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**Agricultural machinery – Subsoiler –
Methods of Test**



BUREAU OF PRODUCT STANDARDS

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National Foreword

This Philippine Agricultural Engineering Standards PAES 150:2010, Agricultural machinery – Subsoiler – Methods of Test was approved for adoption as Philippine National Standard by the Bureau of Product Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD-DOST).

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled “Development of Standards for Agricultural Production and Postharvest Machinery” funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development - Department of Science and Technology (PCARRD - DOST).

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:

ABT 49 Field Equipment Operation

Alberta Farm Machinery Research Centre. 1981. Evaluation Report 643.

American Society of Agricultural Engineers S414.1 – Terminology and Definitions for Agricultural Tillage Implements

ASAE EP496.2 - Agricultural Machinery Management

ASAE D497.4 - Agricultural Machinery Management Data

Regional Network for Agricultural Machinery. 1983. Test codes and procedures for farm machinery. Technical Series No.12. Economic and Social Commission for Asia and the Pacific.

United States Patents 5695012

http://www.portlandimplement.com/vertical_tillage.html

<http://www.opico.co.uk/HE-VA>

http://www.dave-koenig.com/html/subsoiler_200.html

<http://www.indiamart.com/gs-auto/agricultural-implements.html>

<http://www.steelforge.com/alloysteels.htm>

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Agricultural Machinery – Subsoiler – Methods of Test

1 Scope

This standard specifies the methods of test and inspection for a subsoiler. Specifically, it shall be used to:

- 1.1** verify the mechanism, dimensions, materials, accessories of the subsoiler and the list of specifications submitted by the manufacturer;
- 1.2** determine the performance of the equipment; and,
- 1.3** report 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 149:2010 Agricultural Machinery – Subsoiler – Specifications

3 Definitions

For the purpose of this standard, the definitions given in PAES 149 and the following shall apply:

3.1**draft**

total force parallel to the direction of travel required to move the implement

3.2**drawbar power**

power requirement of an implement being towed or pushed

3.3**effective field capacity**

function of field speed, working width and field efficiency expressed in hectares per hour

3.4**field efficiency**

ratio between the productivity of a machine under field conditions and the theoretical maximum productivity

3.5

implement

any agricultural tool mounted on the tractor

3.6

implement width

horizontal distance perpendicular to the direction of travel between the outermost edges of the implement (Fig. 1)

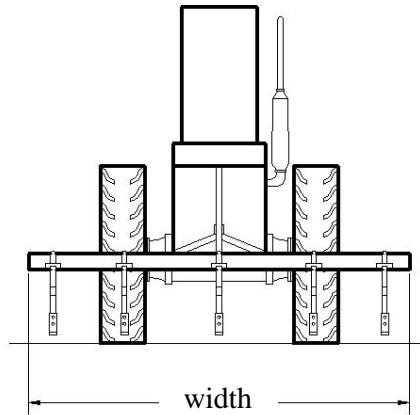


Figure 1. Implement width

3.7

operating width

horizontal distance perpendicular to the direction of travel within which an implement performs its intended function; distance between the outermost shanks of the subsoiler (Fig. 2)

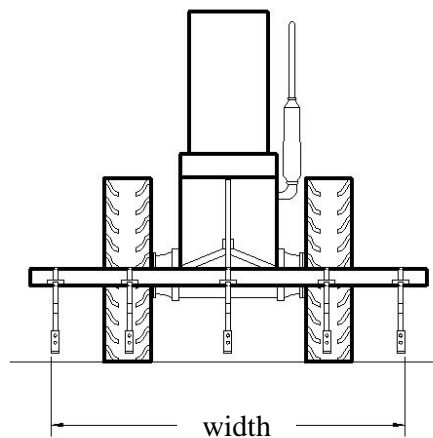


Figure 2. Operating width

3.8**sweep angle**

angle measured from the outer side of the wing in reference to the direction of travel (Fig. 3)

