Foreword

The formulation of this standard PAES 203:2000, Agricultural Machinery: Moisture Content Determination for Rice and Corn was initiated by Agricultural Machinery Testing and Evaluation Center (AMTEC) through the project "Standardization of Postharvest Machinery Testing and Evaluation" funded by the Bureau of Postharvest Research and Extension (BPRE) of the Department of Agriculture (DA).

This formulated standard was reviewed by the Study Team for the Formulation of Standards for Grain Dryer and by the Technical Committee on Postharvest Machinery and was circulated to various private and government agencies/organizations concerned for their comments and reactions. This standard was presented to the Philippine Society of Agricultural Engineers (PSAE) and subjected to a public hearing organized by the National Agriculture and Fisheries Council (NAFC).

This standard has been technically drafted in accordance with PNS 01: Part 4:1998 – Rules for the Structure and Drafting of Philippine National Standards.

The following were specified in the standard:

- calibration procedures to be followed;
- methods of sample size reduction;
- grain sampling procedures; and
- procedures on moisture content determination during the test.

In the preparation of this standard, the following publications/documents were considered:

ISO/DIS 11520-1	Agricultural Grain Dryers – Determination of Drying Performance
ISO 711:1985	Cereals and Cereal Products – Determination of Moisture Content (Basic Reference Method)
ISO 712:1985	Cereals and Cereal Products – Determination of Moisture Content (Routine Reference Method)
ISO 950:1979	Cereals – Sampling (as grain)
ISO 2170:1980	Cereals and Pulses – Sampling of Milled Products
ISO 6540:1980	Maize – Determination of Moisture Content (Basic Reference Method)

Part 16 and 17 of the regional Network for Agricultural Machinery Test Codes and Procedures for Continuous Flow and Batch Rice Dryers

NFA Standard Calibration Procedure – Grains Meter Calibration for Standard Laboratory Procedure

PHILIPPINE AGRICULTURAL ENGINEERING STANDARD PAES 203:2000

Moisture Content Determination for Rice and Corn

1 Scope

This standard specifies the methods for determining the moisture content of rice and corn for mechanical grain dryer testing. Specifically, this shall be used for the following:

1.1 calibration of the moisture meter to be used during dryer tests in reference with the primary method (oven method);

1.2 grain sampling procedures to be undertaken;

1.3 determination of moisture content of grains during tests.

2 Definition

2.1
moisture content
amount of moisture in the grain expressed as percentage of the total weight of the sample, wet basis

NOTE calculated as:

$$\text{Moisture Content, \% w.b.} = \frac{Mo - M_1}{Mo} \times 100$$

Where:
M_o = initial mass in grams of the test portion
M_1 = mass in grams of the dry test portion

2.2
primary method
method of grain moisture determination based on actual extraction of water either by convection heating (oven method) or distillation

2.3
secondary method
method of grain moisture determination based on some characteristics of the grain sample such as electrical resistance and capacitance which are related to moisture content and must be periodically calibrated against an official primary method

3 Apparatus

3.1 analytical balance
accurate balance graduated to permit 0.001g reading and accuracy of ± 0.001g

3.2 desiccator
clean, heavy glass with ground-on cover with knob, and should contain standard desiccant (i.e. silica gel)

3.3 grinding mill – laboratory mill, having the following characteristics:

3.3.1 made of material which does not absorb moisture;

3.3.2 easy to clean and having as little dead space as possible;

3.3.3 enabling grinding to be carried out rapidly and uniformly, without appreciable development of heat and as far as possible without contact with the outside air.

3.4 moisture dishes
drying containers with lid, having a diameter of at least 50 mm. (Aluminum/pyrex glass drying containers with cover, capacity = 30ml with 50 mm diameter.)

3.5 oven
ventilated drying oven with temperature range that can be regulated

3.6 secondary moisture meters (e.g. capacitance type, resistance type etc.)

3.7 sampling apparatus (e.g. sack-type spears or triers, shovels etc.)

4 Calibration

The moisture meter shall be calibrated every six (6) months. The calibration procedures to be followed are given in Annex A.

5 Methods of sample size reduction

5.1 Using sample divider

This device consists of a hopper mounted over a cone, which has a number of small collecting bins around its base. In operation, the divider is set on a level surface. The bulk sample is poured into the hopper with its bottom outlet closed by a disc or platen gate. When the disc or plate is pulled out sideways the grain will flow evenly around the cone and get caught in the collecting bins. Every other collecting bin is discarded and the remaining grains mixed again to form a sub-bulk sample. The process is repeated until the desired size of the sample is obtained.

5.2 Through coning and quartering

In order to get a more accurate information of the test lot, there shall be as many samples as possible. However, in most cases the size of sample collected is large, making it difficult to manage. A method that may be used to reduce these samples to a manageable level and yet still possess the same characteristic elements present in the whole population is called coning and quartering. This method can be performed by the following:

5.2.1 Thoroughly mix all specific samples where a reduced quantity is required as to contain heavy and light materials, dust and other impurities in the same proportion.

