PHILIPPINE NATIONAL STANDARD

PNS/BAFS 336:2022
ICS 65.060.20

Rotary Tiller — Methods of Test

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Foreword

Since 2011, a significant number of rotary tillers have been tested by Agricultural Machinery Testing and Evaluation Center (AMTEC)-University of the Philippines Los Baños (UPLB) without an existing reference standard. In August 2021, AMTEC-UPLB formally proposed for the development of Philippine National Standards (PNS) on Rotary Tiller – Specifications and Methods of Test to the Philippine Council for Agriculture and Fisheries Council (PCAF)-Committee on Agriculture and Fisheries Mechanization (CAFMech).The proposed PNS intend to set minimum requirements for the specification and testing of rotary tiller which will be used as reference not just by AMTEC-UPLB but also by the Bureau of Agricultural and Fisheries Engineering (BAFE)-Department of Agriculture (DA), as the regulatory agency for agriculture and fisheries machinery and infrastructures. PCAF-CAFMech formally endorsed the proposal of AMTEC-UPLB to the Bureau of Agriculture and Fisheries Standards (BAFS)-DA for prioritization through the issuance of PCAF-CAFMech Resolution No. 6, series of 2021 (Recommending to the BAFS the Prioritization of the Development or Revision of the PNS of Various Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development [PCAARRD]-Funded Machinery Projects). In November 2021, BAFS-DA subjected the proposals through a prioritization process, which resulted to their prioritization in 2022.

A Technical Working Group (TWG) was created to develop the PNS under Special Order No. 103, series of 2022 (Creation of TWG for the Development of PNS for Agriculture and Fishery Products, Machineries, and Infrastructures). The establishment of the TWG was amended through Special Order No. 350, series of 2022 (Addendum to Special Order No. 103 series of 2022 entitled, “Creation of TWG for the Development of PNS for Agriculture and Fishery Products, Machineries, and Infrastructures”). The TWG was composed of representatives from relevant government agencies, academe/research institution, Civil Society Organizations (CSO), and private sector. The draft PNS developed by BAFS-DA and the TWG underwent a series of TWG meetings and stakeholder consultations conducted via online platforms before their finalization and endorsement to the DA Secretary for approval.

This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2.

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1 Scope

This Standard specifies the methods of test and inspection for rotary tillers. Specifically, it shall be used to:

a) Verify the mechanism, dimensions, materials, accessories of the rotary tiller, and the list of specifications submitted by the test applicant;
b) Determine the field performance of the rotary tiller;
c) Evaluate the ease of handling and safety features; and
d) 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 their contents constitute the requirements of this document. 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). (2000). Agricultural machinery – Method of sampling. (PAES 103:2000). https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/PAES-103-2000-Agricultural-Machinery-Method-of-Sampling.pdf

Bureau of Agriculture and Fisheries Standards (BAFS)-Department of Agriculture (DA). (2022). Rotary tiller — Specifications. (PNS/BAFS 335:2022).

3 Terms and Definitions

For the purpose of this Standard, the definitions given in PNS/BAFS 335:2022 (Rotary Tiller – Specifications) and the following shall apply.

3.1
clayey soil
type of soil with grain size of less than 2 mm and with clay fraction of at least 35% (AMTEC-UPLB, 2022)

3.2
effective field capacity
effective area covered by the rotary tiller over the total operating time, expressed in hectares per hour (ha/h); also referred to as actual field capacity (AMTEC-UPLB, 2022)

3.3
effective area
area tilled by the rotary tiller, expressed in hectares (ha) (AMTEC-UPLB, 2022)

3.4
overall height
distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the rotary tiller (AMTEC-UPLB, 2022)

3.5
overall length
distance between the vertical planes perpendicular to the median plane of the rotary tiller, each plane touching the front and rear extremities of the rotary tiller (AMTEC-UPLB, 2022)

3.6
overall width
distance between the vertical planes parallel to the median plane of the rotary tiller, each plane touching the outermost point of the rotary tiller on each respective side (AMTEC-UPLB, 2022)

3.7
puddling index
indicates degree of puddling; ratio of the volume of settled soil to the volume of soil and water suspension sample, expressed in percent (%) (AMTEC-UPLB, 2022)

3.8
rotary tilling width
width of cut measured in the field (AMTEC-UPLB, 2022)

