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Agricultural machinery – Spring-tooth Harrow – Methods of Test

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National Foreword

This Philippine Agricultural Engineering Standards PAES 164:2011, Agricultural machinery – Spring-tooth Harrow – 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).

Foreword

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 Department of Science and Technology – Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (DOST-PCARRD).

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:

Alberta Farm Machinery Research Centre. 1991. Evaluation Report 268.

ASAE S414.1 – Terminology and Definitions for Agricultural Tillage Implements

ASAE EP496.2 - Agricultural Machinery Management

ASAE D497.4 - Agricultural Machinery Management Data

Economic and Social Commission for Asia and the Pacific.1983. Regional Network for Agricultural Machinery. Test Codes and Procedures for Farm Machinery. Technical Series No.12.

PAES 106:2000 – Agricultural Machinery – Soil Tillage and Equipment – Terminology

United States Patents 5443127. Spring Tooth Harrow.

Grubinger, V. Cultivation Equipment For Weed Control: Pros, Cons And Sources. University of Vermont Extension.
<http://www.uvm.edu/vtvegandberry/factsheets/cultivators.html>

http://ag.arizona.edu/crops/equipment/agmachinerymgt.html

http://www.sare.org/publications/steel/glossary.htm

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1 Scope

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

1.1 verify the mechanism, dimensions, materials, accessories of the spring-tooth harrow and the list of specifications submitted by the manufacturer;

1.2 determine the performance of the equipment;

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 these standards:

PAES 163:2011 Agricultural Machinery - Spring-tooth Harrow – Specifications

3 Definitions

For the purpose of this standard, the definitions given in PAES 163:2011 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

3.3
effective field capacity
actual rate of being able to work a given area per unit of time

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)

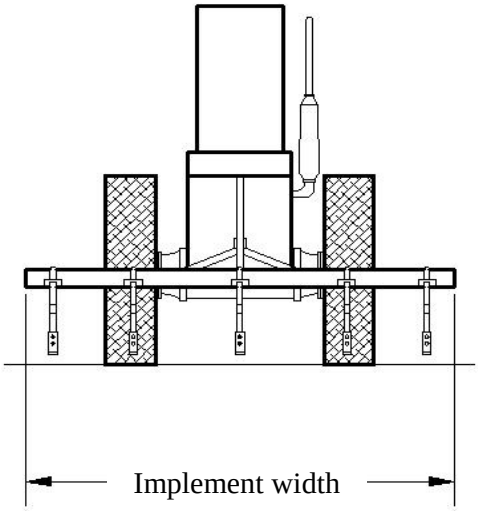

Figure 1. Implement width

3.7
operating width
horizontal distance perpendicular to the direction of travel within which an implement performs its intended function; distance between the outermost teeth of the spring-tooth harrow (Fig.2)

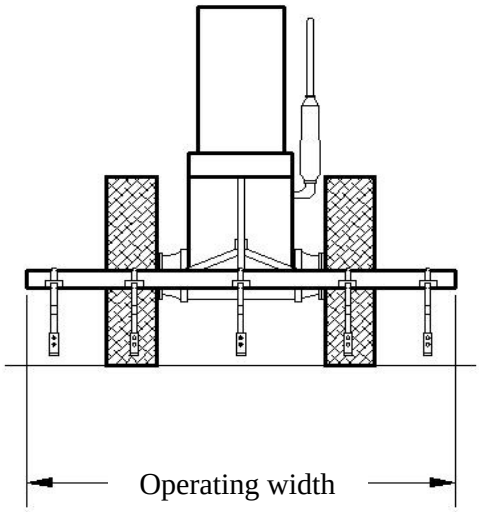

Figure 2. Operating width

3.8
transport height
overall height of the implement measured from the topmost point to its lowest point

3.9
transport length
overall length of the implement measured from the terminal point of the implement to the mounting point

3.10
wheel slip
reduction on the traveled distance by the tractor due to the implement attached

4 General Conditions for Test and Inspection

4.1 Role of manufacturer or dealer

The manufacturer shall submit the operator's manual of the spring-tooth harrow 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 repair matters related to the operation of the equipment.

4.3 Test site conditions

The spring-tooth harrow shall be tested through actual harrowing of the soil. The field shall have ample space to allow turns in headland. The size of the field shall not be less than 1000 m^2 and shall be rectangular in shape, flat, with sides in ratio of 2:1 as much as possible.

4.4 Test instruments or equipment

The suggested list of minimum test materials needed to carry out the spring-tooth harrow 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 spring-tooth harrow in accordance with the manufacturer's specification of required power.

4.6 Termination of test for spring-tooth harrow

If during the test, the spring-tooth harrow 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 spring-tooth harrow 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 equipment.

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.

5.2.2.1 Implement characteristics

Dimensions and other measurements such as the number of teeth shall be noted.