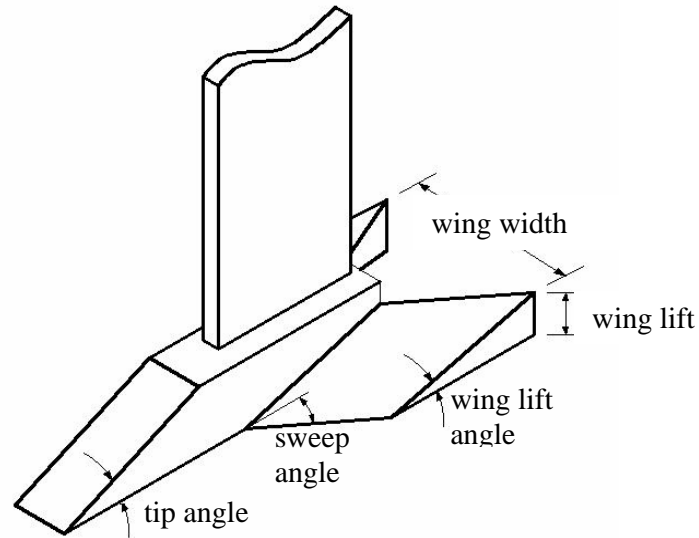


Figure 3. Ripper point characteristics

3.9**theoretical field capacity**

function of speed and operating width expressed in hectares per hour

3.10**tip angle**

angle formed by the top and underside of the ripper point (Fig. 3)

3.11**transport height**

overall height of the implement measured from the topmost point to its lowest point (Fig. 4)

3.12**transport length**

overall length of the implement measured from the terminal point of the implement to the mounting point (Fig. 4)

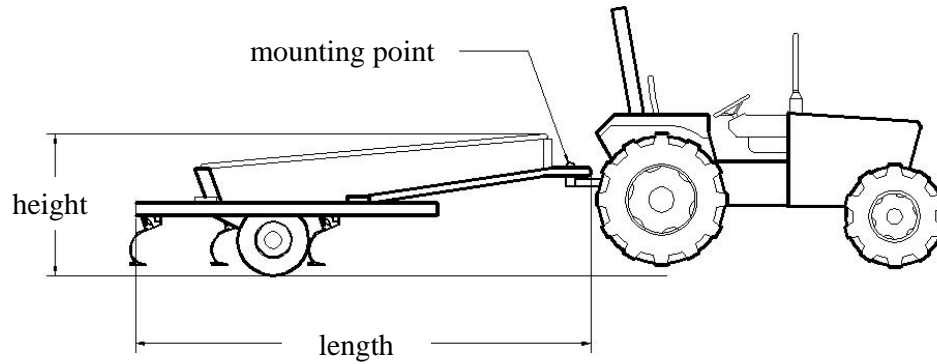


Figure 4. Transport height and length (four-wheel driven type)

3.13

wing lift

length of the side of the wing opposite the wing lift angle (Fig. 3)

3.14

wing lift angle

angle measured between the two sides of the wing (Fig. 3)

3.15

wing width

distance between the tip of each wing (Fig. 3)

4 General Conditions for Test and Inspection

4.1 Role of manufacturer/dealer

The manufacturer shall submit the operator's manual of the subsoiler and shall abide by the terms and conditions set forth by an official testing agency.

4.2 Role of the operator

An officially designated operator shall be skilled and shall be able to demonstrate, operate, adjust and make repairs related to the operation of the equipment.

4.3 Test site conditions

The subsoiler shall be tested through actual cultivation of the soil. The field shall have ample space to allow turns in headland.

4.4 Test instruments/equipment

The suggested list of minimum test materials needed to carry out the subsoiler test is shown in Annex A.

4.5 Tractor to be used

The tractor to be used to conduct the test shall be compatible with the subsoiler in accordance with the manufacturer's specification of required power.

4.6 Termination of test for subsoiler

If during the test, the subsoiler encounters major component breakdown or malfunction, the test engineer shall terminate the test.

