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Preface

This standard includes the following main content items:

——Definitions of special terms used in this document;

——Basic parameters of Intermittent Vertical Tillage Machines;

——The method for assigning a model number to Intermittent Vertical Tillage Machines;

——Engineering requirements placed upon Intermittent Vertical Tillage Machines;

——Safety requirements placed upon Intermittent Vertical Tillage Machines;

——Procedures for testing the degree to which the machine being tested complies with the standards set forth in the engineering requirements section;

——Regulations for manufacturer's quality control department to follow while inspecting products;

——Requirements for the content included in Operators Manuals;

——Requirements for what decals and labeling should be applied to products;

——Requirements for packaging;

——Recommendations for transport and storage.

Intermittent Vertical Machine

1. Scope

This standard defines the machine type, basic dimensions, engineering requirements, testing procedures, inspection protocols, decals, packaging, transport method, and storage of Intermittent Vertical Tillage Machines.

This standard is applicable to all vertical tillage machines that require an external prime mover to function. Intermittent Vertical Tillage portions of other machinery that include a section that vertically tills in an intermittent fashion.

2. Referenced Documents

Provisions of the following documents are incorporated into this standard by way of reference. Revisions and updates (not including corrections of erroneous content) of all dated documents referenced in this standard are not incorporated into this standard, however, newer versions use of these documents in research and development is encouraged. All revisions and updates to undated documents referred to by this standard are incorporated into this standard.

GB/T 197-2003　普通螺纹　公差(ISO 965-1:1998,MOD)

GB/T 3098.1—2000　紧固件机械性能　螺栓，螺针和螺柱(idt ISO 898-1:1999)

GB/T 3098.2—2000　紧固件机械性能　螺母　粗牙螺纹(idt ISO 898-2:1992)

GB/T 5667—2008　农业机械　生产试验方法

GB/T 2828.1—2003　计数抽样检验程序　第 1 部分:按接收质量限(AQL)检索的逐批检验抽样计划(GB/T 2828.1—2003, ISO 2859-1:1999,IDT)

GB/T 9480—2001　农林拖拉机和机械，草坪和园艺动力机械　使用说明书编写规则(eqv ISO 3600:1996)

JB/T 5673—1991　农林拖拉机及机具涂漆　通用技术条件

JB/T 51099—2000　工程农机产品可靠性考核　评定指标体系及故障分类通则

3. Special Terms and Definitions

The following special terms and their definitions are used in conjunction with intermittent vertical tillage machines.

3.1 Intermittent Vertical Tillage

Intermittent vertical tillage is engagement of soil structure that does not create disruption of soil structure in a continuous horizontal pattern; as well as having no effect on the vertical arrangement of soil layers.

3.2 Double Rank

Double rank refers to the number of groups of soil rollers with which an intermittent vertical tillage machine is equipped. Double rank means being equipped with two groups of rollers, and that these two groups are arranged so that tillage is performed first by the leading group, immediately followed by the rear group performing tillage upon the same ground as the leading group.

3.3 Single Rank

Single rank refers to the number of groups rollers with which an intermittent vertical tillage machine is equipped. Single rank means being equipped with one group of rollers, arranged across the breadth of the machine's working width.

3.4 Rotary Harrow

Rotary harrow refers to the type of harrow that works by rotating as it is driven by the soil and/or residue it engages.

3.5 **Swingarm**

Basic frame for individual rollers, the swingarm is in turn installed in the machine's frame.

3.6 **Roller**

Cylindrically shaped assembly containing members (tines) that turns as it is driven by the soil it engages.

3.7 **Tine**

Tine is the name given to the soil engaging members on intermittent vertical tillage machines.

3.8 **Cflex**

U shaped bracket used to suspend rollers on their swingarm frame, and provide shock relief for roller assembly parts and parts that mount the roller to its cflexes.

3.9 **Harrow Tool**

A harrow tool is a soil engaging member installed in rotary harrow tooling sections; designed to perform secondary tillage.

3.10 **Arbor Bolt**

A component commonly used in the roller assemblies of intermittent vertical tillage machines; designed to compress retain components of rollers assemblies together when tightened.

3.11 **Rotary Harrow Tooling Section**

A group of interconnected harrow tools suspended from framing at each end by a bearing assembly.

3.12 **Wing**

A wing is a section of an intermittent vertical machine's main frame that can be rotated about an axis parallel to direction of travel for reducing machine width while in transport, among other purposes.

3.13 **Soil engaging member**

The member, or part, of the vertical tillage machine that physically contacts the soil for the purpose of performing tillage.

4. Types and Basic Parameters

4.1 Types

Intermittent Vertical Tillage machines are separated into two categories: Single Rank, and Double Rank.

Single Rank type is separated by method of attachment to the tractor as follows: Three Point Hitch Type, and Pull Type.