3.9
running-in period
preliminary operation conducted before the actual testing of the rotary tiller to make various adjustments until the operation is stable (AMTEC-UPLB, 2022)

3.10
soil bulk density
oven-dried mass per unit total volume of soil including pore space, expressed in gram per cubic centimeter (g/cm^3) (AMTEC-UPLB, 2022)

3.11
soil moisture content
mass of moisture over the oven-dried mass of soil sample, expressed in percent ($\%_{db}$) (AMTEC-UPLB, 2022)

3.12
soil resistance
resistance of soil to deformation, rupture, or penetration under externally applied mechanical stresses, expressed in kilogram per square centimeter (kg/cm^2); also referred to as soil hardness (AMTEC-UPLB, 2022)

3.13
test applicant
manufacturer, inventor, direct importer, legitimate distributor, dealer, owner, or end-user of the rotary tiller (AMTEC-UPLB, 2022)

3.14
test plot
portion of a field with required size and shape used for testing rotary tillers and self-propelled machineries for land preparation, crop establishment, and harvesting (AMTEC-UPLB, 2022)

3.15
test site
location or area (e.g., field, AMTEC Test Laboratory) where the test is conducted (AMTEC-UPLB, 2022)

3.16
theoretical field capacity
computed rate of field operation in a given area per unit of time; function of traveling speed and operating width, expressed in hectares per hour (ha/h) (AMTEC-UPLB, 2022)

3.17
total operating time
total time consumed during the actual rotary tilling operation, expressed in hours (h) (AMTEC-UPLB, 2022)

4 General Conditions for Test

4.1 Selection of machinery to be tested

Rotary tillers submitted for testing shall be sampled in accordance with PAES 103:2000 (Agricultural machinery – Method of sampling) or any other suitable method of sampling.

4.2 Role of the test applicant

The test applicant shall submit specifications and other relevant information about the rotary tiller. They shall abide by the terms and conditions set forth by the recognized testing agency, provide test plots, and shoulder other variable costs to carry out the test.

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 may be, and decide on matters related to the operation of the rotary tiller.

4.4 Role of 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 to and after the conduct of the testing.

4.5 Test site conditions

Testing shall be conducted on fields which have undergone wet preparation or dry preparation. The rotary tiller shall be tested through actual rotary tilling of the soil. The field shall have ample space to allow turns in headland.

4.6 Suspension/termination of test

During the test run, if the rotary tiller results showed the machine stopping due to breakdown or malfunction affecting the machine's performance, the test engineer may suspend the test. If the machine installed with the tested rotary tiller will not be able to continue the operation, the test engineer may terminate the test with concurrence of the representative of the test applicant.

5 Test Preparation

5.1 Preparation of the rotary tiller for testing

The representative of the test applicant and testing agency shall check the rotary tiller to ensure that it has been assembled and installed in accordance with the instruction of the manufacturer. The recognized testing agency shall test the rotary tiller according to the specifications 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 rotary tiller test is shown in Annex A (Minimum list of field and laboratory test equipment and materials). 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 Size and field condition of test plot

The test plots to be used should have a clayey soil (i.e., sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay). For dry preparation, the test plot shall be initially plowed with depth of 200-400 mm and greater than the tilling depth.

For wet preparation, the test plot shall be unplowed and soaked with water level of 2-3 cm above surface maintained for at least three days before testing. Furthermore, the test plot shall be rectangular and should have sides in the ratio of 2:1. Its size shall not be less than 1000 m^2. The total size of the prepared test plots shall be sufficient for the required number of test trials and running-in as stipulated in 7.2. If the test plots are not conforming to the recommended characteristics, the test engineer shall not proceed with the test.

5.3.2 Tractor to be used

The tractor to be used shall be compatible with the rotary tiller in accordance with the manufacturer’s specification of required power.

5.3.3 Machine setting

The rotary tiller shall follow recommended settings based on the manufacturer's/operator's manual.

The rotary tiller shall be tested at a traveling speed of 1.5-2.5 km/h, rotor shaft speed at maximum power-take-off (PTO) shaft speed with rear cover full down, and depth of rotary tilling of not less than ¾ of the rotor assembly’s radius.

