

Foreword

The pursuance of this standard PAES 202:2000, Agricultural Machinery: Heated-Air Mechanical Grain Dryer – Methods of Test 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 (BPRES) of the Department of Agriculture (DA).

This 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 pursued in accordance with PNS 01: Part 4:1998 – Rules for the Structure and Drafting of Philippine National Standards.

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

ISO/DIS 11520-1 Agricultural Grain Dryers – Determination of Drying Performance

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

Status of Grain Dryers in the Philippines by Justin Tumambing, paper presented at the workshop of Standardization for grain dryers. NAPHIRE, Nueva Ecija.

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Agricultural Machinery – Heated-Air Mechanical Grain Dryer – Methods of Test

1 Scope

This standard specifies the methods of test to determine the following performance characteristics of grain dryers.

1.1 Heating System

1.1.1 Heating system efficiency

1.1.2 Combustion efficiency

1.1.3 Burner/Furnace efficiency

1.1.4 Fuel consumption

1.2 Drying System Performance

1.2.1 Drying capacity

1.2.2 Moisture reduction per hour (per pass)

1.2.3 Heat utilization

1.2.4 Drying efficiency

1.2.5 Drying system efficiency

1.2.6 Electric power consumption

1.3 Quality of dried grains

1.3.1 Cracked grain (for rice and corn)

1.3.2 Milling quality (for rice only)

1.3.3 Hulled/Damaged grain (for rice)

1.3.4 Broken/Split kernel (for corn)

1.3.5 Moisture content gradient

1.3.6 Final moisture content

1.4 Others (e.g. Scattered grains)

2 References

The following document contains provisions, which, through reference in this text, constitute provisions of this Standard:

PAES 201:2000 Agricultural Machinery: Heated-Air Mechanical Grain Dryer – Specifications

PNS 556-1991: Agricultural Machinery: Method of Sampling.

3 Definitions

For the purpose of this standard the definitions given in PAES 201:2000 and the following shall apply:

3.1

airflow rate

volume of air in cubic meters delivered to the mass of grains per second

3.2

burner efficiency

furnace efficiency

ratio of the heat supplied by the burner/furnace, to the heat released by the fuel

3.3

combustion efficiency

ratio of the heat released by the fuel, to the theoretical heat available from the fuel

3.4

conventional energy source

source of energy which includes petroleum-based fuels such as kerosene, gasoline, diesel oil and bunker fuel oil

3.5

damaged grains

grains which are heat damaged, weather damaged, sprouted or distinctly damaged by insects, water, fungi and/or any other means

3.6

drying air temperature

mean temperature of the air to be used for drying the grain, measured at a number of points as close as practicable to its entry to the grain bed

3.7

drying rate

amount of water removed per unit of time, expressed in kilogram per hour

3.8

drying system efficiency

ratio of the total heat utilized for drying, to the heat available in the fuel expressed in percent

3.9

foreign matter

all matters other than rice/corn grains such as sand, gravel, dirt, pebbles, stones, lumps of earth, clay, mud, chaff, straw, weed seeds and other crop seeds

3.10

fuel consumption

total amount of fuel consumed divided by the total drying time

3.11

grain holding capacity

load capacity

continuous flow dryer: weight of grain in the dryer after a period of stable operation

batch type dryer: weight of grain required to fill the dryer at the input moisture content

3.12

heat utilization

total amount of heat utilized to vaporize moisture in the material, expressed in kJ/kg of H₂O

3.13

immature grains

palay which are light green and chalky with soft texture

3.14

moisture reduction rate

ratio of the average percent moisture content removed from the grain, to drying time, expressed in percent per hour

3.15

non-conventional energy source

source of energy that includes non-petroleum based fuels such as biomass and solar energy

3.16

purity

percentage of grains free of foreign matter

3.17

scattered grains

ratio of the weight of grains that fell out from the machine during the drying operation, to the weight of the total grain input to the dryer, expressed in percent

3.18

static pressure

pressure build-up in the plenum chamber to maintain uniform distribution of air flow through the grain mass, expressed in Pascal

3.19

tempering

temporarily holding the grain between the drying passes, allowing the moisture content in the center of the grain and that on the surface of the grain to equalize

4 General conditions for test and inspection

4.1 Machine on test

The machine on test shall be commercially produced or prototype unit or slightly used machine depending upon the test objective. In case of testing commercially manufactured dryers, the dryer sampled for acceptance, lot, routine, and type tests in accordance with “PAES 103:2000 – Agricultural Machinery – Method of Sampling” shall be submitted for test.

