## Foreword

The pursuance of this standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) and with support from the Department of Agriculture.

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

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

Japan International Cooperation Agency. Text Book of Agricultural Machinery.1976.

Kepner,R.A., R. Bainer and E.L. Barger.1978. Principles of Farm Machinery. 3rd Edition. AVI Publishing Company, Inc. Westport, Connecticut.

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

Regional Network for Agricultural Machinery (RNAM). Agricultural Machinery Design and Data Handbook (Seeders and Planters).1991.

Resurreccion, A.N. 1979. Design of a Metering Device of Rootzone Granular Fertilizer Applicators. Philippine Agricultural Engineering Journal. X(4).

Stevens G.N. 1982. *Equipment Testing and Evaluation*. Overall Division, National Institute of Agricultural Engineering (NIAE), Wrest Park, Silsoe Bedford England.

All annexes in this standard are normative.

**CONTENTS** **Page**



**FIGURES**



**ANNEXES**

# Agricultural Machinery – Granular Fertilizer Applicator – Methods of Test

## 1 Scope

This standard specifies the methods of test for granular fertilizer applicator. This standard is not applicable to broadcaster. The verification and test of granular fertilizer applicator shall consist of the following:

**1.1** verify the requirements specified in PAES 145 and the specifications submitted by the manufacturer;

**1.2** determine the laboratory performance of the machine; and

**1.3** determine the field performance of the machine.

## 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 145:2005, Agricultural Machinery – Granular Fertilizer applicator – Specifications

## 3 Definitions

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

**3.1**
**application rate**
amount of fertilizer applied in the field per unit area

**3.2**
**effective field capacity**
actual area covered per unit time

NOTE: The time pertains to the actual time which includes the time spent for turning at headland, adjustment of machine and machine trouble.

**3.3**
**field efficiency**
ratio of effective field capacity to the theoretical field capacity

**3.4**
**fuel consumption**
volume of fuel consumed by the engine

**3.5**
**theoretical field capacity**
computed area covered per unit of time

## 4 General Conditions for Test and Inspection

### 4.1 Fertilizer Applicator on Test

The applicator submitted for test shall be taken from production model or series of production and 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 machine. An official representative shall be appointed to conduct minor repair, handle, adjust and witness the test. It shall be the duty of the representative to make all decisions on matters of adjustment and preparation of the machine for testing. The manufacturer/dealer shall abide with the terms and conditions set forth by the official testing agency.

### 4.3 Running-in and preliminary adjustment

The applicator to be tested shall be run-in prior to test as recommended by the manufacturer.

### 4.4 Test instruments

The instruments to be used shall have been checked and calibrated by the testing agency prior to the measurements. The suggested list of minimum field and laboratory test equipment and materials needed to carry out the test is shown in Annex A.

### 4.5 Termination of Test

If during the test run, the applicator stops due to major component breakdown or malfunctions, the test shall be terminated by the test engineer.

## 5 Test and Inspection

### 5.1 Verification of the Manufacturer’s Technical Data and Information

**5.1.1** This inspection is carried out to verify the mechanism, main dimensions, materials and accessories of the machine in comparison with the list of manufacturer's technical data and information.

**5.1.2** A plain level surface shall be used as reference plain for verification of dimensional specifications of fertilizer applicator.

**5.1.3** The items to be inspected and verified shall be recorded in Annex B.

## 5.2 Laboratory performance test

### 5.2.1 Test for metering mechanism

**5.2.1.1** This is carried out to examine the performance of metering mechanism.

**5.2.1.2** This test should be conducted on the kind of fertilizers for which the machine is suitable as specified by the manufacturer.

**5.2.1.3** The fertilizer used shall be readily available and comply with the machine manufacturer's recommendations.

**5.2.1.4** If possible, this test shall be carried out at 1/4, 1/2 and 3/4 of the fertilizer applicator's hopper capacity with at least three delivery rate settings – maximum, minimum and intermediate (around the mean of maximum and minimum).

