

ASAE EP291.3 FEB2005

Terminology and Definitions for Soil Tillage and Soil-Tool Relationships



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Terminology and Definitions for Soil Tillage and Soil-Tool Relationships

Proposed and developed by the ASAE Cultural Practices Equipment Committee, with assistance by the ASAE Conservation Tillage Methods Committee, and by the Soil Effects Subcommittee of the Society of Automotive Engineers' Construction and Industrial Machinery Technical Committee and the Tillage Terminology Committee of the Soil Science Society of America; approved by the ASAE Power and Machinery Division Technical Committee: adopted by ASAE as a Recommendation June 1965; reconfirmed December 1970; revised June 1972; reconfirmed December 1976; reclassified as an Engineering Practice June 1978; reconfirmed December 1981, December 1986; revised August 1988; reaffirmed December 1993, December 1998, February 2004; revised February 2005.

1 Purpose and scope

1.1 The purpose of this Standard is to provide uniform terminology and definitions for soil tillage and soil-tool relationships in the production of food and fiber.

1.2 This Standard is intended to be consistent with terminology in other ASAE standards including ASAE Standard S414.1, Terminology and Definitions for Agricultural Tillage Implements, and ASAE Standard S477, Terminology for Soil-Engaging Components for Conservation-Tillage Planters, Drills and Seeders.

2 Basic tillage goals

2.1 Tillage action: The action of a tillage tool in executing a specific form of soil manipulation such as soil cutting, shattering, or inversion.

2.2 Tillage objective: The desired soil condition produced by one or more tillage operations.

2.3 Tillage requirement: The soil physical condition which can be produced by tillage and is necessary based on utilitarian and/or economic considerations.

3 General tillage terms and kinds of tillage

3.1 Overall tillage: Tillage of an entire area as contrasted to partial tillage as in bands or strips.

3.2 Cultivation, soil: A shallow tillage operation performed to promote growth of crop plants by creating a soil condition conducive to aeration, infiltration, and moisture conservation or to pest control.

3.3 Earthmoving: Tillage action and transport operations utilized to loosen, load, carry, and unload soil.

3.4 Land forming: Tillage operations which move soil to create desired soil configurations. Forming may be done on a large scale such as contouring or terracing, or on a small scale such as ridging or pitting.

3.4.1 Land grading: Tillage operations which move soil to establish a desired soil elevation and slope. Examples: leveling, contouring, cutting, and filling.

3.4.2 Land planning: A tillage operation that cuts and moves small layers of soil to provide a smooth, refined surface condition.

3.5 Rotary tillage: A tillage operation employing power-driven rotary action to cut, break up, and mix soil.

3.6 Tillage: The mechanical manipulation of soil for any desired purpose, but in agriculture the term is usually restricted to the changing of soil conditions for the enhancement of crop production.

3.7 Tillage depth (tool depth): Vertical distance from the initial soil surface to specified point of penetration of the tool.

3.8 Tillage, deep: A primary tillage operation which manipulates soil to a greater depth than 300 mm. It may be accomplished with a very heavy-duty moldboard or disk plow which inverts the soil, or with a chisel plow or subsoiler which shatters soil.

3.9 Tillage, primary: That tillage which constitutes the initial major soil-working operation. It is normally designed to reduce soil strength, cover plant materials, and rearrange aggregates.

3.10 Tillage, secondary: Any of a group of different tillage operations, following primary tillage, which are designed to create refined soil conditions before seeding to create specific soil surface configurations or to control weed growth.

4 Tillage systems

4.1 Conventional tillage: Tillage operations traditionally performed in preparing a seedbed for a given crop and grown in a given geographical area.

4.2 Minimum tillage: The least soil manipulation necessary for crop production or for meeting tillage requirements under existing soil conditions.

4.3 Optimum tillage: An idealized system which permits a maximized net return for a given crop under given conditions.

4.4 Intensive tillage: Any tillage or seeding system that maintains less than 15% residue cover on the soil surface after planting or maintains less than 560 kg/ha (500 lb/acre) of small grain residue equivalent on the soil surface during the critical erosion period (see also paragraphs 4.5 and 4.6).