4.2 Role of manufacturer/dealer

The manufacturer/dealer shall make the dryer for testing available to an authorized testing agency together with its specifications and other relevant information (Annex A or B). An authorized manufacturers/dealer’s representative shall be appointed to repair, handle, adjust and witness the test. It shall be the duty of the representative to make all decisions on matters of adjustment and preparation of the machine for testing. The manufacturer shall abide with the terms and conditions set forth by the authorized testing agency. The interested party shall provide testing materials and other variable cost as cited in the next section.

4.3 Site of test

The dryer shall be tested as installed for normal operation but it is important for testing that the site should have adjacent to its premises suitable space for storing and turning a sufficient quantity of grains for drying during the test.

4.4 Operation of the dryer

During the test, the dryer shall be operated by the manufacturer’s representative (s) in accordance with the manufacturer’s published instructions (published manual) and verified by the testing authority. The testing authority shall make all measurements, which form part of the test and take the prescribed samples.

4.5 Measurement of dryer holding capacity

The maximum amount of grain required to fill the dryer for proper operation shall be verified when filling the dryer at the beginning of the test. The holding capacity shall be measured in terms of weight and other accompanying information such as moisture content and purity.

4.6 Indication of damage

Samples of grain used for the test shall be subjected to laboratory analysis by test milling and presence of cracked grains before and after drying. Milling test of the samples obtained

during drying test shall be conducted at least 48 hours after the drying test while air-dried samples shall be milled when its moisture content reaches 14%.

4.7 Suspension 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 shall be suspended. The decision to suspend or to continue the test is at the discretion of the test engineer and concurred by the company representative.

5 Test preparation

5.1 Materials and equipment

5.1.1 Fuel

The fuel to be used shall conform to the specification supplied by the manufacturer.

5.1.2 Grain

The grain to be used shall be single variety and the moisture content shall be 20% and above for rice and corn with the highest available moisture content to be used in the test.

5.1.3 Measuring instruments

The measuring instruments for performance testing, especially moisture testers shall be calibrated by the testing station prior to the tests.

5.2 Preparation of the dryer for testing

A check shall be made by the manufacturer and testing authority that the dryer has been assembled and installed in accordance with the instruction of the manufacturer based on installation manual.

5.3 Test set-up

Thermometers shall be mounted on or inside the dryer for temperature sensing. These shall be mounted at the following locations: (1) near the dryer to sense ambient temperature (2) at the grain plenum interface, (3) after the plenum, and (4) immediately outside the dryer to sense exhaust air temperature. Temperature sensors shall be partially shielded to minimize errors from heat radiation effects. A schematic diagram shall be made of the dryer, showing a numbered location for each sensor.

For the measurement of airflow and static pressure, pitot tube and manometer or any other suitable apparatus shall be installed.

The control of drying air condition shall be by adjustment of the setting of an automatic control forming part of the dryer, or by manual adjustment of the furnace by the manufacturer's representative if automatic temperature control mechanism is not fitted. Adjustments for the purpose of maintaining a steady temperature of the drying air may be made at any time but any adjustment of an automatic control shall have been sanctioned by the Testing Center.

5.4 Running-in and preliminary adjustments

The dryer shall be run-in in accordance with manufacturer's operating manual before the start of actual test. The manufacturer may take any adjustment during the period of run-in. Adjustments shall be within the limits specified by the manufacturer.

6 Procedures of test

6.1 Verification of the specifications

6.1.1 This inspection is carried out to verify the mechanism, main dimensions, material and accessories of the dryer conform to the lists of specifications submitted by the manufacturer.