5 Test and Inspection

5.1 Verification of the manufacturer's technical data and information

This inspection is carried out to verify the mechanism, dimensions, materials and accessories of the subsoiler in comparison with the list of manufacturer's technical data and information. All data shall be recorded in Annex B.

5.2 Performance test

5.2.1 This is carried out to obtain actual data on overall performance of the subsoiler.

5.2.2 Measurement of initial data

Initial data, such as field area, soil type and soil moisture content, shall be obtained and recorded in Annex C before the test operation.

5.2.3 Field performance test

5.2.3.1 The subsoiler shall be tested at the recommended depth settings of the manufacturer

5.2.3.2 The tractor speed shall be determined according to the recommended depth setting. This can be done by recording the time required for the tractor to travel a 20 m distance in the field (Fig. 5).

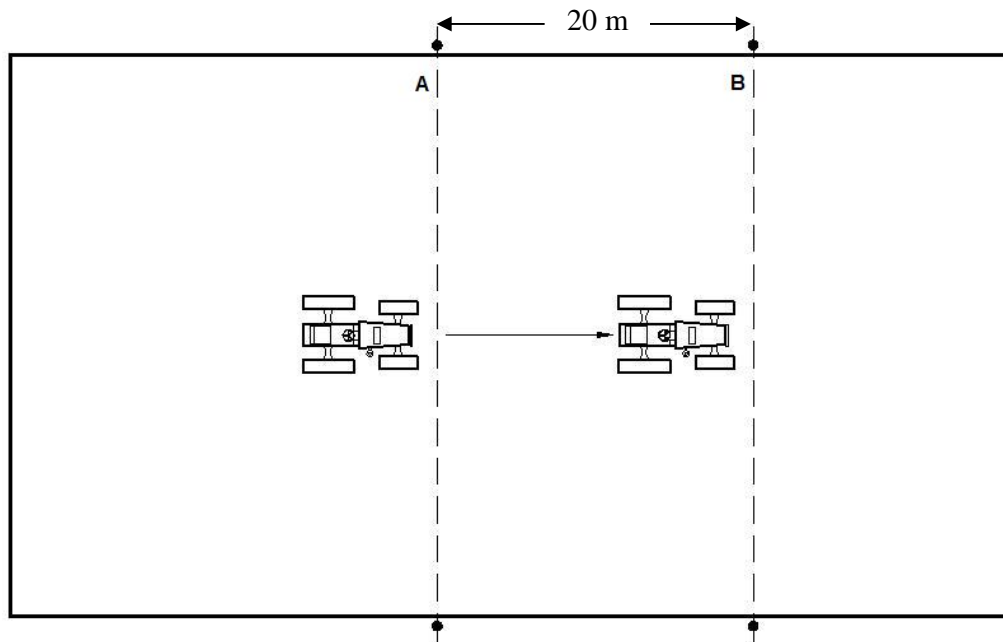


Figure 5. Points for speed test

5.2.3.3 The total test time shall be obtained by acquiring the total time to finish cultivating the test field. Non-productive time (e.g. headland turns) shall be recorded. Productive time shall be obtained by deducting the non-productive time from the total test time.

5.2.3.4 The fuel consumed by the tractor shall be obtained. This can be done by measuring the volume of fuel refilled after the test. The tank shall be filled to full capacity before and after each trial.

5.2.3.5 The working width shall be obtained by measuring the distance between the outermost shanks and shall be noted.

5.2.3.6 Field efficiency, effective field capacity and drawbar power requirements of the implement shall be obtained using the formula in Annex D.

5.2.3.7 Determination of draft

A spring, hydraulic or stain-gauge type dynamometer shall be 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 its operating position (Fig. 6). The draft in the measured distance of 20 m as well as the time it takes to traverse it shall be recorded. On the same field, the draft in the same distance shall be recorded while the implement is lifted above the ground. The difference in the draft readings shall yield the draft of the implement.