4.5 Reduced tillage: Any tillage or seeding system that maintains 15–30% residue cover on the soil surface after planting or maintains 560–1100 kg/ha (500–1000 lb/acre) of small grain residue equivalent on the soil surface during the critical erosion period - or is a system which consists of fewer or less energy intensive operations compared to conventional tillage (see also paragraphs 4.1, 4.4, and 4.6).

4.6 Conservation tillage: Any tillage or seeding system that maintains a minimum of 30% residue cover on the soil surface after planting to reduce soil erosion by water; or where soil erosion by wind is the primary concern, maintains at least 1 100 kg/ha (1,000 lb/acre) of flat small grain residue equivalent on the soil surface during the critical erosion period (see also paragraphs 4.4 and 4.5).

4.7 No-till: A system where crops are grown in narrow slots or tilled strips in previously undisturbed soil. Soil disturbance is typically limited to that required for placement of fertilizer and/or seed, for clearing residue from the seed row and to no more than one third of row width. Plant residue is maintained on the soil surface year-round.

4.8 Strip tillage: A system where crops are grown in narrow tilled strips in previously undisturbed soil. Seedbed preparation, planting, and fertilizer placement disturb no more than one third of row width. Plant residue is maintained on the soil surface year-round.

4.9 Direct seed: A system where crops are grown in narrow slots or tilled strips in previously undisturbed soil. Soil disturbance is limited to that required for placement of fertilizer and/or seed. Includes systems that fertilize and/or plant in one pass and those that fertilize and plant in two passes. Seedbed preparation, planting and fertilizer placement disturb no more than two thirds of the row width.

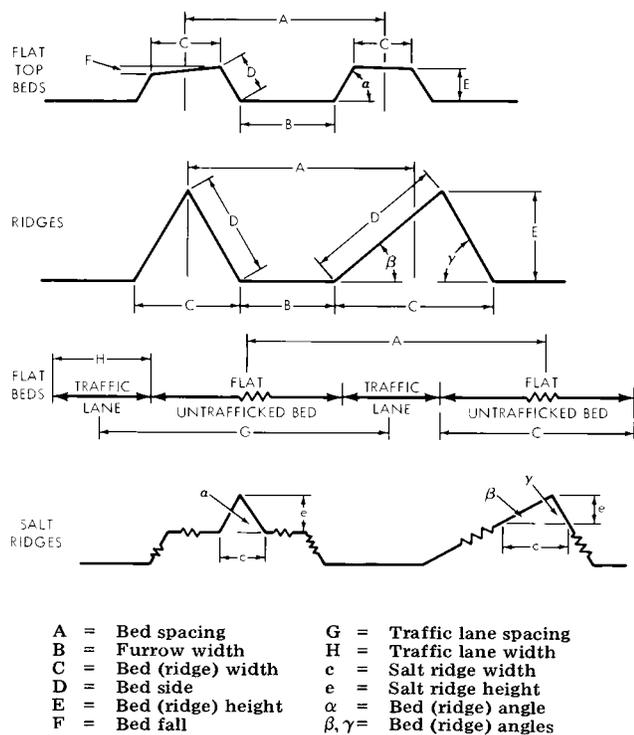


Figure 1 – Bed geometry

4.10 Mulch tillage: Full width tillage system where the entire field surface is disturbed prior to and/or during planting. Tillage is performed in such a way that plant residue is maintained on the soil surface year-round.

4.11 Ridge tillage: A system where crops are grown on pre-formed ridges separated by furrows protected by crop residue. Soil is left undisturbed from harvest to planting. After planting, ridges are rebuilt by cultivation. Planting and fertilizer placement disturb less than one third of row width.

4.12 Reservoir tillage: A system in which a large number of depressions or small reservoirs are formed to hold rain or sprinkler applied water.

5 Specific tillage operation

5.1 Anchoring: Tillage to partially bury and thereby prevent movement of materials such as residues or artificial mulches.