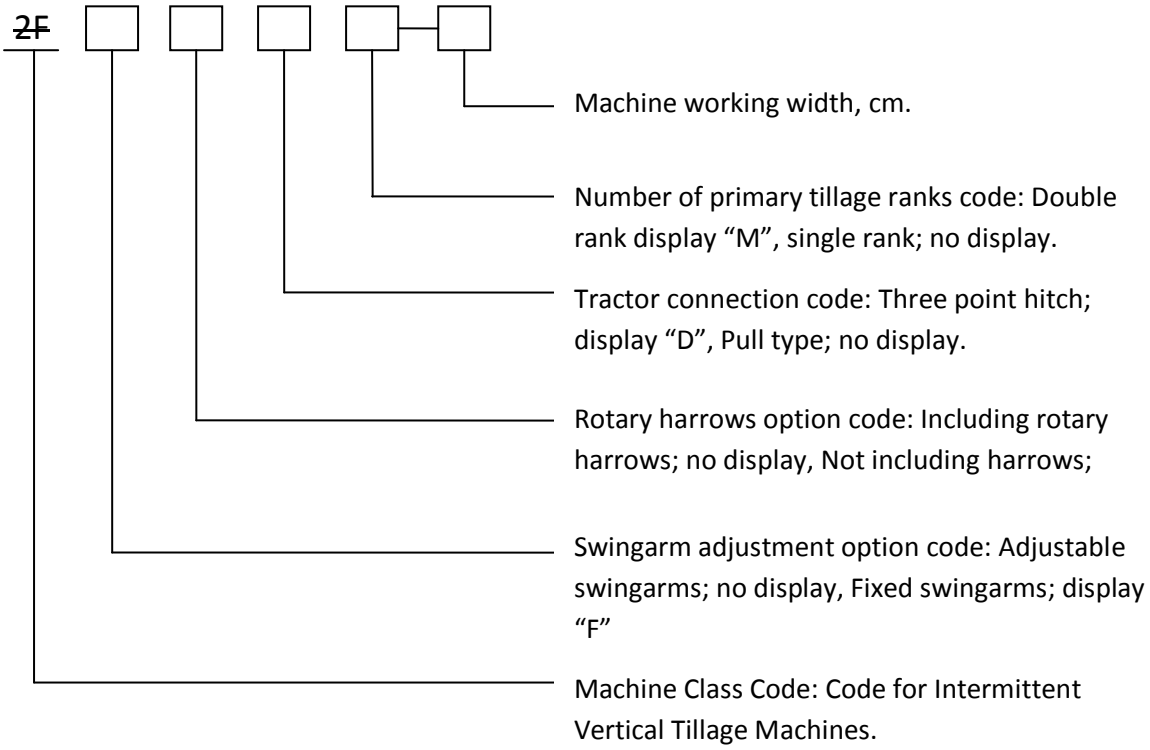
4.2 Basic Parameters

The basic parameters of Intermittent Vertical Tillage Machines must comply with table 1.

Table 1 Basic Parameters

Type	Single Rank		Multiple Rank
	Pull Type	3-Point Hitch Type	Pull Type
Width/ m.	0.4~17	0.4~6.8	0.6~17
Power Req./kW	15~370	15~150	27~450
Density Quality/ kg./m.	520~1050	520~1050	900~1500
Working Speed/ (km/h)	3~16	3~16	3~16
Range of tine length(T_L)/ mm	>220	>220	>220
Tine Spacing ±12.5%/ mm	T_L·75%	T_L·75%	T_L

5. **Model No. Display Method**



6. **Engineering Requirements**

6.1 **Main Functionality Requirements**

6.1.1 See individual tests for instructions on test site selection.

Table 2 Functionality Requirements

Item		Req.
Surface Finish(耕后地表平整度)/cm		≤3
Tilling Depth/cm		≥21
Tilling Depth Consistency/%		≥95
Ground Cover Retention Test	Residue Retention Factor/%	≥90
	Soil Strengh Reduction Factor/%	≥60
	Seedbed Quality/%	≥75
Soil Strength Reduction Factor/%		≥60
Seedbed Quality(碎土率)/%		≥75
Capillary Water Movement Factor/%		≥100
Tine Hole Bottom Density/PSI		≤200
Fracture Offset Ratio/%		≤80
Root Disturbance Test	Root Disturbance Factor/%.	≤10
	Soil Strengh Reduction Factor/%	≥25
Working Hour Productivity Rating	Req. Pulling Power<110kW	≥0.78
	Req. Pulling Power≥110kW	≥1.00

6.1.2 The machine’s reliability characteristic must comply with Table 3.

Table 3 Operating Reliability Characteristic

Item	Target
Mean Time Between Failures(MBTF)/h	≥160
Performance Effiency/%	≥90

6.2 **Common Engineering Requirements**

6.2.1 Intermittent Vertical Tillage machines must be manufactured according to drawings and design documents approved through due process.

6.2.2 螺纹公差应按 GB/T 197-2003 中不低于 6 级精度选用。

6.3 **Main Part Engineering Requirements**

6.3.1 **Cast Parts(roller parts)**

6.3.1.1 Grey iron parts must be manufactured from grade ~ grey iron material. ADI parts must be manufactured from grade ~ material.

