PHILIPPINE NATIONAL STANDARD

PNS/BAFS/PAES 213:2017

Agricultural Machinery – Coffee Huller – Methods of Test

DEPARTMENT OF AGRICULTURE

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Foreword

The implementation of Republic Act 10601 also known as the Agricultural and Fisheries Mechanization (AFMech) Law of 2013 mandated the Bureau of Agriculture and Fisheries Standards (BAFS) to develop standard specifications and test procedures for agricultural and fisheries machinery and equipment.

The Bureau, in collaboration with the Bureau of Agricultural and Fisheries Engineering (BAFE), concerned Department of Agriculture (DA) Bureaus, and attached agencies, Philippine Regulatory Board of Agricultural and Biosystems Engineering (PRB-ABE) and University of the Philippines Los Baños – Agricultural Machinery Testing and Evaluation Center (UPLB-AMTEC), embarked on a project entitled "Development of Philippine National Standard/ Philippine Agricultural Engineering Standard for Various Agricultural Machinery". This project covers the development of PNS for Coffee Huller.

In the Philippines, coffee is considered one of the most highly demanded crops. Arabica, Robusta, Excelsa and Liberica are four of the coffee varieties that can be grown in the country because of its climatic and soil condition. Currently, the country is involved in trading various coffee products such as green coffee bean (GCB), ground coffee, unground coffee. These products initially underwent coffee hulling process.

Coffee hulling is one of the primary processes in coffee production. It is the proper removal of hull or husks from the dried parchment coffee or dried coffee cherry which contributes in the production of high quality coffee products. Incorrect calibration or adjustment of coffee hullers may result to damaged or broken beans that will later lead to cup quality loss. The development of standard specifications and test procedures for coffee hullers is thus significant in preserving the overall quality of GCB.

This standard has been technically prepared in accordance with Bureau of Philippine Standards (BPS) Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

This standard will serve as reference for Agricultural and Biosystems Engineers (ABEs) in the preparation and evaluation of specifications and test reports for coffee hullers pursuant to Republic Act No. 10915 otherwise known as the Philippine Agricultural and Biosystems Engineering Act of 2016.

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 for coffee hullers. Specifically, it shall be used to:

1.1 verify the mechanisms, dimensions, materials and accessories of the coffee huller and the list of specifications submitted by the manufacturer;

1.2 determine the performance of the machine;

1.3 evaluate the ease of handling and safety features; and

1.4 report the results of the tests.

2 References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this National Standard:

PNS/PAES/BAFS 212:2017 Agricultural Machinery – Coffee Huller – Specifications

PAES 103:2000 Agricultural Machinery – Method of Sampling

3 Definitions

For the purpose of this standard, the definitions given in PNS/PAES/BAFS 212:2017 Agricultural Machinery – Coffee Huller – Specifications and the following shall apply:

3.1
foreign matter
impurity
all matters other than green coffee bean (GCB)

3.2
moisture content (wet basis)
amount of moisture in the coffee beans expressed as percent of the total weight of the sample

3.3
overall height
distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the huller

3.4
overall length
distance between the vertical planes at the right angles to the median plane of the huller and touching its front and rear extremities

3.5
overall width
distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the huller on its respective side

3.6
prime mover
used to run the coffee huller

3.7
running-in period
preliminary operation of the machine to make various adjustments prior to the conduct of the test until the operation is stable

3.8
test applicant
manufacturer, direct importer, or any legitimate distributor, dealer, or end-user of the machine

4 General Conditions for Test

4.1 Selection of coffee huller to be tested

Coffee huller submitted for testing shall be sampled in accordance to PAES 103:2000 Agricultural Machinery – Method of Sampling

4.2 Role of the test applicant

The test applicant shall submit specifications and other relevant information about the coffee huller. They shall abide with the terms and conditions set forth by the official testing agency, provide testing materials and shoulder other variable cost such as fuel, etc.

4.3 Role of the representative of the test applicant

An officially designated representative of 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 Test site conditions

The coffee huller shall be tested as installed for normal operation. The site should have ample provisions for material handling, temporary storage, workspace and suitable for normal working condition. Adequate ventilation and lighting shall be provided in the area.

4.5 Suspension/Termination of test

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. If the machine will not be able to continue operation, the test shall be terminated.

