

## RUSLE2 Tillage and Crop Residue Management

Identifying and recording the tillage, planting, and harvest operations within a crop rotation is an important step in determining the soil loss that may occur on a cropland field. Tillage is a sequence of mechanical operations that lifts and pulverizes soil structure to kill weeds and incorporate surface residue, level the soil surface, incorporate pesticides and fertilizers, and make the soil surface firm but friable for the planting of the next crop. Tillage may be periodically repeated to fill and cover over rill and gully erosion while removing compaction and crusting from rain events and of course, terminating weed growth.

The Revised Universal Soil Loss Equation, Version 2 (RUSLE2) model is used to estimate the potential soil erosion by water based on the location, topography, soil type, farming operations and crop rotation, and structural practices installed to control runoff. The model also provides the planner with an assessment of the Soil Conditioning Index (SCI) and the Soil Tillage Intensity Rating (STIR). The SCI value is calculated based on field operations and the effect on soil erosion and soil organic matter; a positive value shows a possible increase in improving the soil resource. The STIR value is based on the annual soil disturbance (tillage, planting, and harvesting).

### CONVENTIONAL TILLAGE

Tillage that occurs with the main focus of residue management, pest suppression, land forming or soil conditioning is an intense disruption in the surface layers of soil. Soil is displaced and thrown from tillage equipment in contact with the soil. Soil structure is destroyed, and soil particles are pulverized. This type of soil tillage makes the soil susceptible to soil erosion and sediment movement offsite by destroying the natural processes to consolidate soil particles. Tillage operations are generally full width implements; the entire field has the soil surface disturbed and displaced.

Tillage implements used as the primary conventional tillage operation are moldboard plows, chisel plows, chisels, sweeps, heavy disks, powered rototillers, and bedders. Secondary operations are smaller and lighter disks, harrows, packers, ground-driven rotary tillers, field cultivators, field conditioners, rollers, bed shapers, and rotary hoes. Light tillage may occur immediately prior to planting merely to kill weeds that have emerged. Tillage to cultivate the crop after planting to remove undesired vegetation may be row crop implements with ground-driven rotary tines, spring tooth tines, shank tine cultivators, rotary hoes, or power-driven rotary tillers. Using tillage for weed control after a crop has been planted is risky – the equipment operator must have the tillage tool set to remove weeds without damaging the planted crop.

Combination tools that perform primary and secondary tillage in one pass may be used. These combination tools may include coulter blades to cut and size surface residue, subsoiler shanks to lift and fracture the soil, or chisel plow shanks and disk blades to fluff and displace soil while covering residue. Secondary tillage tools may be incorporated in a combined tool to “dress up” the field by leveling ridges, filling furrows, packing the surface, or crumbling soil aggregates. RUSLE2 calculations must account for each of these separate operations that occur in a one-pass

tillage system. In some cases even the planting equipment is attached to the tillage tool to reduce time and fuel to get the crop planted.

Conventional tillage will generally have an SCI value that is negative (-) value showing that the farming system is not sustainable and a STIR that is higher than 60. Residue is usually less than 15 percent ground cover with conventional tillage. In most cases this amount of crop residue is not a significant factor in reducing soil erosion by wind or water.

#### CONSERVATION OR MINIMAL TILLAGE (includes Vertical Tillage)

Conservation tillage is used when there is a need to maintain surface residue from harvest to planting time for soil surface protection from wind or water erosion forces. The surface residue is maintained at 30 percent ground cover or higher to provide some mulching effect – allowing crop seedlings to germinate and emerge with some protection from the forces of nature.

The goal with conservation tillage is to leave residue on the surface equal to or in excess of 30 percent ground cover while controlling the weed population and preparing a firm seedbed for the planting of the next crop. Tillage operations are the full width of the implement and will disturb the entire soil surface for the field.

The RUSLE2 SCI with conservation tillage may be either a negative or positive value depending on the type of tillage used. The STIR value is generally between 20 and 70 showing significant soil disturbance.

#### Vertical Tillage

Vertical tillage is the new “buzz word” for tillage equipment and is an attempt to reduce the impact of conservation tillage on the soil surface by using implements that merely till narrow bands, zones, or strips of soil with shanks or smooth coulters entering and exiting the soil on a vertical plane. The primary reason to use vertical tillage is to size heavy residue for planting operations with minimal lateral displacement of soil. The secondary reason is to remove compaction with shanks or coulters pulled through compacted zones. These tillage operations occurring together in one implement are not part of a “no till” system – too much soil is moved and displaced to be considered no till. But the operation may be considered minimum tillage based on the amount of surface soil disturbance, horizontal soil displacement, and residue destruction. True vertical tillage implements size residue but are not residue management implements.

