Agronomy Guide

Purdue University Cooperative Extension Service

SOILS (TILLAGE) **AY-280-W**

Managing Crop Residue with Farm Machinery

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Over 17 percent of Indiana's 12.5 million acres of cropland is eroding at a rate that is faster than what natural processes can replace. Research shows that this erosion can be greatly reduced by maintaining a crop residue cover on the soil surface of at least 30 percent after all tillage and planting operations are completed. This type of system is known as a conservation tillage system.

Conservation tillage is one of the most effective means of cropland erosion control. Uniformly distributed residue shields the soil surface from rainfall impact, thus reducing soil particle detachment and eventual erosion. The residue also creates small dams which slow the rate of runoff, allowing more time for water to infiltrate into the soil. A slower rate and reduced volume of runoff means less soil removed from the field.

Residue can also protect soil from the erosive forces of wind. To what extent, however, depends on the amount of residue present and its orientation (i.e. whether upright or flat). Standing residue is more effective than flattened residue in reducing wind erosion.

Several tillage systems, including chisel plow, disk, ridge-till, and no-till systems, can leave 30 percent residue cover or more after planting. However, the number of field operations must be limited. The number of field operations in a system has a greater impact on residue cover than the type of implement used. For example, when using a chisel or disk system in high yielding corn residue, two tillage operations will generally leave about a 30 percent cover. In high yielding soybean residue, however, no-till is the only system that will consistently leave 30 percent or greater cover.

This guide is intended to be a planning tool only. An ideal residue management program is presented beginning at harvest and proceeding through winter into the spring tillage and planting operations. Ranges are given with respect to how much residue cover remains after single operations of selected tillage machines. Remember, however, that these are general guidelines and actual percentages may vary. **For the most accurate estimation of crop residue levels, actual field measurements are recommended.**

For more information on crop residue management, contact your local USDA Natural Resources Conservation Service or Purdue University Cooperative Extension Service office.

Designing A Crop Residue Management Program

Residue After Harvest

The ideal residue management program for leaving as much residue as possible on the surface after planting begins at harvest. Combines should be adjusted to spread the residue uniformly over as much of the harvested swath as possible. This is usually not a problem for combines that handle 4-row corn heads or 15' or narrower grain tables. However, larger corn heads and grain tables make it difficult to spread the residue evenly over the entire width of the harvested swath. Therefore, chopper attachments (if present) should be adjusted to spread full width and the addition of a chaff spreader attached to the rear axle should be considered. Chaff spreaders are most effective for spreading wheat and soybean residue because a larger percentage of the harvested residue is handled by the combine's cleaning shoe.

Some makes of combines offer a spreader attachment in place of the chopper. While the spreader distributes the residue more uniformly than the chopper, more cover can actually be obtained with the chopper as the residue is chopped into smaller pieces before spreading. The spreader attachment, by design, spreads whole pieces of residue (soybean stems, wheat straw, whole corn stalks) and consequently does not cover as much of the surface. One drawback, however, is that small pieces of residue decompose quickly and are subject to movement by wind and water.

Residue cover following corn harvest is usually in the range of 75-90%. Low yields (e.g. <100 bu. corn and <30 bu. soybeans), however, may result in significantly lower levels of residue cover. Therefore, with residue management in mind, producers should be aware of residue cover levels after harvest. This will allow for planning of fall and spring tillage operations that will leave the desired levels of residue cover. **Refer to Agronomy Guide AY-269 "Estimating Corn and Soybean Residue Cover" for information on methods for estimating corn and soybean residue cover.**

Over-winter Losses

Over the winter months crop residues are decomposed by microorganisms. Warm, moist conditions favor high rates of decomposition. While the months of January and February are quite cold, a thin blanket of snow can actually insulate the surface enough to allow decomposition to take place. For Indiana, over-wintering residue cover losses can approach 40% but typically fall in the range of 15-25%. Field operations conducted prior to winter months can further reduce remaining residue levels. Residue that has been disturbed or buried by fall tillage or knife-type fertilizer applications is more susceptible to over-wintering and decomposition than undisturbed residue. Partially decomposed residue is easily broken and buried during spring tillage, further reducing its erosion control potential.

Producers should take over-wintering losses into account when planning tillage operations.

Tillage and Residue Loss

Ultimately, no-till systems leave the highest levels of residue cover. However, less than 30% of Indiana's cropland is no-tilled. Therefore, a wide variety of primary and secondary tillage implements are used on the remaining cropland. Table 1 summarizes the effects of tillage operations on residue cover. Note that there are two categories for crop residue, non-fragile and fragile. Non-fragile residues mainly include corn and small grains while fragile residues include soybeans, canola, and fall-seeded cover crops.

The numbers in Table 1 are provided for planning purposes, but whenever possible, producers should estimate residue cover after each pass with an implement to ensure that the desired level of residue cover is maintained.