**5.2.2** Test for uniformity of distribution

**5.2.2.1** This test is carried out to determine the uniformity of transverse and longitudinal seed distribution.

**5.2.2.2** The fertilizer applicator shall be operated at the average feed rate setting, with the hopper half full and at the speed recommended by the manufacturer over a blanket or felt.

**5.2.2.3** The fertilizer applicator shall be operated for at least three passes.

**5.2.2.4** Longitudinal and transverse distribution

For each pass, collect and weigh the amount of fertilizer distributed from each row with one-meter length for a 5-meter distance along the direction of travel (Figure 1).

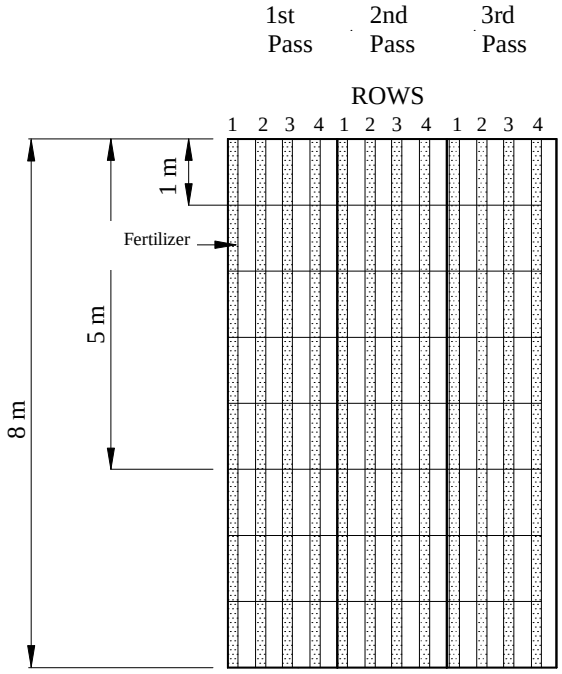


**Figure 1 – Measurement of uniformity of distribution**

**5.2.3** The result of the test shall be presented in a histogram and the standard deviation shall be computed.

**5.2.4** The items to be investigated and measured shall be recorded in Annex C.

## 5. 3 Field performance test

**5.3.1** This is carried out to test the field performance of the fertilizer applicator.

**5.3.2** The test shall be carried out on a dry or wet field. The conditions of the field shall be recorded.

### 5.3.3 Test Condition

#### 5.3.3.1 Fertilizer to be Used

The fertilizer to be used shall be the same as the one used in the laboratory test.

#### 5.3.3.2 Size of the Area per Trial

Fertilizer applicator shall be done in fields not less than 100 $m^2$ for manually-operated, 250 $m^2$ for animal-drawn, 500 $m^2$ for two-wheel tractor-drawn and 1000 $m^2$ for four-wheel

tractor-drawn fertilizer applicators. The plot shall be rectangle in form with sides in the ratio of 2:1 as much as possible.

### 5.3.3.3 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 the attached implement. The non-working time should be minimized as much as possible using the recommended field operational pattern as shown in Figure 2.

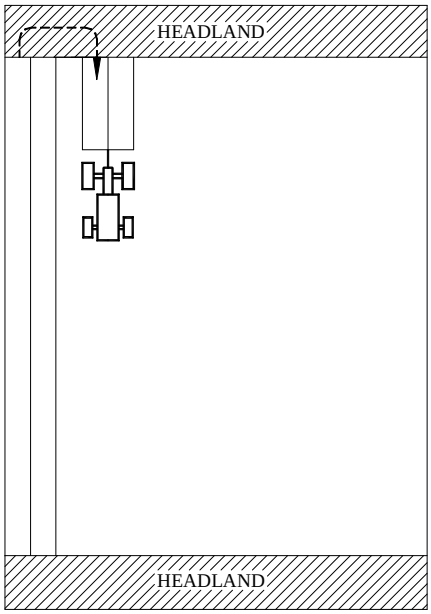


**Figure 2 – Recommended field operational pattern**

### 5.3.3.4 Traveling Speed

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

**5.3.3.4.2** For two-wheel tractor-drawn and manually-operated fertilizer applicators, a traveling speed of 3 kph to 4 kph shall be maintained during the operation.