Very few of the implements sold as “vertical tillage” actually work as described above. The implements are generally set at a shallow draft and are pulled at speeds often as high as 8 to 10 miles per hour. A review of a sampling of these vertical tillage implements sold by common manufacturers have shown that the majority of the implements are merely another form of the basic disk harrow. Check equipment out either in the farmer’s equipment lot or on-line to determine the tillage accomplished. Since there are many different combinations of tillage tools that can be used on this equipment, a planner must be able to identify the RUSLE2 operations that are being performed.

Below is a summary of some of the tools sold as vertical tillage but is not intended to be a complete list of what will be found on the typical Midwest farm: All of these implements may be configured with different or additional attachments than described here.

- **Alamo Earthmaster Verti-Go MWT3400:** two gangs of 25-tooth concave disk blades on 7.5-inch spacing sold at a gang angle setting of 18 degrees designed to move soil horizontally. Implement also includes a seedbed finisher. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow with seedbed finisher.

**Example RUSLE2 operation:**

**Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket**

- **Blu-Jet Coulterpro:** two rows of individually mounted coulters used to size residue prior to planting. This tool is a vertical tillage implement and a strip till operation only when the disturbed soil area is less than 30 percent of the narrowest row width in the crop rotation. With no till the crop must be planted in all the tilled strips.

**Example RUSLE2 operations:**

- 1) **Coulter caddy, with fluted coulters or**
- 2) **Coulter caddy, with smooth coulters**

- **Case IH True-Tandem 330 Turbo:** two offset gangs of disk blades at 18 degree angle designed to move soil horizontally. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket**

- **Case IH Ecolo-Til 2500:** individual coulter for each ripper shank. Minimal surface disturbance with sizing residue and lifting and fracturing soil. This implement is a vertical tillage tool by definition but does not qualify as a no till operation due to the amount of soil displaced.

**Example RUSLE2 operation:**

**Subsoiler, inline with coulter caddy**

- **Degelman Pro-Till:** A compact disk cultivator with independently mounted disks on 10-inch spacing set at 16 degrees. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow with a strip roller packer. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket**

- **Gates Magnum Coulter Disk:** implement is gangs of coulters mounted for on-the-go hydraulic adjustment from 0 to 15 degree angle. Gangs may have an optional manual adjustment at 0, 5, 10, or 15 degrees. This is a vertical tillage implement only when pulled through the field with gangs set at a 0 degree angle to the direction of travel. Any other setting that angles the coulters in relation to the direction of travel would make this tool a disk harrow and would **NOT** meet the definition of a vertical tillage implement. This is not a “no till” operation.

**Example RUSLE2 operations:**

**0-degree angle – Seedbed conditioner, coultter caddy, coil tine harrow, rolling basket**

**5 to 15 degree angle – Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket (combination tool)**

- **Great Plains Ag**

**Turbo-Chopper:** a combination tillage tool with 20-inch diameter turbo coultters spaced every 10 inches, 18-inch diameter chopper reels with 6 blades, a series of rolling spike harrows, and a rolling reel harrow. The turbo coultters, chopper reels, and rolling spike harrows effectively disturb and till the entire soil surface. This tool does **NOT** meet the definition of a vertical tillage implement. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Seedbed finisher, single disk, field cultivator coil tine harrow, rolling basket**

**Turbo-Max:** a combination tillage tool with 2 offset gangs of turbo coultters spaced at 7½ inches (effective tillage every 3¾ inches). Angle on the gangs can be set from the tractor seat at 0° to 6° making this implement into a tandem disk. Common attachments are a rotary spike-toothed harrow and rolling basket. This tool does **NOT** meet the definition of a vertical tillage implement. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket**

**Turbo-Till:** a combination tillage tool with 2 offset gangs of turbo coultters, angled rotary spike-toothed harrows, and a rolling reel. The entire soil surface is disturbed with this equipment with some lateral movement of soil. Implement is used to size residue and cover residue with soil to speed decomposition. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket**

- **HCC Smart-Till:** an aeration tillage tool with multi-tine disks mounted on angled gangs to be operated at shallow depths up to a maximum of 8 inches deep. This implement disturbs the entire soil surface and does **NOT** meet the definition of a vertical tillage tool. This is not a “no till” operation.

**Example RUSLE2 operations:**

**Harrow, rotary**

- **Kongskilde Vertical Tillage 9100:** coultters in gangs that can be angled to the direction of travel at 0, 4, 8, 12, or 16 degrees. Coultters are mounted at an 8-inch spacing. This implement is a vertical tillage tool only when set at an angle of 0 degrees; when set at the 4, 8, 12, or 16 degree settings, this tool does **NOT** meet the definition of a vertical tillage tool and tills the soil as a tandem disk. This is not a “no till” operation.

