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Residue and Tillage Systems for Field Crops

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Abstract

This report documents a method used to define the tillage system used in crop production, based on the percentage of soil surface covered by residue from the previous crop immediately after planting a new crop. Residue estimates were developed for the percentage reduction in residue from a single pass of each tillage implement. The type of tillage used may be a factor in a producer's qualifying for Federal agricultural programs because of conservation provisions in the 1985 Food Security Act and the Food, Agriculture, Conservation, and Trade Act of 1990. The resulting designations are used in conjunction with the Economic Research Service Cropping Practices Survey.

Keywords: Tillage systems, conservation tillage, crop residue, residue incorporation, pest management alternative, water quality, 1985 Food Security Act.

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Introduction

The 1985 Food Security Act and the Food, Agriculture, Conservation, and Trade Act of 1990 require that an approved conservation plan be fully implemented for all highly erodible lands by 1995 or the farmer will lose the option to participate in most Federal agricultural programs. This conservation compliance provision, in many instances, can be met through changes in tillage practices, rather than construction of permanent structures such as terraces or grassed waterways, or a change in rotation. The use of conservation tillage in crop production can reduce soil loss, lower production costs, and improve water quality. A clear understanding and definition of tillage systems and their effect is necessary to facilitate the acceptance and implementation of the conservation plans. Increasing public interest in onfarm pesticide use and the potential for residues in water and food will make the designation of tillage systems an important part of the analysis of integrated pest management practices (IPM). Tillage may be used as an alternative to the application of some chemicals.

The designation of tillage systems will be an important component of determining the costs and benefits of conservation compliance. Changing the tillage system, as part of a conservation plan, will incur cost to a producer as well as providing potential conservation benefits. In some cases, resulting benefits might directly outweigh costs and result in a net gain to the producer. As conservation compliance plans are implemented, the designation of tillage systems and associated costs will be a part of the evaluation of conservation compliance.

Most published estimates of the extent of tillage system adoption have been based on surveys asking the farmer for a designation of the tillage system being used or asking government agencies for estimates of the extent of tillage systems used within a given area (*4, 16*).[1] These methods rely heavily upon the respondent's knowledge and interpretation of what constitutes a specific tillage system. Consequently, estimates may vary greatly even when the respondent is given specific tillage definitions, especially when residue levels are included in the definitions. Residue levels may not be readily recognizable to farmers or other respondents. Therefore, they may rely mainly on the physical description of tillage operations and not include the residue limitations when designating tillage systems.

This report develops a method for defining tillage systems based on the amount of crop residue remaining on the field immediately after planting. Tillage operations and the previous crop planted on the field are used to estimate remaining residue. This method allows a standard designation of tillage systems across geographical areas, over time, and across the planting of different crops. It also reduces variance in survey respondents' tillage designations arising from differences in knowledge and

[1]Italicized numbers in parentheses cite sources listed in the References section.

interpretation of definitions. This standardization will aid in monitoring the effect of conservation compliance by tracking changes in the adoption of tillage systems.

Tillage Systems

A commonly accepted definition of tillage systems is used by the Conservation Technology Information Center (CTIC) in its annual survey of conservation tillage practices (*4*). Those definitions are used in this study and are as follows:

Conservation tillage: Any tillage and planting system that maintains a residue cover of at least 30 percent of the soil surface covered after planting to reduce soil erosion by water; or, where soil erosion by wind is the primary concern, maintains at least 1,000 pounds of flat, small grain residue equivalent on the surface during the critical erosion period.

Types of conservation tillage:

1. No-till: The soil is left undisturbed before planting. Planting is completed in a narrow seedbed or slot created by a planter or drill. Weeds are controlled primarily with herbicides and/or after planting cultivation.

2. Ridge-till: The soil is left undisturbed before planting. Planting is performed on ridges in a seedbed prepared with sweep, disks, or other row cleaners. Residue is left on the surface between ridges. Weeds are controlled with herbicides and/or cultivation. Ridges are rebuilt during the growing season with cultivation for weed control.

