AMTEC METHODS OF TEST

AM 002:2023

Postharvest Machinery – Grain Collector

AGRICULTURAL MACHINERY TESTING AND EVALUATION CENTER

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Contents

Foreword

The formulation of this AMTEC Methods of Test (AM) was initiated by the Agricultural Machinery Testing and Evaluation Center-University of the Philippines Los Baños (AMTEC-UPLB) in response to the need for a reference standard for the testing of grain collector. It was made in collaboration with the Bureau of Agricultural and Fisheries Engineering (BAFE)-Department of Agriculture (DA) as the regulatory agency for agriculture and fisheries machinery and infrastructures.

The draft AM underwent a series of reviews and online circulations among AMTEC engineers and stakeholder consultation on March 24, 2022 via online platform before its finalization and endorsement to the BAFE-DA.

This AM was drafted in accordance with the Bureau of Agriculture and Fisheries Standards (BAFS)-Standards Development Division (SDD) Standardization Guide No. 1: Writing the Philippine National Standards.

The word “shall” is used to indicate mandatory requirements to conform to the standard.

The word “should” is used to indicate that, among several possibilities, one is recommended as particularly suitable without mentioning or excluding others.

1 Scope

This standard specifies the methods of test and inspection for grain collector. Specifically, it shall be used to:

1.1 verify the mechanism, dimensions, materials, accessories of the machine, and the list of specifications submitted by the test applicant;

1.2 determine the performance of the machine;

1.3 evaluate the ease of handling and safety features; and

1.4 prepare the report for the test results.

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.

Agricultural Machinery Testing and Evaluation Center (AMTEC)-University of the Philippines Los Baños (UPLB). (2021). Agricultural and fishery machinery – General Methods of test (AM 001:2021)

AMTEC-UPLB. (2000). Agricultural machinery – Method of sampling (PAES 103:2000)

3 Terms and Definitions

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

3.1
broken/damaged grain
grain that were broken, crushed, or dehulled (partially or fully) as a result of machine operation

3.2
bulk density
weight per unit volume including pore space of the sample, expressed in kilogram per cubic meter (kg/m^3)

3.3
collecting capacity
total weight of collected grains per unit time, expressed in kilogram per hour (kg/h)

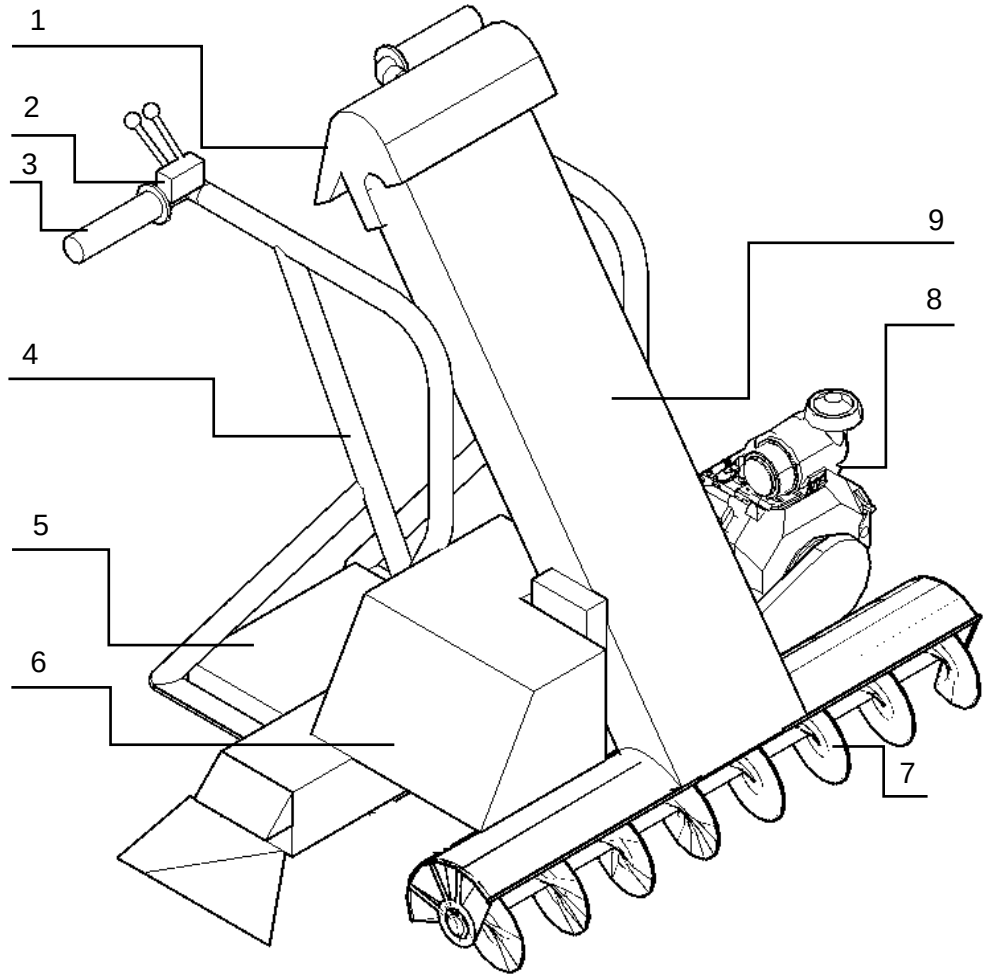
3.4
collecting efficiency
ratio of the total weight of collected grains to the total weight of initially spread grains, expressed in percent (%)