**Example RUSLE2 operations:**

**0-degree angle – Coultter tiller and spike harrow**

**4-16 degree angle – Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket**

- **Kuhn Krause Excelerator 8000:** fluted coultter blades with scalloped edges mounted on gangs adjustable from 1 to 5 degrees. There are gangs of “star wheels” following the coultter blades set at a 6 degree angle and designed to fluff the surface soil while killing small weeds. The implement is designed to throw soil somewhat like a disk and a rotary hoe combination. This tool does **NOT** meet the definition of a vertical tillage tool. This is not a “no till” operation.
  - Example RUSLE2 operation:**
  - Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket**
- **Landoll Series 7400 VT Plus:** shallow concave disk blades mounted in gangs spaced every 7 inches set at a 10-degree angle. This implement is a tandem disk and does **NOT** meet the definition of a vertical tillage tool. This is not a “no till” operation.
  - Example RUSLE2 operation:**
  - Disk, tandem secondary operation**
- **Mandako Twister:** angled coultters up to 9 degrees with spring-tooth harrow or Phillips harrow attachment. Very aggressive tillage with significant horizontal soil movement – this implement does **NOT** meet the definition of a vertical tillage implement. This is not a “no till” operation.
  - Example RUSLE2 operation:**
  - Coultter tiller and spike harrow**
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- **McFarlane Reel Disk:** an angled gang of disks followed by a chopper reel, a spiked tooth harrow, and a rolling reel basket. This implement does **NOT** meet the definition of a vertical tillage tool. This is not a “no till” operation.
  - Example RUSLE2 operation:**
  - Coultter tiller, 10 degree angle, coiled tine harrow, rolling basket**
- **Salford Residue Tillage Specialist Extreme (RTS XT):** two rows of individually mounted coil spring coultters. This is a vertical tillage implement and can be a strip till operation if the crop is planted in the tilled strips.
  - Example RUSLE2 operation:**
  - Coultter caddy, double gang with fluted coultters**
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- **Salford Independent 4100 (HD Extreme):** two gangs of concave disk blades followed by two rows of coultters. This is **NOT** a vertical tillage implement. This is a disk and coultter system of tillage.
  - Example RUSLE2 operation:**
  - Disk, tandem heavy primary op., roller, smooth**
- **Summers Supercoultter Plus:** two gangs of coultters mounted at a 0-degree angle. This is a vertical tillage implement and can be a strip till operation if the crop is planted in the tilled strips
  - Example RUSLE2 operation:**
  - Coultter caddy, double gang with fluted coultters**
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- **Sunflower 6630 Series:** two offset gangs of scalloped disk blades at an 18-degree angle to the frame. This implement does **NOT** meet the definition of a vertical tillage tool. This is a tandem disk with gangs set at the standard 18 degree angle. This is not a “no till” operation.

**Example RUSLE2 operation:**

**Disk, tandem secondary operation**

NO TILL

No full width tillage operation in contact with the soil is allowed under this tillage classification. From harvest of the previous crop to harvest of the current crop, the soil is kept covered in crop residue and the soil has very minimal disturbance from mechanical operations. The planter or drill may be equipped with a coulter to cut residue, residue fingers or wheels to move residue, stronger springs to increase down pressure, extra weight on the planting unit for better penetration, and disk seed-furrow or hoe openers. The area between rows may have as much as 30 percent of the surface soil disturbed (strip till) during or just prior to the planting operation and still qualify as a no till operation. Global positioning technology may allow two operations (sizing residue and planting) to occur at separate times but within the same zone not significantly disturbing the soil area between rows.

The RUSLE2 SCI for no till will usually be a positive value as soil erosion should not be a major concern and there are no field operations that are destroying soil organic matter. The STIR value will be less than 20 with the most desired farming systems having a STIR value less than 10.

**SUMMARY**

The following table lists all RUSLE2 operations as of May 2016 that may be selected when modeling the farming system. The wording used here is a little different from how it is displayed in the RUSLE2 model as the majority of the abbreviated words have been fully written out to assist the RUSLE2 user with understanding the operation.

Complete RUSLE2 Operations Database

<b>Add PAM</b> (polyacrylamide)	<b>Bale Corn</b> stalk strips
<b>Add mulch</b>	<b>Bale combine windrows</b>
<b>Aerator</b> , field surface, ground driven	<b>Bale corn stover</b>
<b>Aerator</b> , field surface, ground driven 0 degree offset	<b>Bale straw</b> or residue
<b>Aerator</b> , field surface, ground driven 10 degree offset	<b>Bed shaper</b>
<b>Aerator</b> , field surface, ground driven 5 degree offset	<b>Bed shaper</b> high disturbance
<b>Aerator</b> , single drum, lugs, angle 0	<b>Bed shaper</b> , 12 inch
<b>Aerator</b> , tandem drum, lugs, angle 10	<b>Bed shaper</b> , 12 inch, low flattening
<b>Aerator</b> , tandem drum, lugs, angle 5	<b>Bed shaper</b> , low flattening, high disturbance
<b>Aerial interseeding</b>	<b>Bedder</b> , hipper, disk hiller
<b>Aerial overseeding</b>	<b>Bedder</b> , hipper, hiller 12 inch high
<b>BFM</b> (bonded fiber matrix) application	<b>Bedder</b> , hipper, hiller 15 inch high
<b>Bale Corn</b> husk, cob and chaff windrows	<b>Bedder</b> , hipper, hiller 18 inch high
	<b>Begin growth</b>
	<b>Begin new growth</b>