6.1.2 Besides gathering of technical data of the machine, observations on the following shall be made:

6.1.2.1 Quality of manufacture

6.1.2.2 Adequacy of protection of components (e.g. bearings, shafting, belts, etc.)

6.1.2.3 Presence of safety controls

6.1.2.4 Presence of dust collection systems

6.1.2.5 Operation and maintenance manual and spare parts catalogue, and special tools required for adjustments and repair should be available and supplied to end-users.

6.1.3 The items to be measured, inspected and observed shall be recorded in Annex A or B.

6.2 Performance test

6.2.1 This is carried out to test the performance of the grain dryer.

6.2.2 Duration of test – Three test trials shall be carried out with the same operational setting. The length of the test shall be such that one full capacity of grain has been dried to a final moisture content of 14% (for rice and corn).

6.2.3 The dryer shall be operated at the drying air temperature as specified by the manufacturer.

6.2.4 In case of continuous flow type dryer, the dryer's discharge mechanism shall be set as specified by the manufacturer and the grains shall undergo tempering process as the case maybe for at least four (4) hours before reloading to the dryer for another pass. For a continuous drying operation, the minimum amount of test material to be used shall be equal to twice the rated capacity.

6.2.5 Measurements – The following shall be measured at 30-minute intervals or as necessary.

6.2.5.1 Air velocity

Measurement of air velocity shall be made at the air duct or at the heat exchanger, whichever is applicable.

6.2.5.2 Temperatures

Grain temperature, drying air temperature, ambient and exhaust air wet bulb and dry bulb temperatures shall be recorded.

6.2.5.3 Static pressure

This shall be taken at the plenum/transition duct (between the blower and the dryer).

6.2.5.4 Moisture content reduction per pass

In case of continuous flow dryer, the percentage of moisture removed for each drying pass shall be recorded.

6.2.5.5 Sound level

This shall be measured with the dryer full of grain, operating at recommended settings of different components, with burner on. (The operator's station will be considered to be within one meter of the controls).

6.2.5.6 Moisture content

Samples for moisture determination shall be taken at the bottom, middle and top layer of the grain for batch type dryers and from the flow of grain from the discharge mechanism for the continuous flow dryer.

6.2.5.7 Power and fuel

Measurement shall be made of the power and fuel used during each test run.

6.2.6 Sampling – For determination of grain quality, such as cracked grain and for milling test (in case for rice), samples from the input and final output shall be taken during each test run.

6.2.7 The items to be measured, inspected and observed shall be recorded in Annex C.

7 Ease of handling and safety feature

The ease of loading and unloading of grain operation, setting and adjustment shall be observed during the test and reported. The design from the point of view of safety for the operator and the different machine components/ assemblies shall be checked and reported. These shall be recorded in Annex A or B.

8 Laboratory analysis of dried samples

This is carried out to have a comparative analysis of the grains used before and after the drying test.

8.1 The quality of dried grain samples from the dryer shall be compared to the quality of dried grain using shade drying.

8.2 The grain samples taken before and after the test shall be subjected to quality analysis in the laboratory. The following shall be determined:

- 8.2.1** Variety
- 8.2.2** Moisture content
- 8.2.3** Purity
- 8.2.4** Cracked grains
- 8.2.5** Broken/Split kernels
- 8.2.6** Immature grains
- 8.2.6** Fermented grains
- 8.2.8** Damaged grains
- 8.2.9** Foreign matter
- 8.2.10** Weed seeds

8.3 In case of rice grains, comparative analysis of the milling potential of the grain used as shown in Figure 1, shall be undertaken.

8.4 Items to be determined shall be recorded in Annex D.

9 Formula

The formula to be used during calculation and testing are given in Annex E.