Residue Management Strategies

(1) The number and intensity of tillage operations should be limited. In general, the number of passes can be as important as the type of tillage operation selected. Residue cover is also sensitive to depth and speed of equipment operation and to row spacing. When selecting values from the ranges in Table 1, consider the following general rules of thumb:

* Shallower operating depths can leave up to 15% more residue on the surface.
* Slower operating speeds tend to leave as much as 20% more residue on the surface.
* Straighter disk blade alignments and straighter chisel plow points and sweeps may leave as much as 20% more residue than curved or twisted counterparts.
* Under some conditions field cultivators and other finishing tools with field cultivator gangs may return as much as 20% of the residue incorporated by previous operations.

(2) Ultimately, no-till systems, where soil is only disturbed when a narrow seed slot is disturbed at planting, or modified versions of no-till such as zone- or strip-till, where only a narrow band several inches immediately adjacent to the seed slot is disturbed, will provide the highest level of residue cover. However, compaction, soil fertility, and other problems should be eliminated before beginning a no-till or related system to prevent potential yield reductions.

(3) Nitrogen management techniques should be changed. With higher levels of crop residue present, surface applied nitrogen will result in high volatilization rates. Therefore, nitrogen should be placed beneath the crop residue by either knifing or injection methods. Additionally, soils may be colder and wetter at planting, and starter nitrogen rates of 20 to 30 pounds per acre should be considered when planting corn.

(4) Planters and drills may require modifications (e.g. row cleaners or coulters) to ensure proper seed and fertilizer placement. The type and positioning of coulters and row cleaning and fertilizer attachments will affect residue levels, however, and the least aggressive units available for a given operation should be used.

(5) Cover crops such as rye, wheat, or hairy vetch should be considered, as they provide additional cover, particularly in low-residue crops such as soybeans or corn silage. In addition, cover crops can suppress weed growth, decrease additional nitrogen requirements, and aid in field moisture management.

Sample Residue Calculations

Following are two examples of how to use the numbers in Table 1. Remember that these numbers are provided for planning purposes only and that the percent residue cover remaining after tillage can vary due to operating speed, operating depth, and soil moisture conditions. Initial "After Harvest" residue numbers for percent flat residue amounts are determined from averages found on Figure 1.

Example #1

A farmer had 180 bu/A corn yield last year and wants to chisel plow with 4" twisted points in the fall.

Table 1. Influence of Various Field Operations on Surface Residue Cover Remaining.

Tillage and Planting Implements	Percent of residue remaining after each operation[1] Non-Fragile	Fragile
Moldboard Plow	0-10	0-5
Machines Which Fracture Soil		
Paratill/Paraplow	80-90	75-80
V-ripper/12-14" deep w/20" spacing	70-90	60-80
Chisel Plows		
Sweeps	70-85	50-60
Straight or spike points	60-80	40-60
Twisted points (3 or 4")	50-70	30-40
Combination Chisel Plows		
Coulter Chisel Plow with:		
Sweeps	60-80	40-50
Straight or spike points	50-70	30-40
Twisted points (3 or 4")	40-60	20-30
Disk Chisel Plow with:		
Sweeps	60-70	30-50
Straight or spike points	50-60	30-40
Twisted points (3 or 4")	30-50	20-30
Disk or Disk Harrows		
Tandem or Offset		
10" or greater blade spacing	25-50	10-25
9" or greater blade spacing	30-60	20-40
7-9" blade spacing	40-70	25-40
After harvest as primary tillage	70-80	40-50
Field Cultivators (including leveling devices)		
As primary tillage:		
Sweeps 12-20"	60-80	55-75
Sweeps or shovels 6-12"	35-75	50-70
Duckfoot points	80-90	60-75
Sweeps or shovels 6-12"	70-80	50-60
Duckfoot points	60-70	35-50
Finishing Tools		
Combination finishing tools with:		
Disks, shanks, and leveling attachment	50-70	30-50
Spring teeth and rolling baskets	70-90	50-70
Harrows:		
Springtooth (coil tine)	60-80	50-70
Spike tooth	70-90	60-80
Flex-tine tooth	75-90	70-85
Roller harrow (cultipacker)	60-80	50-70
Packer roller	90-95	90-95
Row Cultivators (30" and wider)		
Single sweep per row	75-90	55-70
Multiple sweeps per row	75-85	55-65
Finger wheel cultivator	65-75	50-60
Rolling disk cultivator	45-55	40-50
Ridge-till cultivator	20-40	5-25

Table 1. (cont'd)