**Begin weed growth**

**Bulldozer**, clearing/cutting

**Bulldozer**, clearing/cutting light

**Bulldozer**, filling/leveling

**Burn residue**

**Burn residue**, high intensity

**Burn residue**, low intensity

**Burn residue**, moderate high intensity

**Burn residue**, moderate intensity

**Chisel plow**, coulter, straight points

**Chisel plow**, coulter, straight points, cover disks

**Chisel plow**, coulter, straight points, cover disks, rolling basket

**Chisel plow**, coulter, sweeps

**Chisel plow**, coulter, twisted points

**Chisel plow**, coulter, twisted points, cover disks

**Chisel plow**, disk, straight points

**Chisel plow**, disk, straight points, cover disks

**Chisel plow**, disk, twisted points

**Chisel plow**, disk, twisted points, cover disks

**Chisel**, 12-16 inch low crown sweep 3 to 4 inch depth

**Chisel**, straight point

**Chisel**, straight point 12 inch deep

**Chisel**, straight point 15 inch deep

**Chisel**, straight point 5 inch deep

**Chisel**, straight point 5 inch deep, coil tine harrow

**Chisel**, straight point, coil tine harrow

**Chisel**, sweep shovel

**Chisel**, sweep shovel 5 inch depth

**Chisel**, sweep shovel 5 inch depth, coil tine harrow

**Chisel**, sweep shovel, coil tine harrow

**Chisel**, twisted shovel

**Chisel**, twisted shovel (do not use – remove)

**Chisel**, twisted shovel, coil tine harrow

**Chisel**, winged with furrow diker

**Continuous disturbance and smoothing**

**Coulter caddy**, double gang with fluted coulters

**Coulter caddy**, with fluted coulters

**Coulter caddy**, with smooth coulters

**Coulter tiller** and spike harrow

**Coulter tiller**, 10 degree angle, coiled tine harrow, rolling basket

**Cover crop underseeder**

**Cultipacker**, roller

**Cultivate**, manually

**Cultivate**, manually, low intensity

**Cultivate**, manually, moderate intensity

**Cultivate**, rows manually

**Cultivator**, between beds, add residue

**Cultivator, field** 6-12 inch shovels Central

**Cultivator, field** 6-12 inch sweeps

**Cultivator, field** 6-12 inch sweeps, coil tine harrow

**Cultivator, field** w/ spike points

**Cultivator, field** w/ spike points, coil tine harrow

**Cultivator, flame**

**Cultivator**, hipper, disk hiller on beds

**Cultivator**, off bar w/disk hillers on beds

**Cultivator**, rotary

**Cultivator**, rotary on beds

**Cultivator**, rotary on beds; **Bedder**, hipper, disk hiller

**Cultivator, row** - 1st pass ridge till

**Cultivator, row** - 2nd pass ridge till

**Cultivator, row** 1 inch ridge

**Cultivator, row** 3 inch ridge

**Cultivator, row** between beds

**Cultivator, row**, high residue

**Detasseler**, seed corn

**Disk**, inter row strips

**Disk, offset**, heavy

**Disk, offset**, heavy 12 inch depth

**Disk, offset**, heavy 15 inch depth

**Disk, offset**, heavy, roller, corrugated packer

**Disk, offset**, heavy, roller, smooth

**Disk, oxen**, strip 30 percent disturb

**Disk, oxen**, strip 60 percent disturb

**Disk, single gang**

**Disk, tandem** heavy primary operation

**Disk, tandem** heavy primary operation, roller, smooth

**Disk, tandem** light finishing

**Disk, tandem** secondary operation

**Do all (Duall)**

**Do all**, on beds

**Dozer** track walking

**Drill or air seeder** single disk openers 7-10 inch spacing  
**Drill or air seeder** single disk openers, fertilizer openers 7-10 inch spacing  
**Drill or air seeder** tee slot openers 7-10 inch spacing  
**Drill or air seeder**, combo field cult, double disk openers  