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

### 5.3.3.5 Test Trials

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

### 5.3.3.6 Headland

Depending on the tractor/ fertilizer applicator, headland shall be at least 3 meters in length.

### 5.3.4 Measurement of Performance Parameters

#### 5.3.4.1 Field Capacity Determination

##### 5.3.4.1.1 Measurement of Operating Speed

Along the length of the test plot, two poles distance L apart (A, B) are placed approximately in the middle of the test run. On the opposite side, two poles are also placed in similar position, distance L apart (C, D) so that all four poles form corners of a rectangle, parallel to at least one long side of the test plot (Figure 3). The speed will be calculated from the time required for the fertilizer applicator to travel the distance (L) 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 m to 5 m from poles A and C to stabilize speed before measuring and recording data. The value of L is 5 m for manually-operated, 15 m for animal-drawn, 20 m for two-wheel tractor-drawn and 30 m for four-wheel tractor-drawn fertilizer applicator.

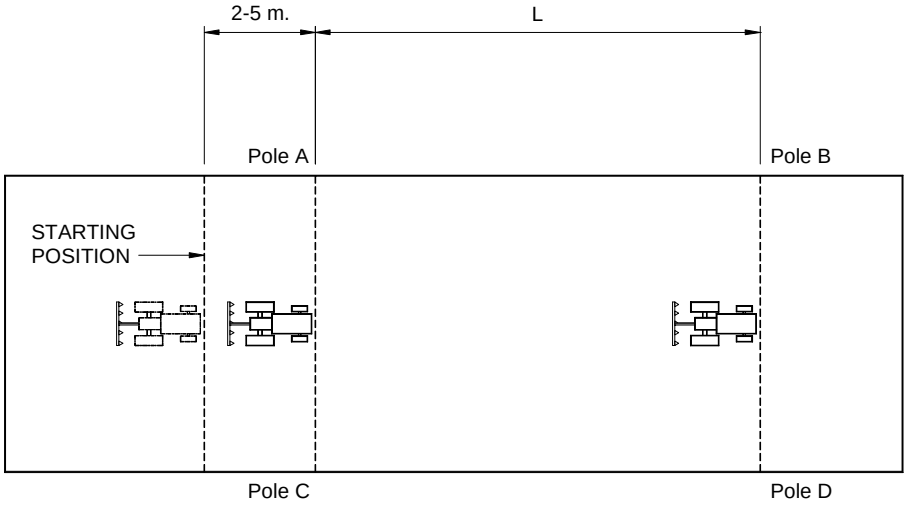


**Figure 3 – Measurement of Operating Speed**

#### 5.3.4.2 Application Rate

**5.3.4.2.1** The hopper shall be filled level full (or up to a convenient mark) and the machine run for a short time to settle the fertilizer. It shall then be re-filled and with the delivery set to the average value, and at nominal speed the machine will be used to cover the required area. The weight of fertilizer required to refill the hopper shall be measured and the application rate shall be recorded.

#### 5.3.4.3 Total Operating Time, Turning Time and other Losses

The total operating time shall be measured once the applicator started to operate up to the time it finished the test area. Turning time and other losses shall be measured. Theoretical time is equal to total operating time minus turning time and other losses.

#### 5.3.4.4 Theoretical Time

Turning time and other time losses shall be measured. Theoretical time is equal to the total operating time minus the turning time and other losses.

#### 5.3.4.5 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.

**5.3.5** The items to be measured and observed shall be recorded in Annex D.

### 5.3 Moisture Content Determination

#### 5.3.1 Oven Method

**5.3.1.1** Three different weight of soil taken randomly from the test area. Each sample shall be weighed and recorded as initial weight. The same number of samples shall be taken for fertilizer moisture content determination.

**5.3.1.2** The sample shall be dried using a convection oven maintained at 150°C for at least eight hours.

**5.3.1.3** The oven dried sample shall then be placed in a desiccators. Each sample shall be weighed and recorded as oven-dried weight.