3.5
cracked grain
grain which shows signs of fissures, fractures, or splinters

3.6
drying mat
plastic sheet or canvas, net, or woven or black mat among others where grains are spread for sun drying

3.7
drying pavement
drying floor
structure intended for large-scale sun drying of grains that is levelled and is usually made of concrete for relatively smooth and durable surface

3.8
grain collector
machine that gathers grains spread evenly over a surface (e.g. mat, pavement) usually for sun drying and conveys them to an outlet which fills in sacks or bags with grains; it can be classified based on the type of propulsion (push-type, walking-type) and type of collecting conveyor (mechanical type, pneumatic type)



1. Grain outlet
2. Control levers
3. Handle
4. Main frame
5. Sack platform
6. Gearbox with guard
7. Collecting head
8. Prime mover
9. Collecting conveyor

Figure 1. Grain collector

3.8.1
collecting conveyor
part of the grain collector (e.g. tube, hose, bucket elevator) that transfers the grains from the collecting head to the grain outlet

3.8.1.1
mechanical type
grain collector which uses bucket elevators as collecting mechanism as shown in Figure 1.

3.8.1.2
pneumatic type
grain collector which uses suction pressure generated by a fan to convey grains as shown in Figure 2.

3.8.2
collecting head
part of the grain collector (e.g. tube, spiral auger) that gathers the grains laid on a surface (e.g. mat, pavement) which are then drawn to the collecting conveyor, grain outlet, or cyclone separator

3.8.3
cyclone separator
separates the grain from the suction air to prevent the grains from entering the impeller; can also function as a grain cleaning device

3.8.4
frame
structure on which all the components of the grain collector are fitted

3.8.5
grain outlet
part of the grain collector that discharges grains for bagging

3.8.6
push-type grain collector
type of grain collector wherein the operator is the sole source of forward propulsion

3.8.7
suction fan
generates suction pressure that moves grains to a higher position

3.8.8
sack mounting frame
part of the grain collector on which sacks are fitted and held during bagging

3.8.9
sack platform
part of the grain collector that carries or supports the sack filled with grains during bagging

3.8.10
walking-type grain collector
type of grain collector wherein mechanical power from the prime mover is distributed between the collecting system and the wheels for forward propulsion

3.9
overall height
distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the machine

3.10
overall length
distance between the vertical planes perpendicular to the median plane of the machine, each plane touching the front and rear extremities of the machine

3.11
overall width
distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the machine on each respective side

3.12
running-in period
preliminary operation conducted before the actual testing of the machine to make various adjustments until the operation is stable

3.13
test applicant
manufacturer, inventor, direct importer, legitimate distributor, dealer, owner, or end-user of the machine

3.14
test plot
portion of a test site with required size and shape used for testing

3.15
test site
location (e.g., field, AMTEC Test Laboratory) where the test is conducted

3.16
uncollected loss
ratio of the weight of grains left uncollected on the test plot, to the total weight of initially spread grains, expressed in percent (%)

3.17
wet-basis moisture content
weight of moisture over the fresh weight of the sample, expressed in percent (%)

4 General Conditions for Test

4.1 Selection of machinery to be tested

The grain collector submitted for testing shall be sampled in accordance to PAES 103:2000 or any other suitable method of sampling.

4.2 Role of the test applicant

The test applicant shall provide the necessary information or documents on the specifications of the machine to be tested. They shall abide with the terms and conditions set forth by the AMTEC, provide test materials, and shoulder other variable costs to carry out the test.

