DEAS 1182:2023

ICS: 65.060

DRAFT EAST AFRICAN STANDARD

Agricultural machinery — Disc and mouldboard ploughs — Test methods

EAST AFRICAN COMMUNITY

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

In order to achieve this objective, the Community established an East African Standards Committee mandated to develop and issue East African Standards.

The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

DEAS 1182:2023 was prepared by Technical Committee EASC/TC 042, *Production and general engineering*.

Agricultural machinery — Disc and mouldboard ploughs — Test methods

1 Scope

This draft East African standard specifies the test methods and inspection for animal-drawn and tractor-operated disc and mouldboard ploughs used for tilling land.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8910, *Machinery and equipment for working the soil – Mouldboard plough working elements – Vocabulary*
ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

3 Terms and definitions

For the purposes of this standard, terms and definitions in ISO 8910 and the following terms and definitions shall apply:

3.1 disc plough
rolling implement that cuts, lifts, inverts and throws to one side a layer of soil (furrow slice) to bury surface materials

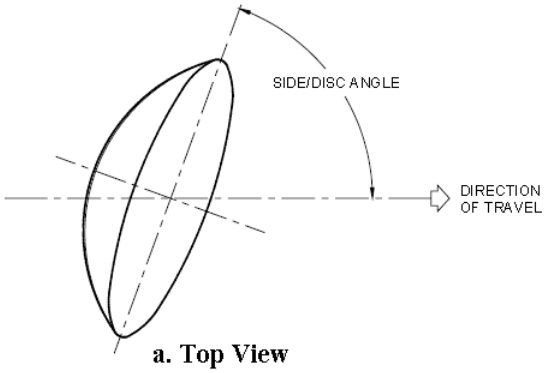
3.2 four-wheel tractor or riding tractor
self-propelled, wheeled vehicle having two axles designed to carry, pull or propel agricultural implements and machines

3.3 headland
unploughed portion of the field at both ends of the furrow strip initially used for turning the draft animal/tractor and implement

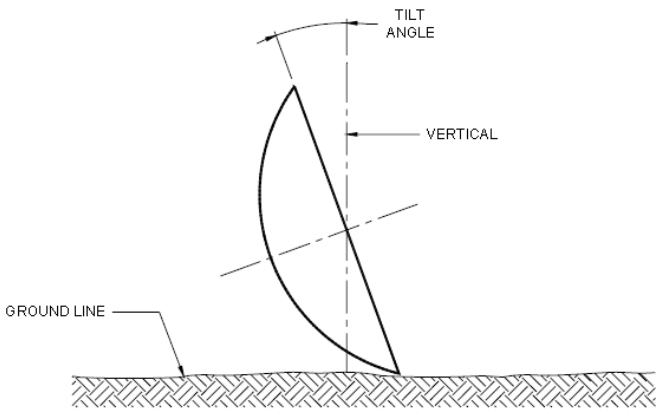
3.4 mouldboard plough
sliding implement that cuts, lifts, inverts and throws to one side a layer of soil (furrow slice) to bury surface materials

3.5 side angle (disc angle)angle at which the plane of the cutting edge of the disc is inclined to the direction of travel and usually it varies between 42º and 45º (See Figure 1a).

3.6 tilt angle
angle at which the plane of the cutting edge of the disc is inclined to the vertical line (see Figure 1b)



a. Top View



b. Side view

Figure 1 –Side and tilt angle

3.7 walking agricultural tractor (two-wheel tractor, hand tractor, pedestrian tractor)
self-propelled machine having a single axle designed primarily to pull and propel trailed or mounted agricultural implements and machinery

3.8 width of cut – disc plough
transverse distance between the cutting edges of the end discs at their depth of cut

NOTE: For measuring the width of cut, the tilt angle shall be set at 15 to 25°. For nonadjustable plough disc blades, the tilt angle shall be set at 18 to 20°.

3.9 width of cut – mouldboard plough
distance measured from the wing of share to the point of share

4 General Conditions for Test and Inspection

4.1 Plough on test
The plough submitted for test shall be sampled in accordance with ISO 2859-1.

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 plough. 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 plough fails to penetrate the soil or becomes non-functional during test, the test shall be terminated by the responsible competent personnel.