3. Mulch-till: The total surface is disturbed by tillage before planting. Tillage tools such as chisels or field cultivators (disks, sweeps, or blades) are used. Weeds are controlled with herbicides and/or cultivation.

Conventional tillage: By default, any system that does not meet the conservation tillage residue requirement after planting is designated as conventional tillage.

Methodology

The procedure developed in this report begins with an estimate of the percentage of the soil surface covered with previous crop residue immediately after planting (Appendix A). These estimates include an average winter weathering effect on the residue produced by an average yield level for each crop. The starting level is then reduced by a specified percentage for each pass of a tillage implement. A different incorporation rate was estimated for fragile and nonfragile residue and each crop residue was assigned to the fragile or nonfragile category.

The fragile residue category consists of crops like soybeans that have residue that is easily or quickly decomposed by incorporation and/or weathering.

The nonfragile crops (corn and small grains) have residue that decomposes less easily. The composite rate of residue reduction associated with each tillage implement depends upon whether the previous crop is designated as having fragile or nonfragile residue. Each crop was assigned to a fragile or nonfragile category (Appendix B). For example, one tillage pass with a disk would incorporate more of a fragile residue type, like soybeans, than it would of a less fragile crop residue, like corn.

The percentage rate of residue reduction associated with each tillage implement (Appendix C) was derived from information in agricultural engineering publications (*1, 3, 9, 19*), university, Agricultural Research Service, and Cooperative Extension Service reports (*5, 7, 8, 17*), agronomy and conservation publications (*2, 10, 18*), and Soil Conservation Service (SCS) bulletins (*13, 14, 15*). Rates for implements not covered in the information sources were derived by extrapolation and discussion with some of the authors of the source papers, agricultural engineers, and regional and State agronomists of SCS and Agricultural Research Service (ARS). These agronomists also assisted in designating fragile and nonfragile residue types and in estimating starting residue levels of the previous crops.

The resulting residue level immediately after planting is then used in designating the tillage system. The assumption is made that the resulting residue is evenly distributed over the soil surface and, therefore, the percentage of soil surface covered corresponds to the residue value.

The procedure is used to identify the major tillage systems. Conventional tillage is divided into systems using a moldboard plow, and systems not using it.

Tillage systems are designated according to machine usage and residue levels. First, the no-till category is defined as a system that has no tillage operations before planting. This does allow field passes of implements (such as stalk choppers), which do not incorporate any residue. A ridge-till system is any no-till system in which a crop is planted on a ridge. The first year of a ridge-till system would not be designated as no-till or ridge-till if other tillage operations were used to build the initial ridges after harvest of the previous crop.

The rest of the tillage systems are split into conventional tillage, which has less than 30 percent of the previous crop residue remaining, and mulch tillage, which has 30 percent or more residue remaining. If a moldboard plow was identified within the machinery complement, that system was designated as conventional tillage with a moldboard plow. If a conventional system did not contain a moldboard plow, it was designated as conventional tillage without a moldboard plow. These systems often contain one or more diskings, incorporating 40-70 percent of the remaining residue with each pass of a disk.

The tillage designation procedure is used to determine the tillage system for data collected by the Economic Research Service, Cropping Practices Survey. This survey annually collects input data used in the production of six major crops: wheat, corn, soybeans, cotton, rice, and potatoes. The survey is implemented through the National Agricultural Statistics Service and is designed to represent the major production acreage for each crop (about 85 percent of total U.S. production). Specific data are collected to identify the previous crop and each machine that passes over the field, from harvest of the previous crop through planting of the current crop. The results are published in the annual *Agricultural Resources: Inputs Situation and Outlook Report* (USDA, ERS).

Special Problems and Limitations

The ridge-till category may not strictly adhere to the general definition of being a type of conservation tillage by meeting the 30-percent minimum residue criterion indicated in the initial definitions. In this report, the use of only a ridge-till planter on a fragile (soybean, for example) residue was identified as ridge-till even though remaining residue was slightly under the 30-percent criterion. This was allowed because it is commonly accepted as being a ridge-till system and was close to the 30-percent break. This is an example of the shortcoming of adhering to and interpreting current definitions. Another deviation from the 30-percent minimum residue definition is when cultivation to rebuild the ridges is done after harvest. This cultivation acts like a tillage operation and usually reduces the previous crop residue to below 30 percent. The steepness of slope upon which ridge-till operations are practiced

may also negate the soil conservation objectives of conservation tillage and ridge-till definitions. Ridge-till operations on steeper slopes would require contouring to prevent soil erosion from runoff.

