

## **Foreword**

The formulation of this National Standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) with support from the Department of Agriculture (DA).

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

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

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

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

Regional Network for Agricultural Machinery (RNAM) Test Codes and Procedures for Farm Machinery. Technical Series No. 12:1983.

Richey, C.B., Jacobson P. and C.W. Hall. *Soil Classification Scheme Adopted by USDA*. Agricultural Engineers’ Handbook. McGraw-Hill Book Company. 1961. pp. 792.

Smith, D.W., Sims B.G, and D.H. O’Neill. *Testing and Evaluation of Agricultural Machinery and Equipment – Principles and practices*. FAO Agricultural Services Bulletin 110. 1994.

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**Agricultural Machinery – Weeder – Methods of Test**

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## **1 Scope**

This standard specifies the methods of test and inspection for manually-operated, animal-drawn, and tractor-drawn weeders for dry and wet fields. Specifically, it shall be used to:

- 1.1 verify the specifications submitted by manufacturer;
- 1.2 determine the field performance of the weeder;
- 1.3 evaluate the ease of handling; and
- 1.4 prepare a report on 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:

PAES 103:2000, Agricultural Machinery – Method of Sampling  
PAES 141:2004, Agricultural Machinery – Weeder – Specifications

## **3 Definitions**

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

### **3.1**

#### **damaged plants**

plants injured (i.e. teared leaves, broken stems, and/or uprooted plant) that may affect crop growth

### **3.2**

#### **percent damaged plants**

percentage of plants injured during the weeding operation

### **3.3**

#### **weeding efficiency**

weeding index

percentage of weeds removed/destroyed per unit area

### **3.4**

#### **weeder**

implement used to remove/destroy the weeds from an agricultural land

### **3.5**

#### **weeds**

unwanted plants growing in a field competing with the main crop for nutrients, moisture and sunlight

## **4 General Conditions for Test and Inspection**

### **4.1 Weeder on Test**

The weeder submitted for test shall be sampled in accordance with PAES 103.

### **4.2 Role of the manufacturer/dealer**

The manufacturer/dealer shall submit to the official testing agency the specifications and other relevant information on the weeder. An official representative of the manufacturer/dealer shall be appointed to conduct minor repairs and adjustments and witness the test. It shall be the duty of the representative to make all decisions on matters of adjustment and preparation of the implement for testing. The manufacturer/dealer shall abide by the terms and conditions set forth by the official testing agency.

### **4.3 Termination of Test**

If the weeder becomes non-functional during the test, the test shall be terminated by the test engineer.

### **4.4 Human, Draft Animal and Tractor to be Used**

**4.4.1** Operator shall be in good health, experienced in the use of weeder and be familiar with the operation and requirements of the test method. Height, weight and stature of the operator shall be recorded. Pulse rate and blood pressure before and after each test trial shall be recorded.

**4.4.2** Draft animal shall be in good physical condition during the test. The draft of the weeder shall be approximately 15% of the animal's body weight.

**4.4.3** The tractor to be used shall be compatible with the weeder in accordance with the manufacturer's specification of required power.

## **5 Tests and Inspection**

### **5.1 Verification of Manufacturer's Technical Data and Information**

**5.1.1** This investigation is carried out to verify that the mechanism and specifications conform to the list of technical data and information submitted by the manufacturer.

**5.1.2** The suggested minimum list of field and laboratory test equipment and materials are given in Annex A and the items to be inspected and verified are given in Annex B.

## 5.2 Field Performance Test

**5.2.1** This is carried out to test the field performance of the weeder.

**5.2.2** The test shall be carried out on a dry and/or wet field where the conditions of the field are to be recorded.

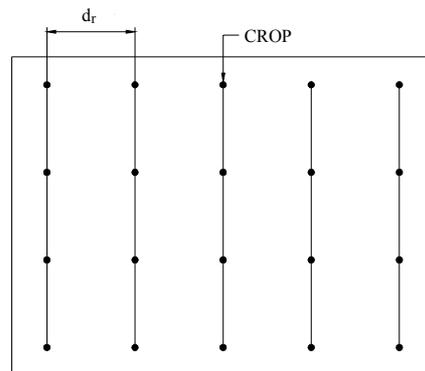
### 5.2.3 Test Conditions

#### 5.2.3.1 Size of the Area per Trial

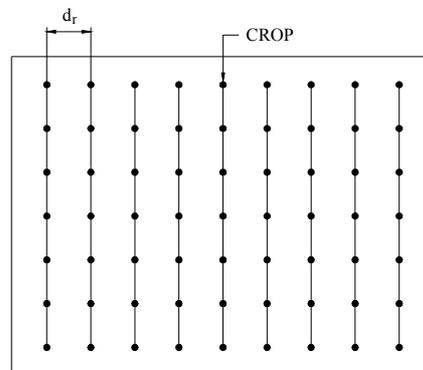
Weeding operation shall be done in fields of not less than 20 m<sup>2</sup> for hand-held, 100 m<sup>2</sup> for push-type, 250 m<sup>2</sup> for animal-drawn, 500 m<sup>2</sup> for two-wheel tractor-drawn and 1000 m<sup>2</sup> for four-wheel tractor-drawn weeders. The plot shall be rectangular in shape with sides in the ratio of 2:1 as much as possible.