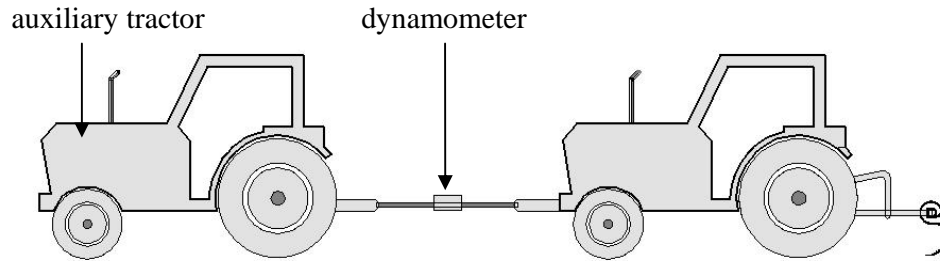


Figure 6. Position of tractors for draft measurement

5.2.3.8 Test for uniformity of depth of cut

5.2.3.8.1 Two points in the field passed shall be marked using pegs. The distance between these points shall be 20 m. Every two meters, a marking peg shall be placed (Fig. 7).

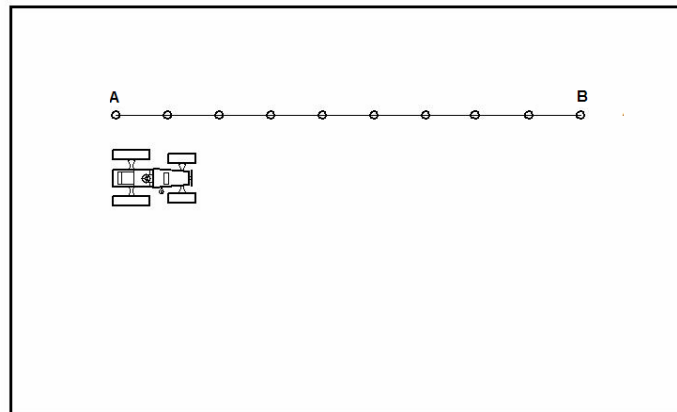


Figure 7. Soil strips marking for operating depth analysis

5.2.3.8.2 The operating depth of the subsoiler shall be set. The subsoiler shall be operated along the marked strips (Fig. 7). These strips of soil shall be observed.

5.2.3.8.3 The depth of cut for each strip shall be measured and shall be recorded (Fig. 8).

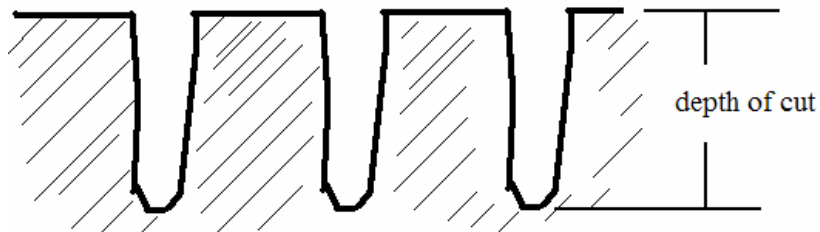


Figure 8. Depth of cut.

5.2.3.8.4 The mean depth and the percent error for the mean depth shall be computed using the formula in Annex D.

5.2.3.8.5 The percentage of wheel slip shall be obtained by recording the difference of the distance traveled without load and the distance traveled with the implement attached. A mark shall be placed on the wheel of the tractor (Fig. 9). The tractor shall be allowed to move forward up to 10 revolutions of the marked wheel under no load (A). The distance shall be measured and recorded. On the same surface, the tractor shall be allowed to move forward with the implement attached. After same number of revolutions, the distance traveled shall be measured and recorded (B). the percentage of wheel slip shall then be computed using the formula in Annex D.