No-till operations (including ridge-till) practiced on previous crops producing small amounts of residue, such as grains harvested as silage, may not meet the remaining residue criterion. These gaps between practice and definition need to be resolved to heighten awareness and interpretation of conservation tillage designations.

The tillage determination method, as defined, limits itself to the 30-percent residue cover portion of the conservation tillage definition. In regard to wind erosion, conservation tillage is also defined as a tillage system that leaves 1,000 pounds of flat, small-grain residue equivalent. No data sources were available to make a clear determination of a starting residue level in terms of percent cover, so tillage designations based upon wind erosion criteria are not yet included in this model.

Other factors affecting the percentage of soil surface covered by previous crop residue include the design of implements, the depth and speed at which an implement is operated, and the condition of the soil. The size and angle of implement attachments, along with the speed and depth of the operation, can affect the rate at which an implement incorporates the residue into the soil. The incorporation rates in Appendix C reflect average settings and speeds. The soil type and condition also affect incorporation rates. Clay soils or wet soils will have different effects on speed and residue incorporation than sandy loam or dry soils.

The timing of an implement pass (fall versus spring and the time between passes) also has an effect. Incorporation also depends on whether the residue is standing (stalks) or flat (cut stems and leaves). If the residue is weathered (for example, if it is flat, more time has elapsed since the last implement pass, and/or the acreage was tilled in spring instead of fall), more residue will be incorporated with each implement pass.

These limitations are beyond the scope of this report and the survey data and account for the development of an average or composite rate for each designated implement. These relationships are being studied and should be considered when revising estimates of residue incorporation.

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Appendix A: Starting Residue Levels

95%	Grass hay or forage silage
	Pasture
	Forage seeds
90%	Alfalfa or other legume hay
85%	Corn
	Sorghum
	Wheat
	Fallow
	Oats
75%	Farmer did not know crop grown
	Speltz
70%	Barley
	Rye
	Millet
	Triticale
65%	Soybeans
	Guar
60%	Rice
	Rapeseed, canola
	Flaxseed
	Safflower
	Buckwheat
	Mustard
50%	Fallow
35%	Cotton
	Sunflowers
	Popcorn
	Dry beans
30%	Peanuts
20%	Dry peas
	Lentils
	Mint
	Tobacco
10%	Sugarbeets
	Corn silage
	Sorghum silage
	Sweet potatoes
	Vegetables (excluding potatoes)
	Irish potatoes
	Grapes
	Flower seeds
	Nursery stock

Appendix B: Residue Types

Nonfragile

Corn
Sorghum
Wheat
Barley
Fallow
Alfalfa or other legume hay
Cotton
Rice
Sunflowers
Corn silage
Flaxseed
Oats
Rye
Sorghum silage
Sugarcane
Tobacco
Grass hay or forage silage
Pasture
Rapeseed, canola
Millet
Triticale
Forage seeds
Safflower
Popcorn
Buckwheat
Speltz
Mustard
Farmer did not know crop grown

Fragile

Soybeans
Nursery stock
Sugar beets
Peanuts
Flower seeds
Sweet potatoes
Dry beans
Dry peas
Lentils
Vegetables (excluding potatoes)
Irish potatoes
Grapes
Guar
Mint

Definitions

Nonfragile: Corn- or small grain-type residue.

Fragile: Soybean type residue.

Appendix C: Tillage Implements and Remaining Residue

Pre-tillage

Rock picker (rake)

Residue remaining:[1] nonfragile = 95%; fragile = 95%.

A heavy-duty machine with pickup teeth or rotating reels that deposit rocks, stones, or boulders from 1 inch in diameter to 500 pounds in a tank or bucket for removal from the field. A heavy side-delivery or wheel-type rake that moves the stones into windrows in order to speedup the process of rock picking.