#### 5.2.3.2 Planting Pattern

The planting patterns for dry and wet fields as shown in Figure 1 shall be used. The distance between rows ( $d_r$ ) for dry and wet fields shall be at least 75 cm (corn) and 20 cm (rice), respectively.



**a. For dry field**

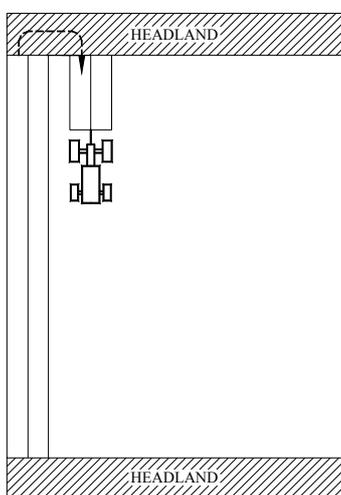


**b. For wet field**

**Figure 1 – Recommended Planting Pattern for the Test Area**

### 5.2.3.3 Operational Pattern for Tractor-drawn Weeders

Field capacity and field efficiency are influenced by field operational pattern which is closely related to the size and shape of the field, the kind and size of implement. The non-working time should be eliminated as much as possible using the recommended field operational pattern as shown in Figure 2.



**Figure 2 – Recommended Field Operational Pattern**

### 5.2.3.4 Traveling Speed

**5.2.3.4.1** For four-wheel tractor-drawn weeders, a traveling speed of 5 kph to 6 kph shall be maintained during the operation.

**5.2.3.4.2** For two-wheel tractor-drawn weeders, a traveling speed of 3 kph to 4 kph shall be maintained during the operation.

**5.2.3.4.3** For animal-drawn weeders, a traveling speed of 2 kph to 4 kph shall be maintained during the operation.

### 5.2.3.5 Test Trials

The test shall be conducted with at least three test trials.

### 5.2.3.6 Headland

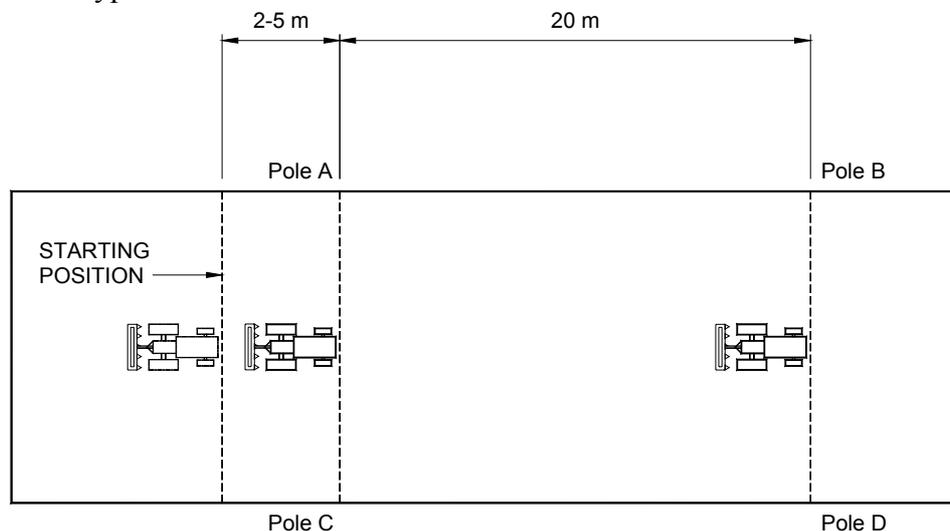
Depending on the tractor size, headland shall be at least 3 m in length.

## 5.2.4 Measurement of Performance Parameters

### 5.2.4.1 Verification of Operating Speed

Outside the long boundary of the test plot, two poles 20 m apart (A, B) are placed approximately in the middle of the test run. On the opposite side also two poles are placed in similar position, 20 m apart (C, D) so that all four poles form corners of a rectangle, parallel to at least one long side of the test plot. (see Figure 3) The speed will be calculated from the

time required for the weeder to travel the distance (20 m) between the assumed line connecting two poles on opposite sides AC and BD. The easily visible point of the machine should be selected for measuring the time. The starting position shall be at least 2 to 5 m from poles A and C to stabilize speed before measuring and recording data. Tractor shall be operated at rated rpm. The same procedure shall be used in determining the actual operating speed for other types of weeder.