**5.3.2** The soil moisture content of the test area and moisture content of fertilizer shall be recorded in Annex D and Annex E, respectively.

## 6 Data Analysis

The formulas to be used are given in Annex E.

## 7 Test Report

**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 fertilizer applicator

**7.8** Results of laboratory and field test

**7.9** 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<br>Range: 0 to 60 minutes Accuracy: 1/10 | 2 |
| **A1.1.2** Weighing scale, capacity: 100 kg | 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 camera | 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 |
| **A2 Materials for field test** | |
| **A2.1** Marking pegs | 10 |

## Annex B
(Informative)

## Inspection Sheet for Fertilizer Applicator

Name of Applicant : _____

Address : _____

Telephone No. : _____

Name of Distributor : _____

Address : _____

Name of Manufacturer : _____

Factory Address : _____

### General Information

Brand :_____Model :_____

Serial No. : _____

Production date of fertilizer applicator to be tested (if available) :_____

### ITEMS TO BE INSPECTED

| ITEMS | Manufacturer's Specification | Verification by Testing Agency |
|---|---|---|
| **B1** Dimensions and weight of the machine | | |
| **B1.1** Overall length, mm | | |
| **B1.2** Overall width, mm | | |
| **B1.3** Overall height, mm | | |
| **B1.4** Weight (hoppers empty), kg | | |
| **B2** Nominal working width, mm | | |
| **B3** Number of rows and row spacing, mm | | |
| **B4** Hill distance, mm (if applicable) | | |
| **B5** Fertilizer for which the machine is suitable | | |
| **B5** Suitable field conditions | | |
| **B6** Recommended traveling speed of equipment, kph | | |
| **B7** Recommended minimum drawbar output of power tiller or tractor, kW | | |
| **B8** Types | | |
| **B8.1** Fertilizer distribution | | |
| **B8.1.1** Row distribution | | |
| **B8.1.2** Broadcaster | | |
| **B8.2** Source of power | | |
| **B8.2.1** Animal-drawn | | |
| **B8.2.2** Manually-operated | | |

| ITEMS | Manufacturer's Specification | Verification by Testing Agency |
|---|---|---|
| **B8.2.3** Tractor-drawn (two- or four-wheel) | | |
| **B8.3** Metering device | | |
| **B8.3.1** Star-wheel type | | |
| **B8.3.2** Revolving bottom type | | |
| **B8.3.3** Auger type | | |
| **B8.3.4** Belt type | | |
| **B8.3.5** Plate and flicker type | | |
| **B8.3.6** Granular pesticide type | | |
| **B9** Hopper | | |
| **B9.1** Number | | |
| **B9.2** Capacity, L | | |
| **B9.3** Material | | |
| **B9.4** Number of fertilizer openings | | |
| **B10** Metering Mechanism Agitator | | |
| **B10.1** Type | | |
| **B10.2** Material | | |
| **B10.3** Source of power of metering mechanism | | |
| **B10.3.1** Ground wheel | | |
| **B10.3.2** PTO (if applicable) | | |
| **B10.3.2.1** Recommended speed, rpm | | |
| **B10.3.2.2** Transmission mechanism and speed ratio of metering shaft to input shaft | | |
| **B11** Clutch for metering mechanism | | |
| **B11.1** Type | | |
| **B11.2** Location | | |
| **B12** Furrow opener | | |
| **B12.1** Type | | |
| **B12.2** Material | | |
| **B13** Furrow closer | | |
| **B13.1** Type | | |
| **B13.2** Material | | |
| **B14** Delivery tube | | |
| **B14.1** Type | | |
| **B14.2** Material | | |
| **B15** Location of fertilizer outlet related to seed outlet (if applicable) | | |
| **B16** Ground wheel | | |
| **B16.1** Diameter, mm | | |
| **B16.2** Material | | |
| **B17** Handle (if applicable) | | |
| **B17.1** Material and construction | | |
| **B17.2** Height of handle from ground level, mm | | |
| **B17.3** Detail of adjustment | | |
| **B18** Marking device (detail of marking) | | |
| **B19** Hitch shape and construction (if applicable) | | |