5.3.4 Field operational pattern

Field capacity and field efficiency are influenced by field operational pattern which is closely related to the size and shape of the test plot and the kind and size of rotary tiller. The nonproductive time should be minimized as much as possible using the recommended field operational patterns as shown in Figure 1. For wet preparation, a circuitous pattern rounded corners shall be used. For dry preparation, a headland pattern from boundaries shall be used.

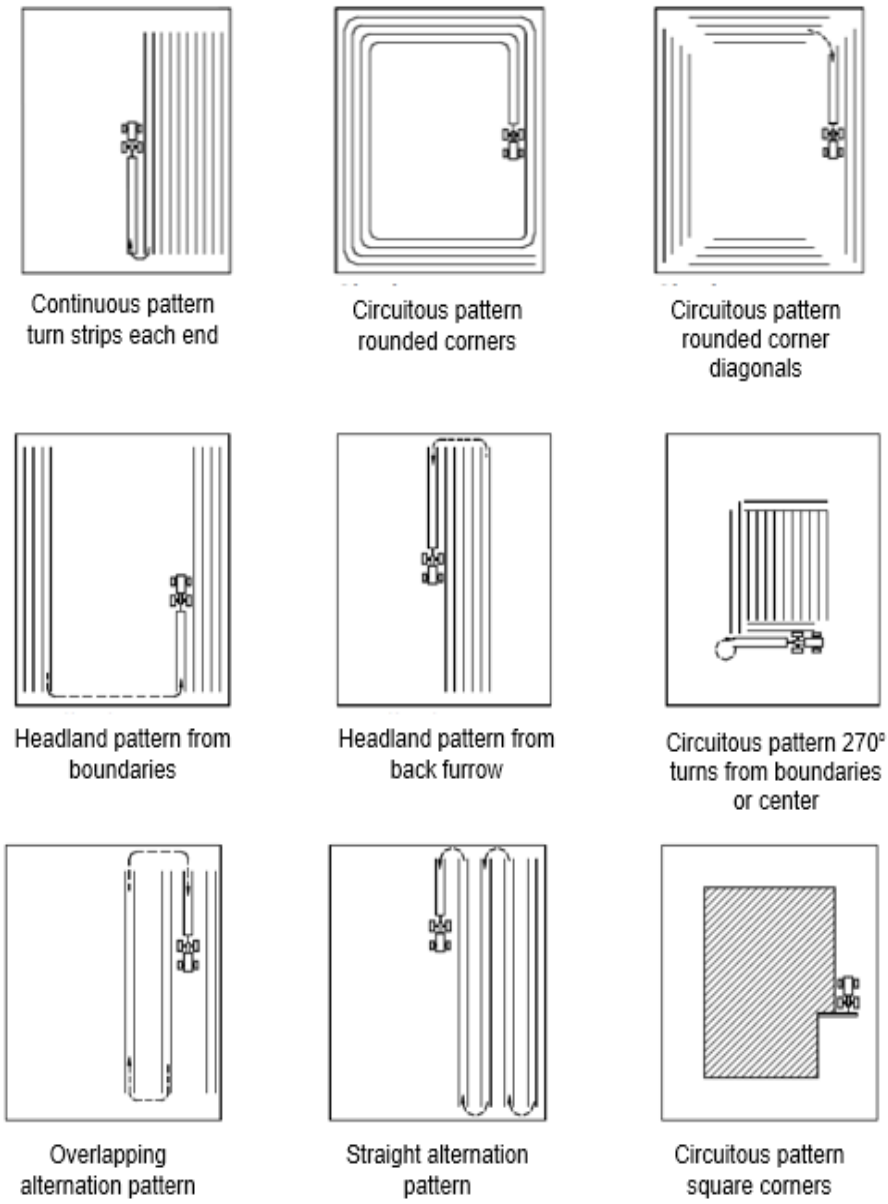

Figure 1. Field operational patterns (Regional Network for Agricultural Machinery [RNAM],1995)

5.4 Running-in and preliminary adjustments

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

6 Pre-test Observation

6.1 Verification of specifications

The specifications claimed by the manufacturer and other physical details given in Annex B (Specifications of rotary tiller) shall be verified by the recognized testing agency. A stable and level surface shall be used as a reference plane for verification of dimensional rotary tiller specifications.

6.2 Initial field and test sample conditions

Initial data such as field conditions shall be obtained by the recognized testing agency before the test. For testing done in upland test plots, representative test samples for soil moisture content and bulk density determination shall be collected for analysis. Sampling procedure is shown in Annex C (Sampling procedures).