Stalk shredder (stalk cutter)

Residue remaining:[1] nonfragile = 100%; fragile = 100%.

A rotobeater with hard metal rods or cutting blades attached to a revolving horizontal shaft.

Plows, Levelers, and Ditchers

Chisel plow (big ox)

Residue remaining:[1] nonfragile = 65%; fragile = 40%.

A primary tillage machine either mounted or trailing that consists of three or more ranks or bars upon which either rigid or spring trip standards or shanks are attached. The shanks are usually spaced 12 to 15 inches apart. A variety of ground-engaging points may be used ranging from narrow points or shovels to 18-inch-wide sweeps. Chisel plows may be used to a maximum depth of 16 inches.

Coulter-chisel (soil saver; soil conserver)

Residue remaining:[1] nonfragile = 70%; fragile = 45%.

A multipurpose machine with one or two ranks of coulters, usually smooth or notched rim, followed by two or three ranks of chisel standards with a wide selection of ground-engaging tools. The main purpose of the coulters is to cut through the crop residue in order to reduce plugging of the chisel standards. This is a primary tillage tool.

Deep ripper (knife; bed-knife; slide)

Residue remaining:[1] nonfragile = 80%; fragile = 65%.

Similar to V-ripper. For deep plowing or breaking.

Disk plow

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

An implement that does essentially the same work as the moldboard plow but has from 1 to 10 large disks set at an angle to the direction of travel. The disks are mounted on individual beams or shanks. It is used in hard ground and where a regular moldboard plow does not penetrate or scour well.

Land plane (land leveler; laser leveler; water leveler)

Residue remaining:[1] nonfragile = 0%; fragile = 0%.

A machine used primarily to level for irrigation to improve drainage. This machine usually has two or more sets of wheels on a long wheelbase supporting one or more bowls, blades, or baskets that are intended to carry soil from high points to low areas in a field. Some systems are controlled by a laser beam for precise leveling.

Levee plow (levee disk; ditch digger; ditcher)

Residue remaining:[1] nonfragile = 100%; fragile = 100%.

A machine used to throw up levees or ridges between rice fields. Most machines have two sets of disks, each with one to three disk blades that throw the soil up into a levee. Most levee disks are tool-bar mounted. The disk sets can be reversed to teardown the levees.

Moldboard plow

Residue remaining:[1] nonfragile = 5%; fragile = 3%.

A machine with one or more (up to 18) curved metal plates (bottoms or moldboards) that engage the soil to a depth up to 12 inches. The curvature of the moldboard causes the soil or furrow slice to be completely inverted. This action pulverizes the soil and buries almost all of the crop residue or stubble. Moldboard plows may be made with one set of moldboards or with two sets. The two-way plows have two sets of moldboards, one left-handed and the other right. This allows the plow to be rotated so that all of the soil can be turned in the same direction. This eliminates dead furrows. This plow is used in irrigated areas to help maintain the level and slope of a field for furrow or bench irrigation.

Paraplow

Residue remaining:[1] nonfragile = 85%; fragile = 70%.

An implement with narrow shafts with flaps at the bottom that create a nearly undisturbed surface layer while loosening and lifting a 20-inch subsurface furrow. It provides hardpan penetration nearly equal to a moldboard plow, while maintaining surface residue nearly equal to no tillage.

Stubble-mulch plow (noble blade; sweep plow; hoeme plow; muckeroy plow)

Residue remaining:[1] nonfragile = 85%; fragile = 55%.

Usually a tool bar or trailing machine with one or more standards that can be fitted with sweeps of various angles of penetration and several widths. Does not turn the soil. Slightly mixes soil and stubble.

Subsoil chisel (ripper, V-ripper)

Residue remaining:[1] nonfragile = 80%; fragile = 65%.

A heavy tillage tool either integral mounted or trailing that has from 1 to 13 heavy shanks, often with a parabolic curve. These shanks usually are fitted with replacement chisel points and can penetrate the soil up to 22 inches. The standards can be fitted with various auxiliary tools such as knives or lister bottoms. This allows the machine to deep-rip the soil and form beds at the same time.