**Drill or air seeder**, combo single disk-hoe openers, 10 inch spacing  
**Drill or air seeder**, hoe opener inch heavy residue  
**Drill or air seeder**, hoe opener inch heavy residue w/ fertilizer openers  
**Drill or air seeder**, hoe/chisel openers 12-15 inch spacing  
**Drill or air seeder**, hoe/chisel openers 12-15 inch spacing w/ fertilizer openers  
**Drill or air seeder**, hoe/chisel openers 6-12 inch spacing  
**Drill or air seeder**, hoe/chisel openers 6-12 inch spacing w/fertilizer openers  
**Drill or air seeder**, paired, opposing single disk openers 6x9 inch spacing  
**Drill or air seeder**, double disk opener w/ fluted coulter 5x10 paired row  
**Drill or air seeder**, double disk  
**Drill or air seeder**, double disk opener, w/ fertilizer openers  
**Drill or air seeder**, double disk, w/ fluted coulters  
**Drill or air seeder**, offset double disk openers  
**Drill or air seeder**, 4 inch stealth openers on 12 inch spacing  
**Drill or air seeder**, 6 inch stealth openers on 12 inch spacing  
**Drill or air seeder**, sweep or band opener  
**Drill, deep furrow** 12 to 18 inch spacing  
**Drill, deep furrow** 7 to 10 inch spacing  
**Drill, double disk**, 7-8 inch packer Central  
**Drill, double disk**, orchard vineyard cover  
**Drill, heavy**, direct seed, double disk opener  
**Drill, heavy**, direct seed, double disk opener w/row cleaners  
**Drill**, semi-deep furrow 12 to 18 inch spacing  
**Drip tape extractor**  
**Drip tape injection shank**  
**Drip tape injection shank** on beds  
**Drip tape injector** bed shaper  
**Erosion blanket application**  
**Fertilizer applicator** anhydrous knife 12 inches

**Fertilizer applicator** anhydrous knife 12 inches, coil tine harrow  
**Fertilizer applicator** broadcast by hand  
**Fertilizer applicator** coulter, high pressure inject 12 inches  
**Fertilizer applicator** deep placement heavy shank  
**Fertilizer applicator** shank low disturbance, 12 inches  
**Fertilizer applicator** shank low disturbance, 12 inches, coil tine harrow  
**Fertilizer applicator** shank low disturbance, 15 inch spacing  
**Fertilizer applicator** side-dress, liquid  
**Fertilizer applicator** surface broadcast  
**Fertilizer applicator**, aerial  
 Fertilizer applicator anhydrous knife 15 inch spacing  
**Fertilizer applicator** anhydrous knife 15 inch spacing high disturbance  
**Fertilizer applicator** anhydrous knife 15 inch spacing high disturbance, coil tine harrow  
**Fertilizer applicator** anhydrous knife 15 inch spacing, coil tine harrow  
**Fertilizer applicator** anhydrous knife 30 inch spacing  
**Fertilizer applicator** anhydrous knife 30 inch spacing, bedded  
**Fertilizer applicator** anhydrous, minimal disturbance precision placement, 30 inch spacing  
**Fertilizer applicator** anhydrous, low disturbance single disk opener, 30 inch spacing  
**Fertilizer applicator** double shot knife 15 inch spacing high disturbance  
**Fertilizer applicator** shallow anhydrous knife 38 inch spacing  
**Fertilizer applicator** single disk opener, low disturbance, 30 inch spacing  
**Fertilizer applicator**, strip-till 30 inch spacing  
**Furrow diker**  
**Furrow shaper**, torpedo  
**Germination of dormant seeding**  
**Graze**, continuous  
**Graze**, continuous overgrazing  
**Graze**, continuous, heavy hoof traffic  
**Graze**, continuous, light hoof traffic  
**Graze**, continuous, moderate hoof traffic  
**Graze**, intensive rotational  
**Graze**, rotational  
**Graze**, stubble or residue