5.2 Bed seeding: A method of seeding in which two or more rows are planted on an elevated level bed. Beds are separated by furrows or ditches.

5.3 Bedding (also called ridging or listing): Tillage which forms a ridge and furrow soil configuration (see Fig. 1).

5.4 Bulldozing: The pushing or rolling of soil by a steeply inclined blade.

5.5 Chisel plowing: Tillage in which a narrow tool is used. Chisel plowing at depths greater than 350 mm is termed *subsoiling* (see paragraph 5.15).

5.6 Combined tillage operations: Operations simultaneously utilizing two or more different types of tillage tools or implements (subsoil-lister, lister-planter, or plow-planter combinations) to simplify, control, or reduce the number of trips over a field.

5.7 Harrowing: A secondary tillage operation commonly used before seeding which pulverizes, smoothes, and firms the soil.

5.8 Incorporating (mixing): Tillage operations which mix or disperse foreign materials, such as pesticides, fertilizers, or plant residues, into the soil.

5.9 Lister seeding: A method of seeding in which the seed is placed in the bottom of furrows.

5.10 Listing (also called bedding or ridging): Tillage which forms a ridge and furrow soil configuration (see Fig. 1).

5.11 Middlebreaking: The use of a lister in a manner that forms a furrow midway between two rows of plants.

5.12 Moldboard plowing: Primary tillage which is performed to shatter soil with partial or complete soil inversion.

5.13 Residue processing: Operations that cut, crush, anchor or otherwise handle residues in conjunction with soil manipulation.

5.14 Ridging (also called bedding or listing): Tillage which forms a ridge and furrow soil configuration (see Fig. 1).

5.15 Subsoiling: Deep tillage, below 350 mm for the purpose of loosening soil for root growth and/or water movement (see paragraph 5.5).

5.16 Vertical mulching: An operation in which a vertical band of mulching material is injected into the slit immediately behind a tillage tool shank.

6 Nomenclature for tillage tools and implements

6.1 Applicator, soil-additive: A machine utilized to apply, or to apply and incorporate by means of tillage soil additives. Examples: granular herbicide applicator, lime or manure spreader, fumigation and fertilizer distributor, or chemical incorporator.

6.2 Bed shaper: A soil-handling implement which forms uniform ridges of soil to predetermined shapes.

6.3 Blade: A soil-working tool, consisting of an edge and a surface, which is primarily designed to cut through soil (e.g., rotary tiller blades, anhydrous ammonia knife).

6.4 Coulter: A circular, flat tool used to cut plant material and soil.

6.5 Draft: The force to propel an implement in the direction of travel. (Equal and opposite to drawbar pull.)

6.6 Effective operating width: Operating width minus overlap (see paragraph 6.19).

6.7 Edge-clearance angle: The effective angle which is included between the line of travel and a line drawn through the back or non-soil-working surface of the tool at its immediate edge.

6.8 Ground clearance: Minimum vertical distance between the soil surface and a potentially obstructing machine element.

6.9 Hitch: The portion of an implement designed to connect the implement to a power source.

6.10 Implement width: The horizontal distance perpendicular to the direction of travel between the outermost edges of the implement.

6.11 Incorporator, soil-additive: A machine used to mechanically incorporate or mix material into the soil.

6.12 Injector: An implement used to insert materials into the soil.

6.13 Jointer: A miniature moldboard plow attachment whose purpose is to turn over a small furrow slice directly ahead of the main moldboard plow bottom, to aid in covering trash.

6.14 Lateral tool spacing: The horizontal distance between corresponding reference points on adjacent tools when projected upon a vertical plane perpendicular to the direction of travel.

6.15 Line of travel: The line and direction along which the tillage implement travels.

6.16 Lister-planter: A combined tillage implement which is composed of a lister and planting attachment to permit a single listing-seeding operation with the planter normally being operated in the furrow.

6.17 Longitudinal tool spacing: The horizontal distance between corresponding reference points of two tools when projected upon a vertical plane parallel to the direction of travel.