4.4 Tractor and draft animals to be used
4.4.1 The tractor to be used shall be compatible with the plough in accordance with the manufacturer's specification of required power.
4.4.2 Draft animals shall be in good physical condition during the test. The implement's draft shall be approximately 15% of the animal's body weight.

5 Tests and Inspection

Inspection and testing shall be done by the competent personnel.

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 plough.
5.2.2 The test shall be carried out on a dry or wet field as specified by the manufacturer 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
Ploughing operation shall be done in fields of not less than 250 m2 for animal-drawn, 500 m2 for two-wheel tractor-operated and 1,000 m2 for four-wheel tractor-operated ploughs. The plot shall be rectangular in shape with sides in the ratio of 2:1 as much as possible.

5.2.3.2 Operational Pattern
Field capacity and field efficiency are influenced by field operational pattern which is closely related to the size and shape of the field and the kind and size of implement. The nonworking time should be minimized as much as possible using the recommended field operational patterns as shown in Figure 2.

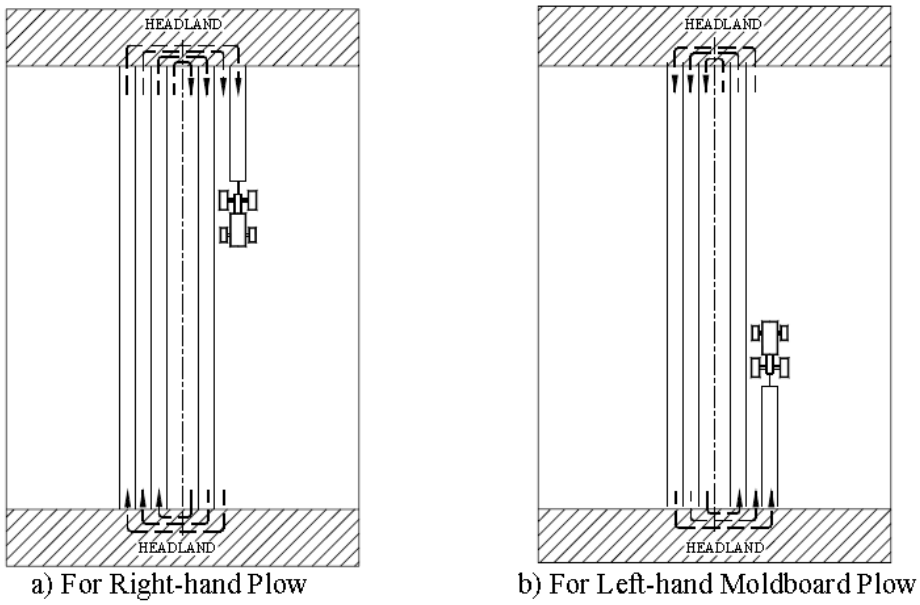


Figure 2 – Recommended field operational pattern

5.2.3.3 Traveling Speed
5.2.3.3.1 For four-wheel tractor-operated ploughs, a traveling speed of 5 kph to 6 kph shall be maintained during the operation.
5.2.3.3.2 For two-wheel tractor-operated ploughs, a traveling speed of 3 kph to 4 kph shall be maintained during the operation.
5.2.3.3.3 For animal-drawn ploughs, a traveling speed of 2 kph to 4 kph shall be maintained during the operation.

5.2.3.4 Depth of Cut
5.2.3.4.1 The depth of cut shall be set at 1/3 of the disc diameter for disc plough.
5.2.3.4.2 The depth of cut for mouldboard plough shall be set at the vertical height from the point of share to the uppermost part of the shin as shown in Figure 3.