## Annex C

(Informative)

## Laboratory Performance Test Data Sheet

### C1 Fertilizer metering

Date of test :_____

**C1.1** Test condition

**C1.1.1** Conditions of fertilizer

**C1.1.1.1** Kind : _____

**C1.1.1.2** Name : _____

**C1.1.1.3** Moisture content, % db : _____

**C1.1.1.4** Bulk density, kg/L : _____

**C1.1.2** Condition of fertilizer applicator

**C1.1.2.1** Metering shaft speed adjustment (if any) : _____

**C1.1.2.2** Mechanism and speed : _____

### C2 Delivery rate

| Particulars | Delivery rate setting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ¾ Hopper Capacity | | | ½ Hopper Capacity | | | ¼ Hopper Capacity | | |
| | low | med | high | low | med | high | low | med | high |
| **C2.1** Ground wheel-driven metering | | | | | | | | | |
| **C2.1.1** Effective rolling diameter of ground wheel, m | | | | | | | | | |
| **C2.1.2** No. of revolutions of ground wheel for measuring delivery | | | | | | | | | |
| **C2.1.3** Delivery for C2.1.2, kg | | | | | | | | | |
| **C2.1.4** Delivery rate, kg/ha | | | | | | | | | |
| **C2.1.5** Observations | | | | | | | | | |
| **C2.2** PTO-driven metering | | | | | | | | | |

**C3** Uniformity of Distribution

| **Particulars** | | **1st Pass** | | | | **2nd Pass** | | | | **3rd Pass** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Row 1 | Row 2 | Row 3 | Row 4 | Row 1 | Row 2 | Row 3 | Row 4 | Row 1 | Row 2 | Row 3 | Row 4 |
| Weight of fertilizer distributed, kg | First: 1 m length | | | | | | | | | | | | |
| | Second: 1 m length | | | | | | | | | | | | |
| | Third: 1 m length | | | | | | | | | | | | |
| | Fourth: 1 m length | | | | | | | | | | | | |
| | Fifth: 1 m length | | | | | | | | | | | | |

## Annex D
(Informative)

## Field Performance Test Data Sheet

### Items to be inspected

| Particulars | Test Number | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Ave. |
| **Date of Test** | | | | |
| **D1 Test Condition** | | | | |
| **D1.1 Condition of fertilizer** | | | | |
| **D1.1.1** Name | | | | |
| **D1.1.2** Kind | | | | |
| **D1.1.3** Moisture content, % db | | | | |
| **D1.1.4** Bulk density, kg/L | | | | |
| **D1.2 Condition of field** | | | | |
| **D1.2.1** Location | | | | |
| **D1.2.2** Field type and soil condition | | | | |
| **D1.2.3** Length, m | | | | |
| **D1.2.4** Width, m | | | | |
| **D1.2.5** Area, $m^2$ | | | | |
| **D1.2.6** Shape | | | | |
| **D1.2.7** Method of land preparation | | | | |
| **D1.3 Condition of operation** | | | | |
| **D1.3.1** Row spacing, mm | | | | |
| **D1.3.2** Depth of furrow, mm | | | | |
| **D1.3.3** Fertilizing rate, kg/ha | | | | |
| **D1.4 Condition of metering mechanism** | | | | |
| **D1.4.1** Metering shaft speed adjustment (if any) | | | | |
| **D1.4.2** Delivery opening adjustment | | | | |
| **D1.5 Condition of power source** | | | | |
| **D1.5.1** Draft animal | | | | |
| **D1.5.1.2** Breed | | | | |
| **D1.5.1.3** Number | | | | |
| **D1.5.2** Power tiller or tractor | | | | |
| **D1.5.2.1** Make and model | | | | |
| **D1.5.2.2** Rated engine horsepower, kW | | | | |
| **D1.5.2.3** Rated drawbar horsepower, kW | | | | |
| **D1.5.2.4** Gear shift setting | | | | |
| **D1.5.2.5** PTO speed, rpm (if used) | | | | |