Tillage and Planting Implements	Non-Fragile	Fragile
Unclassified Machines		
Anhydrous applicator	75-85	45-70
Anhydrous applicator with closing discs	60-75	30-50
Subsurface (injected) manure applicator	60-80	40-60
Rotary hoe	85-90	80-90
Drills		
Conventional w/ double-disc openers	85-95	75-85
No-till with following coulters		
Ripple or no coulter	85-95	70-85
Bubble or fluted/wavy (<1" wide)	80-85	65-85
Fluted/wavy (1" wide or greater)	75-80	60-80
Planters		
Conventional:		
Staggered double-disc openers	90-95	85-95
Non-staggered double-disc openers	85-95	75-85
No-till:		
Smooth, ripple or no coulter	85-90	75-90
Bubble or fluted/wavy (<1" wide)	75-90	70-85
Fluted/wavy (1" wide or greater)	65-85	55-80
Strip-till:		
2 or 3 fluted/wavy coulters	60-80	50-75
Row cleaning devices (5-10" bare strip)	60-80	50-60
Ridge-till (sweeps/double-discs/horizontal)	60-80	40-60
Climatic Effects		
Over-winter weathering:		
Following summer harvest (wheat/oats)	70-90	65-85
Following fall harvest	80-95	70-80

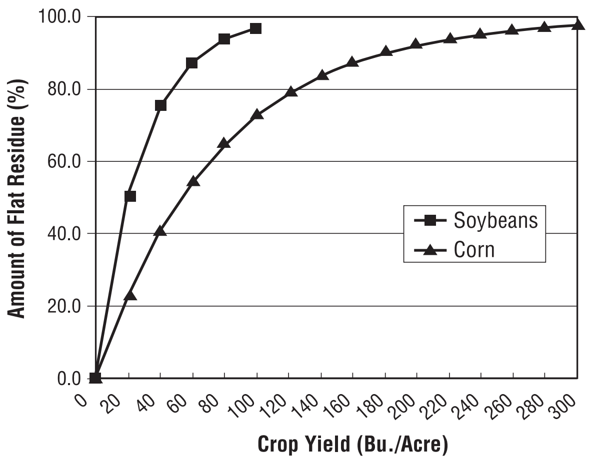
[1] Crop residues are generally classified as either non-fragile or fragile. Following is an abbreviated listing of crops common to Indiana that are classified into these categories:

Non-Fragile: Corn, Wheat, Rye, Oats, Alfalfa or legume hay, Cotton, Tobacco

Fragile: Soybeans, Canola, Rapeseed, Fall-seeded cover crops, Vegetables

In the spring, he will disk twice (tandem, 7-9" blade spacing) and field cultivate once (6" shovels). The new crop will be planted with a conventional planter with staggered double-disc openers. The winter months were considered mild (maximum decomposition). From Table 1, the following factors can be found for each operation. *Remember, there is no set rule for deciding which number to choose that lies within the listed ranges. The highest number in the range may represent “optimal” conditions (e.g. above average yields that result in high levels of residue cover) while the lowest number may represent “poor” conditions. A conservative general rule of thumb would be to pick the number that lies in the middle of the range.*

Figure 1. Residue Levels for Corn and Soybeans Based on Yield



Source: Stott, Alberts, and Weltz, 1995

Simply multiplying the factors together will give the percent residue cover after planting. For this example, the percent residue cover is equal to:

90% x 60% x 80% x 55% x 55% x 75% x 95% =
9.3 or 9% residue cover

This system would not qualify as a conservation tillage system since less than 30% residue cover is maintained after planting.

If spikes (or 2" straight points) are used instead of 4" twisted points, the percent residue cover would equal:

90% x 70% x 80% x 55% x 55% x 75% x 95% =
10.8 or 11% residue cover

Field Operation	Percent Residue Cover Remaining (Non-fragile, from Table 1)
After Harvest (high yield)	90%
Chisel Plow with 4" twisted points	60%
Over-winter (mild winter)	80%
Disk once	55%
Disk once (the second time)	55%
Field Cultivate once	75%
Plant	95%

Switching points did not significantly increase residue cover after planting since three secondary operations were still used. Switching points can make a difference, however, in systems where secondary operations are limited to one or two passes with less aggressive tools (e.g. field cultivate once only).

Example #2

A farmer had 45 bu/A soybeans last year and wants to no-till corn in the spring. He will apply anhydrous ammonia (with closing discs) in the spring and will plant with a no-till planter that has 1" wavy coulters. The winter was cold with little snowfall (minimum decomposition). The factors from Table 1 are as follows:

Percent residue cover after planting (calculated in the same fashion as example #1) would then equal 26% which is near the definition of a conservation tillage system. *Producers should remember that soybean residue is very fragile and that even some no-till systems can leave low levels of residue cover after planting.*

Field Operation	Percent Residue Cover Remaining (Fragile, from Table 1)
After Harvest (high yield)	80%
Over-winter (cold winter)	80%
Apply anhydrous ammonia	50%
Plant	80%

This method provides only rough estimates since the variables involved prevent accurate determination of residue cover. However, Table 1 can be helpful in comparing tillage and planting operations. Producers should always consider measuring residue cover after each pass with an implement to ensure that crop residue management objectives are being met.

Adapted from the United States Department of Agriculture - Soil Conservation Service and the Equipment Manufacturers Institute, *"Estimates of Residue Cover Remaining After Single Operation of Selected Tillage Machines"*, February 1992.

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