Residue Management & Cultural Practices

1. How far away can a falling raindrop splash soil particles?

2. How much residue cover is recommended for conservation tillage?

3. Name some of the factors that affect residue cover.

(Answers located on page 4.)

IOWA STATE UNIVERSITY
Extension and Outreach

Most experts believe the most effective conservation tillage practices leave at least 30 percent residue after planting. Residue burial or removal for biomass harvest should be tempered with conservation benefits.

When residue is removed, there is nothing to cushion the impact of raindrops, which dislodge soil particles and splash them up to 3 feet away. Such soil splash also seals the soil surface, reducing infiltration and increasing surface runoff. The runoff carries dislodged soil particles, and causes gullies and severe rill erosion. On fields with bare soil, these combined effects can lead to severe water erosion. Residue reduces water energy impact and dams water, increasing infiltration and reducing surface runoff velocity.

Residue Management & Cultural Practices

Crop residue is one of the most important conservation tillage factors for improving soil's physical and chemical properties. Residue helps reduce surface runoff and soil loss, conserving soil moisture and improving soil microorganism populations, soil organic matter content, and soil hydraulic/ physical properties. The effectiveness of residue is linked to the soil topography and soil slope, as well as other factors that impact the sustainability of the residue on the soil surface. Relatively flat fields can be protected against water erosion with 12 to 20 percent residue cover. Fields with steeper or longer slopes require at least 50 to 60 percent residue cover. The amount of residue to be left on the field depends on the site and the percentage of coverage that is agreed upon while preparing the conservation plan with the Natural Resources Conservation Service.

The Effects of Harvest on Residue

Harvest has a considerable impact on crop residue distribution and management. Uneven distribution of residue can create weed control problems and poor tillage due to residue plugging farm implements. Poor residue distribution also can hinder seedbed preparation when windrows and piles of residue plug planting equipment and create poor seed-to-soil contact. Excess residue over the seedbed can contribute to various degrees of plant injury that may result in poor stands and yields. The combine spreader and/ or chopper should be adjusted to increase spread uniformity.

Other Factors That Affect Residue Cover

Each of the following factors can affect residue cover:

- type of residue
- chopping versus leaving residue unchopped
- carryover of residue
- degree of grazing after harvest
- type of field operations
- soil moisture and weather conditions
- timing of field operations

The effect of each of these factors varies considerably. The fragility of the residue is important and will determine the amount of residue that will remain on the soil surface as it interacts with the other factors. Typical amounts of residue coverage left after harvest of various crops are listed in Table 1.

The Effects of Field Operations

The amount of residue cover left on the field is greatly affected by the type of operation and the implements that have been used (Table 2). Each implement's design, adjustments, and depth of soil disturbance, and to a lesser extent, its speed and the condition of the residue, will have an effect on the percentage of both fragile and non-fragile residue remaining on the soil surface.

Table 1. Typical crop residue cover after harvest of various crops.[1]

This is only an estimate of the percentage of residue cover. The actual values can vary significantly from these values. When a precise residue percentage is needed, field determination/measurement is advised.

Crop	Cover Percentage After Harvest
Non-fragile Residue	
Alfalfa or legume hay	
Immediately after cutting	35
After Growth	85
Barley[2]	75
Corn	
Harvested for grain	
60 to 120 bushels/acre yield	80
120 to 200 bushels/acre yield	95
Harvested for silage	15
Forage silage	
Immediately after cutting	35
After regrowth	85
Grain Sorghum	
Harvested for grain	75
Harvested for silage	15
Millet	70
Oats	80
Pasture	85
Popcorn	65
Rye[2]	75
Wheat[2]	
30 to 60 bushels/acre grain yield	50
60 to 100 bushels/acre grain yield	85
Fragile Residue	
Canola/Rapeseed	65
Dry edible beans	20
Dry peas	20
Lentils	20
Soybeans	70
Sunflowers	40
Vegetables	20

[1] Adapted and modified from "Conservation Tillage Systems and Management," MWPS-45, P. 40, 2nd Ed., 2000.

[2] Small grains harvested with a rotary combine or a combine with a straw chopper, or if the straw is cut into small pieces, should be considered fragile.