10 Test report format

- 10.1** Title
- 10.2** Summary
- 10.3** Scope of Test
- 10.4** Method of Test
- 10.5** Condition of Machine
- 10.6** Description of the Machine
- 10.7** Results and Discussion

10.8 Observations (include pictures)

10.9 Names and Signatures of Test Engineers

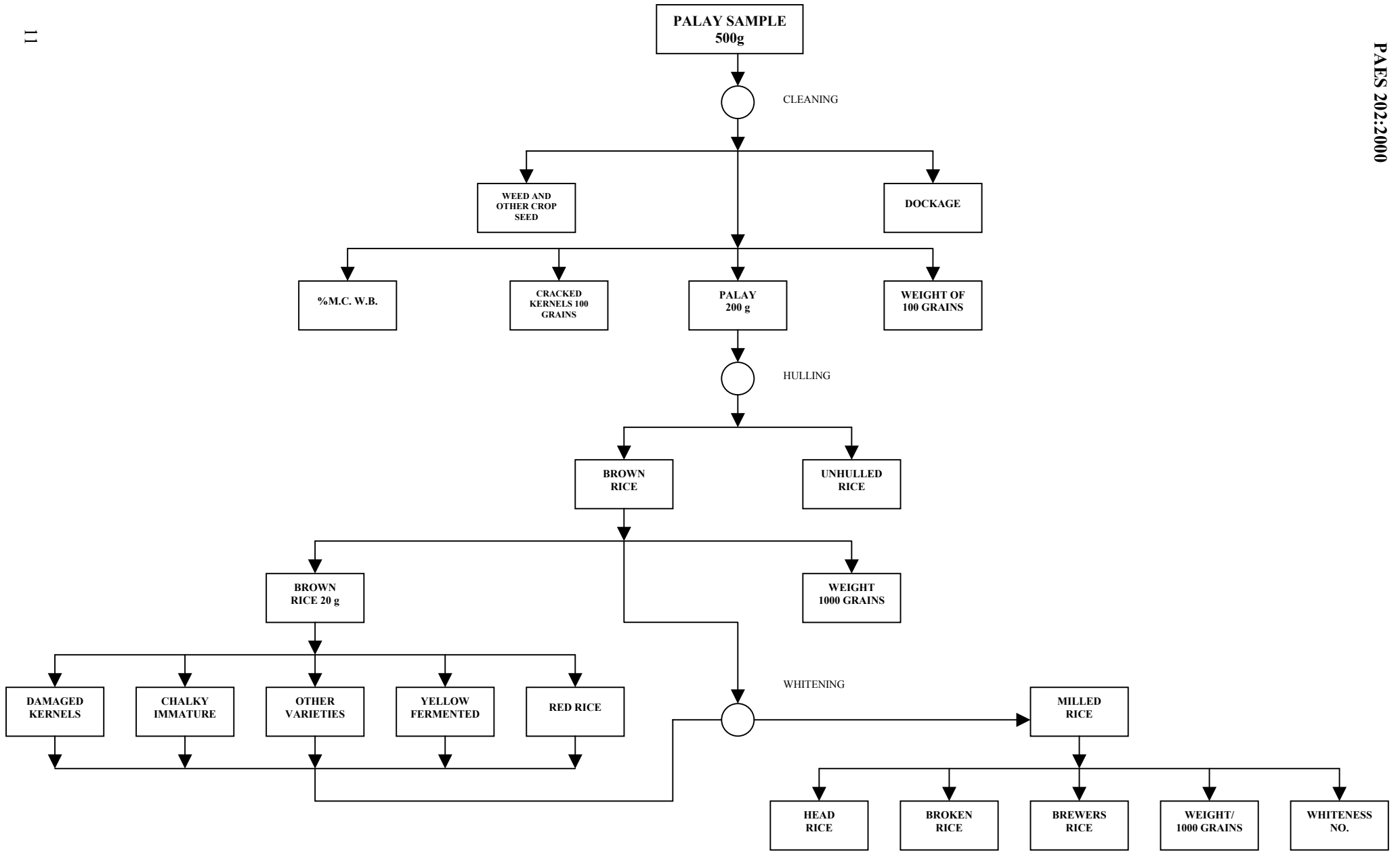


Figure 1. Standard laboratory method in assessing milling quality of paddy

Annex A
SPECIFICATION OF GRAIN DRYERS
(Continuous-Flow Type)