6.3.1.2 Cast tines must have a hardness of ~ HRC.

6.3.1.3 铸件不应有裂纹，气孔，夹砂其他降低强度的铸造缺陷。

6.3.2 **Cflex(U 形托架)**

6.3.2.1 The Cflex part must be manufactured from spring steel 1095; A684 material.

6.3.3 **Harrow Tooling**

6.3.3.1 Harrow tooling must be manufactured from AISI1020 or equivalent steel materials.

6.3.4 **Framing**

6.3.4.1 All framing must be manufacture from Q345 or equivalent carbon steel materials.

6.3.5 **Hydraulic System**

6.3.5.1 All parts in the machine's hydraulic system must be rated to operate at a pressure of 3500 psi.

6.3.6 **Fasteners**

6.3.6.1 The fasteners category includes all fasteners except fasteners formed with a bending process. Fasteners must be manufactured from 4.8 or 8.8 grade material.

6.3.7 **Fasteners formed with a bending process**

6.3.7.1 Fasteners formed with a bending process must be manufactured from 4.8 grade material.

6.3.8 **Arbor bolt**

6.3.8.1 Arbor bolt must be manufactured from AISI4140 pre-hardened or equivalent grade carbon steel.

6.4 **Assembly Engineering Requirements**

6.4.1 Roller should spin with no more than 20N·m.

6.4.2 After assembly the machine should complete a warm-up test at recommended speed for a minimum duration of 1 hour.

6.5 **Assembled Machine Engineering Requirements**

6.5.1 After completing the warm-up test, the machine must comply with the following requirements:

a) Rollers should turn with no more than 20N·m.
b) Rotary harrow tooling sections should not sag more than 2.5% of their suspended length.

6.5.2 Main fastener's strength ratings: Bolts and screws should not have a rating less than grade 8.8 as defined in GB/T 3098.1-2000, nuts should not have a rating less than grade 8 as defined in GB/T 3098.2-2000; tightening torques for main fasteners are specified in table 4.

Main fasteners are the fasteners that serve the following purposes: securing main frame components, securing front hitching assembly pull points, and hinge pins.

Table 4 Fastener Tightening Torques

公称直径/ mm	拧紧力矩/（N·m）	
	最小值	最大值
5	5	8
8	14	19
10	27	38
12	47	66
14	75	106
16	118	165
18	162	227
20	230	322
22	315	441
24	398	557

6.5.3 涂漆外观质量应色泽均匀，平整，光滑，无露底，其中悬挂销和外露花键等应采取防~措施；漆膜附着力不低于 II 级。

7. Safety Requirements

7.1 Winged models must have devices installed for the purpose of securing wings in their raised position.

7.2 A system must be provided securing the machine in the raised position for the purpose of transport and servicing of the machine.

7.3 Machines must be equipped with a landing jack to adjust the height of the tongue for the purpose of attaching and detaching from tractors.

7.4 Safety Symbols

7.4.1 When applying warning symbols; indicate the following hidden dangers.

a) Falling wing sections
b) Pinch points
c) Tine puncture hazards

7.5 When applying caution markings; indicate the following.

a) Please read the owner's manual carefully and in its entirety before using the machine.
b) Check to make sure all rollers are tightened to the specified torque.
c) Check to make sure all swingarms are secured.
d) Grease fittings and their service intervals.
e) Before performing maintenance, make sure transport safety lock is in place with machine in the fully raised position.

8. Testing Procedure

8.1 Functionality Testing

8.1.1 Test Preparation

8.1.1.1 Machine to be tested

Testing sample should conform to the manufacturer's operators manual, pass quality control, and be in production ready form.

8.1.1.2 **Tractor**

The primary mover(tractor) must meet the power requirement dictated by the design of the machine being tested，技术状态应良好。

8.1.1.3 **Test Site Selection**

See the “Test Site Selection” section of each test for instructions on selecting the test site.

8.1.1.4 **Test Measuring Instruments and Equipment**

试验所用的仪器，设备需检查校正，计量器具应在规定的有效检定周期内。

8.1.1.5 **Test Requirements**

To till soil the machine must attain a minimum speed of 12km/h. All soil that the machine covers while not moving at or above the minimum speed is not considered as having been tilled. This will necessitate providing ample working area to accelerate up to minimum speed before engaging the area of soil to be tilled.

8.1.2 **Test-site Inspection**

a) **Percent Ground Cover:** Select a 30m square area of ground that represents the percent of ground cover in question. Form a hole of 5mm in diameter through the center of a piece of cardboard at least 30cm square, or 30cm in diameter. The person conducting the test should stand on a position inside the selected, and throw the cardboard disc so that it lands at least 2m from their position. For each time the cardboard disc comes to rest on the ground observe the ground underneath the piece cardboard by looking through the hole in its center. Record a value of 1 if less than half of the ground beneath the hole appears to be soil, and a value of 0 if more than half of the ground beneath the hole appears to be soil. After all 50 points have been checked in the specified manner calculate the Percent Ground Cover using formula (1).

a) Percent Ground Cover.

$$c = \left(\frac{\sum_{j=1}^{n} b_j}{n} \right) \times 100 \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

Arguments:

c——Percent Ground Cover, %;

b_j——ground cover check value;

n——Checked throw number “n”.

b) **Hole Depth:** Till an area of soil at least 5m in length. While tilling this area of soil, do not engage the rotary harrows. Follow this by randomly selecting 20 tine holes. Use a meter stick to measure these holes’ depths(h_j). Measure the vertical distance from the soil surface to the lowest point of each tine hole.

c) **Percent Slope:** Select the area of a slope to be measured. Various parts of the area selected must all appear to have the same percent slope. Attach a 6m length of string to a stake that has been driven into the ground at the top of the selected area. Grasp the string and move down the slope from the stake. While keeping the string level move down the slope until the point on the string where it is being held is 5m from the stake in the horizontal direction. While keeping the string level measure the vertical distance(h) between this point(point1) and the ground, distance precise to a centimeter. Calculate Percent Slope according to formula (2).

$$S = \frac{h}{5m.} \times 100 \quad \cdots\cdots (2)$$

Arguments:

S——Percent Slope, %;

h——Vertical distance between point1 and the soil surface, unit is m.