Table 2. Percentage of residue remaining on the soil surface following implement or field operation usage.[1]

Implement	Percentage of Residue Remaining: Non-Fragile Residue	Fragile Residue
Plows:		
Moldboard plow	0-10	0-5
Disk plow	10-20	5-15
Machines that fracture soil:		
Paratill/Paraplow	70-90*	60-85*
V Ripper/Subsoiler	60-80*	40-60*
Combination tools:		
Chisel-Subsoiler	50-70	40-50
Disk-Subsoiler	30-50	10-20
Chisel plows with:		
Sweeps	70-85	50-60
Straight spike points	35-75*	30-60*
Twisted points or shovels	25-65*	10-30*
Disk chisel plow with:		
Sweeps	60-70	30-50
Straight points or shovels	30-60*	25-40*
Twisted points or shovels	20-50*	5-30*
Disk harrows:		
Tandem or offset:		
Primary tillage	30-60	10-35*
Secondary tillage	40-70	25-40
Light tandem disk after harvest, before other tillage	70-80	40-50
Field Cultivators: (including leveling attachments)		
Used as primary tillage:		
Sweeps 12” to 20” wide	60-80	55-75
Sweeps or shovels 6” to 12” wide	35-75	50-70
Duckfoot points	35-60	30-55
Used as secondary tillage		
Sweeps 12” to 20” wide	80-90	60-75
Sweeps or shovels 6” to 12” wide	70-80	50-60
Duckfoot points	60-70	35-50
Finishing Tools:		
Combination finishing tools with:		
Disks, shanks, and leveling attachments	50-70	30-50
Spring teeth and rolling baskets	70-90	50-70
Harrows:		
Spring tooth (coil tine)	60-80	50-70
Spike tooth	70-90	60-80
Flex-tine tooth	75-90	70-85
Rotary tiller:		
Primary operation 6” deep	15-35	5-15
Secondary operation 3” deep	40-60	20-40
Strip tiller (12” tilled on 36” rows)	55-70*	40-55*

Implement	Percentage of Residue Remaining: Non-Fragile Residue	Fragile Residue
Row-crop planters:		
Conventional planters with:		
Runner openers	85-95	80-90
Staggered double disk openers	90-95	85-95
Double disk openers	85-95	75-85
Planters with:		
Smooth coulters	85-95	75-90
Ripple or bubble coulters	75-90	70-85
Fluted coulters	65-85	55-80
Strip-till planters with:		
2 or 3 fluted coulters	75-90	70-85
Row cleaning devices (8” to 14” wide bare strip using brushes, spikes, furrowing disks, or sweeps)	60-80	50-60
Ridge-till planter	40-60	20-40
Drills:		
Hoe opener drills	50-80	40-60
Semi-deep furrow drill or press drill (7” to 12” spacing)	70-90	50-80
Deep furrow drill with 12” spacing	60-80	50-80
Single disk opener drills	85-95*	75-85
Double disk opener drills	80-95*	60-80
Drills with the following attachments in residue:		
Smooth coulters	85-95	70-85
Ripple or bubble coulters	80-85	65-85
Fluted coulters	50-80*	40-70*
Row cultivators: (30” and wider row spacing)		
Single sweep per row	75-90	55-70
Multiple sweep per row	75-85	55-65
Ridge-till cultivator	20-40	5-25
Other Implements:		
Knife applicator with:		
Rigid shanks	75-85*	45-70*
With coulters	80-90*	50-75*
Coil shanks	70-80*	40-65*
With coulters	75-85*	45-70*
Closing disks	55-70*	30-50*
Manure injector/applicator with:		
Chisel or sweep injectors	25-65*	5-15*
Disk applicators	40-70*	15-45*
Coulter applicators	75-95*	60-80*
Rotary hoe	85-90	80-90
Stalk chopper or shredder	65-95*	60-95*
Climatic effects of over-winter weathering		
Fall harvested crops	80-100*	75-100*
Additional fall/winter weathering	85-95*	80-85*

[1] Adapted and modified from “Conservation Tillage Systems and Management, MidWest Plan Service Publications, MWPS-45, P.44-46, 2nd Ed., 2000.

*Values adjusted based on University of Nebraska research and field observations. When a precise residue percentage is needed, field determination is advised.

Table 2 summarizes the percentage of both fragile and non-fragile residues remaining after an operation, compared to the percentage of residue that was present before the operation. The estimate is based on factors such as plant characteristics (size and amount of leaves and stems), total amount of residue, density of plant materials, degree of residue decomposition when it is disturbed or exposed to the weather, and the actions of field implements. The actual percentage of cover can vary significantly from values calculated using Table 2.

The timing of the disturbance also affects the soil surface cover percentage. Fall operations such as tillage, fertilizer application or knifing, manure injection, grazing, and stalk shredding will result in less protective residue cover during winter and early spring. Although delaying some field operations until spring leaves residue undisturbed over the winter, residue will be partially decomposed. Therefore, spring operations leave less cover after planting than the same operations in the fall. Thus, simply shifting a field operation from fall to spring does not necessarily improve cover after planting in June when heavy rainfall can occur.