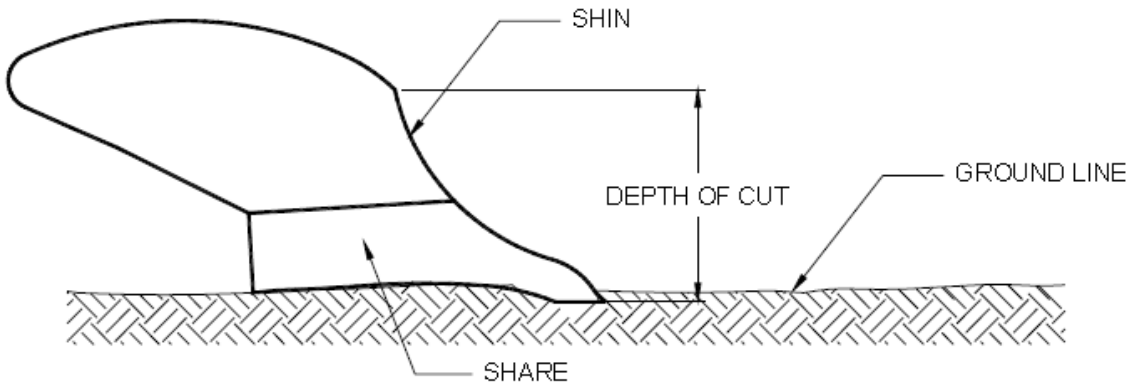


Figure 3 – Depth of cut for mouldboard plough

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 Field Capacity Determination
5.2.4.1.1 Working Width and Depth
A depth and width meter as shown in Figure 4 shall be used in measuring the working width and depth simultaneously for animal-drawn and tractor-operated ploughs. The working depth and width are measured by placing the tip of graduated depth scale to the ploughed surface (B) and putting a pin at point A of width scale. This procedure will be repeated for the succeeding passes and the distance between two pins adjacent to each other is the working width and the distance between point B and baseline for reading depth is the working depth. However, ploughed surface is not always level depending on the feature of the implement. Therefore, the tip of the depth scale shall be placed at relatively same point in each pass.

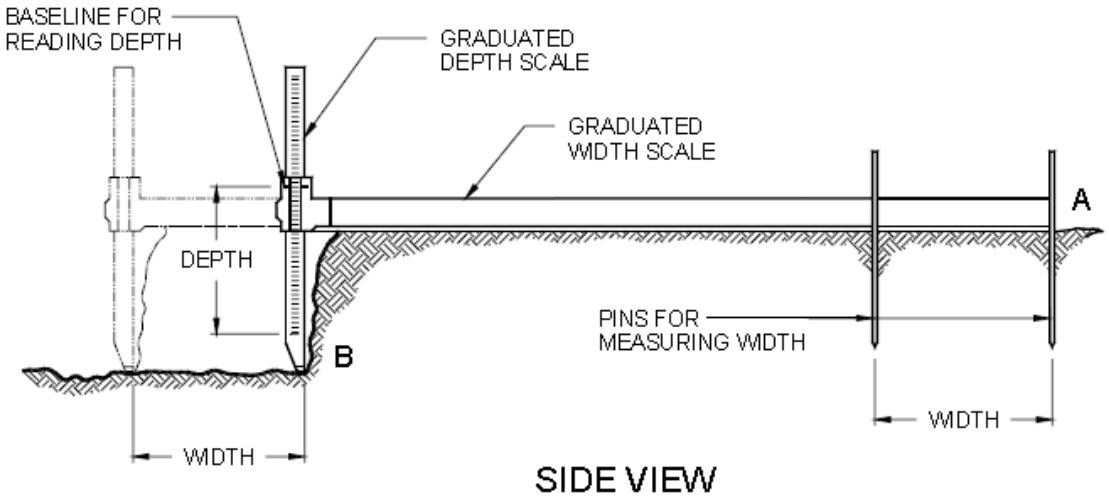


Figure 4 – Depth and width measurement

5.2.4.1.2 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 plot. 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 5) The speed will be calculated from the time required for the tractor 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 tractor should be selected for measuring the time. The starting position

shall be at least 2 m to 5 m from poles A and C to stabilize speed before measuring and recording data. Tractor shall be operated at rated engine speed (rpm). The same procedure shall be used in determining the actual operating speed for two-wheel tractor-operated and animal-drawn ploughs.