8.1.3 **Functionality Evaluation**

8.1.3.1 **Surface Finish**

a) **Introduction**

This test is designed to determine the degree to which the machine will leave the soil flat. It is considered that a flat finish is more desirable than a rough finish.

b) **Test Site Selection**

This test should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%. Ground cover density should be no greater than 5%.Test area should as wide as the test machine and at least 40m in length. Beside this area there should also be sufficient area for other necessary maneuvers and activities.

c) **Required Equipment and Materials**

String: A length of at least twice as long as the width of the machine being tested is required.

Metal stakes: two stakes are required for each baseline.

For example: If the machine being tested has a width of 4.5m, four stakes are required.

Measuring ruler: one is required.

Line Level: one is required.

d) **Test Procedure**

After the machine has been run over at least 40m of soil, establish three level base lines 10~15cm above the soil surface. The third baseline should be established 5m before the end of the run, with the second base line 10m before it, and the first baseline 10m before the second. A baseline should be no longer than 3m and no shorter than the working width of the machine being tested. If the machine being tested has a working width greater than 3m, divide its width into portions of equal length. These equal lengths should be no longer than 3m. Determine ten equally spaced points on each baseline, call these base-points. Measure the vertical distance between each base-point and the soil surface, distance precise to 1mm. Calculate the average height of each baselines base-points according to formula (3). Calculate the Soil Smoothness Factor according to formula (4)

a) The average base-point height for a baseline.

$$a_j = \frac{\sum_{i=1}^{n_j} a_{ji}}{n_j} \quad \text{..... (3)}$$

Arguments:

a_j ——Average base-point height for baseline number "j", unit is cm;

a_{ji} ——Height of base-point number "i" in baseline "j", unit is cm;

n_j ——Total number of base-points in baseline "j".

b) Soil Surface Smoothness Factor. (耕后平整度)

$$a = \frac{\sum_{j=1}^{N} a_j}{N} \quad \text{..... (4)}$$

Arguments:

a ——Soil surface smoothness factor, unit is cm;

a_j ——Standard deviation of base-point heights in baseline "j", unit is cm;

N ——Total number of baselines.

8.1.3.2 **Tilling Depth**

a) **Introduction**

This test is designed to determine how reliably the soil engaging members are fully inserted when they engage the soil. It is best for the soil engaging members to insert completely every time they engage the soil.

b) **Test Site Selection**

This test may be performed on any soil type with moisture content of 15% to 25%. Percent Ground Cover should be no greater than 10%.Test area should as wide as the test machine and at least 40m in length. Beside this area there should also be sufficient area for other necessary maneuvers and activities.

c) **Required Equipment and Materials**

Meter stick: one is required.

d) **Test Procedure**

Perform test according to the procedure in 8.1.2 item b). Calculate the tilling depth according to formula (5).

a) Tilling depth.

$$T = \frac{\sum_{j=1}^{n} h_j}{n} \quad \text{..... (5)}$$

Arguments:

T——Tilling depth, unit is cm;

h_j ——Depth of hole number "j", unit is cm;

n ——Total number of holes measured.

8.1.3.3 **Tilling Depth Consistency**

a) **Introduction**

This test is designed to determine the ability of the machine being tested to consistently operate at the recommended depth.

b) **Test Site Selection**

This test may be performed on any soil type with moisture content of 15% to 25%. Percent Ground Cover should be no greater than 10%.Test area should as wide as the test machine and at least 40m in length. Beside this area there should also be sufficient area for other necessary maneuvers and activities.

c) **Required Equipment and Materials**

Meter Stick: one is required.

d) **Test Procedure**

Perform test according to the procedure in 8.1.2 item b). Calculate Tilling Depth Consistency according to formulae (6)~(8).

a) Average hole depth.

$$a = \frac{\sum_{j=1}^{n} h_j}{n} \qquad \cdots\cdots(6)$$

Arguments:

h_j——Depth of hole number "j", unit is cm;

a——Average hole depth, unit is cm;

n——Total number of measured holes.

b) Standard deviation of hole depths.

$$S = \sqrt{\frac{\sum_{j=1}^{n} (h_j - a)^2}{n-1}} \qquad \cdots\cdots(7)$$

Arguments:

S——Standard deviation of hole depths, unit is cm;

h_j——Depth of hole number "j", unit is cm;

a——Average hole depth, unit is cm;

n——Total number of measured holes.

b) Tilling Depth Consistency

$$W = \frac{S}{a} \times 100 \qquad \cdots\cdots(8)$$

Arguments:

W——Tilling Depth Consistency, %;

S——Standard deviation of hole depths, unit is cm;

a——Mean hole depth, unit is cm.