**Figure 3 – Measurement of Operating Speed for Tractor-drawn Weeder**

#### **5.2.4.2 Total Operating Time**

Total operating time shall be measured once the machine/implement starts to weed up to the time it finished weeding the test area. Time losses for adjustment, turning and machinery breakdown shall be deducted from the total operating time.

#### **5.2.4.3 Fuel Consumption (for power- and tractor-mounted weeders)**

The tank is filled to full capacity before and after each test trial. The volume of fuel refilled after the test is the fuel consumption during the test. When filling up the tank, careful attention should be taken to keep the tank horizontal and not to leave empty space in the tank.

#### **5.2.4.4 Soil Hardness**

The soil hardness shall be measured using cone penetrometer.

#### **5.2.4.5 Wheel Slip (for tractor-drawn weeder)**

The weeder's driving wheel is marked with colored tape. For a given distance, the number of revolutions of the driving wheels with load ( $N_l$ ) and without load ( $N_0$ ) shall be recorded. (refer to Annex E for the formula used in calculating wheel slip).

### 5.2.4.6 Weeding Efficiency

Prior to weeding operation, ten strips with 1-meter length shall be randomly selected and marked on the unweeded land as shown in Figure 4. All the weeds on each strip shall be recorded as  $W_1$ . After weeding operation, the weeds on each of the ten marked strips shall be recorded as  $W_2$ . Weeding efficiency can be computed based on the following formula:

$$\varepsilon_w = \frac{W_1 - W_2}{W_1} \times 100$$

where:

- $\varepsilon_w$  is the weeding efficiency, %
- $W_1$  is the number of weeds before operation per unit area
- $W_2$  is the number of weeds after operation per unit area

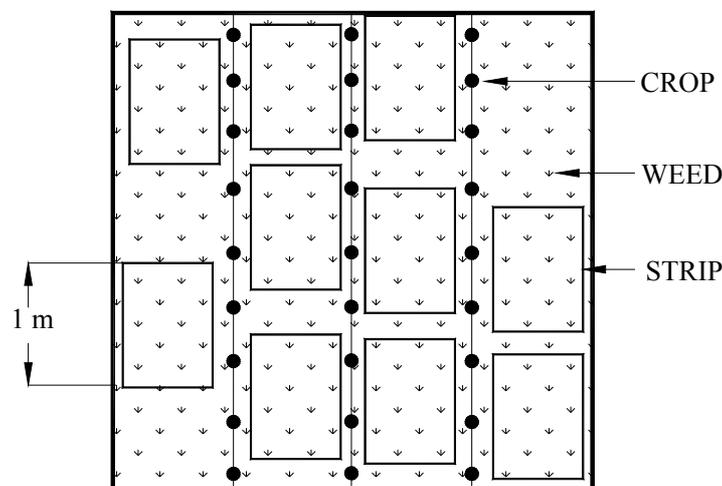


Figure 4 – Marked Strip for Assessment of Weeding Efficiency

### 5.2.4.7 Percent Damaged Plants

Ten 10-meter row length shall be marked prior to weeding operation. The number of plants on each row shall be recorded. After weeding, the number of damaged plants on each of the marked rows shall be recorded. Percent damaged plants can be computed based on the following formula:

$$PDP = \frac{q}{p} \times 100$$

where:

- $PDP$  is the percent damaged plants, %
- $p$  is the number of plants in 10-meter row length before weeding
- $q$  is the number of damaged plants in 10-meter row length after weeding

### 5.2.4.8 Effective working width

Effective working width is determined by measuring the total width per row of the weeder.

### 5.3 Power Requirement Determination

#### 5.3.1 Draft Measurement of Human Power

The manually-operated weeder shall be operated with a load cell attached to its handle. For every pass, draft readings shall be taken for every 20-meter distance traveled by the weeder, readings shall be obtained.

NOTE A mature human can continuously develop an output of 75 Watts (0.01 hp).

#### 5.3.2 Draft Measurement for Animal-Drawn Weeder (Optional)

5.3.2.1 The weeder shall be operated with the spring or strain-gauge type dynamometer inserted between the implement yoke and the hitch of the weeder as shown in Figure 4. There shall be a minimum of three passes wherein data shall be gathered. For every 20 m distance traveled by the weeder, five dynamometer readings shall be obtained.