5.2.3 Field performance test

5.2.3.1 The spring-tooth harrow shall be tested at the maximum operating depth (152 mm or 6").

5.2.3.2 The tractor speed shall be determined according to the maximum depth setting. This can be done by recording the time required for the tractor to traverse a 20 m distance in the field (Fig. 3).

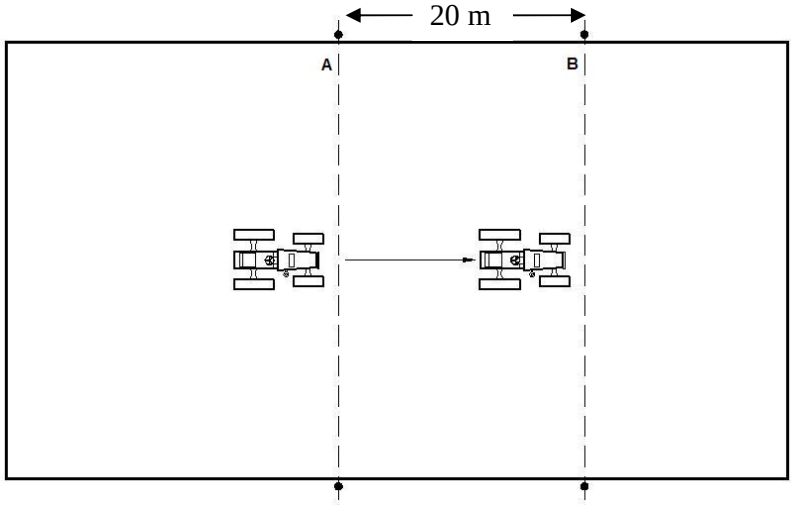

Figure 3. Points for speed test

5.2.3.3 The total test time shall be obtained by acquiring the total time to finish harrowing the test field. Test time shall start when harrowing operation starts. Non-productive time (time when the teeth is disengaged) shall be recorded.

Productive time (time when teeth is engaged) shall be obtained by deducting the non- productive time from the total test time.

5.2.3.4 The fuel consumption of the tractor when using the spring-tooth harrow shall be obtained as described in Annex E.

5.2.3.5 The operating width shall be obtained by measuring the distance between the outermost teeth 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 The draft of the spring-tooth harrow shall be determined as described in Annex E.

5.2.3.8 Wheel slip shall be determined as described in Annex E.

5.2.3.9 Condition of spring-tooth harrow 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 to conduct 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 tape length: 5 m; 50 m	 1 1
A.3 weighing scale capacity, 1000 kg	1
A.4 fuel consumption	
graduated cylinder capacity, 1000 mL (minimum)	1
A.5 four-wheel tractor	1 unit
A.6 soil analysis	
soil test kit	1
oven	1
A.7 marking pegs	4
A.8 marking tape	1
A.9 draft measurement	
spring, hydraulic or strain-gauge type dynamometer	1

Annex B
(informative)

Specifications of Spring-tooth Harrow

Name of Applicant/ Distributor: _____
Address: _____
Tel No: _____

GENERAL INFORMATION
Name of Manufacturer: _____
Make: _____
Classification: _____
Serial No: _____ Brand/Model: _____
Production date of spring-tooth harrow 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 height, mm		
B.1.2 transport length, mm		
B.1.3 implement width, mm		
B.1.4 weight, kg		
B.1.5 operating width, mm		
B.2 main frame		
B.2.1 material		
B.2.2 dimensions, mm		
B.3 lever assembly (if present)		
B.3.1 material		
B.3.2 length, mm		
B.3.3 number of levers		
B.4 runner		
B.4.1 material		
B.4.2 number of runners		
B.4.3 thickness, mm		
B.4.4 width, mm		
B.4.5 length, mm		
B.5 transverse tool bar		
B.5.1 material		
B.5.2 thickness, mm		
B.5.3 dimensions, mm		
B.6 tooth or tine		
B.6.1 material		
B.6.2 thickness, mm		
B.6.3 width, mm		

ITEMS	Manufacturer's Specification	Verification by the Testing agency
B.6.4 number of teeth		
B.7 gauge wheels (if present)		
B.7.1 diameter, mm		
B.7.2 adjustments		
B.8 mounting details		
B.9 tractor		
B.9.1 type		
B.9.2 recommended travelling speed, kph		
B.9.3 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										
C.2.2 Tractor speed, kph										
C.2.3 Operating time, h	**Trials**									
	I		**II**		**III**		**Average**			
	Test time	Non-productive	Test time	Non-prod.	Test time	Non-prod.	Test time	Non-prod.	Productive time	
C.2.4 Fuel consumption, Lps	**Trials**									
	I		**II**		**III**		**Average**			
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 Wheel slip (W.S.)										
Trials										**Ave. (%)**
I			**II**			**III**				
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 tooth deformed after test	
C.3.4 number of tooth 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
2 – good
3 – satisfactory
4 – poor
5 – very poor