8.1.3.4 **Ground Cover Retention Test**

a) **Introduction**

This test is designed to determine the ability of the machine being tested to perform tillage while avoiding incorporation of plant residue into the soil.

b) **Test Site Selection**

Select one hectare of ground that had corn as its previous crop. The corn stover from the previous crop of corn must still be on the soil surface. This hectare of ground must have enough corn stover remaining to attain a percent ground cover of least 80%. This test may be performed on any soil type with moisture content of 15% to 25%.

c) **Required Equipment and Materials**

Cardboard disc: one is required.

d) **Test Procedure**

Determine the Percent Ground Cover according to 8.1.2 item a) before tilling the selected area. Till the selected area once. Perform this tillage with the machine's swingarms offset from perpendicular to the direction of travel by 3deg. While tilling set the harrows to run no deeper than 5cm deep. After the selected area is finished being tilled, determine the percent ground cover according to 8.1.2 item a)., Soil Strength Reduction Factor according to 8.1.3.5 item d)., and the Seedbed Quality according to 8.1.3.6 item d). Calculate Residue Retention Factor according to formula (9).

a) Residue Retention Factor

$$I = \frac{r_h}{r_q} \times 100 \qquad \cdots\cdots(9)$$

Arguments:

I——Residue Retention Factor, %;

r_q——Percent Ground Cover before tilling, %;

r_h——Percent Ground Cover after tilling, %.

8.1.3.5 **Soil Strength Reduction Test**

a) **Introduction**

This test is designed to determine whether or not a minimum amount of soil strength reduction is achieved. This reduction of soil strength should occur on the sides of each tine insertion. Reduction of soil strength will result in a reduced requirement for penetration pressure.

b) **Test Site Selection**

First select an area of ground that is level. This area should be at least as wide as the machine being tested, and have a length of at least 10m. Beside this area there should also be sufficient area for other necessary maneuvers and activities. Percent Ground Cover should be less than 5%, calculate Percent Ground Cover according to 8.1.2 item a).

c) **Required Equipment and Materials**

Sampling grid: The sampling grid's outside dimensions must be 1m square. Inside the sampling grid there are 100 small squares. These small squares are 10cm square. Label each square in order from left to right, top to bottom, with the numbers 1~100. One sampling grid is required.

Penetrometer: one is required.

d) **Test Procedure**

Place the sampling grid on a position inside the selected area. Insert one flag at three of the sampling grid's corners. Take a penetrometer reading at 17cm deep in each of the sampling grid's 100 square areas. Record the penetrometer's reading(p_{qn}) in PSI, precise to 5PSI. After taking these 100 readings, till the selected area of ground once. Perform this tillage with the machine's swingarms offset from perpendicular to the direction of travel by 5deg. Next, replace the sampling grid onto its previous position in coordination with the three flags inserted earlier. Lastly record another 100 readings(p_{hn}) with a penetrometer according to the method described in the first part of this paragraph. Calculate Soil Strength Reduction Factor according to formulae (10)~(11).

a) Soil strength reduction ratio for each square area.

$$p_n = \frac{p_{hn}}{p_{qn}} \qquad \cdots\cdots(10)$$

Arguments:

p_n——Soil strength reduction ratio for small square number "n";

p_{hn}——Tilled soil strength reading for small square number "n", unit is PSI;

p_{qn}——Untilled soil strength reading for small square number "n", unit is PSI.

b) Soil Strength Reduction Factor

$$P = \frac{r_q}{r_t} \times 100 \qquad \cdots\cdots(11)$$

P——Soil Strength Reduction Factor, %;

r_q——Number of "p_n"s that are less than or equal to 0.5;

r_t——Total number of "p_n"s.

8.1.3.6 **Seedbed Quality Test**

a) **Introduction**

This test is designed to determine the degree to which the machine being tested can be used to perform primary tillage and create soil, ready for planting, in one pass.

b) **Test Site Selection**

This test should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%. Test area should not be ridged. Test area should as wide as the test machine and at least 40m in length. Beside this area there should also be sufficient area for other necessary maneuvers and activities.

c) **Required Equipment and Materials**

Soil collection box: one is required.

d) **Test Procedure**

Till the selected area once. Perform this tillage with the machine's swingarms offset from perpendicular to the direction of travel by 3deg. While tilling set the harrows to run no deeper than 7cm deep. After tilling select five 1m^2 plots inside the tilled area. Rake the top of each plot to remove any clods sitting on the very top. Gather the soil out of these plots down to 6cm. Measure the mass(m_{zj}) of the soil in each plot. Measure the total mass(m_{pj}) of small soil particles in each plot. A small soil particle is a soil particle which has a largest dimension of less than or equal to 2cm. Calculate Seedbed Quality according to formula (12).

a) Seedbed Quality.

$$Z = \frac{\sum_{j=1}^{n} m_{pj}/m_{zj}}{n} \times 100 \qquad \cdots\cdots(12)$$

Arguments:

Z——Seedbed quality, %;

m_{pj}——Mass of small soil particles in plot number "j", unit is kg;

m_{zj}——Mass of soil in plot number "j", unit is kg;

n——Total number of plots.