4.3 Role of the representative of the test applicant

An official representative from the test applicant shall operate, demonstrate, adjust, repair as the case maybe, and decide on matters related to the operation of the machine.

4.4 Role of the test engineer

The certified test engineer shall lead the conduct of the performance testing in accordance with the provisions of this Standard. Furthermore, the test engineer shall oversee other relevant activities prior and subsequent to the conduct of the testing.

4.5 Test site conditions

The grain collector shall be tested through actual collection and bagging of grains on a drying pavement, mat, or any concrete floor. The test site should have ample provisions for material handling, temporary storage, workspace and should be suitable for normal working condition. It shall be completely dried. Adequate ventilation and lighting shall be provided especially if the test site is enclosed (e.g., warehouse).

4.6 Suspension/Termination of test

4.6.1 During the testing operation, the test may be suspended if the machine stops or cannot operate or cannot be tested due to the conditions listed below. At such instances, the AMTEC may allow the representatives of the test applicant to repair and/or replace with similar specifications an assembly of a machine and to change a test material with a new one that conforms to the recommended size, characteristics, quality, and/or conditions. The AMTEC may also await such instances until they are resolved to continue the test operation.

Item No.	Conditions for Suspension
4.6.1.1	Minor breakdown or malfunction
4.6.1.2	Insufficient amount of test material
4.6.1.3	Nonconformity of the test material to the recommended characteristics and quality
4.6.1.4	Insufficient area of test plot
4.6.1.5	Nonconformity of the test plot to the recommended characteristics and conditions
4.6.1.6	Unmatched prime mover used
4.6.1.7	Clogged or choked part/s of the machine
4.6.1.8	Accident and injury of the personnel/representatives of test applicant or AMTEC
4.6.1.9	Poor and severe weather conditions that may affect the test

4.6.2 During the testing operation, the test shall be terminated if the machine cannot continue its operation due to the conditions listed below.

Item No.	Conditions for Termination
4.6.2.1	Three breakdowns during the whole duration of all test trials
4.6.2.2	Three clogging or choking during the whole duration of all test trials
4.6.2.3	Major malfunction, breakdown, or damage affecting performance of the machine

5 Test Preparation

5.1 Preparation of the machinery for testing

The official representatives of both the test applicant and AMTEC shall check the machine to ensure that it has been assembled and installed in accordance with the instruction of the manufacturer. The AMTEC shall test the machine according to the specifications and conditions set by the manufacturer.

5.2 Test instruments and other materials

The suggested list of minimum field and laboratory test equipment and materials needed to carry out the grain collector test is shown in Annex A. These instruments shall be calibrated regularly. Before and after each test, these instruments shall be physically checked for operation and shall be cleaned, respectively. A checklist of instruments and materials to be used before departure to and from the testing area shall be prepared.

5.3 Test conditions

5.3.1 Test material

Grains (e.g., rice, corn, sorghum) to be used shall come from commonly or locally grown crops of single variety with moisture content as indicated in Table 1. The amount of test material to be supplied shall be sufficient for the required test trials, running-in,

and laboratory analyses. Specifically, the amount of test material shall be sufficient for at least 15 minutes of operation per test trial. Equal quantity of test material shall be used for all test trials. The test materials shall be prepared in such a way that they shall have identical characteristics when they are used for running-in period and in each test trial. If the test materials are not compliant with the recommended quantity and characteristics, the AMTEC test engineer shall not proceed with or shall suspend the test.

Table 1. Recommended moisture content of grains to be used as test materials.

Type of Grain	Moisture Content, $\%_{wb}$
Paddy/rice	≥ 22
Corn	≥ 22
Sorghum	16-20

5.3.2 Size of test plot

The test plot shall be rectangular with sides in the ratio of 2:1 as much as possible. The grains shall be spread evenly over the test plot at least 25 mm thickness. If the clearance from the ground of the collecting head is less than 25 mm, then the grain collector shall be tested at the maximum clearance. Equal size and conditions of test plot should be used for all test trials. If the test plots are not compliant with the recommended characteristics, the AMTEC shall not proceed with or shall suspend the test.

5.3.3 Traveling speed

The grain collector shall be tested at the manufacturer's recommended forward speed. If the machine has no manufacturer's recommended settings, it should be tested at a traveling speed of 1 to 2 kph.