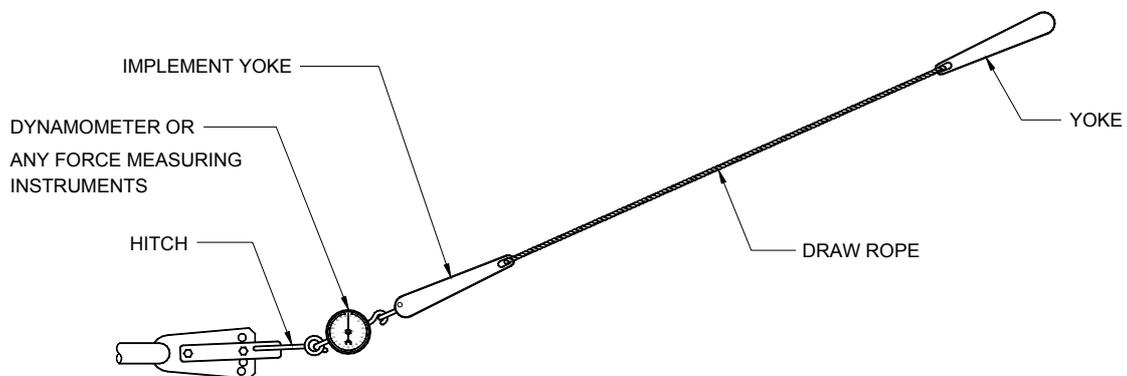


Figure 4 – Draft Measurement for Animal-Drawn Weeder

5.3.2.2 The angle in which the line of pull makes with the horizontal shall be measured using following methods:

##### a. Trigonometric Method

The angle of pull with a draft animal shall be calculated based on the measurements as shown in Figure 5.

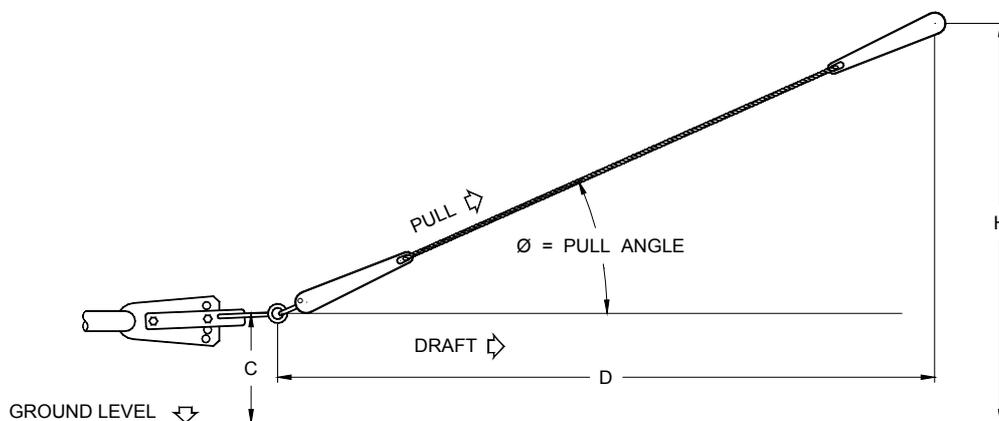


Figure 5 – Angle of Pull Measurement for Animal-drawn Weeder

The pull angle shall be calculated as follows:

$$\theta = \arctan \frac{H - C}{D}$$

where:  $H$  is the distance from the top of the yoke to the ground, mm  
 $C$  is the clearance between the hitch point and the ground, mm  
 $D$  is the distance between two vertical lines, one passing through the hitch point and one through the top of the yoke, mm

#### b. Pendulum Method

This is a method which uses the principle of the pendulum to obtain the horizontal reference. A protractor for measuring the angle shall be placed on the hitch of the weeder. It shall be placed so that it can circularly move freely; a weight shall be suspended from the protractor to maintain the zero of the protractor in the horizontal position. The angle shall be determined by taking the angle that the rope makes with the horizontal.

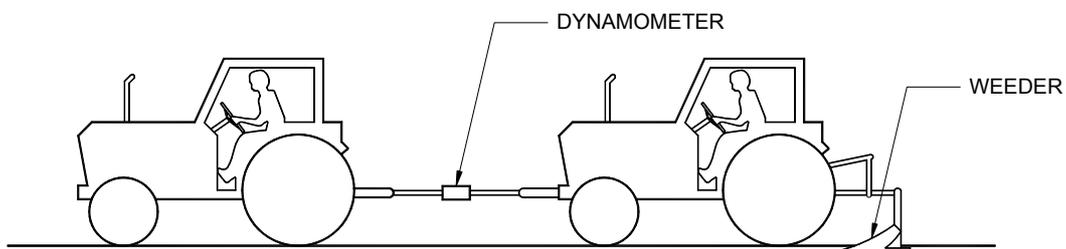
**5.3.2.3** Calculate the draft requirement of the animal-drawn weeder using the following formula:

$$D = P \cos \theta$$

where:  $D$  is the draft, kg  
 $P$  is the pull, kg  
 $\theta$  is the angle between the line of pull and the horizontal