8.1.3.7 **Capillary Water Movement Test**

a) **Introduction**

This test is designed to determine the degree to which the machine being tested is able to fracture soil and restore normal capillary water movement. In this test the desired result is for the soil to absorb the water and then diffuse it quickly through capillary action. The water should diffuse fast enough to stop its movement down a sloped surface.

b) **Test Site Selection**

This test must be conducted on sloping ground of 20~30%. The width of the area must be no less than 40m. The length of the slope should be no less than 20m. This test

should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%.

c) **Required Equipment and Materials**

Liquid detergent, 2L are required.

Water, 4000L are required.

d) **Test Procedure**

Till the selected area of the slope once. Next, mix 4000L of water and 2L of liquid detergent. Take this solution and place it above the tilled area. Release this solution from its container onto the tilled area at a rate of at least 800L/min. After 10min, a blanket of bubbles should appear above the soil in which the liquid has diffused. Measure the width(k) and length(l) of this blanket of bubbles. Calculate the Capillary Water Movement Factor according to formula (13).

a) Capillary Water Movement Factor.

$$C = \frac{k}{l} \times 100 \qquad \cdots\cdots(13)$$

Arguments:

C——Capillary Water Movement Factor, %;

k——width of water diffusion, unit is m;

l——Length of water diffusion, unit is m.

8.1.3.8 **Tine Hole Bottom Soil Density Test**

a) **Introduction**

This test is designed to determine the degree to which the soil engaging members of the machine being tested compacts the soil under itself while tilling.

b) **Test Site Selection**

Select an area of soil at least 5m in length and at least as wide as the machine. Beside this area there should also be sufficient area for other necessary maneuvers and activities. This test should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%.

c) **Required Equipment and materials**

Meter stick: one is required.

d) **Test Procedure**

Till the selected area of ground soil once. While performing this tillage do not engage the rotary harrows. Follow this by randomly selecting 20 tine holes. Use a penetrometer to measure the density(y_j) at the lowest point of the bottom of these tine holes. Calculate Tine Hole Bottom Density according to formula (14).

a) Tine Hole Bottom Density.

$$Y = \frac{\sum_{j=1}^{n} y_j}{n} \qquad \cdots\cdots(14)$$

Arguments:

Y——Tine Hole Bottom Density, unit is PSI;

y_j——Density of hole bottom number "j", unit is PSI;

n——Total number of holes measured.(被测定刀孔的总数.)

8.1.3.9 **Fracture Offset Test**

a) **Introduction**

An Intermittent Vertical Tillage Machine will fracture soil in front of its rollers while running. Soil should start be fractured before the centerline of the machine's roller passes over it.

b) **Test site selection**

Select an area of soil at least 40m long and at least as wide as the machine being tested. Beside this area there should also be sufficient area for other necessary maneuvers and activities. This test should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%.

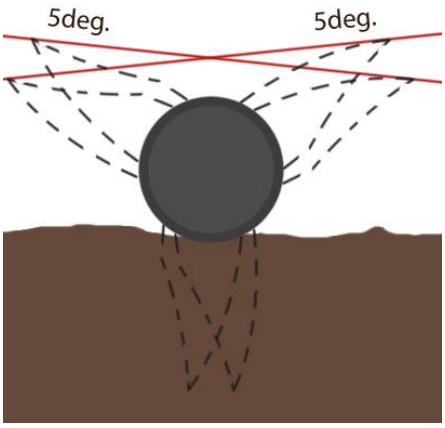
c) **Required Equipment and Materials**

Surveyor's flags: two are required for each roller in the front rank of the machine being tested.

d) **Test Procedure**

Run the machine in standard manner and then stop. Follow this by marking the positions of the rollers in the machine's front rank using Surveyor's Flags. Place one flag at each of the roller's two ends. A tine is pointed vertically down if the tips of the two tines adjacent to it are within 5deg of being level (see illustration 1). Place surveyor's flags directly in front of vertical tines. After the flags are placed, raise the machine to transport height.

Illustration 1



Establish the centerline of each roller as the line between pairs of flags. Measure the density of soil directly in front of vertical at two positions. Use a penetrometer to measure soil density(b_{ji}) 12cm in front of vertical tines at a depth of 17cm, precise to 5PSI. Use a penetrometer, again, to measure soil density(y_{ji}) 57cm in front vertical tines at a depth of 17cm, precise to 5PSI. Calculate Fracture Offset Ratio according to formulae (15) and (16).

a) Fracture Offset Ratio for stop number "k".

$$L_j = \frac{\sum_{i=1}^{n} \frac{b_{ji}}{y_{ji}}}{n_j} \qquad \text{.....(15)}$$

Arguments:

L_j ——Fracture Offset Ratio for stop number "*j*".

b_{ji}——Soil density at a location 12cm forward of vertical tine number "*i*" in stop number "*j*".

y_{ji}——Soil density at a location 57cm forward of vertical tine number "*i*" in stop number "*j*".

n_k——Total number of vertical tines in stop number "*k*".

b) Fracture Offset Ratio.

$$L = \frac{\sum_{j=1}^{n} L_j}{n} \quad \text{.....(16)}$$

Arguments:

L——Fracture Offset Ratio;

L_j——Fracture Offset Ratio for stop number "*j*";

n——Total number of stops.