5 Test Preparation

5.1 Preparation of the coffee huller for testing

The representative of the test applicant and testing agency shall check the coffee huller so as to ensure that the huller has been assembled and installed in accordance with the instruction of the manufacturer. The official testing agency will test the coffee huller according to the desired output of 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 coffee huller test is shown on Annex A. These instruments should be calibrated regularly. It shall be physically checked and cleaned for operation before and after each test. A checklist of instruments and materials shall be prepared before departure to and from the testing area.

5.3 Test Materials

Dried parchment coffee or dried coffee cherry to be used shall be from commonly or locally grown coffee variety with 9%-12% moisture content (wet basis). If the machine uses rubber roll huller, dried parchment coffee shall be used. The amount of test material to be supplied shall be sufficient for the required test trials, running-in, and laboratory tests. At least three (3) trials shall be conducted with minimum duration of fifteen (15) minutes per trial. However, if the test materials are not conforming to the recommended quantity and characteristics, the test engineer shall not pursue the test.

5.4 Running-in and preliminary adjustments

The coffee huller 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 according to the recommendation of the manufacturer.

NOTE No other adjustments shall be permitted during the test.

6 Pre-test Observation

6.1 Verification of specifications

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

6.2 Test samples

Random representative test samples shall be collected from the test material for the determination of moisture content. Samples shall be prepared in such a way that test sample to be used for the running-in and in each test trial have identical characteristics in terms of moisture content and variety. Care should be taken so as to prevent alterations of the conditions of the test samples. Sampling procedure is shown in Annex C.

7 Performance Test

7.1 Operation of the coffee huller

The coffee huller shall be operated for sufficient duration with load at the test site by the official representative of the test applicant using the manufacturer's recommended setting. The same setting recommended by the manufacturer shall be maintained during the test run. The testing agency shall make all measurements, which form part of the test and take the prescribed samples. After the test run, the area shall be cleaned and then prepared for the next test trial. This procedure shall be repeated for the succeeding test trials.

7.2 Test trials

A minimum of three (3) test trials, with duration of at least fifteen (15) minutes per trial, shall be adopted.

7.3 Sampling

Samples shall be collected at different outlets using each test trial. Sampling procedure is shown in Annex C.

7.4 Data Collection

7.4.1 Duration of test

The duration of each test trial shall start from the feeding of the test materials into the hulling mechanism (first drop) and ends at the last drop of the test materials from the GCB outlet.

7.4.2 Noise level

The noise emitted by the machine, with or without load, shall be measured using a noise level meter at the location of the operator(s). The noise, expressed in decibel [dB (A)], shall be measured approximately 50 mm away from the ear level of the operator(s).

7.4.3 Power requirement/Fuel consumption

The procedure for determining power requirement/fuel consumption is given in Annex C.

7.4.4 Speed of components

The speed of the rotating shafts of the major components of the coffee huller shall be taken using a tachometer.

NOTE Measurements shall be taken with and without load.

7.5 Data Recording and Observations

Record sheet for all data and information during the test is given in Annex D. Observations to be taken during the performance test shall be recorded in this sheet.

8 Laboratory Analysis

Laboratory analysis shall be made to determine the moisture content, purity, blower loss, percent unhulled GCB and percent mechanically damaged bean. The laboratory procedure to be followed in the analysis is given in Annex E while the data sheet is 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 schematic diagram of the power transmission system shall also be included. Observations made on the machine while in operation shall be supported with photographs.

10 Formula

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

11 Test Report

The test report shall include the following information in the order given:

11.1 Title

11.2 Summary of Results (including the performance compared with the criteria)

11.3 Purpose and Scope of Test

11.4 Methods of Test

11.5 Conditions of the Machine

11.6 Description of the Machine

11.7 Results and Discussions

11.8 Observations (include pictures)

11.9 Names and Signatures of Test Engineers

12 Bibliography

Mutua, Joackim (2000). Postharvest Handling and Processing of Coffee in African Countries. Food and Agriculture Organization - Agro Industries and Post-Harvest Management Service

PAES 221:2004 Agricultural Machinery – Peanut Sheller – Methods of Test

Annex A
(informative)

Minimum List of Field and Laboratory Test Equipment and Materials

A.1 Field Test Equipment and Materials

EQUIPMENT/MATERIAL	QUANTITY
A.1.1 Hand-held Tachometer	1
A.1.2 Stop Watch	2
A.1.3 Measuring Tape	1
A.1.4 Noise Level Meter	1
A.1.5 Weighing Scale Capacity: at least 100 kg Resolution: 0.1 kg	1
A.1.6 AC/DC Power Meter/Multimeter	1
A.1.7 Camera	1
A.1.8 Graduated cylinder Capacity: at least 500 mL	1