#### 5.3.3 Draft Measurement for Tractor-Drawn Weeder (Optional)

A strain-gauge type dynamometer is attached to the front of the tractor on which the implement is mounted. Another auxiliary tractor will pull the implement-mounted tractor through the dynamometer in neutral gear but with the implement in the operating position as shown in Figure 6. The draft in the measured distance of 20 m as well as the time it takes to traverse it shall be read and recorded. On the same field, the draft in the same distance shall be read and recorded while the implement is lifted above the ground. The difference gives the draft of the implement.



**Figure 6 – Draft Measurement for Tractor-Drawn Weeder**

5.3.4 Calculate the power requirement for animal- and tractor-drawn weeders using the following formula:

$$P = \frac{Dv}{100.5}$$

where:  $P$  is the power requirement of the implement, kW  
 $D$  is the draft of the implement, kg  
 $v$  is the speed of the tractor or draft animal, m/s

5.4 The items to be measured, investigated and recorded during the field tests are given in Annex C.

### 5.5 Soil Analysis (Laboratory Method)

The soil texture and moisture content of the test area shall be determined by the recommended methods given in Annex D and shall be recorded in Annex C.

## 6 Data Analysis

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

## 7 Test Report

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

- 7.1 Name of testing agency
- 7.2 Test report number
- 7.3 Title
- 7.4 Summary
- 7.5 Purpose and scope of test
- 7.6 Methods of test
- 7.7 Description and Specifications of the Weeder
- 7.8 Results of Field Test
- 7.9 Name and Signature of Test Engineers

## Annex A

Suggested Minimum List of Field and Laboratory  
Test Equipment and Materials

Items	Quantity
<b>A1 Equipment</b>	
<b>A1.1 Field Equipment</b>	
<b>A1.1.1</b> Timers Range: 0 to 60 minutes Accuracy: 1/10	2
<b>A1.1.2</b> Steel tape, 50 m and 5 m	2
<b>A1.1.3</b> Graduated cylinder, capacity: 1,000 mL	1
<b>A1.1.4</b> Noise level meter	1
<b>A1.1.5</b> Digital video camera	1
<b>A1.1.6</b> Tractor: Four-wheel tractor, minimum: 65 kW Two-wheel tractor Diesel, minimum: 5 kW Gasoline, minimum: 7 kW	1 1
<b>A1.2 Laboratory Equipment (soil analysis and verification of specifications)</b>	
<b>A1.2.1</b> Convection oven	1
<b>A1.2.2</b> Electronic balance, capacity: 1 kg	1
<b>A1.2.3</b> Sieve Sizes: 2 mm, 0.05 mm, and 0.002 mm	3
<b>A1.2.4</b> Vernier caliper	1
<b>A2 Materials for Field Test</b>	
<b>A2.1</b> Marking pegs	30

**Annex B**  
**Inspection Sheet for Weeder**

Name of Applicant: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone No. : \_\_\_\_\_

Name of Distributor: \_\_\_\_\_

Address: \_\_\_\_\_

Name of Manufacturer: \_\_\_\_\_

Factory Address: \_\_\_\_\_

**GENERAL INFORMATION**

Brand: \_\_\_\_\_ Model: \_\_\_\_\_

Serial No. : \_\_\_\_\_ Type: \_\_\_\_\_

Production date of weeder to be tested: \_\_\_\_\_

**Items to be inspected**

ITEMS	Manufacturer's Specification	Verification by Testing Agency
<b>B1</b> Dimensions and weight of weeder		
<b>B1.1</b> Overall length, mm		
<b>B1.2</b> Overall width, mm		
<b>B1.3</b> Overall height, mm		
<b>B1.4</b> Weight, kg		
<b>B2</b> Crops for which suitable		
<b>B3</b> Details of soil engaging component		
<b>B3.1</b> Type		
<b>B3.2</b> Dimensions		
<b>B3.2.1</b> Length, mm		
<b>B3.2.2</b> Width, mm		
<b>B3.2.3</b> Thickness, mm		
<b>B3.3</b> Number of rows		
<b>B3.4</b> Width per row, mm		
<b>B3.5</b> Total working width, mm		
<b>B3.6</b> Material of construction		