8.1.3.10 **Root Disturbance Test**

a) **Introduction**

This test is designed to test the degree to which the machine being tested is able to reduce soil strength without disturbing root systems.

b) **Test Site Selection**

Select an area of soil at least 40m long and at least as wide as the machine being tested. Beside this area there should also be sufficient area for other necessary maneuvers and activities. This test should be conducted on silt loam soils (粉砂壤土/粉质壤土) with moisture content of 15% to 25%.

c) **Required Equipment and Materials**

Sampling Grid: one is required.

d) **Test Procedure**

Till the selected area once. While performing this tillage do not engage the rotary harrows. Place the sampling grid on the ground inside the tilled area at 3 random locations. Check each of the grids small squares for plants that are easily uprooted. Record the total number(Z_r) of small squares with disturbed plants at each location(n_j) where the sampling grid is placed. Calculate percent Root Disturbance Factor for each location where the sampling grid is placed according to formula (17). Calculate Root Disturbance according to formula (18). Calculate Soil Strength Reduction according to 8.1.3.5 item d).

a) Root Disturbance Factor for individual sampling grid locations.

$$G_y = Z_r \quad \text{.....(17)}$$

Arguments:

G_y——Root Disturbance Factor for sampled location number "*h*", %;

Z_r——Total number of small squares with disturbed root systems is sampled location number "*j*".

b) Root Disturbance.

$$G = \frac{\sum_{j=1}^{n} G_y}{n} \quad \text{.....(18)}$$

Arguments:

G——Root Disturbance Factor, %;

G_y—— Root Disturbance Factor for sampled location number "*h*", %;

n——Total number of sampled locations.

8.2 **Production Test**

8.2.1 **Reliability Test**

采用定时截尾试验方法，three sample machines to be tested, each machine to be tested for a total of 250 h, to be run at designated speeds. While testing, working status, failure incidents, repairs, and other situations are to be recorded. The mean time between failures(MBTF) and working efficiency(A) are to be calculated, precise to the minute, categorization of periods during production testing to be conducted in accordance with standards set forth in GB/T 5667—2008, categorization of failures to be conducted in accordance with standards set forth in JB/T 51099—2000, for a guide to categorizing failure categories see appendix B.

If at any time during production testing a test sample machine has a severe or life threatening failure(explanation. meaning a failure that causes injury of death as a result of), minimum time between failures and working efficiency are considered out of compliance.

8.2.1.1 **Mean Time Between Failures**

$$MBTF = \frac{T_z}{R_c} \quad \cdots\cdots(19)$$

Arguments:

$MBTF$——Mean time between failures, unit is hours (h);

T_z——Duration of each working run in the reliability testing period, unit is hours (h);

R_c——Total number of common or severe failure occurrences in the reliability testing period, non-critical failures are not considered.

8.2.1.2 **Working Efficiency**

$$A = \frac{\sum T_z}{\sum T_g + \sum T_z} \quad \cdots\cdots(20)$$

Arguments:

A——Working efficiency, %;

T_g——Total repair time for working runs in the production testing period, unit is hour (h);

8.2.2 **Hourly Productivity Factor**

Conduct three working runs scheduled close to each other of minimum duration, 6 h each, precise to the second. Calculate Hourly Productivity Factor according to formula (21).

$$E_c = \frac{\sum Q_{cb}}{B \sum T_c} \quad \cdots\cdots(21)$$

Arguments:

E_c——Hourly Productivity Factor, unit is hectares per hour meter[$hm^2/(h \cdot m)$];

Q_{cb}——Square are tilled during the three working runs, unit is hectares(hm^2);

B——Working width, unit is meters (m);

T_c——Duration of working runs, unit is hours (h).

8.3 **Inspection of assembly and overall appearance**

8.3.1 **Main Fastener grades and torques**

Main fastener grades to be checked visually for agreement with documentation accompanying purchased product.

Main fasteners should be checked for proper tightness using a torque wrench; no less than ten individual main fasteners should be checked.

8.3.2 **Roller Turning Torque**

After the warm-up test use a torque wrench on the end of all rollers to measure how much torque is required for them to begin turning.

8.3.3 **Harrow Tooling Sag**

After the warm-up test raise the machine so that the rotary harrows' tooling sections are not resting on the ground. Measure the vertical distance(l_g) from the horizontal frame to the nearest tooling. Measure the vertical distance(l_d) from the horizontal frame to the farthest tooling. Measure the length(j_c) of the tooling section. Calculate harrow tooling sag according to formula (22).

a) Harrow Tooling Sag

$$X = \frac{(l_g - l_d)}{j_c} \times 100 \qquad \cdots\cdots(22)$$

Arguments:

X——Harrow Tooling Sag, %.

l_g——Vertical distance between the highest point on the bottom of harrow tooling and ground level, unit is centimeters (cm);

l_d——Vertical distance between the lowest point on the bottom of harrow tooling and ground level, unit is centimeters (cm);

j_c——Length of harrow tooling section, unit is centimeters (cm).

8.3.4 **Paint finish and strength**

Test the overall machine's paint finish, and strength according to standards set forth in JB/T 5673—1991.