5.4 Running-in and preliminary adjustments

The machine shall have undergone a running-in period before starting the test. During the running-in period, the various adjustments of the machine shall be made accordingly to the recommendation of the manufacturer. No adjustments shall be permitted during the test proper.

6 Pre-test Observation

6.1 Verification of specifications

The specifications claimed by the manufacturer and other physical details given in Annex B shall be verified by the AMTEC. A stable and level surface shall be used as reference plane for verification of dimensional machine specifications.

6.2 Test sample conditions

The crop conditions including source, variety, and grain dimensions, bulk density, moisture content and purity shall be obtained and recorded. Representative test samples shall be collected from the test material for analysis. Sampling procedure is shown in Annex C.

7 Performance Test

7.1 Operation of the grain collector

The grain collector shall be operated with load at the test site by the official representative of the test applicant using the recommended settings of the manufacturer and/or test applicant. The same recommended setting shall be maintained during the test operation. As part of the test, the AMTEC shall make all measurements and shall take the prescribed samples. After each test trial, the machine and area shall be cleaned and then prepared for the next test trial. This procedure shall be repeated for the succeeding test trials. No other adjustments shall be permitted during the test.

7.2 Test trials

A minimum of three (3) test trials should be conducted.

7.3 Data collection

7.3.1 Duration of test

The duration of each trial shall start when the grain collector begins to collect grains laid on the test plot and shall end once the last drop of grains from the grain outlet is collected in the sack. This shall also be referred to as the total operating time. The total operating time shall start when the collecting head starts collecting and shall end after the last grains are collected. The total nonproductive time shall be excluded from the total operating time.

7.3.2 Traveling speed

7.3.2.1 Outside the longer side of the test plot, mark two (2) points (A, B) approximately in the middle of the test plot as shown in Figure 3 to mark the traveling distance. These two points should be 5 m apart. On the opposite side, mark another two (2) points (C, D) in similar position and distance so that all four (4) points form corners of a rectangle, parallel to at least one long side of the test plot.

7.3.2.2 Calculate speed from the time required for the machine to travel the distance between the assumed line connecting two (2) points on opposite sides AC and BD. The reference point of the machine should be selected for measuring the time.