ITEMS	Manufacturer's Specification	Verification by Testing Agency
<b>B3.6</b> Hardness (Rockwell/ Brinell)		
<b>B3.7</b> Other details		
<b>B4</b> Details of depth wheel (if any)		
<b>B4.1</b> Dimension, mm		
<b>B4.2</b> Material		
<b>B5</b> Details of frame/toolbar		
<b>B5.1</b> Dimension, mm		
<b>B5.2</b> Material		
<b>B5.3</b> Adjustment		
<b>B5.4</b> Type of hitch		
<b>B5.5</b> Ground clearance, mm		
<b>B6</b> Details of handle		
<b>B6.1</b> Height of handle from ground level		
<b>B6.2</b> Material		
<b>B6.3</b> Details of adjustments		
<b>B7</b> Details of tine		
<b>B7.1</b> Dimension, mm		
<b>B7.2</b> Material		
<b>B8</b> Mounting details		
<b>B9</b> Adjustments for row spacing (range)		
<b>B10</b> Details of power unit (for power-operated weeders)		
<b>B11.1</b> Type of power unit		
<b>B11.2</b> Make		
<b>B11.3</b> Model		
<b>B11.4</b> Serial No.		
<b>B11.5</b> Year of manufacture		
<b>B11.6</b> Power, kW		
<b>B11.7</b> Speed, rpm		
<b>B11.8</b> Type of lubrication		
<b>B11.9</b> Recommended lubricant and capacity		
<b>B11.10</b> Fuel type		
<b>B11.11</b> Fuel tank capacity, L		
<b>B12</b> Details of power transmission system ( from engine to the soil working parts- a line diagram may be attached)		

## Annex C

## Field Performance Test Data Sheet

## Items to be Measured and Inspected

ITEMS	Trials			Average
	1	2	3	
<b>C1</b> Test Conditions				
<b>C1.1</b> Condition of field and soil				
<b>C1.1.1</b> Location				
<b>C1.1.2</b> Dimensions of field (L x W), m				
<b>C1.1.3</b> Area, m <sup>2</sup>				
<b>C1.1.4</b> Soil type (clay, clay loam, sandy, etc)				
<b>C1.1.5</b> Moisture content (dry basis), %				
<b>C1.1.6</b> Depth of standing water, cm				
<b>C1.1.7</b> Period after land operation				
<b>C1.2</b> Condition of Weed				
<b>C1.2.1</b> Type of weed				
<b>C1.2.2</b> Common name of weed				
<b>C1.2.3</b> Weed population, no./ m <sup>2</sup>				
<b>C1.2.4</b> Height of weed, cm				
<b>C1.3</b> Condition of crop				
<b>C1.3.1</b> Name of crop				
<b>C1.3.2</b> Variety				
<b>C1.3.3</b> Age in days after planting				
<b>C1.3.4</b> Planting method				
<b>C1.3.5</b> Row spacing, cm				
<b>C1.3.6</b> Hill distance, cm				
<b>C1.3.7</b> No. of plants in a hill				
<b>C1.3.8</b> Plant population, plant/ m <sup>2</sup>				
<b>C1.3.9</b> Height of plant, cm				
<b>C1.4</b> Weather condition				
<b>C1.4.1</b> Temperature				
<b>C1.4.1.1</b> Dry bulb, °C				
<b>C1.4.1.2</b> Wet bulb, °C				
<b>C1.4.2</b> Wind velocity, kph				
<b>C1.4.3</b> Weather (sunny, cloudy, rainy, hot, cold)				

ITEMS	Trials			Average
	1	2	3	
<b>C2</b> Field Performance				
<b>C2.1</b> Date of test				
<b>C2.2</b> Type of field operation				
<b>C2.3</b> Time lost, min				
<b>C2.3.1</b> Turning				
<b>C2.3.2</b> Adjustment				
<b>C2.3.3</b> Others (specify)				
<b>C2.4</b> Area covered, m <sup>2</sup>				
<b>C2.5</b> Traveling speed, kph				
<b>C2.6</b> Effective width of cut of one row unit for one run, cm				
<b>C2.7</b> No. of runs required in between rows				
<b>C2.8</b> Field capacity, ha/ h				
<b>C2.9</b> Field efficiency, % (if applicable)				
<b>C2.10</b> Effective width covered by the weeder in between two rows, cm				
<b>C2.11</b> Percentage of width covered by the weeder to row spacing, %				
<b>C2.12</b> Weeding efficiency				
<b>C2.12.1</b> Count of weeds in between two rows for 1m length or in m <sup>2</sup> before weeding (W <sub>1</sub> )				
<b>C2.12.2</b> Count of weeds in between two rows for 1m length or in m <sup>2</sup> after weeding (W <sub>2</sub> )				
<b>C2.12.3</b> Weeding efficiency, %				
<b>C2.12.4</b> Field condition after weeding				
<b>C2.13</b> Damaged plants				
<b>C2.13.1</b> No. of plants in 10-meter row length before weeding				
<b>C2.13.2</b> No. of damaged plants in 10-meter row length after weeding				
<b>C2.13.3</b> Percent plant damaged, %				
<b>C2.14</b> Draft of the implement, kN				
<b>C2.15</b> Power requirement, kW				
<b>C2.16</b> Labor requirement				
<b>C2.16.1</b> No. of laborers				
<b>C2.16.2</b> Total man-hour during test, man-h				
<b>C2.17</b> Condition of Operator				
<b>C2.17.1</b> Pulse rate before weeding operation				
<b>C2.17.2</b> Pulse rate after weeding operation				
<b>C2.17.3</b> Percent increase in pulse rate after weeding operation, %				