The Effect of Crop Rotation and Tillage Systems on Residue Cover

Crop rotation can have an influence on the success of conservation tillage practices, especially no-till and the distribution of plant residue from the previous crop. Long-term studies show that a corn-soybean rotation improves yield under no-till compared to continuous corn. Generally, no-till contributes to low soil temperature, which can contribute to potential yield reduction with continuous corn. This yield reduction is more evident on poorly drained soil, where no-till is often a disadvantage with in-row residue cover of 20 percent or more. A study from Ohio designed to separate the effects of crop residue and crop rotation indicates that poor performance of no-till corn following corn is more likely due to effects of the previous crop than the surface residue conditions that prevented early season warming and drying of soils.

Methods of Measuring Crop Residue

There are several acceptable methods for estimating crop residue. For every method, repeat measurements at several sites within each field and average them to ensure an acceptable estimate for the entire field.

Line-Transect Method:

This is the preferred method. It consists of counting the number of times a marked line intersects a piece of residue. Use a 100-foot tape measure (or a rope with marks spaced at 1-foot intervals). Stretch the tape between two stakes placed diagonally at a 45-degree angle from the direction of the crop rows (exclude end rows). Looking down from directly above the tape, count the number of times a mark intersects with crop residue. Make your judgment consistently at a point on only the left or right side of the mark to avoid over-counting residue. When done, the result converts directly into the percentage of crop residue remaining in that sample area. For example, if 38 of 100 marks intersect residue, then residue covers 38 percent. Record a minimum of five measurements, using areas that are typical of the field being measured. Average the estimates to obtain the most accurate overall assessment. (See Figure 1, above right.)

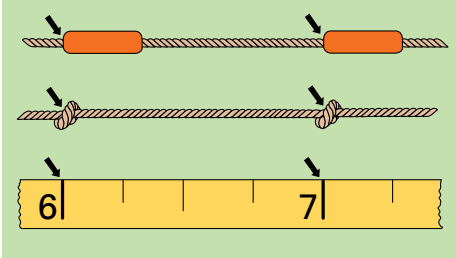

Figure 1. At each mark, consistently focus exactly on a single point on the same side of the measuring device, rather than on the entire mark.*

Meter Stick Method:

Place the meter stick on the soil. (A yardstick with metric marks can be used.) At each centimeter's mark evaluate the crop residue occurring along one edge of the meter stick and total those measurements. For example, if the total residue occurring along the meter stick was present at 35 centimeter marks, the percentage of residue remaining on the ground is 35 percent. Again, sample several areas of the field. Places for measurement can be determined randomly by throwing the meter stick several feet away through the air.

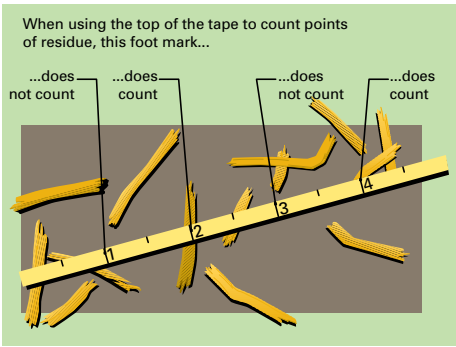

Figure 2. Count only the pieces of residue that are directly under the mark.*

Quiz Answers: 1. Up to 3 feet. 2.Experts generally suggest at least 30 percent, depending on soil topography and slope. 3. Type of residue, field operations, grazing, weather conditions, chopping, harvesting.

Photo Comparison Method:

Photos can provide an estimate by comparing field conditions to percentages in photos that show a known percentage of crop residues. To use a photo in the field, look straight down when comparing photos to the soil surface cover. The photo comparison method produces a quick estimate, but is less accurate than other methods.