A.2 Laboratory Test Equipment and Materials

EQUIPMENT/MATERIAL	QUANTITY
A.2.1 Digital Weighing Scale Resolution: 0.01 g	1
A.2.2 Laboratory oven	1
A.2.3 Desiccators	1
A.2.4 Aluminum Moisture Cans	9
A.2.5 Sample Bags	20
A.2.6 Labeling Tags which include: Date of Test Coffee Huller on Test Sample Source Variety Trial Number	20

Annex B
(informative)

Specifications of Coffee Huller

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

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

General Information:
Serial No. : _____ Brand/Model : _____
Classification : _____ Make : _____
Production date of the machine to be tested: _____

Item*	**Manufacturer's Specification**	**Verification by the Testing Agency**
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 the prime mover (kg), if applicable		
B.2 Rated hulling capacity (kg/h)		
B.2.1 Parchment coffee		
B.2.2 Coffee cherry		
B.3 Prime mover		
B.3.1 Electric motor		
B.3.1.1 Brand		
B.3.1.2 Model		
B.3.1.3 Serial Number		
B.3.1.4 Make		
B.3.1.5 Rated power (kW)		
B.3.1.6 Rated speed (rpm)		
B.3.1.7 Electric service required (single phase or 3-phase)		
B.3.1.8 Voltage (V)		
B.3.1.9 Current (A)		
B.3.1.10 Frequency (Hz)		
B.3.2 Engine		
B.3.2.1 Brand		
B.3.2.2 Model		
B.3.2.3 Make or manufacturer		
B.3.2.4 Type		

B.3.2.5 Serial number		
B.3.2.6 Rated power (kW)		
B.3.2.7 Rated speed (rpm)		
B.3.2.8 Displacement (cm^3)		
B.3.2.9 Cooling system		
B.3.2.10 Starting system		
B.3.2.11 Power transmission system		
B.4 Hopper		
B.4.1 Overall dimensions (mm)		
B.4.1.1 Length		
B.4.1.2 Width		
B.4.1.3 Height		
B.4.2 Height from the ground (mm)		
B.4.3 Material		
B.4.4 Location		
B.4.5 Means of attachment		
B.5 GCB Outlet		
B.5.1 Overall dimensions (mm)		
B.5.1.1 Length		
B.5.1.2 Width		
B.5.1.3 Height		
B.5.2 Height from the ground (mm)		
B.5.3 Material		
B.5.4 Location		
B.5.5 Means of attachment		
B.6 Hulling Mechanism		
B.6.1 Type		
B.6.2 Dimension, L x W x T (mm)		
B.6.3 Means of attachment		
B.6.4 Material		
B.7 Safety devices		
B.8 Special features		

*The parameter will be checked upon availability.

B.9 Illustration of transmission system

Annex C
(normative)

Sampling Procedures and Measurements

C.1 Sampling Procedures for Dried Parchment Coffee or Dried Coffee Cherry Input

The conditions of the dried parchment coffee or dried coffee cherry input such as moisture content and percent initially damaged bean to be used in each test shall be taken using three (3) "representative samples", which represent the different conditions of input in the bulk. This is done by randomly taking samples at the top, middle and bottom portions of the bulk. Half of the sample shall be used for laboratory analysis and the other half shall be used for reference purposes or for an eventual second check in case of review. Samples representing the materials for each test trial shall be placed in appropriate containers for laboratory analysis.

C.2 Sampling from GCB Outlet

Using a plastic bag or an appropriate container, randomly collect three (3) samples of at least 500 g each for purity and three (3) samples of at least 100 g each for mechanically damaged bean determination.

C.3 Sampling from Blower Outlet

During the test, three samples shall be randomly taken from the fan outlet for duration of at least fifteen (15) seconds per collection. These samples shall be placed in appropriate containers and labeled as blower loss.

C.4 Handling of Samples

All samples to be used must be properly labeled and kept in airtight, dry and food grade containers.

C.5 Other Measurements Required During the Test Run

The speed of rotating components and noise level at operator's location shall be taken. For each data, there shall be a minimum of five (5) observations. These shall be taken with and without load. Before taking the data, it should be ensured that the feed rate, speed and other functional characteristics have stabilized.

C.5 Measurement of Power Requirement/Fuel Consumption

C.5.1 Using electric motor as prime mover

Use a power meter to measure the voltage, current, and the total electric power requirement of the coffee huller. There shall be three (3) sets of data with a minimum of five (5) observations per set taken with and without load.