Disks

Chisel-disk (mulch-tiller)

Residue remaining:[1] nonfragile = 65%; fragile = 55%.

A multipurpose implement consisting of single disk followed by two or more ranks of chisel shanks.

Discovator

Residue remaining:[1] nonfragile = 60%; fragile = 50%.

A multi-tillage machine made up of disk blades, followed by a drag, and followed by a harrow.

Offset disk, light duty

Residue remaining:[1] nonfragile = 50%; fragile = 35%.

Offset disk, heavy duty

Residue remaining:[1] nonfragile = 40%; fragile = 30%.

A simple offset disk is the equivalent duty of one side of a tandem. All disks in each rank throw the soil in the same direction. Offset disks may vary in size from 5 feet to 35 feet or larger. The larger offsets have several disk units in each rank in order to gain flexibility. Disk blades may be conical or spherical and have diameters as large as 30 inches for extra-heavy-duty conditions.

One-way disk (disk tiller)

Residue remaining:[1] nonfragile = 55%; fragile = 40%.

A machine used mainly in the Plains and Northwestern areas as a primary tillage tool. It mainly consists of a series of spherical disk blades, 20-26 inches in diameter, set on a single solid shaft. This machine throws the soil all in one direction. Sizes range from 10 to 20 feet with multiple hitches available.

Single disk

Residue remaining:[1] nonfragile = 60%; fragile = 50%.

Two sets of disk blades that throw the soil out from the center when angled. Size may vary from 5 to 40 feet or more. Used as a secondary tillage tool. Most single disks have been replaced by tandems, offsets, or chisel plows.

Tandem disk

Residue remaining:[1] nonfragile = 55%; fragile = 40%.

Tandem, plowing disk

Residue remaining:[1] nonfragile = 40%; fragile = 30%.

Two gangs of disk blades hitched in tandem; the front set throws the soil outward and the rear set throws it inward. Width of cut may vary from 5 feet up to 35 feet or more. The blades may have different spacing, with 7, 9, and 11 inches being most common. The diameter of each blade may vary from 16 inches to as much as 24 inches. The shape of each blade may be either conical or spherical. The conical blades are mainly for use in heavy soil conditions for primary tillage. The blades can be smooth or notched. These machines may be three-point hitch mount, trailing, double-tandem, or other configurations.

Field Cultivators and Light Tillage

Doall (tillall; landall; mix-n-till)

Residue remaining:[1] nonfragile = 55%; fragile = 40%.

A multi-tillage machine of two to four ranks of shovels, disks, coulters, blades, or basket rollers. Usually disk blades, followed by shovels, and followed by reel and spikes or basket rollers.

Field cultivator, heavy duty (duckfoot cult)

Residue remaining:[1] nonfragile = 70%; fragile = 45%.

Residue remaining:[2] nonfragile = 80%; fragile = 80%.

Same as regular field cultivator except of heavier construction and may have "duckfoot" shanks.

Field cultivator, regular (digger; Danish tined; Swedish tined; S-tine cultivator; vibra-shank harrow; incorporator; lilliston tiller; triple K;)

Residue remaining:[1] nonfragile = 80%; fragile = 60%.

Residue remaining:[2] nonfragile = 85%; fragile = 80%.

An implement somewhat like a chisel plow except of lighter construction and with the shanks closer together, about 6 inches overall. The shanks are usually of a spring steel, vibra-shank type. Ground-engaging tools may be points, shovels, or sweeps. Size may range up to 70-80 feet in width. Used primarily as a secondary tillage machine.

Soil finisher (finishing tool; mulch finisher; tri-tiller; task master)
Residue remaining:[1] nonfragile = 55%; fragile = 40%.
A multi-tillage machine made up of disk blades, followed by field cultivator shanks, and ending with some type of harrow or drag.