- Graze**, stubble or residue 25 percent
- Graze**, stubble or residue 50 percent
- Graze**, stubble or residue 75 percent
- Grazing** set season, time on, time off, rate
- Grazing**, continuous, high traffic, set season, rate
- Grazing**, continuous, set season, rate
- Grazing**, continuous, severe hoof traffic, set season, rate
- Grazing**, continuous, time on, time off, rate
- Grazing**, frost kill
- Grazing**, set end height, and rate
- Grazing**, set end height, and time on
- Grazing**, set Harvest portion and time on
- Grazing**, set Harvest portion, and removal rate
- Grazing**, set season, Harvest portion, removal rate and start mass
- Grazing**, set season, start height, end height, rate
- Grazing**, set season, start height, end height, rate, then mowed
- Grazing**, set season, start height, end height, time on
- Grazing**, set season, start height, end height, time on, then mowed
- Grazing**, set season, Harvest portion, start mass, and time on
- Harrow**, coiled tine
- Harrow**, coiled tine weeder
- Harrow**, disk chain
- Harrow**, heavy
- Harrow**, heavy on heavy residue
- Harrow**, rolling
- Harrow**, rotary
- Harrow**, rotary paddle wheel and spike gangs
- Harrow**, rotary, light, fluff fragile residue
- Harrow**, rotary, light, fluff residue
- Harrow**, spike tooth
- Harrow**, spike tooth, cover seed
- Harrow**, tine, on beds
- Harvest**, broccoli and cauliflower
- Harvest**, cabbage and head lettuce
- Harvest**, cabbage and head lettuce, hand
- Harvest**, combine windrows
- Harvest**, corn cobbage or earlage
- Harvest**, corn grain and 60 percent of residue mass
- Harvest**, corn grain and cobs
- Harvest**, corn grain and part of stover, 14 inch stubble
- Harvest**, corn silage with cover crop
- Harvest**, cotton
- Harvest**, cotton and shred
- Harvest**, cut flowers
- Harvest**, dig root crops 12 inch depth residue buried
- Harvest**, dig root crops 12 inch depth residue on surface
- Harvest**, dig root crops residue buried
- Harvest**, dig root crops residue buried 10 inch ridge
- Harvest**, dig root crops residue on surface
- Harvest**, forage sorghum
- Harvest**, fruit crops
- Harvest**, grain, grow cover
- Harvest**, grass or legume seed, burn forage
- Harvest**, grass or legume seed, leave forage
- Harvest**, grass or legume seed, remove forage
- Harvest**, grass seed, remove forage
- Harvest**, hand pick
- Harvest**, hand pick multiple times
- Harvest**, hand pick vegetables
- Harvest**, hand pull
- Harvest**, hay set date
- Harvest**, hay set season, start and end height
- Harvest**, hay, grass
- Harvest**, hay, legume
- Harvest**, hay, no regrowth
- Harvest**, kenaf
- Harvest**, killing crop 10 percent standing stubble
- Harvest**, killing crop 20 percent standing stubble
- Harvest**, killing crop 20 percent standing stubble, release cover crop
- Harvest**, killing crop 30 percent standing stubble
- Harvest**, killing crop 50 percent standing stubble
- Harvest**, killing crop 50 percent standing stubble, release cover crop
- Harvest**, killing crop 60 percent standing stubble
- Harvest**, killing crop 70 percent standing stubble
- Harvest**, knife, windrow, combine
- Harvest**, leafy vegetables
- Harvest**, leafy vegetables mechanical
- Harvest**, legume seed, remove forage
- Harvest**, onions

- Harvest**, orchard and nut crops
- Harvest**, residue, forage chopper, complete
- Harvest**, residue, forage chopper, incomplete
- Harvest**, residue, forage chopper, intermediate
- Harvest**, rootcrops, manually
- Harvest**, rootcrops, manually, 25 percent of field disturbed
- Harvest**, rootcrops, manually, 33 percent of field disturbed
- Harvest**, rootcrops, manually, 50 percent of field disturbed
- Harvest**, rootcrops, manually, one third
- Harvest**, seed heads by hand
- Harvest**, silage
- Harvest**, silage 3-foot stubble
- Harvest**, small grain haylage 5 inch height
- Harvest**, small grain silage with cover crop
- Harvest**, small grain, release understory
- Harvest**, snapper header
- Harvest**, sprig rototiller digger
- Harvest**, stalk chopping corn header
- Harvest**, stripper header
- Harvest**, timber remove tops
- Harvest**, tobacco, burley
- Harvest**, tobacco, burley, mechanical harvester
- Harvest**, tobacco, flue cured
- Harvest**, tobacco, flue cured, 1 pass mechanical
- Harvest**, tobacco, flue cured, selective mechanical harvest
- Harvest**, tree buck
- Harvest**, tree length logs
- Harvest**, tree pulpwood cut
- Harvest**, tree, Christmas grow cover
- Harvest**, trees, chipper
- Harvest**, vine crops
- Harvest**, vine crops, mechanical
- Harvest**, windrows
- Harvest**, woody biomass
- Hilling**, manual hoe
- Hydro-seeder**
- Install Compost Sock**
- Install Silt Fence**
- Install Straw Bale**
- Kill crop**
- Knife**, windrow dry beans
- Land plane**
- Land plane**; orchard and vine crops
- Laser Land leveler**
- Lister**, 30 inch
- Lister**, 30 inch with fertilizer applicator
- Lister**, 40 inch
- Lister**, 40 inch with fertilizer applicator
- Log skidder**
- Manure injector**, liquid high disturbance 30 inch
- Manure injector**, liquid low disturbance 15 inch
- Manure injector**, liquid low disturbance 30 inch
- Manure injector**, low disturbance 15 inch
- Manure injector**, low disturbance 30 inch
- Manure spreader**, liquid
- Manure spreader**, slurry
- Manure spreader**, solid and semi-solid
- Manure**, liquid irrigation
- Middle buster**, digger
- Mow pasture**
- Mower**, swather, on stubble
- Mower**, swather, on stubble 4 inch
- Mower**, swather, windrower
- Mulch crimper**
- Mulch treader**
- No operation**
- Para-plow** or para-till
- Pasture renovator**
- Paving**
- Permeable weed barrier applicator**
- Planter**, RELAY INTERCROP, double disk opener w/fluted coulter
- Planter**, double disk opener on 12 inch high beds
- Planter**, double disk opener on 15 inch high beds
- Planter**, double disk opener on 18 inch high beds
- Planter**, double disk opener on 8 inch high beds
- Planter**, double disk opener
- Planter**, double disk opener w/fluted coulter
- Planter**, double disk opener w/fluted coulter with starter fertilizer
- Planter**, double disk opener w/fluted coulter, 15 inch row spacing
- Planter**, double disk opener with starter fertilizer