C.5.2 Using engine as prime mover

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
(informative)

Performance Test Data Sheet

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

Items	Trial 1	Trial 2	Trial 3	Average
D.1 Conditions of dried parchment coffee or dried coffee cherry				
D.1.1 Source				
D.1.2 Variety				
D.1.3 Moisture content (%)				
D.1.4 Bean dimension (L x W x Thickness) (mm)				
D.1.5 Coffee bean bulk density (kg/m^3)				
D.2 Weight of input (kg)				
D.3 Input capacity (kg/h)				
D.4 Operating time (h)	`			
D.5 Hulling capacity (kg/h)				
D.6 Specific energy consumption (kW-h/kg)				
D.7 GCB (kg)				
D.8 Speed of components (rpm)				
D.8.1 Prime mover				
D.8.1.1 Without load				
D.8.1.2 With load				
D.8.2 Hulling shaft				
D.8.2.1 Without load				
D.8.2.2 With load				
D.9 Noise level [dB (A)]				
D.9.1.1 Without load				
D.9.1.2 With load				
D.10 Power requirement				
D.10.1 Power (kW)				
D.10.1.1 Without load				
D.10.1.2 With load				
D.10.2 Current (A)				
D.10.2.1 Without load				
D.10.2.2 With load				
D.10.3 Voltage (V)				
D.10.3.1 Without load				
D.10.3.2 With load				

D.11 Fuel consumed (L)				
D.12 Fuel consumption (L/h)				

D.13 Other Observations

D.13.1 Ease of transporting the machine

_____
_____
_____
_____

D.13.2 Ease of cleaning the machine

_____
_____
_____
_____

D.13.3 Ease of adjusting and repairing of parts

_____
_____
_____
_____

D.13.4 Ease of loading input and collecting output

_____
_____
_____
_____

D.13.5 Safety

_____
_____
_____
_____

D.13.6 Labor Requirements

_____
_____
_____
_____

D.13.7 Failure or abnormalities that may be observed on the machine or its component parts during and after the cleaning operation.

_____
_____
_____
_____

D.12.8 Others

_____
_____
_____
_____

Annex E
(normative)

Laboratory Analysis

E.1 Purity Determination

Take three (3) 500 g samples of GCB. Clean the samples to remove foreign matters, the clean sample shall be weighed and recorded.

E.2 Moisture Content Determination

At least five (5) representative samples of 25 g each shall be taken randomly for moisture content determination, preferably using the Air-Oven Drying Method.

E.3 Determination of Unhulled Coffee Bean

Unhulled coffee beans collected at the GCB outlet shall be manually hulled and weighed. The total weight and time of collection shall be taken and recorded for the computation of unhulled coffee bean.

E.4 Determination of Blower Loss

Three (3) samples taken from the blower outlet shall be cleaned and weighed. The blown unhulled coffee bean shall be manually hulled and weighed. The total weight of the blown GCB and the total time of collection shall be recorded for the computation of the blower loss.

E.5 Determination of Input GCB

Take three (3) 100 g samples from the dried parchment coffee or dried coffee cherry input. Manually hull and record the weight of GCB. This will be used for the computation of theoretical GCB input and initially damaged beans.

E.6 Determination of Mechanically Damaged Bean

Take three (3) 100 g samples from the GCB outlet. Separate the beans that were broken or crushed, then weigh. Perform the same procedure to the GCB obtained from the determination of input GCB. Beans shall be labeled as damaged after operation and initially damaged beans, respectively. These shall be used for the computation of percent mechanically damaged bean.

Annex F
(informative)

Laboratory Analysis Data Sheet

Machine Tested: _____ Analyzed By: _____
Date of Test: _____ Date Analyzed: _____

F.1 Dried Parchment Coffee or Dried Coffee Cherry Conditions
F.1.1 Moisture Content (% wet basis)

Average					

F.1.2 Loss Determination

TRIAL	**Blower Loss**	
	Duration:	
	Sample Wt. Kg	**Total Kg**
1- a		
b		
c		
Ave.		
2- a		
b		
c		
Ave.		
3- a		
b		
c		
Ave.		