Packers and Mulchers

Culti-mulcher (roller harrow; pulvi-mulcher; packer-mulcher; crumbler)
Residue remaining:[1] nonfragile = 80%; fragile = 65%.
Two ranks of packer rollers (smooth "vee" toothed, crowfoot, sprocket, birdfoot, or serrated type). Two or more ranks of field-cultivator-type teeth are in between. Packer roller wheels turn independently of each other.

Culti-packer (pulverizer; packer)
Residue remaining:[1] nonfragile = 90%; fragile = 90%.
An implement with a series of heavy crowfoot, inverted V-rim, or serrated rim wheels running independently on a shaft. May be a single or tandem unit. Main uses of this implement are to firm the seed beds and to reduce the size of clods and lumps of soil.

Rotary hoe (crust buster)
Residue remaining:[1] nonfragile = 90%; fragile = 85%.
A series of curved spider wheels attached either to a solid shaft or in segments of two to four wheels for flexibility. Used to kill small weeds in summer fallow or row crops, to incorporate herbicide, and sometimes as a wind erosion stopgap. Rotary hoes are usually pulled at speeds of 6 mph and above and may be hitched to cover up to 50 feet or more.

Roterra (lely)
Residue remaining:[1] nonfragile = 75%; fragile = 55%.
A machine with several sets of counter-rotating vertical tines that rotate with an overlapping action. The result is a stirring action; top soil remains on top, the soil is not turned over. Various attachments, such as planters and sprayers, are available. Tillage, planting, pesticide application and incorporation are possible in one trip.

Roto-tiller (rotary tiller)
Residue remaining:[1] nonfragile = 45%; fragile = 30%.
A series of bolo or slicer blades attached to a rotating shaft. Used as a primary or secondary tillage implement. Can be used in tandem with planting equipment as a conservation tillage system. Mounted motor or PTO powered.

Bedders and Listers

Bedder (hipper; disk bedder; row disk; lister bedder; hiller; rotary bedder; bedding plow)
Residue remaining:[1] nonfragile = 20%; fragile = 15%.
An implement, usually two to eight rows, used to make beds for seed planting using either disk blades, powered knives, or lister bottoms. Can be used with planter to plant either on the bed or in the furrow. Also used to break or "bust" the beds. *Row disks*—Disk blades arranged on a tool bar in sections of three or more. Blades adjustable to angle two ways. Used to disk beds for weed control, reshape beds, and clean furrows for irrigation. (A bed disk cultivator.)

Bedder-shaper (bedshaper; crowder)

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

A bedder with a forming device that flattens or shapes the bed in preparation for seeding. Shapers are sometimes used as a single tool bar implement. Planters may be attached.

Lister (middle buster; breaker)

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

Same as bedder but lister (plow type) bottoms. Different types of bottoms available (hard land, general purpose, soft land, and planter sweeps).

Subsoil bedder (ripper-hipper)

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

Any type of bedder either attached to a subsoil shank or as a separate bedder attached behind a subsoiler shank.

Harrows, Scratchers, Conditioners, Weeders, and Drags

Finishing harrow (harrogator)

Residue remaining:[1] nonfragile = 80%; fragile = 75%.

Spiral cutting blade reels followed by spike teeth or field cultivator shanks (two or more ranks), possibly another rank of spiral knives, and a smoothing board of wood or steel.

Flat roller (seed bed roller)

Residue remaining:[1] nonfragile = 95%; fragile = 95%.

Flat or concave rim wheel rollers. Used to pack soil in rows immediately before or after planting.

Flex-tine tooth harrow (coiltine harrow)

Residue remaining:[1] nonfragile = 85%; fragile = 80%.

Usually 5.5 to 6-foot sections of five bars or ranks. Teeth are spring steel about 5/16 inch in diameter and usually about 10 inches long. Teeth are formed in a spring coil and bolted to the bar, or set in rubber and bolted to the bar. Usually 50 teeth for 6-foot sections. At field speed, 3.5-5 mph, the tines vibrate in a circular motion to break clods, smooth seedbeds, and kill weeds. Can be hitched up to 10 sections in one unit.

Float

Residue remaining:[1] nonfragile = 95%; fragile = 95%.

A device, usually homemade, that is used for rough leveling. Soil-moving bars or blades may be of wood or metal.