7 Performance Test

7.1 Operation of the rotary tiller

The rotary tiller shall be operated at the test site until the rotary tilling operation is finished. It shall be operated by the official representative of the test applicant using the recommended settings. As part of the test, the recognized testing agency shall make all measurements and take the prescribed samples. No other adjustments shall be permitted during the test.

7.2 Test trials

A minimum of two test trials shall be conducted.

7.3 Data collection

7.3.1 Duration of test

The duration of each trial shall last until the rotary tilling operation in the required area is finished.

7.3.2 Tests and measurements

7.3.2.1 Soil resistance before rotary tilling

Soil resistance shall be measured using a cone penetrometer.

7.3.2.2 Traveling speed

a) Outside the longer side of the test plot, place two poles (A, B) approximately in the middle of the test plot (as shown in Figure 2) to mark the traveling distance. These two poles should be 20 m apart. On the opposite side,

place another two poles (C, D) in similar position and distance so that all four poles form corners of a rectangle, parallel to at least one long side of the test plot.

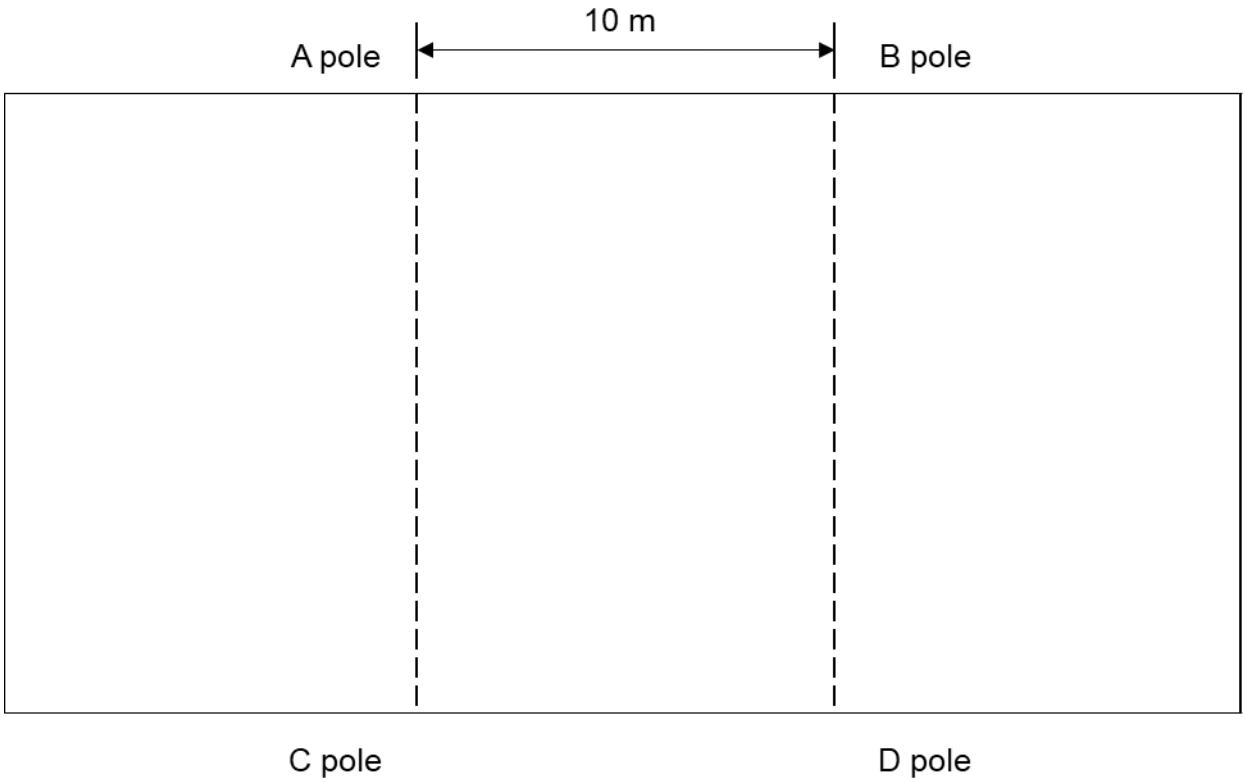

Figure 2. Measurement of operating/traveling speed (adapted from UPLB-AMTEC, 2004)

b) Calculate speed from the time required for the rotary tiller to travel the distance between the assumed line connecting two poles on opposite sides AC and BD. The reference point (e.g., pneumatic wheels) of the machine should be selected for measuring the time.