| Particulars | Test Number | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Ave. |
| **D2 Field Performance** | | | | |
| **D2.1** Actual operating time, min | | | | |
| **D2.2** Time lost owing to | | | | |
| **D2.2.1** Turning at headland, min | | | | |
| **D2.2.2** Adjustment, min | | | | |
| **D2.2.3** Refilling of fertilizer, min | | | | |
| **D2.2.4** Repair, min | | | | |
| **D2.3** Actual area covered, $m^2$ | | | | |
| **D2.4** Nominal working width (no. of rows x row spacing), m | | | | |
| **D2.5** Traveling speed, kph | | | | |
| **D2.6** Effective field capacity, ha/h | | | | |
| **D2.7** Field efficiency, % | | | | |
| **D2.8** Operational pattern | | | | |
| **D2.9** Width of headland, m | | | | |
| **D2.10** Fuel consumption rate, L/h and L/ha | | | | |
| **D2.11** Comments and observations on the following: | | | | |
| **D2.11.1** Ease of operation in traveling straight path<br>_____<br>_____<br>_____ | | | | |
| **D2.11.2** Ease of turning<br>_____<br>_____<br>_____ | | | | |
| **D2.11.3** Ease of refilling fertilizer<br>_____<br>_____<br>_____ | | | | |
| **D2.11.4** Ease of replacing and adjusting the parts<br>_____<br>_____<br>_____ | | | | |
| **D2.11.5** Safety features<br>_____<br>_____<br>_____ | | | | |
| **D2.11.6** Failure or abnormalities that may be observed on the tractor or its component parts<br>_____<br>_____ | | | | |

## Annex E
(Informative)

## Formulas Used During Calculation and Testing

**E1** Delivery Rate

**E1.1** Nominal working width, *W*, (m)

$$W = n \times d_r$$

where: $W$ is the nominal working width, m
$n$ is the number of rows
$d_r$ is the row spacing, m

**E1.2** Ground wheel-driven machine

**E1.2.1** Effective diameter of ground wheel under load

$$D_e = \frac{d}{\pi \times N}$$

where: $D_e$ is the effective diameter, m
$N$ is the number of rotations of ground wheel
$d$ is the distance for a given N, m

**E1.2.2** Delivery Rate

$$Q = \frac{L \times 10{,}000}{\pi De \times N \times W}$$

where: $Q$ is the delivery rate, kg/ha
$L$ is the delivery for a given N, kg

**E1.3** PTO-driven machine

$$Q = \frac{L \times 10{,}000}{v \times t \times W}$$

where: $Q$ is the delivery rate ,kg/ha
$L$ is the delivery for a given *t*, kg
$v$ is the tractor speed, m/s
$t$ is the time for measuring delivery, s

**E2** Effective Field Capacity, *efc*, ($m^2$/h)

$$efc = \frac{A}{t}$$

where: $A$ is the area covered, $m^2$
t is the time used during the operation, hr

**E3** Theoretical Field Capacity, *tfc*, ($m^2$/h)

$$tfc = \frac{A\ s}{d} \quad x \quad 3600$$

where: $s$ traveling speed, m/s
$d$ distance travel (length of the field multiplied by the number of passes), m

**E4** Field efficiency, $\varepsilon$ f, (%)

$$\varepsilon f = \frac{efc}{tfc} \quad x \quad 100$$

where: $efc$ is the effective field capacity, $m^2$/h
$tfc$ is the theoretical field capacity $m^2$/h

**E5** Fuel Consumption Rate, $F_t$, (L/h)

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

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

**E6** Standard Deviation, STDV

$$STDV = \sqrt{\frac{n\left(\sum x^2\right) - \left(\sum x\right)^2}{n(n-1)}}$$

where: STDV is the standard deviation
n is the number of samples
x is the weight of sample

**E7** Coefficient of Variation, CV

$$CV = \frac{STDV}{AVE} \quad x \quad 100$$

where: AVE average of the collected fertilizer

**E8** The moisture content (%dry weight basis) shall be computed as follows:

$$Moisture\ content(\%\ dry\ weight\ basis) = \frac{Wi - Wf}{Wf} \times 100$$

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