**C3 Observations**

A minimum of three persons (test engineer, manufacturer’s representative and the operator) shall rate the following observations.

<b>Items</b>	<b>Rating*</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>C.3.1</b> Work quality					
<b>C.3.2</b> Ease of handling and stability when machine is working and turning					
<b>C.3.3</b> Ease of making adjustments and repairs					
<b>C.3.4</b> Durability of part (based on wear of soil-working parts, visible deformation, etc)					
<b>C.3.5</b> Other observations _____ _____ _____					

- \* 1 – Very Good
- 2 – Good
- 3 – Satisfactory
- 4 – Poor
- 5 – Very Poor

## Annex D

### Soil Analysis (Laboratory Method)

#### D1.1 Soil Texture Determination

**D1.1.1** This test is carried out to analyze the soil samples taken during the performance test to determine the soil texture of the test area.

**D1.1.2** Three soil samples shall be taken from the test area. Each soil sample shall be weighed and recorded.

**D1.1.3** Each soil sample shall then be passed through series of sieves.

**D1.1.4** The type of soil (i.e. sand, silt and clay) that is retained in a particular sieve shall be weighed. (see Table D1)

**Table D1 – Grain Size for Different Soil Types**

Soil Type	Grain Size Mm	Remarks
Sand	2.0 – 0.05	Passed through the 2 mm sieve but retained by the 0.05 mm sieve
Silt	0.05 – 0.002	Passed through the 0.05 mm sieve but retained by the 0.002 mm sieve
Clay	< 0.002	Passed through the 0.002 mm sieve

**D1.1.5** The relative composition of each soil type expressed in percent shall be computed as follows:

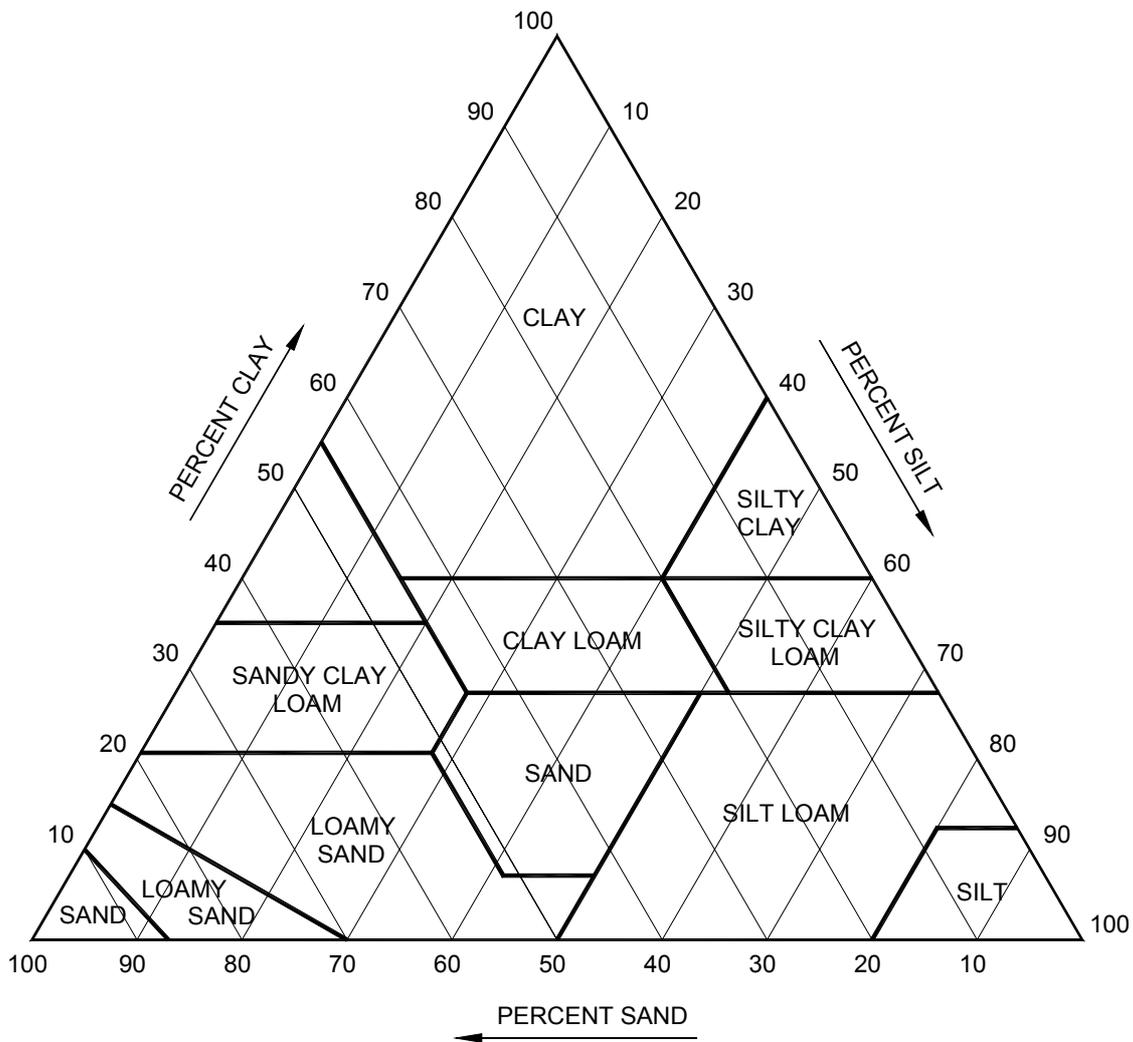
$$\% \text{ Sand} = \frac{\text{Weight of sand}}{\text{Total weight of soil}} \times 100$$