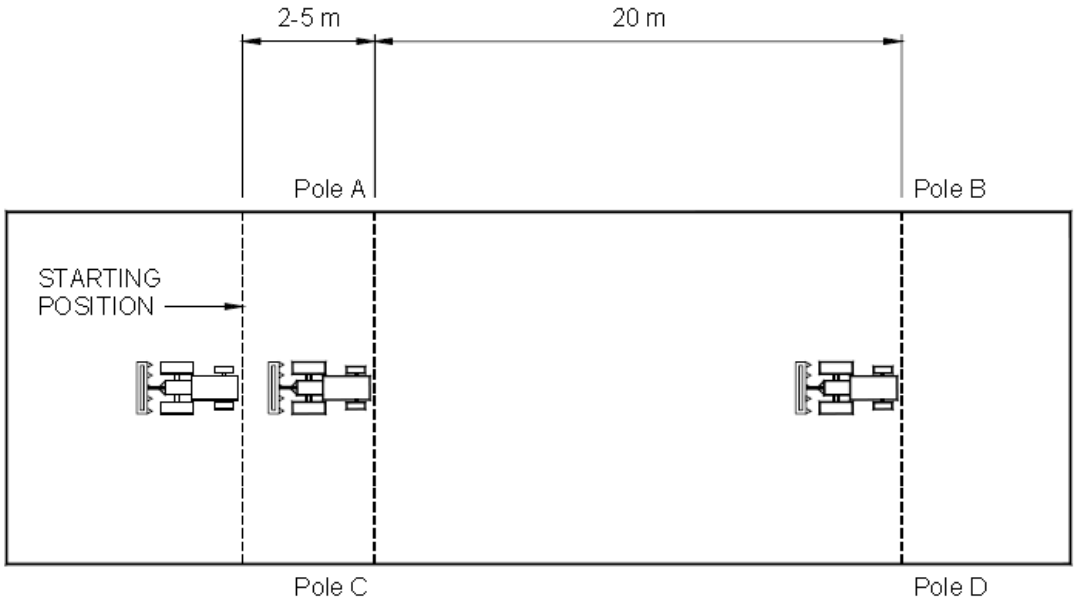


Figure 5 – Measurement of operating speed

5.2.4.3 Soil Hardness
The soil hardness shall be measured using cone penetrometer.

5.2.4.4 Wheel Slip or Travel Reduction
The tractor drive wheel is marked with colored tape. For a given distance, the number of revolutions of the driving wheels with load (N1) and without load (N0) shall be recorded. The formula used in calculating wheel slip is shown in Annex E.

5.2.4.5 Fuel Consumption (Optional)
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.

5.3 Power Requirement Determination

5.3.1 Draft Measurement for Animal-drawn Plough
5.3.1.1 The plough shall be operated with the spring or strain-gauge type dynamometer inserted between the implement yoke and the hitch of the plough as shown in Figure 6. There shall be a minimum of three passes wherein data shall be gathered. For every 20-meter distance traveled by the plough, five dynamometer readings shall be obtained.