5.2.2 Heap the sample into a cone-shape.

5.2.3 Using a rectangular or sharp-edge stick, level the upper portion of the cone.

5.2.4 Divide the sample into four equal parts by cutting vertically using the same sharp-edge stick.

5.2.5 Discard the two opposite parts and retain the other two parts.

5.2.6 If the resulting sample size is still unmanageable, repeat the whole procedure until a manageable quantity is obtained.

6 Methods of grain sampling

6.1 Sampling from materials in bulk

Approximately divide the grain bulk into 4 lots. From each lot, take 50 samples of not less than 100 g each and bulk to provide one sample of about 5 kg. Reduce the sample from 5-kg bulk sample to 2-kg sample.

6.2 Sampling from materials in bags or pre-packed units

Test samples shall be taken from different parts of the bag (for example, top, middle and bottom) by means of a sack-type spear from the number of bags specified in Table 1.

Table 1 – Number of bags to be sampled

Test materials	To be sampled
Up to 10	Each bag
10 to 100	10, taken at random
More than 100	Square root (approximately) of total number, taken according to a suitable sampling scheme

Obtain 100g sample from each sample points and bulk. Reduce the size of the sample.

7. Moisture content determination during the test

7.1 Choice of sampling points

To determine the average condition of the output grain, sampling should be done after any device in the grain handling line, which mixes the grain, e.g., screw conveyor. If grain is discharged in batches from the dryer or from a hopper, e.g., in bags or sacks, care should be taken that samples taken are representative of the batch, as the properties of the first, middle and last grain in the batch may vary significantly. Samples may be taken from the dryer itself to determine the properties inside the machine.

7.2 Quantity per sample

For each sample at least 50 g of grain shall be taken from one-liter volume of grain taken from the grain stream.

7.3 Frequency of sampling for grain moisture content

7.3.1 Continuous flow dryers

The frequency of sampling from the outgoing grain stream(s) shall be such that a minimum of 12 samples is obtained, spaced evenly over a test period. The timing and frequency of sampling of the outgoing grain stream shall be such that (a) the grain sampled corresponds with that which will leave the dryer during the test period, and (b) a minimum of 12 sampling intervals.

7.3.2 Batch dryers

At least 12 samples from the batch of grain to be dried shall be taken, spaced evenly over the loading period. Samples shall be taken from different portions of the dryer (bottom, middle and top). At least 50 samples randomly taken from the batch of dried grain shall be taken during unloading.

7.4 Moisture content determination

Moisture content measurements should be measured when the grain has cooled to ambient temperature. Moisture meters, which operate on the principle of changes in capacitance or resistance with the moisture content of the grain sample, can be used during dryer test. Manufacturer’s instructions should be followed to obtain accuracy and precision.

Annex A
Grains Moisture Meter Calibration
For Standard Laboratory Procedure

A.1 Apparatus

Refer to Section 3 Apparatus.

A.2 Sample preparation

A.2.1 Collect 3-kg original samples of homogenous variety to be used in calibration.

A.2.2 Pass the entire grain sample through a grain sieve (aspirator) to make sure that the grain samples are pure and free from impurities.

A.2.3 Weigh 10 samples of approximately 250 g and place in airtight plastic film bags or test sample bottles. The quantity of each sample in the test sample container should exceed the quantity that will be taken by the moisture meter to be calibrated.

A.3 Test procedure

A.3.1 Grinding – adjust the grinding mill. Grind a small quantity of the laboratory sample and discard it. Then quickly grind a quantity of the laboratory sample approximately 15g to allow for a duplicate analysis. For rough rice, grind for 30 seconds; 25 seconds for milled rice.

A.3.2 Rapidly weigh 5g of ground material into each dishes (previously pre-heated and tared, together with its lid to the nearest 0.001g.The weighed dishes are placed in the desiccator until all the weighings have been carried out on the rest of the samples.

A.3.3 Drying – Place all 30 dishes (3 for each samples) containing the test portion together with the lid, in the oven which has been pre-heated to 130^{o}C and leave for 120 minutes $\pm$ 5 minutes for rice and 240 minutes $\pm$ 5 minutes for corn.

A.3.4 Rapidly take the dish out of the oven, cover it and place it in the desiccator. When the dish has cooled to laboratory temperature (between 40 minutes and 45 minutes) after it has been placed in the desiccator, weigh it to the nearest 0.001g.

A.3.5 Calculate the moisture content of each sample, expressed as percentage by weight, wet basis, as follows:

$$\text{Moisture Content, \% w.b.} = \frac{M_o - M_1}{M_1} \times 100$$

Where:

M_o = initial mass in grams of the test portion
M_1 = mass in grams of the dry test portion

A.3.6 Test each sample (portion of sample remaining in the container) with the moisture meter to be calibrated and repeat the test three to five times to ensure reliable results.

A.3.7 Calculate the average values of the obtained moisture content for both oven and given meter. Use the results of the oven tests as reference points to evaluate the grain moisture meter.