Multi-weeder (culti-weeder)

Residue remaining:[1] nonfragile = 80%; fragile = 75%.

An implement made up of either tines or field cultivator shanks followed by a harrow.

Powered spike tooth harrow

Residue remaining:[1] nonfragile = 75%; fragile = 60%.

A harrow with spike tine teeth in two rows that move back and forth. Powered by power-take-off (PTO).

Rail (pipe, log, chain, drag)

Residue remaining:[1] nonfragile = 95%; fragile = 95%.

Makeshift device used alone or in tandem with another implement to smooth soil or crunch clods.

Rod weeder

Residue remaining:[1] nonfragile = 90%; fragile = 85%.
Residue remaining:[2] nonfragile = 95%; fragile = 95%.
A steel rod usually square, 7/8 or 1 inch diameter, rotating in bearings on shanks. Rotation of rod is in reverse direction. Power for rod rotation is either from the drive wheels on the machine or hydraulic from the tractor. Some makes have a freewheeling rod. Sections are normally 10 feet wide, but they can be linked together to make up a unit as wide as 80 feet. Rod weeders are often used in summer fallow areas and on relatively rock-free ground.

Sandfighter

Residue remaining:[1] nonfragile = 80%; fragile = 75%.
An implement used as an aid in controlling wind erosion. Essentially a shaft or bar with a frame and bearings to allow the shaft to rotate. Blades or teeth, about 10 inches long and 2-3 inches wide, are welded to the shaft at intervals. The teeth enter the soil as the machine is pulled forward. This digging action roughens the soil and retards wind erosion. Sizes range up to 24 rows (72 feet).

Seed bed conditioner (soil conditioner; field conditioner; ground hog; scratcher)

Residue remaining:[1] nonfragile = 85%; fragile = 60%.
A lightweight wheeled tillage tool, usually two or three bars or ranks of spring steel teeth spaced 12-18 inches apart on the bars. A tine-tooth version is available as a 30-60 foot-wide attachment.

Spike tooth harrow

Residue remaining:[1] nonfragile = 80%; fragile = 75%.
Usually 5-6 foot sections of five bars or ranks with seven or eight steel spikes or teeth per bar. Angle of spikes is adjustable. Can be hitched together with 8 to 10 sections in one unit.

Spring tooth harrow

Residue remaining:[1] nonfragile = 80%; fragile = 75%.
Usually built in sections 3 to 4 feet in width. Some wheeled models have a 10-foot center section with wings to make up to a 57-foot machine. Teeth are spaced 12 inches on center on three-bar models and 18 inches on four-bar models. The teeth are C-shaped spring steel and about 1.75 inches wide with a single or double curve. Points are replaceable on many models. The wheelless, drag models have metal skids for transport and depth control.

Markers and Dikers

Furrow-diker (corrugator; dammer-diker; diker)

Residue remaining:[1] nonfragile = 90%; fragile = 85%.
A device of various configurations that produces vee-shaped indentations in the soil to aid or impede the flow of irrigation water.

Marker

Residue remaining:[1] nonfragile = 95%; fragile = 95%.
An implement similar to a light row cultivator that makes a shallow furrow at the designated row width for a planter to follow.

Mulch treader (skew treader)

Residue remaining:[1] nonfragile = 80%; fragile = 75%.
Implement with tined wheels on a gang shaft that can be angled like a section of a tandem or single disk. Tined wheels resemble rotary hoe wheels.

Planters, Drills, and Seeders

Aircraft seeded

Residue remaining:[1] nonfragile = 100%; fragile = 100%.

Seeding by either fixed or rotary wing aircraft. Used in rice areas and to seed small grains into other standing crops.

Drill, air delivery

Residue remaining:[1] nonfragile = 85%; fragile = 80%.

Same as conventional drill, except seed is taken from a supply box through a manifold and blown by air through tubes to the seeding points.

Drill, no till

Residue remaining:[1] nonfragile = 85%; fragile = 80%.