7.3.2.3 Average width of rotary tilling

a) A width meter, as shown in Figure 3, shall be used in measuring the width and depth of rotary tilling simultaneously.

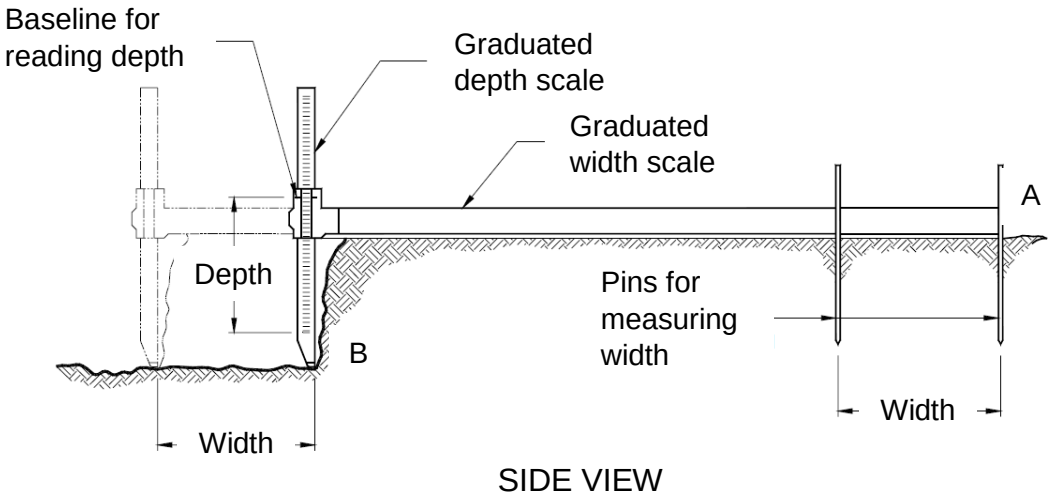

Figure 3. Measurement of width and depth of rotary tilling (UPLB-AMTEC, 2022)

b) Measure the depth and width by placing the tip of graduated depth scale to the rototilled surface (point B) and putting a pin at point A of width scale. This procedure shall be repeated for the succeeding passes. The distance between two pins adjacent to each other is the width of rotary tilling and the distance between point B and baseline for reading depth is the depth of rotary tilling. However, the rototilled surface is not always level depending on the feature of the rotary tiller. Therefore, the tip of the depth scale shall be placed at relatively the same point in each pass.

c) Determine the mean of the measured width and depth for the average width and depth of rotary tilling.

7.3.2.4 Effective field capacity and percent overlapped/untilled

a) Actual operating width of rotary tiller, test plot's length, width and area, and number of rounds during operation shall be recorded for each trial. Actual width of swath, total distance traveled, effective area, and effective field capacity shall be calculated using the formulas in Annex D (Formulas used during calculations and testing).

b) Percent overlapped or untilled shall be calculated using the formula in Annex D (Formulas used during calculations and testing). If the actual width of swath is less than the actual width of rotary tiller, the operator has passed over part of the area twice to secure better coverage. If the actual width of swath is greater than the actual width of rotary tiller, the operator has left part of the untilled area.

7.3.2.5 Theoretical field capacity

With the actual operating width recorded and operating speed computed, the theoretical field capacity shall be obtained using the formula in Annex D (Formulas used during calculations and testing).

7.3.2.6 Fuel consumption

a) Total operating time of the tractor's engine from the time it started until the time it stopped shall be recorded.

b) To get the amount of fuel consumed, a refill method shall be used. The fuel tank shall be filled to full capacity or to a certain level before the test. After the test, the tank shall be refilled up to the same level before the test. The amount of fuel used to refill the tank shall be recorded. While filling up the fuel tank, it shall be kept horizontal and shall have no empty space left inside.

c) Fuel consumption per unit time, per area covered, per change in soil bulk density, per area covered per change in soil bulk density, and per volume of soil pulverized shall be calculated using the formulas in Annex D (Formulas used during calculations and testing).