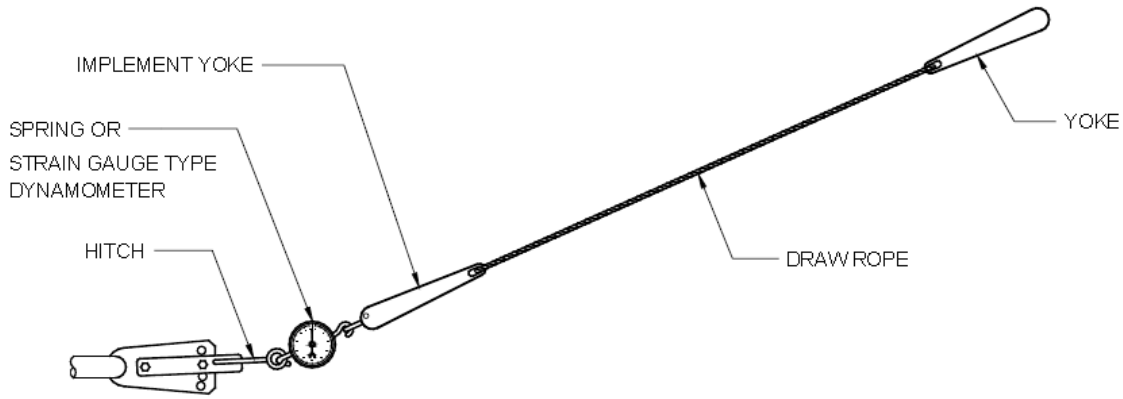


Figure 6 – Draft Measurement for Animal-drawn Plough

5.3.1.2 The angle 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 7.

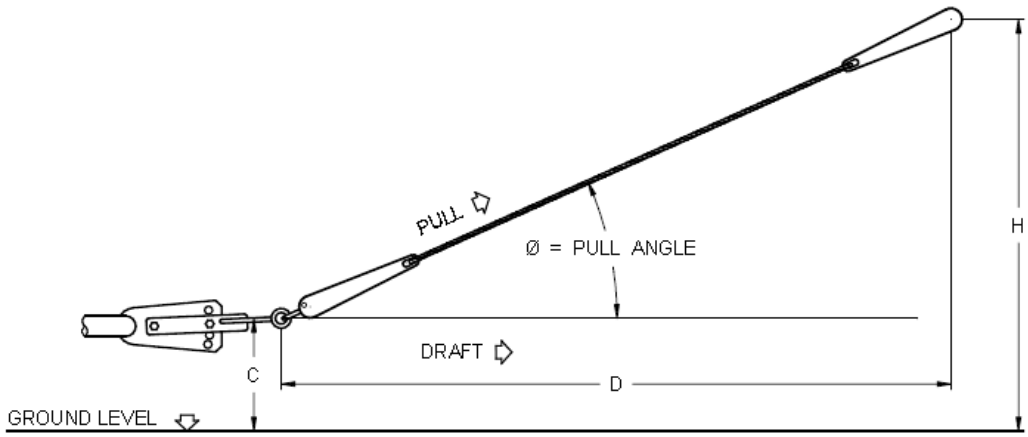


Figure 7 – Angle of Pull Measurement for Animal-drawn Plough

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 plough. 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.

5.3.1.3 Calculate the draft requirement of the animal-drawn plough using the following formula:

$$D = P \cos \theta$$

Where: D is the draft, kg
P is the pull, kg
θ is the angle between the line of pull and the horizontal

5.3.2 Draft Measurement for Tractor-operated Plough

A strain-gauge type dynamometer is attached to the front of the tractor on which the implement is mounted. Another auxiliary tractor shall pull the implement-mounted tractor through the dynamometer in neutral gear but with the implement in the operating position as shown in Figure 8. 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.

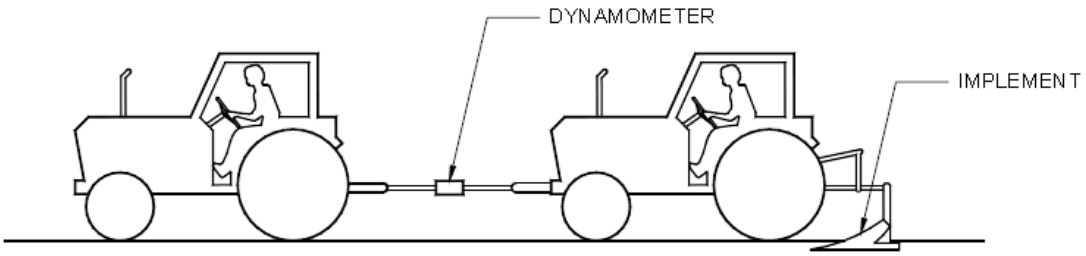


Figure 8 – Draft Measurement for Tractor-operated plough

5.3.3 Calculate the power requirement for animal-drawn and tractor-operated ploughs 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 observed, measured 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 may include the following information in the order given:

a) Name of testing agency
b) Test report number
c) Title
d) Summary
e) Purpose and scope of test
f) Methods of test
g) Description and Specifications of the Plough
h) Results of Field Test
i) Name and Signature of Test Engineers

Annex A

(Informative)

Suggested minimum list of field and laboratory test equipment and materials

Items	Quantity
A1 Equipment	
A1.1 Field equipment	
A1.1.1 Timers Range: 0 to 60 minutes Accuracy: 1/10	2
A1.1.2 Cone penetrometer	1
A1.1.3 Steel tape, 50 m	1
A1.1.4 Graduated cylinder, capacity: 1,000 mL	1
A1.1.5 Width and depth gauge	1
A1.1.6 Digital video camera	1
A1.1.7 Four-wheel tractor or riding tractor, matching with power requirement of the plough to be tested.	1
A1.2 Laboratory equipment (soil analysis and verification of specifications)	
A1.2.1 Convection oven or soil moisture meter	1
A1.2.2 Electronic balance**,** capacity: 1 kg	1
A1.2.3 Sieve Sizes: 2 mm, 0.05 mm, and 0.002 mm	3
A1.2.4 Vernier caliper	1
A2 Materials for field test	
A2.1 Marking pegs	10