6.18 Moldboard plow clearances

6.18.1 Horizontal clearance: Distance measured between specified points on adjacent plows, e.g., diagonal (rake) (tip of share to tip of share), fore and aft, width of cut or furrow slice, throat width (minimum distance from face of moldboard to projecting member of preceding bottom).

6.18.2 Vertical clearance: Distance measured from cutting edge of share to nearest potentially obstructing member, e.g., main truss (backbone), frame, beam, release mechanism, etc.

6.19 Operating overlap: The distance perpendicular to the direction of travel that an implement reworks soil previously tilled.

6.20 Operating width: The horizontal distance perpendicular to the direction of travel within which an implement performs its intended function.

6.21 Orientation, tool: The position of the tool in a framework of cartesian coordinates which is usually oriented with the soil surface and the direction of travel. Orientation is specified in side, tilt, and lift angles as a minimum.

6.21.1 Lift (rake) angle: The angle, in a vertical plane parallel to the direction of travel, between a tool axis and the soil surface.

6.21.2 Side angle: The angle, in the soil surface plane, between a tool axis and a line which is perpendicular to the direction of travel.

6.21.3 Tilt angle: The angle, in a vertical plane perpendicular to the direction of travel, between a tool axis and the soil surface.

6.22 Protected zone: Soil and/or plant zone purposely protected by virtue of tool design, tool spacing or evasive tool movement.

6.23 Scouring (shedding): A soil-tool reaction in which soil slides over the surface of the tillage tool without significant adhesion.

6.24 Shank: A structural member primarily used for attaching a tillage tool to a beam or a standard.

6.25 Shovel: A spade-shaped, V-pointed soil-working tool which is used for various plow stocks, cultivators, grain drills, and soil scarifiers.

6.26 Side force (side draft): The horizontal component of pull perpendicular to the line of motion.

6.27 Soil opener: A tillage tool (e.g., disk, knife, runner) used to slice through soil and create an opening for the insertion of material (e.g., seeds, pesticides, fertilizers).

6.28 Soil roller: A rotating implement which pulverizes, firms or smoothes soil by crushing or compacting.

6.29 Soil-sliding path: The path along which one element of soil slides across a tillage tool.

6.30 Soil-sliding path length: The length of the path along a tillage tool upon which soil slides.

6.30.1 Soil-ascending angle: The angle between the sliding path and the horizontal at any point along the sliding path.

6.30.2 Soil-sliding angle: The angle at any point on the surface of a tool between the soil-sliding path and a horizontal contour line constructed through the surface of the tool.

6.31 Soil-tool geometry: The configuration of the soil-tool boundary. The overall shape is usually oriented with the direction of travel of the tool and the soil surface.

6.32 Soil-working surfaces: Portions of tillage tools which are designed to be in contact with soil.

6.33 Specific draft (unit draft): Draft force of an implement per unit area of tilled cross section.

6.34 Standard (beam): An upright support which connects the shank to a tillage implement frame.

6.35 Sweep: A type of cultivator shovel which is wing-shaped.

6.36 Teeth: Projections on tillage tools which serve to penetrate, grip, cut, or tear soil.

6.37 Tillage implement (machine): Single or groups of soil-working

tools together with power transmission structure, control, and protection systems present as integral parts of the machine.

6.38 Tillage tool: An individual soil-working element.

6.39 Tillage tools, multi-powered: Tillage tools powered by more than one form of power, such as draft and rotating power, or draft and electrical power.

6.40 Tool clearance: The minimum distance in a specified direction between a point on the tool and the nearest potentially obstructing implement element.

6.41 Tool-operating width: The maximum horizontal distance perpendicular to the line of motion over which a tool performs its intended function.

6.42 Tool overlap: The distance perpendicular to the direction of travel in which a tool-operating width coincides with the operating width of another tool.

6.43 Tool-skip area: The area of soil surface left undisturbed during passage of a tool.

6.44 Tool width: Maximum horizontal projection of a tool in the soil perpendicular to the line of motion.

6.45 Vertical tool spacing: The vertical distance between corresponding points on adjacent tools when projected upon a vertical plane parallel to the direction of travel.