7.3.2.7 Noise level

a) The sound emitted by the four-wheel tractor used during rotary tilling operation, shall be measured 50 mm away from the ear level of the operator/s using a sound level meter, expressed in decibel [dB (A)].

b) There shall be a minimum of five observations in a two-minute interval. Before collecting data, it should be ensured that the operations and other functional characteristics of the rotary tiller have stabilized. The time of recording shall be properly spaced during the whole duration of the test trial.

7.3.2.8 Dynamic balance of rotating parts

Assessments of rotating parts for dynamic balance shall be conducted through qualitative visual observation by a skilled test engineer.

7.4 Data recording and observations

Record sheet for all data and information during the test is given in Annex E (Performance test data sheet). Necessary observations and other parameters to be taken during the performance test should be recorded in this sheet.

7.5 Sampling

Representative test samples for soil bulk density and puddling index determination shall be collected after each test trial for analysis. Sampling procedure is shown in Annex C (Sampling procedures).

8 Laboratory Analysis

Laboratory analysis shall be made to determine the soil bulk density before and after rotary tilling, soil moisture content, and puddling index. The laboratory procedures for the analyses are given in Annex F (Laboratory analysis).

9 Presentation of Results

Rotary tiller specifications and the results of the test shall be presented in tabular form in which data shall be taken from Annexes B (Specifications of rotary tiller) and E (Performance test data sheet). A photo of the rotary tiller with labeled parts shall also be included. Observations made on the rotary tiller while in operation shall be supported with photographs.

10 Formula

The formula to be used during calculations and testing are given in Annex D (Formulas used during calculations and testing).

11 Test Report

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

a) Name of recognized testing agency;
b) Test report number;
c) Title;
d) Summary of results;
e) Purpose and scope of test;
f) Methods of test;
g) Description of the rotary tiller;
h) Specifications;
i) Results;
j) Observations (include pictures); and
k) Names, signatures, and designation of test engineers.

Annex A
(Informative)

Minimum list of field and laboratory test equipment and materials

Table A.1. List of laboratory equipment and materials

	Equipment	Quantity
A.1	Performance Test	
A.1.1	Field Test	
A.1.1.1	Timers Maximum resolution: 0.1 sec	2
A.1.1.2	Cone penetrometer	1
A.1.1.3	Measuring tape (at least 50 m)	1
A.1.1.4	Steel tape (at least 5 m)	1
A.1.1.5	Sound level meter Range: 30 to 130 dB(A)	1
A.1.1.6	Graduated cylinder Capacity: 1000 mL	1
A.1.1.7	Width and depth gauge	1
A.1.1.8	Cylindrical soil sampler	3
A.1.1.9	Digital camera	1
A.1.1.1(	Vernier caliper Accuracy: 0.025 mm	1
A.1.2	Laboratory Test	
A.1.2.1	Analytical balance Sensitivity: 0.01 g	1
A.1.2.2	Air oven	1
A.1.2.3	Aluminum moisture can	6
A.1.2.4	Desiccator	1
A.2	Materials for Field Test	
A.2.1	Sample bags	6
A.2.2	Labeling tags which include: Date of test Machine on test Trial number	6
A.2.3	Marking pegs	15

Annex B
(Informative)

Specifications of rotary tiller

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	Verification by the testing agency
1	Overall dimensions and weight		
1.1	Length, mm		
1.2	Width, mm		
1.3	Height, mm		
1.4	Weight, kg		
2	Rotor assembly		
2.1	Type of rotary shaft		
2.2	Number of rotary flanges		
2.3	Overall diameter, mm		
2.4	Number of blades per rotary flange		
2.5	Rotary tilling blades		
2.5.1	Total number of blades		
2.5.2	Width, mm		
2.5.3	Thickness, mm		
2.5.4	Type (C, I, J, L, or Picked)		
2.5.5	Material/s		

Item		Manufacturer's Specification	Verification by the testing agency
3	Operating width of rotary tilling, mm		
4	Power transmission system		
4.1	Type of power train		
4.2	Rated PTO shaft speed, rpm		
5	Rear cover		
5.1	Material		
5.2	Thickness, mm		
6	Safety devices		
7	Special features		

Annex C
(Normative)

Sampling procedures

C.1 Soil sampling from lowland test plots

After each test trial, soil and water suspension samples shall be obtained immediately by immersing a 100 ml aluminum cans to a depth of about 10 cm in three different locations in the test plot.