Name of Applicant (or Distributor): _____

Address: _____

Tel. No.: _____

Name of Manufacturer: _____

Address: _____

Tel. No.: _____

General information:

Make: _____ Model: _____

Serial No.: _____ Classification: _____

Production date of dryer to be tested: _____

Testing Agency: _____ Date of Testing: _____

Test Engineer: _____

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.1 Grain flow rate (t/h)*		
A.2. Drying chamber		
A.2.1 Drying and cooling section		
A.2.1.1 Overall dimensions (mm)		
A.2.1.1.a Length		
A.2.1.1.b Width		
A.2.1.1.c Height		
A.2.1.2 Grain holding capacity		
A.2.1.2.a Volumetric (m ³)		
A.2.1.2.b Weight (kg.)		

* based on input to the dryer

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.2.1.3 Materials of construction		
A.2.2 Grain discharge section		
A.2.2.1 Metering device		
A.2.2.1.a Type		
A.2.2.1.b Number of elements		
A.2.2.1.c Control drive arrangement		
A.2.2.1.d Drive unit (kW)		
A.2.2.2 Materials of construction of discharge hopper		
A.3 Air distribution system		
A.3.1 Drying and cooling section		
A.3.1.1 Plenum		
A.3.1.1.a Intake manifold		
Material (s) of construction		
A.3.1.1.b Exhaust manifold		
Material (s) of construction		
A.3.1.2 Ducting		
Material (s) of construction		
A.3.2 Fans		
A.3.2.1 Drying and Cooling Section		
A.3.2.1.a Number		
A.3.2.1.b Type		
A.3.2.1.c Make and Model		
A.3.2.1.d Electric Motor		
A.3.2.1.d.1 Number and Type		
A.3.2.1.d.2 Total Rated Power (kW)		
A.3.2.1.d.3 Rated speed (rpm)		
A.3.2.1.d.4 Phase		
A.3.2.1.d.5 Voltage (V)		
A.3.2.1.d.6 Frequency (Hz)		

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.3.2.1.e Fan shaft speed (rpm)		
A.3.2.1.f Air flow rate (m ³ /min)		
A.4. Heating system		
A.4.1 Main		
A.4.1.1 Type (direct or indirect)		
A.4.1.2 Type of fuel		
A.4.1.3 Temperature control		
A.4.1.4 Fuel consumption (L/h)		
A.4.1.5 Other feature(s)		
A.4.2 Supplementary		
A.4.2.1 Type (direct or indirect)		
A.4.2.2 Fuel		
A.4.2.3 Temperature control		
A.4.2.4 Other feature(s)		
A.5. Tempering bin(s)		
A.5.1 Number		
A.5.2 Holding capacity (m ³)		
A.5.2.1 Type		
A.5.2.2 Unloading rate (kg/h)		
A.5.3 Material(s) of construction		
A.5.4 Other feature (s)		
A.6. Material handling system		
A.6.1 Dump pit		
A.6.1.1 Pit dimension		
A.6.1.2 Material(s) of construction		
A.6.1.3 Feature (s)		
A.6.2 Elevator (s)		
A.6.2.1 Number and height (m)		
A.6.2.2 Capacity (t/h)		
A.6.2.3 Belt dimensions (w x t, mm)		
A.6.2.4 Elevator buckets		

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.6.2.4.a Dimensions (mm)		
A.6.2.4.b Material (s) of construction		
A.6.2.5 Drive Motor		
A.6.2.5.a Type		
A.6.2.5.b Rated power (kW)		
A.6.2.5.c Rated speed (rpm)		
A.6.2.5.d Phase		
A.6.2.5.e Voltage (V)		
A.6.2.5.f Frequency (Hz)		
A.6.2.6 Material (s) of construction		
A.6.2.7 Other Feature (s)		
A.6.3 Conveyor (s)		
A.6.3.1 Type		
A.6.3.2 Number		
A.6.3.3 Capacity (t/h)		
A.6.3.4 Drive motor		
A.6.3.4.a Type		
A.6.3.4.b Rated power (kW)		
A.6.3.4.c Rated speed (rpm)		
A.6.3.4.d Phase		
A.6.3.4.e Voltage (V)		
A.6.3.4.f Frequency (Hz)		
A.6.3.5 Control (s)		
A.6.3.6 Material (s) of construction		
A.6.3.7 Other feature (s)		
A.6.4 Other types of material handling		
A.6.4.1 Description		
A.7 Instruments and controls		
A.7.1 Temperature , moisture and pressure		
A.7.1.1 Air temperature		