6.46 Wings: Projections attached to the sides of tillage tools to increase the volume of soil which can be disturbed, or to control the nature and distance of soil movement. Wings usually have lift, tilt, and side angles which are different from those found in the orientation of the main tool and standard.

7 Soil reaction nomenclature

7.1 Soil reaction: The soil response to the application of mechanical forces.

7.1.1 Soil abrasion: The scratching, cutting, or abrading of materials caused by the action of soil.

7.1.2 Soil adhesion: The sticking of soil to objects such as tillage tools or wheels.

7.1.3 Soil compaction: The act of reducing the specific volume of soil.

7.1.4 Soil cutting: Separation of a soil mass by a slicing action.

7.1.5 Soil failure: The alteration or destruction of a soil-structural condition by mechanical forces such as in shearing, compression, or tearing.

7.1.6 Soil heaving: The lifting or swelling of soil resulting from natural forces such as freezing.

7.1.7 Soil shatter (pulverization): The general fragmentation of a soil mass resulting from the action of tillage forces.

7.1.8 Soil sliding: The sliding of soil across a surface.

7.1.9 Soil throw: The movement of soil in any direction as a result of kinetic energy imparted to the soil by the tillage tool.

8 Soil nomenclature

8.1 Additive, soil: Foreign materials, other than seeds, which are added to and/or incorporated in soil for directly influencing the soil condition or environment. (These include pesticides, fertilizers, mulches, or conditioners, but not foreign bodies such as drain tiles which have an indirect influence).

8.2 Adhered soil bodies: Masses of soil which adhere on soil-working surfaces and act as a part of the tool. Soil bodies may be stationary or in a relatively slow motion (i.e., soil cone, an adhered soil body which resembles a cone; soil sheet, an adhered soil body which covers a large area of a tool like a sheet; soil wedge, an adhered soil body which resembles a narrow wedge).

8.3 Clods: Soil blocks or masses that are cut, sheared, or broken loose by tillage tools.

8.4 Compacted layer (plow pan, traffic pan, plow soil): A dense layer of soil immediately below tillage depth created by mechanical pressure and/or soil-shearing forces.

8.5 Concretions: Soil-structural units which are irreversibly cemented together.

8.6 Covering depth: The thickness of soil with which materials are covered by an implement.

8.7 Foreign materials: All material added to or mixed into soil, including residues, soil additives, and foreign bodies that have not originated in the soil's development.

8.8 Mechanical impedance: The resistance to the movement of plant parts or tillage tools through soil that is caused by the mechanical strength of the soil.

8.9 Mechanical stability (strength): The degree of resistance of soil to deformation.

8.10 Residues: See foreign materials, paragraph 8.7, and additives, paragraph 8.1.

8.11 Shear blocks (or clods): The blocks of soil which are sheared loose from the main soil mass by tillage tool action.

8.12 Shear surfaces: Failure surfaces occurring where the soil has sheared.

8.12.1 Primary shear surfaces: The initial and distinct surfaces appearing during failure which are caused mainly by shear.

8.12.2 Secondary shear surface: Shear surfaces which result from the twisting, pushing, or tumbling of the soil after or during the initial displacement. Secondary shear surfaces are often perpendicular to the primary shear surfaces.

8.13 Soil aggregates (peds): Agglomerations of primary soil particles which are produced by natural processes.

8.14 Tillability: The degree of ease with which a soil may be manipulated for a specific purpose.

9 Soil and surface characteristics

9.1 The following nomenclature is recommended for describing all types of beds.

9.1.1 Furrow depth (ditch, pit, trench): Depth of depression below a specified (initial or subsequent) soil surface.

9.1.2 Ridge height (bed, hill, windrow): Height of soil above a specified (initial or subsequent) soil surface.

9.1.3 Root bed: The soil profile modified by tillage or amendments for use by plant roots.

9.1.4 Root zone: That part of the soil profile exploited by the roots of plants.

9.1.5 Seed bed: The soil zone which affects the germination and emergence of seeds.