$$\% \text{ Silt} = \frac{\text{Weight of silt}}{\text{Total Weight of soil}} \times 100$$

$$\% \text{ Clay} = \frac{\text{Weight of clay}}{\text{Total Weight of soil}} \times 100$$

**D1.1.6** The relative composition of the sand, silt and clay shall be used to determine the soil type using the soil texture triangle as shown in Figure D1.

**EXAMPLE:** If you have a soil with 20% clay, 60% silt and 20% sand, it will fall in the “silt loam” texture class.



Source: Soil classification scheme adopted by USDA, Agricultural Engineering Handbook, 1961.

**Figure D1 – Soil Texture Triangle Showing Relative Composition of Texture Class**

## D1.2 Soil Moisture Content Determination

### D1.2.1 Oven Method

**D1.2.1.1** This test is carried out to analyze the soil samples taken during the performance test to determine the soil moisture of the test area.

**D1.2.1.2** Three core soil samples in at least three different locations of test plots shall be taken randomly from the test area. Each soil sample shall be weighed and recorded as initial weight.

**D1.2.1.3** The samples shall be dried using a convection oven maintained at 150°C for at least eight hours.

**D1.2.1.4** The oven dried sample shall then be placed in a desiccator. Each soil sample shall be weighed and recorded as oven-dried weight.

**D1.2.1.5** The soil moisture (% dry weight basis) shall be computed as follows:

$$\text{Soil Moisture (\% dry weight basis)} = \frac{W_i - W_f}{W_f} \times 100$$

where:  $W_i$  is the initial weight of the soil, kg  
 $W_f$  is the oven-dried (final) weight of the soil, kg

**D1.2.2** The soil moisture content can also be measured using a soil moisture meter.

## Annex E

### Formulas Used During Calculations and Testing

#### E1.1 Field Efficiency

$$\varepsilon_f = \frac{W_e T_p}{W_t (T_p + T_l)} \times 100$$

where:  $\varepsilon_f$  is the field efficiency, %  
 $W_e$  is the effective working width, mm  
 $W_t$  is the theoretical working width, mm  
 $T_p$  is the productive time, h  
 $T_l$  is the non-productive time, h

#### E1.2 Wheel slip

$$\text{Wheel slip, \%} = \frac{N_1 - N_0}{N_1} \times 100$$

where:  $N_1$  is the number of revolutions of the driving wheels for a given distance with slip, rpm  
 $N_0$  is the number of revolutions of the driving wheels for the same distance without slip, rpm

#### E1.3 Fuel Consumption Rate

$$F_t = \frac{V}{t}$$

where:  $F_t$  is the fuel consumption rate, L/h  
 $V$  is the volume of fuel consumed, L  
 $t$  is the total operating time, h

#### E1.4 Effective Fuel Consumption Rate

$$F_e = \frac{10,000 V}{A_e}$$

where:  $F_e$  is the effective fuel consumption rate, L/ha  
 $V$  is the volume of fuel consumed, L  
 $A_e$  is the effective area covered, m<sup>2</sup>