F.1.3 Percent Mechanically Damaged Bean Determination

ITEMS		**Trial 1**				**Trial 2**				**Trial 3**				**General Average**
		a	b	c	Ave	a	B	c	Ave	a	b	c	Ave	
Dried parchment coffee or dried coffee cherry Inlet	Sample wt. (g)													
	Total wt. (g)													
GCB Outlet	Sample wt. (g)													
	Total wt. (g)													

F.2. Product Analysis (Hulling Efficiency/Hulling Recovery Determination)

	Trial 1	**Trial 2**	**Trial 3**	**Average**
A Initial weight of input dried parchment coffee or dried coffee cherry (g)				
B Weight of GCB in the GCB outlet (g)				
C Weight of unhulled coffee bean in the GCB outlet (g)				

F.3 Purity Determination

ITEMS	**Trial 1**				**Trial 2**				**Trial 3**				**General Average**
	a	b	c	Ave	a	B	c	Ave	a	b	c	Ave	
Cleaned (g)													
Purity (%)													

Annex G
(normative)

Formula Used During Calculations and Testing

G.1 Moisture Content

$$MC_{wb} = \frac{W_i - W_f}{W_i} \; x \; 100$$

where:

MC_{wb} is the moisture content (%)
W_i is the initial mass of the sample (g)
W_f is the final mass of the sample (g)

G.2 Capacity

G.2.1 Hulling

$$C_h = \frac{W_i}{T}$$

where:

C_h is the hulling capacity (kg/h)
W_i is the weight of input dried parchment coffee or dried coffee cherry (kg)
T is the total operating time (h)

G.2.2 Input

$$C_i = \frac{W_i}{T_i}$$

where:

C_i is the input capacity (kg/h)
W_i is the weight of input dried parchment coffee or dried coffee cherry (kg)
T_i is the input time (h)

G.2.3 Output

$$C_o = \frac{W_o}{T_o}$$

where:

C_o is the output capacity (kg/h)
W_o is the weight of cleaned GCB collected at the GCB outlet (kg)
T_o is the output time (h)

G.3 Input GCB

$$I = \frac{W_h}{N}\ x\ W_i$$

where:

I is the input GCB (kg)
W_h is the weight of the manually hulled GCB (g)
W_i is the weight of input dried parchment coffee or dried coffee cherry (kg)
N is the 100-gram sample

G.4 Hulling Recovery

$$H_r = \frac{W_c}{W_i}\ x\ 100$$

where:

H_r is the hulling recovery (%)
W_c is the weight of cleaned GCB collected at the GCB outlet (kg)
W_i is the weight of input dried parchment coffee or dried coffee cherry (kg)

G.5 Hulling Efficiency

$$H_e = \frac{W_b + W_o}{I}$$

where:

H_e is the hulling efficiency (%)
W_b is the weight of cleaned blown GCB (kg)
W_o is the weight of cleaned GCB collected at the GCB outlet (kg)
I is the input GCB (kg)

G.6 Unhulled Coffee Bean

Amount

$$U = \frac{W_u}{T_c} T_o$$

where:

U is the unhulled coffee bean (kg)
W_u is the weight of unhulled coffee bean in the sample (kg)
T_c is the duration of collection (h)
T_o is the duration of operation (h)

Percentage

$$U = \frac{W_u}{I}\ x\ 100$$

where:

U is the unhulled coffee bean (%)
W_u is the weight of unhulled coffee bean in the sample(kg)
I is the input GCB (kg)

G.7 Purity

$$P = 1 - \frac{W_{im}}{W_{ucl}}\ x\ 100$$

where:

P is the purity (%)
W_{im} is the weight of impurities (g)
W_{ucl} is the weight of uncleaned GCB (g)

G.8 Blower Loss

Amount

$$B_l = \frac{W_b}{T_c} T_o$$

where:

B_l is the blower loss (kg)
W_b is the weight of blown GCB and GCB in blown unhulled coffee bean in the sample (kg)
T_c is the duration of collection (h)
T_o is the duration of operation (h)

Percentage

$$B_l = \frac{W_b}{I}\ x\ 100$$

where:

B_l is the blower loss (%)
W_b is the weight of blown GCB and GCB in blown unhulled coffee bean in the sample (kg)
I is the input GCB (kg)

G.9 Mechanically damaged bean

$$MD_b = \frac{W_{mdf} - W_{mdi}}{N} \; x \; 100$$

where:

MD_b is the mechanically damaged bean (%)
W_{mdf} is the weight of mechanically damaged bean after operation (g)
W_{mdi} is the weight of initially damaged bean (g)
N is the 100 gram sample

G.10 Fuel/Electric energy consumption

G.10.1 Fuel consumption

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

where:

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

G.10.2 Electric energy consumption

$$E_c = P_c \; x \; T$$

where:

E_c is the electric energy consumption (kW-h)
P_c is the amount of power consumed (kW)
T is the total operating time (h)

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