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.7.1.1.a Type (s)		
A.7.1.1.b Location (s)		
A.7.1.2 Grain temperature		
A.7.1.2.a Type (s)		
A.7.1.2.b Location (s)		
A.7.1.2 Grain moisture content		
A.7.1.2.a Type (s)		
A.7.1.2.b Location (s)		
A.7.1.3 Pressure/ airflow indicator (s)		
A.7.1.2.a Type (s)		
A.7.1.2.b Location (s)		
A.7.1.4 Other feature (s)		
A.8 Pre-cleaner		
A.8.1 Type		
A.8.2 Capacity		
A.8.3 Fan		
A.8.3.1 Type		
A.8.3.2 Material (s) of construction		
A.8.4 Sieve		
A.8.4.1 Type		
A.8.4.2 Number		
A.8.4.3 Size of perforations (mm)		
A.8.4.4 Material (s) of construction		
A.8.5 Air Duct		
A.8.5.1 Diameter (mm)		
A.8.5.2 Material (s) of construction		
A.8.6 Electric Motor		
A.8.6.1 Type		
A.8.6.2 Rated power (kW)		
A.8.6.3 Rated speed (rpm)		
A.8.6.4 Phase		

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
A.8.6.5 Voltage (V)		
A.8.6.6 Frequency (Hz)		
A.8.7 Other feature (s)		
A.9 Dust emission control (s)		
A.9.1 Type (s)		
A.9.2 Location (s)		
A.9.3 Other feature (s)		
A.10 Safety feature (s)		
A.10.1 Product safety		
A.10.2 Machine safety		
A.10.3 Operation and maintenance safety		

A.11 Schematic diagram of the dryer set-up

The following are to be filled-up by the testing agency

A.12 Comments on the quality of manufacture

A.13 Comments on adequacy of protection of components (e.g. bearings, shafting, belts, etc.)

A.14 Comments on safety controls/devices

A.15 Comments on dust collection systems

A.16 Availability of manuals, brochure, and standard and special tools for adjustments and repair

A.17 Comments on instrumentation

A.18 Comments on ease of loading and unloading

A.19 Comments on settings and adjustments

A.20 Other comments/ observations

Annex B
SPECIFICATION OF GRAIN DRYERS
(Batch Type)

Name of Applicant (or Distributor): _____

Address: _____

Tel. No.: _____

Name of Manufacturer: _____

Address: _____

Tel. No.: _____

General Information:

Make: _____ Model: _____

Serial No.: _____ Classification: _____

Production date of dryer to be tested: _____

Testing Agency: _____ Date of Testing: _____

Test Engineer: _____

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
B.1. Machine Specifications		
B.1.1 Drying Rate (kg/h)		
B.1.2 Machine Structure		
B.1.2.1 Overall Dimensions (mm) (installed)		
B.1.2.1.a Length		
B.1.2.1.b Width		
B.1.2.1.c Height		
B.1.3 Drying Bin		
B.1.3.1 Type		
B.1.3.2 Dimensions (mm)		
B.1.3.2.a Length		
B.1.3.2.b Width/ Diameter		