Annex B

(Informative)

Inspection Sheet for Plough

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 plough to be tested: _____

Items to be inspected

ITEMS	**Manufacturer's Specification**	**Verification by Testing Agency**
B1 Dimensions and weight		
B1.1 Overall length, mm		
B1.2 Overall width, mm		
B1.3 Overall height, mm		
B1.4 Weight, kg		
B1.5 Weight per disc, kg		
B2 Disc plough		
B2.1 Number of discs		
B2.2 Disc		
B2.3 Brand		
B2.4 Make		
B2.5 Type (plain or notched)		
B2.6 Diameter, mm		
B2.7 Thickness, mm		
B2.8 Concavity, mm		
B2.9 Disc spacing, mm		
B2.10 Side angle, °		
B2.11 Tilt angle, °		
B2.12 Scraper		
B2.12.1 Length, mm		
B2.12.2 Width, mm		
B2.12.2 Thickness, mm		
B2.13 Main frame		
B2.13.1 Dimension, mm		
B2.13.2 Material		
B2.14 Rear furrow wheel		
B2.14.1 Diameter, mm		
B2.14.2 Thickness, mm		
B3 Mouldboard plough		
B3.1 Source of power		
B3.1.1 Animal-drawn		

B3.1.2 Walking agricultural tractor - operated (or two-wheel tractor – operated)		
B3.1.3 Four-wheel tractor - operated (or riding tractor – operated)		
B3.2 Number of plough bottom		
B3.3 Share		
B3.3.1 Type		
B3.3.2 Material		
B3.4 Mouldboard		
B3.4.1 Type		
B3.4.2 Material		
B3.5 Standard		
B3.5.1 Type		
B3.5.2 Location		
B3.5.3 Material		
B3.6 Handle (for animal-drawn)		
B3.6.1 Material		

Annex C

(Informative)

Field Performance Test Data Sheet

Items to be Measured and Inspected

ITEMS	Trials			Average
	1	2	3	
C1 Test Conditions				
C1.1 Condition of field				
C1.1.1 Location				
C1.1.2 Dimensions of field (L x W), m				
C1.1.3 Area, m^2				
C1.1.4 Soil type (clay, clay loam, sandy, etc)				
C1.1.5 Moisture content, %				
C1.1.6 Weed density (low, medium, or high)				
C1.1.7 Soil hardness, kg/cm2				
C1.1.8 Last crop planted				
C2 Draft measurement				
C2.1 Draft without load, kN				
C2.2 Draft with load, kN				
C2.3 Difference, kN				
C3 Field performance				
C3.1 Date of test				
C3.2 Type of field operation				
C3.3 Tractor's gearshift setting				
C3.4 Traveling or operating speed, kph				
C3.5 Depth of tillage, mm				
C3.6 Width of tillage, mm				
C3.7 Time lost, min				
C3.7.1 Turning, min				

C3.7.2 Others (specify), min				
C3.8 Duration of test, min				
C3.9 Actual field capacity, ha/h				
C3.10 Theoretical field capacity, ha/h				
C3.11 Field efficiency, %				
C3.12 Fuel consumption rate, L/h (optional)				
C3.13 Effective fuel consumption rate, L/ha (optional)				
C3.14 Method of operation				
C3.15 Percent unploughed/overlap				

C4 Observations
A minimum of two persons (responsible competent personnel, the operator and manufacturer's representative (if available)) shall rate the following observations.

ITEMS	**Rating***				
	1	2	3	4	5
C4.1 Ease of handling and stability when machine is working					
C4.3 Straightness of furrow					
C4.4 Quality of soil inversion					
C4.5 Uniformity of depth					
C4.6 Non-adhesion of soil to disc/mouldboard					
C4.7 Ease of making adjustments					
C4.8 Durability of soil engaged parts (based on wear of soil-working parts, visible deformation, etc)					
C.4.9 Other observations_____ _____ _____					

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

Annex D

(Informative)

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:

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

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

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

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 E1.