C.2 Soil core sampling from upland test plots

C.2.1 Before and after each test trial, soil core samples shall be obtained using a cylindrical soil sampler from three different locations in the test plot. Using a small hammer or mallet, carefully drive or push the sampler into the soil to prevent breaking the core sample.

C.2.2 Remove the core sample by trenching the soil around it. Clean the sample by removing the excess soil protruding beyond the top and bottom rims of the sampler using a sharp knife.

C.3 Handling of samples

All soil samples to be taken to the laboratory shall be placed in appropriate, dry, and airtight containers and shall be properly labeled. Care should be taken so as to prevent alterations of the conditions of the test samples.

Annex D
(Normative)

Formulas used during calculations and testing

D.1 Field capacity

D.1.1 Effective field capacity and % overlapped/untilled

$$S = \frac{W}{2N} \quad (1)$$

$$D = \frac{A_t}{S} \quad (2)$$

$$A_e = wD \quad (3)$$

$$FC_e = \frac{0.006A_e}{T} \quad (4)$$

$$\%\, A_o = \frac{A_e - A_t}{A_t} \times 100 \quad (5)$$

$$\%\, A_u = \frac{A_t - A_e}{A_t} \times 100 \quad (6)$$

where:

S is the actual width of swath (m)
W is the width of plot (m)
N is the number of rounds
D is the total distance traveled (m)
A_t is the area covered during test (m^2)
A_e is the effective area accomplished (m^2)
w is the actual operating width of rotary tiller (m)
T is the total operating time (min)
FC_e is the effective field capacity (ha/h)
% A_o is the percent overlapped (%)
% A_u is the percent untilled (%)

D.1.2 Theoretical field capacity

$$FC_t = \frac{wS_o}{10}$$

where:

FC_t is the theoretical field capacity (ha/h)
w is the actual operating width of rotary tiller (m)
S_o is the operating or traveling speed (kph)

D.2 Dry-basis soil moisture content

$$MC_s = \frac{M_{s0} - M_{s1}}{M_{s1}} \; x \; 100$$

where:

MC_s is the dry-basis moisture content of soil sample ($\%_{db}$)
M_{s0} is the initial weight of the soil sample (g)
M_{s1} is the oven-dried weight of the soil sample (g)

D.3 Fuel consumption

D.3.1 Based on operating time

$$F_{ct} = \frac{F_v}{T_t}$$

where:

F_{ct} is the fuel consumption per unit time (L/h)
F_v is the volume of fuel consumed (L)
T_t is the total operating time of tractor (h)

D.3.2 Based on area covered

$$F_{ca} = \frac{F_v}{A_t}$$

where:

F_{ca} is the fuel consumption per area covered (L/ha)
F_v is the volume of fuel consumed (L)
A_t is the area covered during test (ha)

D.3.3 Based on change in soil bulk density

$$F_{cb} = \frac{F_v}{\rho_{sb1} - \rho_{sb0}}$$

where:

F_{cb} is the fuel consumption per change in soil bulk density (L-m^3/kg)
F_v is the volume of fuel consumed (L)
ρ_{sb0} is the soil bulk density before rotary tilling (kg/cm^3)
ρ_{sb1} is the soil bulk density after rotary tilling (kg/cm^3)

D.3.4 Based on area covered per change in soil bulk density

$$F_{cb} = \frac{Fv}{A_t(\rho_{sb1} - \rho_{sb0})}$$

where:

F_{cb} is the fuel consumption per change in soil bulk density (L-cm^3/ha-g)
F_v is the volume of fuel consumed (L)
A_t is the area covered during test (ha)
ρ_{sb0} is the soil bulk density before rotary tilling (g/cm^3)
ρ_{sb1} is the soil bulk density after rotary tilling (g/cm^3)

D.3.5 Based on volume of soil pulverized

$$F_{cv} = \frac{F_v}{A_t D_r}$$

where:

F_{cv} is the fuel consumption per volume of soil pulverized (L/m^3 soil)
F_v is the volume of fuel consumed (L)
A_t is the area covered during test (m^2)
D_r is the average depth of rotary tilling (m)

D.4 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)

D.5 Puddling index

$$PI = \frac{V_{ss}}{V_{sw}} \times 100$$

where:

PI is the puddling index (%)
V_{ss} is the volume of settled soil (mL)
V_{sw} is the volume of soil and water suspension (mL)

D.6 Soil bulk density using soil core sampling

$$\rho_{sb} = \frac{M_{s1}}{V_{ts}} \quad (1)$$

$$V_{ts} = \frac{\pi {d_{cs}}^2 h_{cs}}{4} \quad (2)$$

where:

ρ_{sb} is the soil bulk density (g/cm^3)
M_{s1} is the oven-dried weight of soil sample (g)
V_{ts} is the total volume of soil sample (cm^3)
d_{cs} is the internal diameter of the cylindrical core sampler (cm)
h_{cs} is the height of the cylindrical core sampler (cm)

Annex E
(Informative)

Performance test data sheet

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

No.	Item	Trial 1	Trial 2	Average
1	Field condition			
1.1	Last crop planted			
1.2	Field type			
1.3	Dimensions of the field, m			
1.3.1	Length			
1.3.2	Width			
1.4	Area, m^2			
1.5	Soil type			
1.6	Initial soil resistance, kg/cm^2			
1.7	Initial soil bulk density, kg/cm^3			
1.8	Soil moisture content, $\%_{db}$			
1.9	Height of stubbles, (if applicable) mm			
1.10	Spacing of stubbles, row x hill, (if applicable) mm			
1.11	Weed density			
1.12	Field condition before operation			
2	Field performance			
2.1	Type of operation			
2.2	Tractor's gearshift setting			
2.3	Soil bulk density after rotary tilling, g/cm^3			
2.4	Change in soil bulk density, g/cm^3			
2.5	Puddling index, %			
2.6	Traveling speed, kph			
2.7	Average depth of rotary tilling, mm			
2.8	Average width of rotary tilling, mm			
2.9	Effective field capacity			
2.9.1	ha/h			
2.9.2	h/ha			
2.10	Theoretical field capacity			

No.	Item	Trial 1	Trial 2	Average
2.10.1	ha/h			
2.10.2	h/ha			
2.11	Field efficiency, %			
2.12	Total operating time, h			
2.13	Nonproductive time, h			
2.13.1	Turning, h			
2.13.2	Others (specify), h			
2.14	Fuel consumption			
2.14.1	Per unit time, L/h			
2.14.2	Per area covered, L/ha			
2.14.3	Per change in soil bulk density, L-cm^3/g			
2.14.4	Per area covered per change in soil bulk density, L-cm^3/ha-g			
2.14.5	Per volume of soil pulverized, L/m^3 soil			
2.15	Noise level, dB(A)			
2.16	Field operational pattern			
2.17	Overlapped/untilled, % (define)			

2.18 Observations:

2.18.1 Number of operators

_____

2.18.2 Working depth adjustment

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_____

2.18.3 Warning and safety stickers

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2.18.4 Failures or abnormalities of the rotary tiller or its component parts during and after the operation

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2.18.5 Ease of handling and safety features of the machine

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2.18.6 Other remarks

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2.18.7 Dynamic balance of the rotating parts

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Annex F
(Normative)

Laboratory analysis

F.1 Determination of soil moisture content and bulk density

F.1.1 Place the soil core samples taken from the test plots in separate moisture cans of predetermined weight. Ensure that no moisture is lost or gained by the sample between the time it was transferred until it is weighed in a moisture can. Weigh and record all the initial weights.

F.1.2 Dry the samples in the oven at 105°C for 72 hours or until constant weight is attained.

F.1.3 After removing the samples from the oven, place the moisture can with samples in a desiccator and allow them to cool to the ambient temperature.

F.1.4 Weigh the moisture can with the dried sample. Record the final weights. Calculate the moisture content using the formula in Annex D (Formulas used during calculations and testing).

F.1.5 Measure the height and internal diameter of the cylindrical soil sampler to determine the total volume of soil sample. With the oven-dried weights obtained in E.1.4, calculate the soil bulk density using the formula in Annex D (Formulas used during calculations and testing).

F.2 Determination of Soil Puddling Index

F.2.1 Oven-dry the 100 ml soil and water suspension samples at 105 °C for 48 hours.

F.2.2 Determine and record the volume of settled soil. Calculate the puddling index using the formula in Annex D (Formulas used during calculations and testing).

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