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
B.1.3.2.c Height		
B.1.3.3 Holding Capacity (kg)		
B.1.3.4 Maximum Grain Depth*(mm)		
B.1.3.5 Material		
B.1.3.5.a Frame		
B.1.3.5.b Holding Bin		
B.1.3.5.c Wall		
B.1.4 Fan		
B.1.4.1 Type		
B.1.4.2 Brand/Model		
B.1.4.3 Air Flow Rate (m ³ /min)		
B.1.4.4 Static Pressure (Pa)		
B.1.4.5 Material		
B.1.4.6 Prime mover		
B.1.4.7 Others (specify)		
B.1.5 Heater		
B.1.5.1 Type		
B.1.5.2 Brand/Model		
B.1.5.3 Fuel		
B.1.5.4 Heat output (kJ/h)		
B.1.5.5 Fuel Consumption (kg/h or L/h)		
B.1.5.6 Capacity of fuel tank (L)		
B.1.5.7 Method of temperature control		
B.1.5.9 Materials of construction		
B.1.5.10 Others (specify)		
B.1.6 Material Handling System**		
B.1.6.1 Dump Pit		
B.1.6.1.a Pit Dimension,L x W x H (mm)		

* maximum grain depth – air path distance from inlet to outlet

**for recirculating batch only

ITEMS	Manufacturer's Specifications	Actual Measurement/ Inspection by the Testing Agency
B.1.6.1.b Material(s) of construction		
B.1.6.1.c Other Feature (s)		
B.1.6.2 Elevator (s)		
B.1.6.2.a Number and Height (m)		
B.1.6.2.b Capacity (t/h)		
B.1.6.2.c Belt dimensions (w x t, mm)		
B.1.6.2.d Elevator buckets		
B.1.6.2.d.1 Dimensions (mm)		
B.1.6.2.d.2 Material (s) of construction		
B.1.6.2.e Drive Motor		
B.1.6.2.e.1 Type		
B.1.6.2.e.2 Rated power (kW)		
B.1.6.2.e.3 Rated speed (rpm)		
B.1.6.2.e.4 Phase		
B.1.6.2.e.5 Voltage (V)		
B.1.6.2.e.6 Frequency (Hz)		
B.1.6.2.f Material (s) of construction		
B.1.6.2.g Other Feature (s)		
B.1.7 Safety Feature (s)		
B.1.7.1 Product Safety		
B.1.7.2 Machine Safety		
B.1.8 Operator Safety		

B.2 Schematic Diagram of the Dryer Set-up

The following are to be filled-up by the Testing Agency

B.3 Comments on the quality of manufacture

B.4 Comments on adequacy of protection of components (e.g. bearings, shafting, belts, etc.)

B.5 Comments on safety controls/devices

B.6 Comments on dust collection systems

B.7 Availability of manuals, brochure, and standard and special tools for adjustments and repair

B.8 Comments on instrumentation

B.9 Comments on ease of loading and unloading

B.10 Comments on settings and adjustments

B.11 Other comments/ observations

Annex C
DRYING PERFORMANCE TEST

C.1	Crop conditions		
C.1.1	Kind/Variety	:	_____
C.1.2	Initial grain moisture content (%)	:	_____
C.1.3	Total weight of grain (kg)	:	_____
C.1.4	Cracked grain (%)	:	_____
C.1.5	Damaged grain (%)	:	_____
C.1.6	Impurities (%)	:	_____
C.2	Ambient conditions		
C.2.1	Temperature	:	_____
C.2.1.1	Dry bulb (°C)	:	_____
C.2.1.2	Wet bulb (°C)	:	_____
C.2.2	Relative humidity (%)	:	_____
C.2.3	Atmospheric pressure (Pa)	:	_____
C.3	Dryer performance		
C.3.1	Drying rate (kg/batch or kg/hr)	:	_____
C.3.2	Drying air temperature (°C)	:	_____
C.3.3	Ave. ambient air temperature (°C)	:	_____
C.3.3.1	Wet bulb	:	_____
C.3.3.2	Dry bulb	:	_____
C.3.4	Ave. ambient air relative humidity (%)	:	_____
C.3.5	Ave. exhaust air temperature (°C)	:	_____
C.3.4.1	Wet bulb	:	_____
C.3.4.2	Dry bulb	:	_____
C.3.6	Ave. exhaust air relative humidity (%)	:	_____
C.-3.7	Ave. grain temperature (°C)	:	_____
C.3.8	Ave. air velocity (m/s)	:	_____
C.3.9	Ave. static pressure (Pa)	:	_____
C.3.10	Burner fuel consumption (L/h)	:	_____
C.3.11	Electrical power consumption (kW)	:	_____
C.3.12	Drying time (h)	:	_____
C.3.13	Moisture content reduction per pass or per batch (%/h)	:	_____
C.3.14	Drying system efficiency (%)	:	_____
C.3.15	Burner/furnace efficiency (%)	:	_____
C.3.16	Heating system efficiency	:	_____
C.3.17	Heat utilization (KJ/kg of H ₂ O)	:	_____
C.3.18	Dryer efficiency (%)	:	_____
C.3.19	Moisture content (% w.b.)	:	_____
C-3.20	Moisture content gradient (%)	:	_____