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

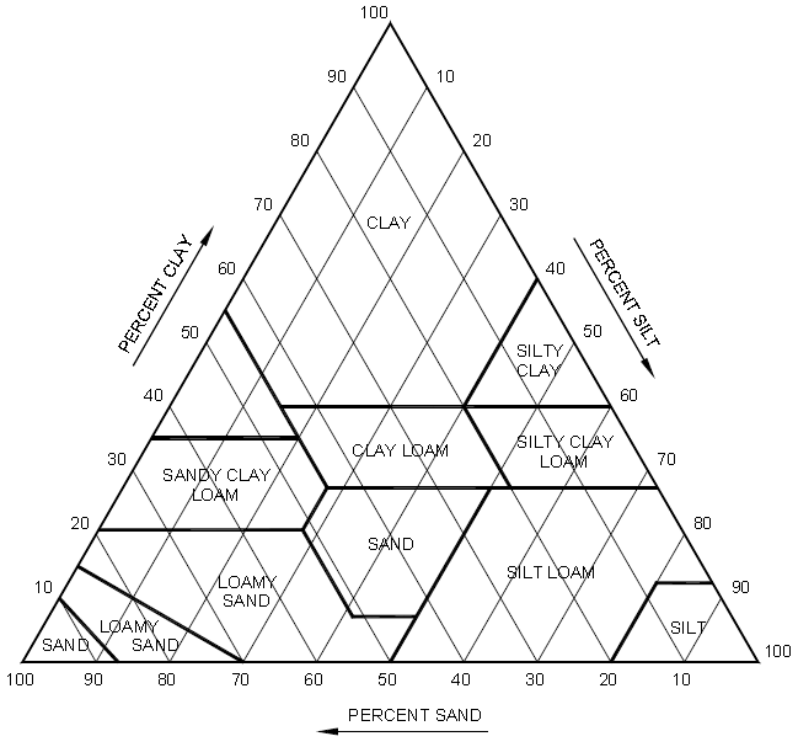


Figure D1 – Soil texture triangle showing relative composition of texture class.

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 105ºC 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:

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

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

(Informative)

Formulas Used During Calculations and Testing

E1.1 Estimation of Effective Field Capacity

E1.1.1 Width of cut

$$S = \frac{W}{2n}$$

where: S is the width of cut, m

W is the width of plot, m

n is the number of rounds

2 is the number of trips per round

E1.1.2 Total distance traveled

$$D = \frac{A}{S} = 2nL$$

where: D is the total distance traveled, m

A is the area of the plot, m^2

L is the length of the plot, m

E1.1.3 Effective area accomplished

$$A_e = wD = 2nLw$$

where: A_e is the effective area accomplished, m^2

w is the width of plough, m

E1.1.3.1 If width of cut is less than the plough's width, the operator has passed over part of the area twice to secure better coverage, therefore:

$$A_o = |A_e - A|$$

where: A_o is the overlap (area which is ploughed twice), m^2

E1.1.3.2 If the width of cut is greater that the plough's width, the operator has left part of the area unploughed, therefore:

$$A_u = A - A_e$$

where: A_u is the unploughed area (area missed), m^2

E1.1.4 Actual field capacity

$$afc = \frac{0.006\ A_e}{t}$$

where: *afc* is the actual field capacity, ha/h

t is the time used during the operation, min

E1.2 Theoretical Field Capacity

$$tfc = \frac{w_e\ v}{10{,}000}$$

where: *tfc* is the theoretical field capacity, ha/h

w_e is the effective/theoretical width of tillage, m

v is the speed of operation, m/h

E1.3 Field Efficiency

$$\varepsilon_f = \frac{afc}{tfc} \quad \text{x} \quad 100$$

where: ε_f is the field efficiency, %

E1.4 Wheel slip

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

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

E1.5 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

E1.6 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, m2

Bibliography

1) PAES 132:2004, *Agricultural Machinery – Disc/Mouldboard Plough – Methods of Test*

2) Agricultural Engineering Handbook, 1961 *Soil classification scheme adopted by USDA*