Usually fluted or rippled coulters that open up narrow prepared soil areas for the single- or double-disk drill shoes to deposit the seed in otherwise untilled soil. Herbicide attachments are available. Modified chisel plows with coulters also used.

Drill, press, disk, hoe

Residue remaining:[1] nonfragile = 85%; fragile = 80%.

Seeder with seed box, metered seed fed through tubes to single or double disk openers. Tubes are spaced 7, 9 or 10 inches apart. May have fertilizer attachment. May have press wheels to firm soil.

Lister planter (lister drill)

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

Planter mechanism either plate-type or plateless, air or otherwise actuated. Drill seeder with seed box, metered seed fed through tubes to openers. Seed is deposited in furrows made by either hard-land or soft-land lister bottoms (may be equipped with fertilizer, insecticide, and herbicide attachments).

Planter, air delivery

Residue remaining:[1] nonfragile = 90%; fragile = 85%.

Same as regular planter except seed is taken from a supply box through a manifold and blown by air through tubes to the seeding points.

Planter, bedder-shaper

Residue remaining:[1] nonfragile = 20%; fragile = 15%.

Plants upon a bed formed by disks or lister bottoms and shaped by a metal smoothing form into a flat bed. Used mostly in the South for cotton, peanuts, and sorghum.

Planter, no-till (ripper planter)

Residue remaining:[1] nonfragile = 95%; fragile = 90%.

Fluted, rippled, or smooth coulters and/or subsoil shanks or narrow chisel used to disturb the untilled soil in a narrow band for the planter units to deposit seeds. Seeds can be deposited in conjunction with fertilizers, herbicides, and insecticides.

Planter, potato

Residue remaining:[1] nonfragile = 75%; fragile = 65%.

A planter of various designs that takes the cut seed potatoes from a hopper and deposits them in the soil at predetermined intervals. Usual sizes are 1-, 2-, 3-, 4-, and 6-row, cup or picker models.

Planter, regular (flex planter; tye planter)

Residue remaining:[1] nonfragile = 90%; fragile = 85%.

Plate or plateless metering devices that drop seed through a boot or shank in a seed furrow or bed opened by a shoe or disk. Seed is covered by a press wheel. Planters may be trail-type wheel carried or tool-bar mounted. Size may be from 2 to 24 rows.

Planter, ridge till

Residue remaining:[1] nonfragile = 65%; fragile = 40%.

Same as no-till planter except with sweeps or disk blades that cut the top of preformed ridges and deposit the residue between the rows.

Seeder, broadcast

Residue remaining:[1] nonfragile = 100%; fragile = 100%.

Spinner-type seeder, either tractor mounted (PTO or electric) or trailer mounted (wheel driven).

Row Cultivators

Furrow-out cultivator

Residue remaining:[1] nonfragile = 50%; fragile = 45%.

A row cultivator of the shovel variety where a fairly large shovel is placed to operate between the rows and open a furrow for irrigation. Thus, weeds are cultivated out and irrigation ditches are formed in one pass.

Row cultivator (shank, rolling, or disk cultivator)

Residue remaining:[1] nonfragile = 50%; fragile = 45%.

An implement with shanks arranged in such a manner that rows of crops can pass through without damage while the weeds are removed from between the rows. The shanks or standards may be fitted with shovels, disks, or spider-wheels set at an angle to the direction of travel. Size can vary from 1 to 24 rows. Most are rear tool-bar or front mounted on tractors.

Endnotes

[1]Nonfragile = Corn- or small grain-type residue remaining after one pass of designated implement. Fragile = Soybean type of residue remaining after one pass of designated implement.

[2]Specifies the different level of residue remaining for the nonfragile and fragile categories when the designated implement follows another specific implement in tillage sequence. The specific implements that precede in the sequence are: moldboard plow, tandem disk, tandem-plowing disk, light duty and heavy duty offset disk, single disk, or one-way disk.

Sources of implement definitions

American Society of Agricultural Engineers, "Terminology and Definitions for Agricultural Tillage Implements," ASAE Standards: ASAE S414, 1985.

U.S. Department of Agriculture, Economic Research Service, Farm Costs and Returns Survey materials.

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