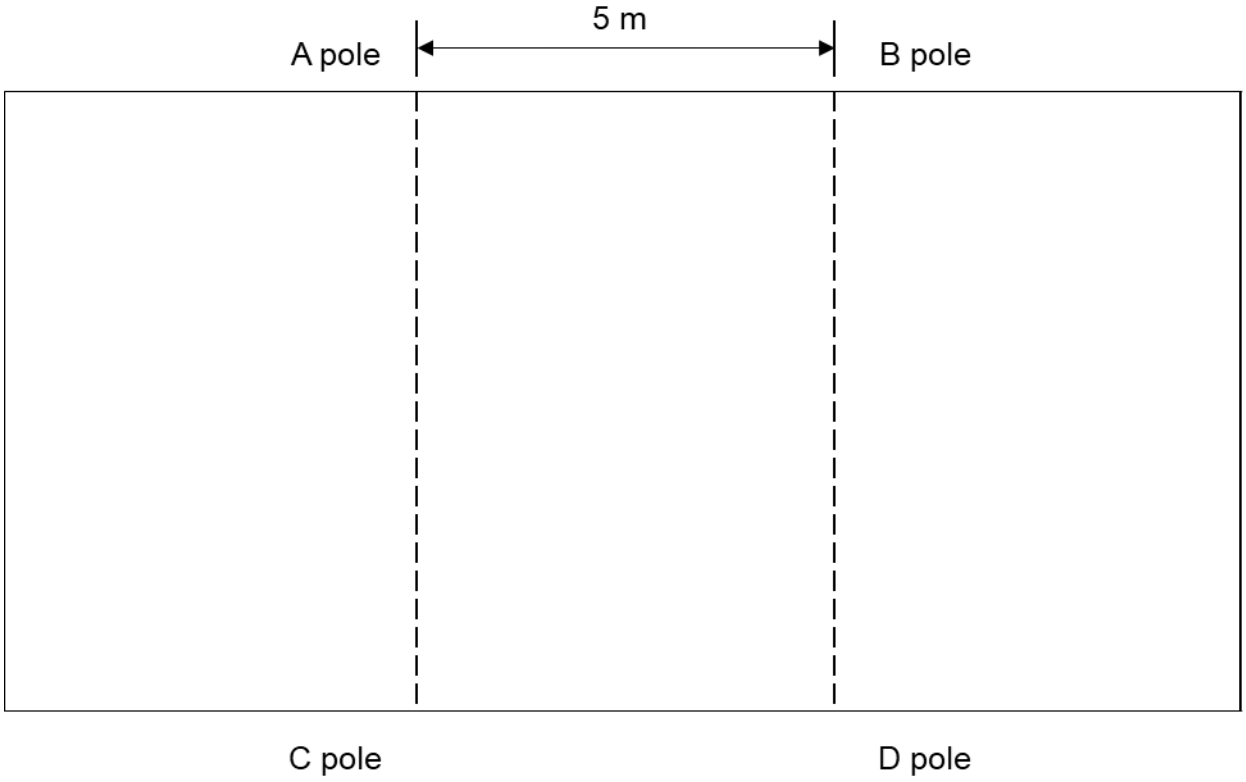


Figure 3. Measurement of operating/traveling speed

7.3.3 Collecting capacity

The total operating time, total nonproductive time, and weight of collected grains shall be recorded. The total nonproductive time shall include time for unloading of sack filled with grains, refilling of sacks, and adjustments, among others. Collecting capacity shall be calculated using the formulas in Annex G.

7.3.4 Uncollected losses

After each test trial, grains left on the test plot shall be collected and weighed to determine the uncollected losses.

7.3.5 Collecting efficiency

Weight of initially spread grains and weight of grains collected shall be determined and recorded. Collecting efficiency shall be calculated using the formula in Annex G.

7.3.6 Fuel consumption

7.3.6.1 The total operating time of the engine from the time it started until the time it stopped shall be recorded.

7.3.6.2 To get the amount of fuel consumed, refill method shall be used. Fill the tank to full capacity or to a certain level before the test. After the test, fill the tank with measured fuel to the same level before the test. When filling up the fuel tank, extra attention shall be paid to keep it horizontal and to ensure that empty space is not left inside.

7.3.7 Noise level

7.3.7.1 The sound emitted by the machine, with and without load, shall be measured using a sound level meter at the zone of the operator/s' ear level.

7.3.7.2 There shall be a minimum of five observations for each data to be taken. It should be ensured that the feed rate, speed, and other functional characteristics have stabilized before taking data. The time of recording shall be properly spaced during the whole duration of the test trial. There shall be at least ten (10) data or readings obtained.

7.4 Sampling

Random representative test samples shall be collected by the AMTEC for the analysis of the total grain losses, net percent cracked grains, and mechanically damaged grains. Sampling procedure is shown in Annex C.

7.5 Data recording and observations

The record sheet for all data and information during the test is given in Annex D. Necessary observations to be taken during the performance test shall also be recorded in this sheet.

8 Laboratory Analysis

Laboratory analysis shall be made to determine the test material conditions such as dimensions, bulk density, moisture content, and performance parameters including net cracked grains and broken/damaged grains. The laboratory procedures for the analyses are given in Annex E, while the data sheets to be used are given in Annex F.

9 Presentation of Results

Machine specifications and the results of the test shall be presented in tabular form in which data shall be taken from Annexes B and D. A photo of the machine with labeled parts shall also be included. Observations made on the machine while in operation shall be supported with photographs.

10 Formula

The formula to be used during calculations and testing are given in Annex G.

11 Test Report

The AMTEC test report shall include the following information in the order given.

11.1 Name of Testing Agency

11.2 Test Report Number

11.3 Title

11.4 Summary of Results

11.5 Observations

11.6 Purpose and Scope of Test

11.7 Methods of Test

11.8 Description of the Machine

11.9 Specifications

11.10 Results

11.11 Other Observations (include pictures)

11.12 Names, Signatures and Designation of Test Engineers and AMTEC Director

Annex A
(informative)