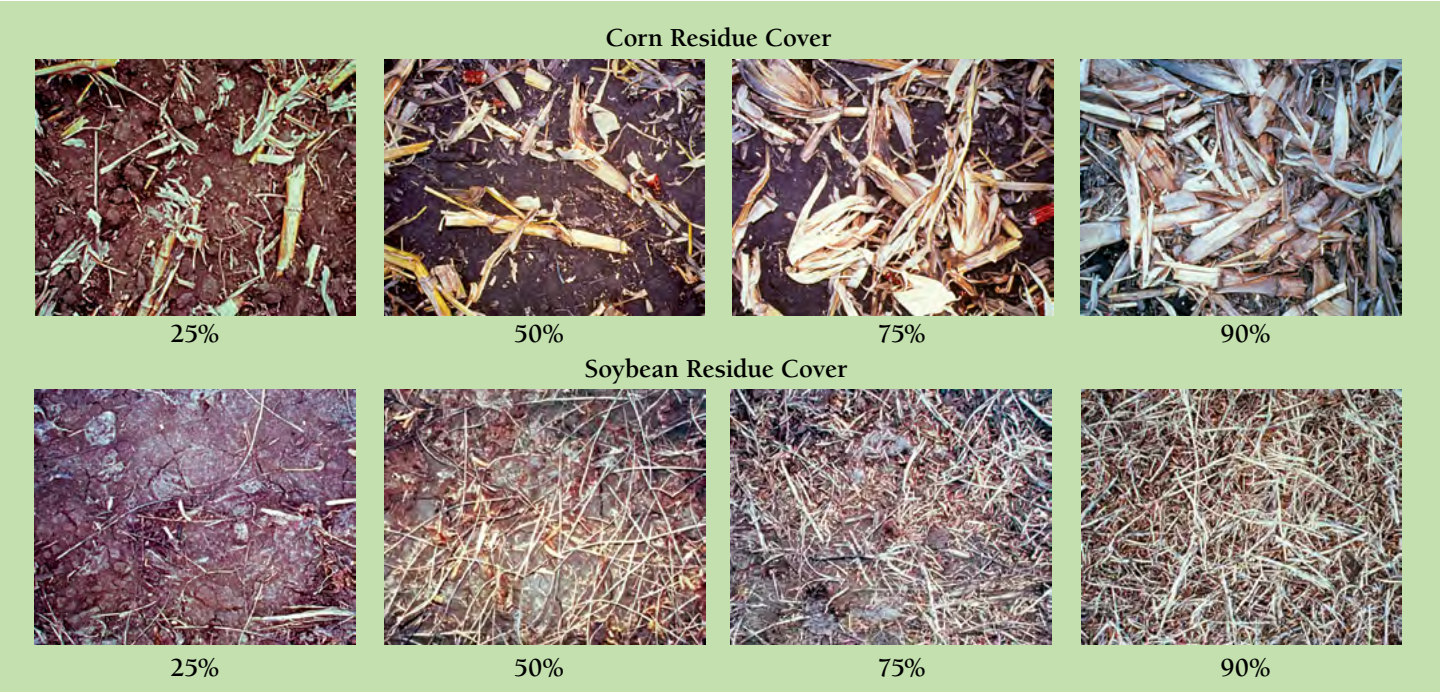

Figure 3. Photographs of corn and soybean residue cover percentages.*

Calculation Method:

Calculation is a good way to get a rough estimate of remaining residue without going to the field. Because there are many variables, however, such as weather and differences between individual operators of tillage equipment, it is less reliable. Residue percentage calculations remaining after different field operations using information from Table 2 are summarized in the following example:

*Adapted and modified from "Conservation Tillage Systems and Management," MWPS-45, Pages 36 - 39, 2nd Ed., 2000.)

Example of calculating residue losses from fall harvest to after planting (for corn): Determine the percent of the existing residue cover after harvest, and then multiply that percent by the percent of remaining residue after each following field operation.

Field Operation/Conditions	Residue Remaining After Each Operation	Final Residue Cover Percent
Harvest	0.95 x 100 =	95
Winter Decomposition (Weathering):	0.90 x 95 =	86
Spring Chiseling (Straight spike points):	0.55 x 86 =	47
Spring Disking (Tandem disk, secondary tillage):	0.55 x 47 =	26
Planting: (Double disk openers)	0.90 x 26 =	23

Estimated residue remaining after all operations are completed is: 23%

Residue Management & Cultural Practices

Resources Conservation Practices: Residue Management & Cultural Practices is published by Iowa State University Extension, with funding support from the USDA Natural Resources Conservation Service through Cooperative Agreement No. 74-6114-0-2.

Prepared by Mahdi M. Al-Kaisi, Assistant Professor, Department of Agronomy, and Mark Hanna, Extension Agricultural Engineer, Department of Agricultural and Biosystems Engineering. Edited by Tracy S. Petersen. Design by Jill Koch, CedarLeaf Design.

Visit the ISU Deparment of Agricultural and Biosystems Engineering Web site at http://www.ae.iastate.edu/ and the ISU Deparment of Agronomy Web site at http://www.agron.iastate.edu/.

This institution is an equal opportunity provider. For the full non-discrimination statement or accommodation inquiries, go to www.extension.iastate.edu/diversity/ext.

File: Agronomy 8-1

PM 1901a March 2002