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

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

where:

C effective field capacity, m^2/h

T operating time, h

E effective area accomplished, m^2

$$E = wD$$

where:

w actual working width, m

D total distance traveled, m

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

where:

A area of plot, m^2

s average swath or width of cut, m

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

where:

W width of plot, m

N number of trips per round

D.3 Field efficiency

$$Eff = \frac{C}{C_o} \; x \; 100$$

where:

Eff field efficiency, %

C effective field capacity, m^2/h

C_o theoretical field capacity, m^2/h

D.5 Wheel slip

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

where:

% *W.S.* wheel slip, %

A distance traveled by the tractor under no load after a given number of wheel revolution, m

B distance traveled by the tractor with implement attached after a given number of wheel revolution, m

D.6 Theoretical Field Capacity

$$C_o = w \; x \; S$$

where:

C_o theoretical field capacity, m^2/h

w actual working width, m

S speed of tractor, m/h

D.7 Fuel consumption

$$E_f = \frac{V_i - V_f}{t}$$

where:

E_f fuel consumption, Lps

V_i initial volume of fuel in tank, L

V_f final volume of fuel in tank, L

t time of operation, s

ANNEX E

Field Performance Test

E.1 Fuel consumption

This shall be done by filling the tank with a known volume of fuel. After the test, the tank shall be emptied by draining the fuel from the fuel tank. The drained fuel shall be measured using a graduated cylinder. The difference between the initial volume of fuel and the final volume shall be divided by the time of operation to determine the fuel consumption of the equipment.

Fuel consumption can also be measured by filling the tank to full capacity before and after the each test trial. The amount of fuel refilled shall be measured using a graduated cylinder. The difference in the volume of the fuel shall be divided by the time of operation to yield the fuel consumption of the equipment.

E.2 Draft of the implement

A spring, hydraulic or strain-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 the operating position (Fig.4). The draft in the measured distance of 20m 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 but with the implement lifted above the ground. The difference in the readings shall be obtained as the draft of the implement.

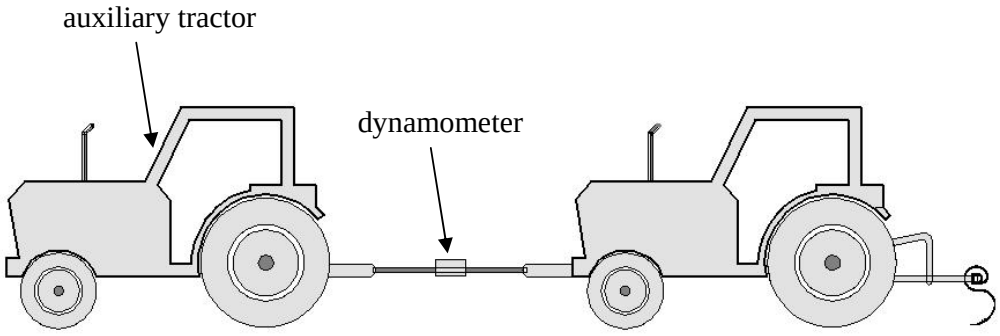

Figure 4. Position of tractors for draft measurement

E.3 Wheel slip analysis

The percentage of wheel slip shall be obtained by recording the difference of the traveled distance without load and the traveled distance with the implement attached. A mark shall be placed on the wheel of the tractor (Fig.5). 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.

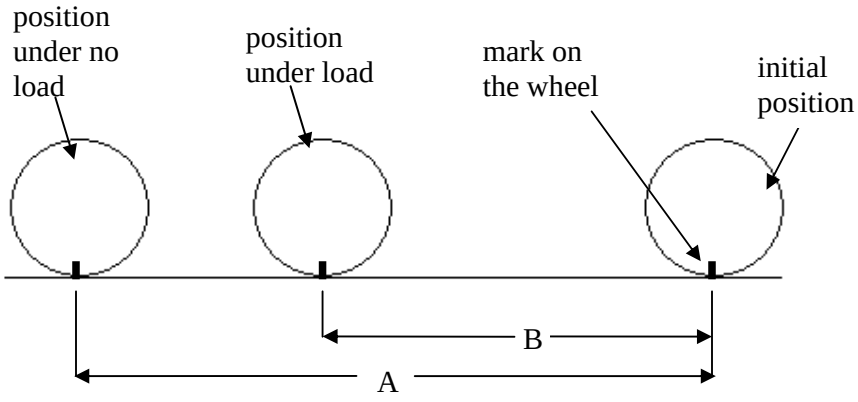

Figure 5. Measurement of wheel slip

Philippine Agricultural Engineering Standards

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

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