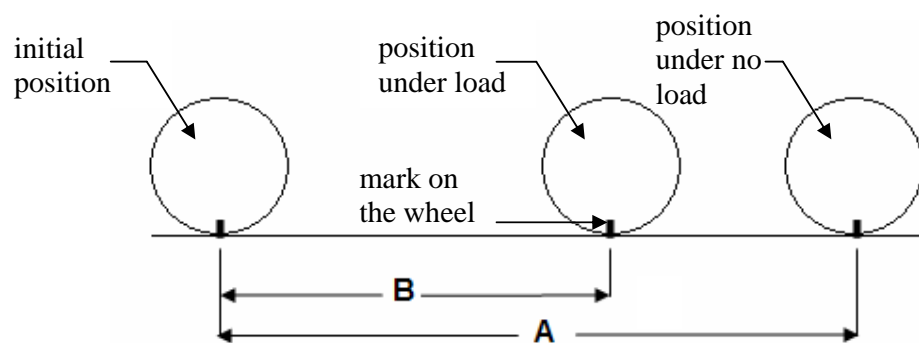


Figure 9. Measuring of wheel slip

5.2.3.9 Condition of subsoiler after test shall be compared to its initial condition.

5.2.3.10 Welded parts shall be inspected.

5.2.3.11 Loosened bolts shall be noted.

5.2.3.12 All data shall be recorded in Annex C.

5.3 Test trial

There shall be at least three (3) trials in conducting the test.

6 Test Report

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

6.1 Title

6.2 Summary

6.3 Purpose and Scope of Test

6.4 Methods of Test

6.5 Description of the Machine

Table 1 – Machine Specifications

6.6 Results and Discussions

6.7 Observations (include pictures)

Table 2 –Performance test data

6.8 Name(s), signature(s) and designation(s) of test engineer(s)

Annex A

Suggested Minimum List of Test Equipment

Items	Quantity
A.1. timer accuracy: 0.10 s	1
A.2 steel tapes length: 5 m; 50 m	2
A.3 weighing scale capacity, 1000 kg	1
A.4 fuel consumption	
graduated cylinder capacity, 1000 mL	1
A.5 four-wheel tractor	2
A.6 soil analysis	
soil test kit	1
oven	1
A.7 marking pegs	4
A.8 marking tape	1
A.9 calculations	
scientific calculator	1
A.10 draft measurement	
spring, hydraulic or strain-gauge type dynamometer	1

Annex B
(informative)

Specifications of Subsoiler

Name of Applicant/ Distributor: _____

Address: _____

Tel No: _____

GENERAL INFORMATION

Name of Manufacturer: _____

Make: _____

Classification: _____

Serial No: _____ Brand/Model: _____

Production date of subsoiler to be tested: _____

Testing Agency: _____ Test Engineer: _____

Date of Test: _____ Location of Test: _____

Items to be inspected

ITEMS	Manufacturer's Specification	Verification by the Testing agency
B.1 overall dimensions		
B.1.1 transport length, mm		
B.1.2 transport height, mm		
B.1.3 implement width, mm		
B.1.4 weight, kg		
B.1.5 working width, mm		
B.2 main frame		
B.2.1 material		
B.2.2 thickness, mm		
B.3 shank assembly		
B.3.1 wear shin		
B.3.1.1 material		
B.3.1.2 thickness, mm		
B.3.1.3 length, mm		
B.3.2 shank		
B.3.2.1 material		
B.3.2.2 dimensions, mm		
B.3.2.3 ground clearance, mm		
B.3.2.4 stem angle, degrees		
B.3.2.5 type		
B.3.2.6 number of shanks		
B.3.3 ripper point		
B.3.3.1 material		
B.3.3.2 type		
B.3.3.3 dimensions, mm		
B.3.3.4 tip angle, degrees		
B.3.3.5 sweep angle (for winged type), degrees		

ITEMS	Manufacturer's Specification	Verification by the Testing agency
B.3.3.6 wing width (for winged type), mm		
B.3.3.7 wing lift (for winged type), mm		
B.3.3.8 wing angle (for winged type), mm		
B.4 transverse tool bar		
B.4.1 material		
B.4.2 dimensions, mm		
B.4.3 number of shanks		
B.5 gauge wheels (if present)		
B.5.1 diameter, mm		
B.5.2 adjustments		
B.6 mounting details		
B.7 cylinder (if present)		
B.7.1 type		
B.7.2 capacity, Pa		
B.7.3 bore, mm		
B.7.4 stroke, mm		
B.8 tractor required		
B.8.1 type		
B.8.2 recommended travelling speed, kph		
B.8.3 engine power, kW		

ANNEX C

Performance Test Data Sheet

Items to be measured and Inspected

C.1 Test field conditions	Remarks
C.1.1 area of field, m ²	
C.1.2 soil type (clay, clay loam, sandy, etc.)	
C.1.3 soil texture (fine, medium, coarse)	
C.1.4 soil moisture content (% d.b.)	