Minimum List of Field and Laboratory Test Equipment and Materials

A.1	**Field Test Equipment and Material**	**Quantity**
A.1.1	Timers Maximum resolution: 0.1 sec	2
A.1.2	Weighing scale Minimum capacity: 100 kg Maximum scale divisions: 0.2 kg	1
A.1.3	Measuring tape (at least 50 m)	1
A.1.4	Steel tape (at least 5 m)	1
A.1.5	Sound level meter Range: 30 to 130 dB(A)	1
A.1.6	Graduated cylinder Capacity: 1000 mL	1
A.1.7	Portable moisture meter (duly calibrated using the standard method)	1
A.1.8	Digital camera	1
A.1.9	Caliper Resolution: 0.05 mm	1
A.1.10	Sample bags	10
A.1.11	Labeling tags which include: Date of test Grain collector on test (Brand and Model) Trial number Crop Variety Source	10
A.2	**Laboratory Test Equipment and Materials**	**Quantity**
A.2.1	Analytical balance Sensitivity: 0.01 g	1
A.2.2	Air oven	1
A.2.3	Aluminum moisture can	6
A.2.4	Desiccator and desiccants	1
A.2.5	Bulk density tester/meter	1
A.2.6	Grain caliper Resolution: 0.025 mm	1
A.2.7	Vernier caliper Resolution: 0.05 mm	
A.2.8	Portable moisture meter (duly calibrated using the standard method)	1

Annex B
(informative)

Specifications of Grain Collector

Name of Applicant : _____
Address : _____
Tel. No. : _____

Name of Manufacturer : _____
Address : _____
Tel. No. : _____

GENERAL INFORMATION

Make : _____ Type : _____
Serial No. : _____ Brand/Model : _____
Date of Manufacture : _____
Testing Agency : _____ Test Engineer : _____
Location of Test : _____ Date of Test : _____

Item		Manufacturer's Specification	AMTEC Verification
B.1	Main structure		
B.1.1	Overall dimensions, mm		
B.1.1.1	Length		
B.1.1.2	Width		
B.1.1.3	Height		
B.1.2	Weight, without prime mover, kg		
B.2	Collecting capacity, kg/h		
B.3	Collecting system		
B.3.1	Collecting head		
B.3.1.1	Type		
B.3.1.2	Dimensions, mm		
B.3.1.3	Collecting width, mm		
B.3.1.4	Materials of construction		
B.3.2	Collecting conveyor		
B.3.2.1	Type		
B.3.2.2	Dimensions, mm		
B.3.2.3	Materials of construction		
B.3.3	Suction fan		
B.3.3.1	Type		
B.3.3.2	Dimensions, mm		
B.3.3.3	Number of blades		

Item		Manufacturer's Specification	AMTEC Verification
B.4	Bagging system		
B.4.1	Grain outlet		
B.4.1.1	Dimensions, mm		
B.4.1.2	Height from the sack platform, mm		
B.4.1.3	Location		
B.4.1.4	Materials of construction		
B.4.2	Sack mounting frame		
B.4.2.1	Dimensions, L x W, mm		
B.4.2.2	Location		
B.4.2.3	Materials of construction		
B.4.3	Sack platform		
B.4.3.1	Dimensions, L x W, mm		
B.4.3.2	Materials of construction		
B.5	Main frame		
B.5.1	Dimensions, L x W x T, mm		
B.5.2	Materials of construction		
B.6	Engine		
B.6.1	Brand		
B.6.2	Model		
B.6.3	Serial number		
B.6.4	Manufacturer or country of manufacture		
B.6.5	Type		
B.6.6	Rated power, kW		
B.6.7	Rated speed, rpm		
B.6.8	Displacement, cm^3		
B.6.9	Fuel type		
B.6.10	Fuel tank capacity, L		
B.6.11	Cooling system		
B.6.12	Starting system		
B.6.13	Weight, kg		
B.7	Safety features		
B.8	Special features		

Annex C
(normative)

Sampling Procedures

C.1 Sampling from Input Test Material

The condition of the test material shall be determined using three (3) representative samples which represent the different conditions of the material in the bulk, each weighing 1 kg. This is done by randomly taking samples at the top, middle, or bottom portions of the different sacks of the input grains. Half of the sample shall be used for laboratory analysis and the other half shall be used for reference purposes or for eventual second check in case of review.

C.2 Sampling from Grain Outlet

During each test trial, three (3) samples shall be collected at equal interval from the grain outlet which shall be analyzed in the laboratory for cracked grains and broken/damaged grains. The minimum amount of sample to be taken shall be twice as much as what is needed for a particular analysis. The excess sample shall be used for reference purposes or for an eventual second check in case of review.

C.3 Handling of Samples

All samples to be taken to the laboratory shall be placed in appropriate containers and shall be properly labeled. If the sample is to be used for determining moisture content, it shalls be kept in dry and airtight containers. Care should be taken so as to prevent alterations in the conditions of the test samples.