- Planter**, double disk opener, 15 inch row spacing
- Planter**, double disk opener, 18 inch rows
- Planter**, double disk opener, 40 inch rows
- Planter**, furrow opener 4 inch deep furrows
- Planter**, furrow opener 6 inch deep furrows
- Planter**, furrow opener 8 inch deep furrows
- Planter**, in-row subsoiler
- Planter**, in-row subsoiler low disturbance
- Planter**, in-row subsoiler w/ residue managers
- Planter**, narrow slot w/smooth or rippled coulter
- Planter**, potato, 6 inch beds
- Planter**, ridge till
- Planter**, runner opener
- Planter**, small vegetable seed
- Planter**, small vegetable seed on 8 inch high beds
- Planter**, sprig conventional
- Planter**, sprig, no-till
- Planter**, sprigs on beds
- Planter**, strip till
- Planter**, strip till, 22 inch
- Planter**, strip till, shallow subsoiler
- Planter**, strip till, subsoiler
- Planter**, transplanter, vegetable
- Planter**, transplanter, vegetable on 8 inch high beds
- Planter**, transplanter, vegetable, no-till
- Planter**, tree, mechanical transplanter
- Planting**, broadcast interseeder
- Planting**, broadcast seeder
- Planting**, hand 10 percent disturbed
- Planting**, hand 5 percent disturbed
- Planting**, manual
- Planting**, manual on 8 inch high beds
- Planting**, no-till manually
- Plastic hoop tunnel** installation 100 percent cover
- Plastic hoop tunnel** installation 50 percent cover
- Plastic hoop tunnel** installation 75 percent cover
- Plastic hoop tunnel** installation on beds 50 percent cover
- Plastic hoop tunnel** installation on beds 75 percent cover
- Plastic hoop tunnel** removal on beds
- Plastic hoop tunnel**, removal
- Plastic mulch applicator** 40 inch beds 100 percent cover
- Plastic mulch applicator** 40 inch beds 75 percent cover
- Plastic mulch applicator** 48 inch beds 100 percent cover
- Plastic mulch applicator** 48 inch beds 80 percent cover
- Plastic mulch applicator** 54 inch beds 100 percent cover
- Plastic mulch applicator** 54 inch beds 80 percent cover
- Plastic mulch applicator** 64 inch beds 100 percent cover
- Plastic mulch applicator** 64 inch beds 85 percent cover
- Plastic mulch applicator** 100 percent cover
- Plastic mulch applicator** 40 percent cover
- Plastic mulch applicator** 50 percent cover
- Plastic mulch applicator** 75 percent cover
- Plastic mulch**, 5 percent removal
- Plastic mulch**, 10 percent removal
- Plastic mulch**, 25 percent removal
- Plastic mulch**, 50 percent removal
- Plastic mulch**, remove all
- Plastic weed barrier** 40 inch beds 100 percent cover
- Plastic weed barrier** 40 inch beds 50 percent cover
- Plastic weed barrier** 40 inch beds 75 percent cover
- Plastic weed barrier applicator** 100 percent cover
- Plastic weed barrier applicator** 50 percent cover
- Plastic weed barrier applicator** 75 percent cover
- Plow, deep**, large, moldboard
- Plow, disk**
- Plow, moldboard**
- Plow, moldboard** 10 inch depth
- Plow, moldboard** 6-7 inch depth
- Plow, moldboard**, conservation
- Plow, moldboard**, up hill
- Plow, oxen** 12 inch ridge
- Plow, oxen** 18 inch ridge
- Plow, oxen** on 6 inch ridge
- Plow, oxen**, strip 30 percent disturbance
- Plow, oxen**, strip 60 percent disturbance
- Plow, reversible**
- Power mulcher** bed conditioner
- Pruning**

