac{\text{Number of cracked kernels}}{\text{100 kernel sample}} \times 100$$

9 Mechanically damaged kernel (D_g), %

$$D_g = \frac{\text{Weight of mechanically damaged kernels, g}}{\text{100 gram sample}} \times 100$$

Price based on nnn pages