9. **Inspection Regulations**

9.1 **Inspection Protocols**

9.1.1 Before leaving the manufacturer machines must be passed by the manufacturer's quality control department as complying with (sections of this standard), the certificate of inspection must also be attached before shipment.

9.1.2 Quality inspection for production machines must be concerned with the items in Table 5.

9.1.3 Machines that fail to meet the conditions in (sections of this standard) are non-compliant.

9.1.4 The following categories are established according to the severity of their effect on product quality; A-nonconformant, B-nonconformant, and C-nonconformant. For categorization of nonconformant conditions see Table 5.

Table 5 不合格项目分类表

不合格分类		项　　目
类	项	
A	1	Safety Requirements, 安全要求
	2	MBTF, 平均故障间隔时间
	3	Tilling Depth, 深耕
B	1	Working Efficiency, 有效度
	2	Tilling Depth Consistency, 深耕稳定性
	3	Surface Finish, 耕后地表平整度
	4	Ground Cover Retention,
	5	Soil Strength Reduction Factor,
	6	Seedbed Quality,
	7	Capillary Water Movement Factor,
	8	Tine Hole Bottom Density,
	9	Fracture Offset Ratio,
	10	Main Fastener Grade, 主要紧固件的强度等级
	11	Main Fastener Torque, 主要紧固件的拧紧力矩
	12	Working Hour Productivity Rating, 纯工作小时生产率

不合格分类		项　　目
类	项	
C	1	Roller Turning Torque,
	2	Paint Strength, 涂漆附着力
	3	Paint Finish, 涂漆外观质量
	4	Tine Hardness, 耕刀硬度

9.2　**抽样方案**

9.2.1　按 GB/T 2828.1—2003 进行抽样，在生产企业近 6 月生产的产品中随机抽取。样本大小为 2 台，产品检查批应不低于 20 台。抽样方案见表 6。

9.2.2　订货单位抽验产品质量时，按合同进行。按收质量限和检验批量，由供货方和订货方协商确定。合同未作规定时，按 GB/T 2828.1—2003 执行。

9.2.3　产品的出厂检验，生产企业可自行确定抽样方法。

9.3　**判定规则**

采用逐项考核，按类判定。判定数组见表 6。

表 6　抽样方案

抽样方案	类别	A	B	C
	项目数	3	12	4
	检验水平	S - 1		
	样本量字码	A		
	样本量	2		
	AQL	6.5	40	65
	Ac　Re	0　1	2　3	3　4

10.　**Operators Manual, Decals, Packaging, Transport and Storage**

10.1　**Operators Manual**

The Operators Manual must be written in compliance with GB/T 9480—2001, it must contain clear descriptions of all dangers involved in operating the various functions of the machine.

10.2 **Decals**

Every machine must securely affix the decals in positions that are clearly seen; displaying the following.

a) The machine's name and model number
b) Power requirement
c) Main specifications
d) Manufacturer's logo
e) Production date and serial number
f) Certification number

10.3 **Packaging**

10.3.1 Packaging must be firm and sound, packing box must contain parts and accessories as determined by the manufacturer.

10.3.2 The following information should be displayed on the outside of the packing box.

a) Product's name, make, and model number.
b) Name of the packing box, it's quality rating, item number, and serial number.
c) Name and address of manufacturer
d) Address of shipper, and name of recipient.

10.3.3 Upon leaving the manufacturer every machine must be accompanied by the following documents:

a) Quality Certificate
b) Operation and maintenance manual
c) A detailed list of the package's contents

10.4 **Transport**

Method of transport and its requirements will be agreed upon by manufacturer and purchaser.

10.5 **Storage**

The machine should be stored in a well ventilated and dry environment. Take measures to protect the machine from sunlight, rain, and snow if it cannot be stored inside.

Appendix A
(Informative Appendix)
Important Testing Instruments and Equipment

Meter Stick(100cm)
Line level(挂在绳子上的那种水平尺)
Torque Wrench
Stopwatch
Soil Penetrometer
Surveyors tape(30m~50m)
Sampling grid(1m ×1m)
Check Disc
Surveyors Flags
String
Metal Stakes

Appendix B
(Informative Appendix)
Failures Listing

Table B.1 Intermittent Vertical Tillage Machines Failures Listing

Item No.	Name	Failure Severity	Result	Category
1	Hitching mechanism	Broken, Hanging	Unsafe, can result in injury or death	Ⅰ
2	Hitching mechanism	Bent, Cracking	Can affect normal operation	Ⅱ
3	Roller	Broken, Disfunctional	Prevents normal operation	Ⅱ
4	Roller bearing housings	Cracking	Operates normally	Ⅲ
5	Roller bearing housings	Damaged, Disfunctional	Prevents normal operation	Ⅱ
6	Tine	Multiple Broken		Ⅳ
7	Main Fasteners	Multiple Broken	Loss of structural integrity	Ⅱ
8	Main Fasteners	Multiple damaged or loose	Weakened structural integrity	Ⅲ
9	Paint	Peeling and loss	Can lead to weakening of structural integrity following rusting of the exposed metal.	Ⅳ
10	Grease Fittings	Damaged, Missing		Ⅳ