Annex D
(informative)

Performance Test Data Sheet

Test Trial No. : _____ Date : _____
Test Engineers : _____ Location : _____
Assistants : _____ Machine : _____
Test Applicant : _____ Manufacturer : _____

Item		Trial 1	Trial 2	Trial 3	Average
D.1	Condition of test materials				
D.1.1	Crop				
D.1.2	Source				
D.1.3	Variety				
D.1.4	Dimensions of grain, mm				
D.1.4.1	Length				
D.1.4.2	Width/Diameter				
D.1.4.3	Thickness				
D.1.5	Bulk density, kg/m^3				
D.1.6	Moisture content, $\%_{wb}$				
D.1.7	Purity, %				
D.2	Test conditions				
D.2.1	Dimensions of test plot				
D.2.1.1	Length, m				
D.2.1.2	Width, m				
D.2.1.3	Area, m^2				
D.2.1.4	Thickness of spread, mm				
D.3	Field performance				
D.3.1	Weight of grains spread, kg				
D.3.2	Weight of grains collected, kg				
D.3.3	Total operating time, h				
D.3.4	Total nonproductive time				
D.3.4.1	Unloading of filled sacks, h				
D.3.4.2	Refilling of sacks, h				
D.3.4.3	Others, h				
D,3.5	Traveling speed, kph				
D.3.6	Collecting capacity, kg/h				

Item		Trial 1	Trial 2	Trial 3	Ave
D.3.7	Total grain losses, kg				
D.3.7.1	Uncollected loss				
D.3.7.2	Other losses				
D.3.8	Collecting efficiency, %				
D.3.9	Noise level, dB(A)				
D.3.10	Fuel consumption rate, L/h				
D.4	Laboratory analysis				
D.4.1	Net cracked grains, %				
D.4.2	Broken/damaged grains, %				

D.5 Other Observations

D.5.1 Number of operators

_____

D.5.2 Cleaning of parts

_____
_____

D.5.3 Adjusting and repairing of parts

_____
_____

D.5.4 Transporting the machine

_____
_____

D.5.5 Handling and stability when the machine is working and turning

_____
_____

D.5.6 Safety features

_____
_____

D.5.7 Failures or abnormalities of the machine or its component parts during and after the operation

_____
_____

D.5.8 Other remarks

_____
_____

Annex E
(normative)

Laboratory Analysis

E.1 Determination of Grain Bulk Density

E.1.1 Randomly obtain samples from the representative samples of the input grain samples. The bulk density of each sample shall be measured using a bulk density tester/meter.

E.1.2 Fill the bulk density meter's measuring cup with samples at a standard height. Level the heap above the cup using a blunt ruler. Weigh the samples inside the cup and record the resulting weight. Replicate these steps five (5) times.

E.2 Determination of Grain Purity

E.2.1 Randomly take three (3) 500 g samples from the representative samples of the material.

E.2.2 Clean each sample to remove the impurities. Weigh the clean sample and record the resulting weight. Calculate the purity using the formula in Annex G.

E.3 Grain Moisture Content Determination by Air Oven Method

E.3.1 Manually remove all foreign matter from the sample. Randomly obtain three (3) 100 g of representative samples and place them in moisture cans. Ensure that no moisture is lost or gained by the sample between the time it was collected until it is weighed in a moisture can. Weigh and record all the initial weights.

E.3.2 Dry the samples in the oven with a temperature 100 ± 3 °C for 72 hours.

E.3.3 After removing the samples from the oven, place the moisture can with samples in a desiccator and allow them to cool in the ambient temperature.

E.3.4 Weigh the moisture can with the dried sample. Record the final weight. Calculate the moisture content using the formulas in Annex G.

E.4 Grain Moisture Content Determination by Moisture Meter

E.4.1 Randomly obtain at least five (5) representative samples. Ensure that no moisture is lost or gained by the sample between the time it was collected until its moisture content is determined.

E.4.2 Measure the moisture content of the samples using a calibrated moisture meter.

E.5 Determination of Net Cracked Grains

E.5.1 Obtain three (3) samples from each input test material sample and grain outlet sample. Each sample shall consist of 100 grains.

E.5.2 Inspect each sample for grains with fissures. Count these grains.

E.5.3 The net cracked grains shall be taken as the difference between the number of cracked grains obtained before and after collecting and bagging as presented in the formula in Annex G.

E.6 Determination of Broken/Damaged Grains

E.6.1 Obtain three (3) samples from each input test material sample and grain outlet sample. Each sample shall consist of 100 g.

E.6.2 For each sample, separate and weigh grains that were broken, crushed, or dehulled (partially or fully).

E.6.3 Compute for the net broken/damaged grains using the formula in Annex G.