- Rake or windrower**
- Reel disk** vertical tiller
- Regrow**
- Remove Compost Sock**
- Remove Silt Fence**
- Remove Straw Bale**
- Residue conditioner**, coil tine harrow, rolling basket
- Residue removal by wind**
- Residue, row cleaner**
- Rice residue stomper**
- Ripper**, intra row
- Ripper**, intra row and furrow diker
- Road grader**
- Rodweeder**
- Rodweeder**, harrow, spike tooth
- Roller harrow**
- Roller**, corrugated packer
- Roller**, corrugated packer 6 by 16
- Roller**, crimp, cover crop
- Roller**, on beds
- Roller**, residue
- Roller**, residue incorporator
- Roller**, row shaper
- Roller**, smooth
- Rolling basket incorporator**
- Root rake**
- Rotary hoe**
- Rotary hoe**, on heavy soil
- Rotary hoe**, residue
- Rototiller**, field
- Rototiller**, field, add residue
- Rototiller**, on beds
- Rototiller**, row cultivation add residue
- Rototiller**, row cultivator
- Scalper**, tree
- Scarifier**
- Scraper/pan/grader**, clearing/cutting
- Seedbed conditioner**, coil tine harrow, rolling basket
- Seedbed conditioner**, coulter caddy, coil tine harrow
- Seedbed conditioner**, coulter caddy, coil tine harrow, rolling basket
- Seedbed conditioner**, coulter caddy, field cult, spike harrow
- Seedbed conditioner**, coulter caddy, rotary harrow
- Seedbed conditioner**, coulter caddy, rotary harrow, rolling basket
- Seedbed conditioner**, coulter caddy, spike harrow
- Seedbed conditioner**, coulter caddy, spike harrow, rolling basket
- Seedbed finisher**
- Seedbed finisher**, field cult, chop, spike harrow, rolling basket
- Seedbed finisher**, field cult, coil tine harrow, rolling basket
- Seedbed finisher**, field cultivator, mulch treader
- Seedbed finisher**, field cultivator, rotary harrow
- Seedbed finisher**, single disk, field cultivator, coil tine harrow, rolling basket
- Seedbed finisher**, single disk, rotary harrow
- Seedbed finisher**, single disk, field cultivator, coil tine harrow
- Seeder**, corrugated packer
- Seeder**, dormant, corrugated packer
- Seeder**, high density vegetable
- Shred residue**, 6 inch stubble
- Shred standing residue** in live cover crop
- Shredder**, flail or rotary
- Shredder**, flail or rotary, add other cover
- Shredder**, flail or rotary, filberts and pecans
- Shredder**, rotary mower
- Shredder**, rotary, regrow vegetation
- Shredder**, rotary, remove residue
- Slip plow** 48 to 60 inches deep
- Sod cutter**
- Sod installation**
- Spader**
- Spader**, shallow depth
- Spray**, glyphosate on resistant growing crop
- Sprayer**, backpack, kill vegetation
- Sprayer**, backpack, post emergence
- Sprayer**, defoliant
- Sprayer**, fungicide
- Sprayer**, fungicide and insecticide tank mix
- Sprayer**, growth regulator
- Sprayer**, insecticide post emergence
- Sprayer**, kill cover in growing crop
- Sprayer**, kill cover in growing vegetables

**Sprayer**, kill crop  
**Sprayer**, kill strips  
**Sprayer**, post emergence  
**Sprayer**, post emergence and fertilizer tank mix  
**Sprayer**, pre-emergence  
**Stalk chopper**, rolling  
**Stalk chopper**, rolling, light disturbance  
**Stalk chopper**, rolling, on ridgetill ridges  
**Stalk chopper**, rolling, strip  
**Stalk chopper**, rotary  
**Stalk chopper**, strip rotary  
**Stalk puller**  
**Stalk puller** high disturbance  
**Stalk slicer**  
**Stop Grazing**  
**Strip till bed conditioner**  
**Striptiller** w/ middlebuster on beds  
**Subsoil disk ripper**  
**Subsoil disk ripper**, coulter smooth, rolling basket  
**Subsoil disk ripper**, roller smooth  
**Subsoiler**  
**Subsoiler bedder** (ripper/hipper)  
**Subsoiler leveler**  
**Subsoiler ripper**, 24 to 40 inches deep  
**Subsoiler**, 12 foot spacing  
**Subsoiler**, in row  
**Subsoiler**, in row strip conditioner  
**Subsoiler**, in row strip conditioner, 40 inch row  
**Subsoiler**, inline heavy shanks with coulter caddy  
**Subsoiler**, inline with coulter caddy  
**Subsoiler**, rolling stalk chopper, roller, mulch treader  
**Subsoiler**, wide spacing  
**Subsoiler**; stalk chopper, rolling  
**Sweep plow** 20-40 inch wide  
**Sweep plow** wider than 40 inch w/ mulch treader  
**Sweep plow**, under bed  
**Sweep plow**, wider than 40 inches  
**Sweep**, single under row  
**Sweep**, single under row, regrow perennial  
**Tree spade**, holes left  
**Tree spade**, holes plugged  
**Water mulch**; off  
**Water mulch**; on  
**Weed control**, hoeing in row  
**Weed control**, manual hoe  
**Weed control**, string trimmer  
**Weeder**, finger weeder  
**Winter kill** annual crop