C.2 Field performance									
C.2.1 Actual operating depth, mm									
Manufacturer's recommended depth setting, mm	Trials								average
	1		2		3				
C.2.2 Tractor speed, kph									
C.2.3 Operating time, h	Trials								average
	1		2		3				
	Test time	Non-productive	Test time	Non-prod.	Test time	Non-prod.	Test time	Non-prod.	Productive time
C.2.4 Fuel consumed, mL									
	Trials								average
	1		2		3				
C.2.5 Field efficiency, %									
C.2.6 Effective field capacity, ha/h									
C.2.7 Draft, N									
C.2.8 Drawbar power, kW									

C.2.9 Depth of cut analysis										
Depth of cut preset, mm:										
Strip, m	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20
Depth, mm										
Mean depth, mm:										
Percent error, %:										
C.2.10 Percentage of wheel slip (% W.S.)										
Trials									Ave. (%)	
1			2			3				
A(m)	B(m)	% W.S.	A(m)	B(m)	% W.S.	A(m)	B(m)	% W.S.		

C.3 Other observations	Remarks
C.3.1 ease of mounting/dismounting *	
C.3.2 accessibility of grease points *	
C.3.3 number of shanks deformed after test	
C.3.4 number of shovels detached after test	
C.3.5 cracks on welded parts	
C.3.6 detached welded parts	
C.3.7 loosened bolts	
C.3.8 miscellaneous:	

* rating: 1 – very good 4 – poor
 2 – good 5 – very poor
 3 – satisfactory

ANNEX D

Formula Used During Calculation and Testing

D.1. Drawbar power

$$P = \frac{D \times S}{3.6}$$

where:

P	drawbar power required for the implement, kW
D	draft force required to move the implement, kN
S	speed of tractor, kph

D.2. Effective field capacity

$$C = \frac{60 E}{T}$$

where:

C	effective field capacity, ha/h
E	effective area accomplished, m ²
T	operating time ,h

D.3. Field efficiency

$$Eff = \frac{C}{C_o} \times 100$$

where:

Eff	field efficiency, %
C	effective field capacity, m ² /h
C_o	theoretical field capacity, m ² /h

D.4. Effective area accomplished

$$E = wD$$

where:

E	effective area accomplished, m ²
w	actual working width, m
D	total distance traveled, m

D.5. Total distance traveled

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

where:

D	total distance traveled, m
A	area of plot, m ²
S	average swath or width of cut, m

D.6. Average swath or width of cut

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

where:

S	average swath or width of cut, m
W	width of plot, m
N	number of trips per round

D.7. Percent error for mean depth

$$\% \text{ error} = \frac{|D_m - D_p|}{D_p} \times 100$$

where:

$\% \text{ error}$	percent error, %
--------------------	------------------

D_m	mean depth, mm
D_p	theoretical depth, mm

D.8. Percentage of wheel slip

$$\% W.S. = \frac{A-B}{A} \times 100$$

where:

$\% W.S.$	percent of wheel slip, %
A	distance traveled by the tractor under no load after a given number of revolution, m
B	distance traveled by the tractor with implement attached after a given number of revolution, m

D.9. Theoretical Field Capacity

$$C_o = w \times S$$

where:

C_o	theoretical field capacity, ha/h
w	operating width, m
S	speed of tractor, m/h

Philippine Agricultural Engineering Standards

AMTEC-UPLB – PCARRD Project: “Development of Standards for Agricultural Production and Postharvest Machinery”

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