E.7 Measurement of Average Grain Size or Dimension

E.7.1 Randomly take at least ten (10) pieces of samples from the representative samples of the material.

E.7.2 For each sample, measure the largest dimensions (e.g., diameter, length, width, thickness) using a caliper. Record the measurement to the nearest 0.01 mm.

Annex F
(informative)

Laboratory Analysis Data Sheet

Machine Tested: _____ Date Tested: _____
Analyzed by: _____ Date Analyzed: _____

F.1 Determination of Grain Bulk Density

Sample no.	Bulk density, kg/m^3
1	
2	
3	
4	
5	
Average	

F.2 Moisture Content (% wet basis) Determination of Input Grains by Air Oven

Item	Trial 1	Trial 2	Trial 3	Ave
Initial weight, g				
Final weight, g				
Moisture content, $\%_{wb}$				

F.3 Moisture Content (% wet basis) Determination by Moisture Meter

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Ave

F.4 Determination of Net Cracked Grains

Test Trial No.	Number of Cracked Grains								
	Before collecting and bagging				After collecting and bagging				Difference
	1	2	3	Ave	1	2	3	Ave	
1									
2									
3									
Ave									

F.5 Determination of Broken/Damaged Grains

Test Trial No.	Trial	Sample wt., g	Wt. of broken grains, g	Percentage
1	a			
	b			
	c			
	Ave			
2	a			
	b			
	c			
	Ave			
3	a			
	b			
	c			
	Ave			

F.6 Measurement of Average Grain Size or Dimension

Dimension	Trial										Ave
	1	2	3	4	5	6	7	8	9	10	

Annex G
(normative)

Formulas Used During Calculations and Testing

G.1 Average Grain Size or Dimension

$$\bar{x} = \frac{\sum x_j}{n}$$

where:

- x_j is the dimension (length, width, thickness, diameter) of individual sample (mm)
- n is the total number of samples
- $\bar{x}$ is the average size or dimension (mm)

G.2 Bulk Density

$$\rho_b = \frac{M_s}{V_s}$$

where:

- ρ_b is the bulk density (kg/m^3)
- M_s is the weight of sample (kg)
- V_s is the volume of sample (m^3)

G.3 Collecting Capacity

$$C_c = \frac{W_{gc}}{T - T_n}$$

where:

- C_c is the collecting capacity (kg/h)
- W_{gc} is the total weight of grains collected (kg)
- T is the total operating time (h)
- T_n is the total nonproductive time (h)

G.4 Collecting Efficiency

$$E_c = \frac{W_{gc}}{W_{gi}} \times 100$$

where:

- E_c is the collecting efficiency (%)
- W_{gc} is the total weight of grains collected (kg)
- W_{gi} is the total weight of grains initially spread (kg)

G.5 Fuel Consumption

$$F_c = \frac{F_v}{T_e}$$

where:

F_c is the fuel consumption (L/h)
F_v is the volume of fuel consumed (L)
T_e is the total operating time of engine (h)

G.6 Uncollected Loss

$$\%\, Uc_l = \frac{W_{gi} - W_{gc}}{W_{gi}} \times 100$$

$$\%\, Uc_l = 100 - E_c$$

where:

$\%\ Uc_l$ is the uncollected loss (%)
W_{gc} is the total weight of grains collected (kg)
W_{gi} is the total weight of grains initially spread (kg)

G.7 Wet-Basis Moisture Content

$$MC, \%_{wb} = \frac{M_0 - M_1}{M_0}\ x\ 100$$

where:

MC, $\%_{wb}$ is the wet-basis moisture content of sample (%)
M_0 is the initial weight of the sample (g)
M_1 is the weight of the dried sample (g)

G.8 Net Cracked Grains

$$NC_k = \frac{C_0 - C_1}{100\ grain\ sample}\ x\ 100$$

where:

NC_k is the is the net cracked grains (%)
C_0 is the number of cracked grains before collecting and bagging operation
C_1 is the number of cracked grains after collecting and bagging operation

G.9 Operating/Traveling Speed

$$S_o = \frac{3.6D_t}{T_t}$$

where:

S_o is the operating or traveling speed (kph)
D_t is the traveling distance (m)
T_t is the traveling time (s)

G.10 Broken/Damaged Grains

$$B_k = \frac{M_{bk}}{100\ g\ sample}\ x\ 100$$

where:

B_k is the percent broken/damaged grains (%)
M_{bk} is the weight of broken grains (g)

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