Annex D
LABORATORY ANALYSIS OF SAMPLES

D.1 Analysis of palay samples

D.1.1 Before and after drying

Machine tested : _____

Date of test : _____

Variety : _____

Laboratory analyst : _____

Condition	Moisture Content (%)	Bulk Density (kg/m ³)	Purity (%)	Foreign Matter (%)	Cracked Grains (%)	Immature Grains (%)	Weed Seeds (%)	Fermented Grains (%)	Damaged Grains (%)	Remarks
Before Drying										
After Drying										

D.1.2 Analysis of milled rice

Condition	Head Rice (%)	Broken Rice (%)	Milling Recovery (%)	Whiteness Index	Milling Degree	Date of Test	Moisture Content (%)	Remarks
Air Dried or Laboratory Dryer								
Dryer on Test								

Note: Laboratory milling of rice shall be conducted, minimum of 48 hours after drying.

D.2 Analysis of corn samples

Machine tested : _____

Date of test : _____

Variety : _____

Laboratory analyst : _____

Condition	Moisture Content (%)	Bulk Density (kg/m ³)	Purity (%)	Foreign Matter (%)	Cracked Kernels (%)	Damaged Kernels (%)	Remarks
Before Drying							
After Drying							

Annex E
Formula to be Used in the Computation of Drying Parameters

1. Drying capacity (kg/h) = $\frac{\text{Initial weight of test material (kg)}}{\text{Actual drying time (h)}}$

2. Final weight of test material, W_2 (kg)

$$W_2 = \frac{W_1(100 - MC_1)}{(100 - MC_2)}$$

3. Moisture reduction per hour

$$\text{By weight (kg/h)} = \frac{\text{Initial weight of test material (kg)} - \text{Final weight of test material (kg)}}{\text{Actual drying time (h)}}$$

4. Heating system efficiency (%)

$$\text{HSE} = \frac{\text{Heat supplied to the dryer}}{\text{Heat available in the fuel}} \times 100$$

where :

$$\text{Heat supplied} = \frac{[\text{Enthalpy}(h_2) - \text{Enthalpy}(h_1)] \times \text{air flow rate (m}^3/\text{min)}}{\text{specific volume (m}^3/\text{kg dry air)}} \times 60 \frac{\text{min}}{\text{h}}$$

$$\text{Heat available} = \text{Fuel feed rate (kg/h)} \times \text{heating value of fuel (kJ/kg)}$$

5. Heat utilization (kJ/kg) = $\frac{\text{Heat supplied (kJ/h)} \times \text{drying time (h)}}{\text{Amount of moisture removed (kg)}} \times 100$

6. Drying efficiency (%) = $\frac{\text{Total heat utilized (kJ/h)}}{\text{Heat supplied to the burner (kJ/h)}} \times 100$

7. Combustion efficiency (%) = $\frac{\text{Heat released by the fuel (kJ/h)}}{\text{Amount of fuel (kg/h)} \times \text{heating value of fuel (kJ/kg)}} \times 100$

8. Drying system efficiency (%) = $\frac{\text{Total heat utilized (kJ/h)}}{\text{Amount of fuel (kg/h)} \times \text{heating value of fuel (kJ/kg)}} \times 100$