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## G95-1135 Estimating Percent Residue Cover Using the Calculation Method

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# Estimating Percent Residue Cover Using the Calculation Method

This NebGuide describes how to use the calculation method to estimate the percent of the soil surface that will be covered with crop residue after using residue-disturbing implements and operations.

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Leaving crop residue on the soil surface is the easiest and most cost-effective method of reducing soil erosion. Research in Nebraska and other midwestern states found that leaving as little as 20 percent of the soil surface covered with crop residue can reduce soil erosion caused by rainfall and flowing water by one-half compared to residue-free conditions. Greater amounts of residue cover will further reduce erosion. (Refer to NebGuide 81-544, *Residue Management for Soil Erosion Control* for further details on the erosion process and the benefits of residue cover.)

Many conservation plans developed to meet conservation compliance provisions of the 1985 Food Security Act and the 1990 Food, Agriculture, Conservation, and Trade Act (Farm Bills), specify crop residue management, or residue left on the soil surface, as the primary erosion control method. Generally, the amount of cover required after planting ranges from 20 percent to 65 percent.

It is important to accurately determine percent residue cover to verify effective erosion control and compliance with conservation plan specifications. In these cases, the line-transect method should be used to obtain in-field measurements. (Refer to NebGuide 93-1133, *Estimating Percent Residue Cover Using the Line-Transect Method* for specific procedures.)

In some instances, such as for planning purposes, rough estimates of percent cover may be adequate. For example, it may be desirable to determine if eliminating a certain operation from a tillage and planting system is likely to result in adequate residue cover to meet the level called for in a conservation plan. The calculation method of estimating residue cover is useful for such a determination.

To use the calculation method, first determine or estimate the amount of residue cover present after harvest. Multiply this value by estimates of the percentage of cover that will remain following weathering, tillage, and any other residue-disturbing operations.

### Residue Cover After Harvest

The most accurate way to determine the amount of cover after harvest is by field measurements using the line-transect method or through observations using the photo-comparison method. If a more accurate determination is not possible, an average value can be used. *Table I* presents typical after-harvest percent residue cover values for various crops in Nebraska. Use these values with caution -- the actual amount of cover in a particular field can vary considerably depending on crop variety and yield, conditions throughout the growing season, and other factors. For all crops, the residue should be uniformly distributed at harvest, not left in windrows, clumps, or bunches.

### Factors Influencing the Amount of Residue Remaining

#### Fragile or Non-Fragile Residue

Crop residues are classified as fragile or non-fragile (*Table I*). This classification is based on plant characteristics (size and amount of leaves and stems), total amount of plant material produced, and ease of residue decomposition or breakdown when the residue is disturbed or exposed to the weather.

<b>Table I. Crop residue classification and typical percent residue cover after harvest of various crops in Nebraska. Use these values for estimation purposes only when the percent cover for a field cannot be more accurately determined.</b>	
<b>Crop</b>	<b>% Cover</b>
<i>Non-fragile residue</i>	
Alfalfa	85
Barley*	85
<i>Corn</i>	
<i>Harvested for grain</i>	
60 to 120 bu/ac grain yield	80
120 to 200 bu/ac grain yield	95
<i>Harvested for silage</i>	
Forage Silage	15
Grain Sorghum	75
Hay crops	85
Millet	70
Oats*	80
Pasture	85
Popcorn	70
Rye*	85

<i>Wheat*</i>	
30 to 60 bu/ac grain yield	50
60 to 100 bu/ac grain yield	85
<b><i>Fragile residue</i></b>	
Canola/Rapeseed	70
Dry edible beans	15
Dry peas	20
Potatoes	15
Soybeans	70
Sugarbeets	15
Sunflowers	40
Vegetables	30
*For small grains, if a rotary combine or a combine with a straw chopper is used, or if the straw is otherwise cut into small pieces, consider the residue to be fragile.	

### **Residue-disturbing operations**

Estimates of the percentage of residue cover remaining after various residue-disturbing operations are listed in *Table II*. For a given implement, the actual amount of residue remaining will be influenced by implement design, adjustments, speed, depth of soil disturbance, previous residue disturbance, and soil and residue condition. The ranges of values given for both fragile and non-fragile types of residue account for some of these factors.

Be conservative and use your judgement when selecting values from the table. Do not use all high values; the result is usually overestimation of final cover. This is especially true on land designated as highly erodible. For these areas, values near the lower end of the range usually result in better estimates of actual cover. However, if all implements are designed, adjusted, and operated with the specific goal of preserving residue cover, values near the middle or upper end of the range may be appropriate.

### **Moisture and climate**

Biological processes cause a general deterioration of residue condition. Moisture and warmer temperatures increase the rate at which this occurs.

One way that residue cover is affected by moisture and climate is an actual reduction of percent cover due to decomposition or decay of the residue, particularly the leaves and small pieces. In a study of soybean residue in southeast Missouri, a 31 percent loss of cover occurred between measurements taken after harvest and again before spring field operations. Approximately 25 inches of rainfall was received between these two measurements. In northwest Missouri, with cooler temperatures and about eight inches of rainfall during the same time period, losses averaged 12 percent. Conditions in southeast Nebraska generally are similar to those in northwest Missouri, and some actual residue cover loss is likely over the winter. However, in most of Nebraska, overwinter losses do not appear to be a significant factor. For example, in a northeast Nebraska study, the amount of soybean residue cover was comparable both after harvest and in the following spring.

Even though actual decreases in percent cover may be minimal, with exposure to the weather, residue becomes more fragile over time. This is most pronounced for residue that has been tilled or otherwise disturbed, but it also occurs with undisturbed residue. Because of less annual precipitation, this change takes place more slowly in western Nebraska than in the eastern part of the state.

## Timing of operations

Weathering and when the residue-disturbing operations are performed are closely related. If residue is disturbed in the fall by grazing, tillage, stalk chopping, or knifing-in fertilizer, subsequent spring operations reduce cover more than if all operations are conducted in the spring. This is because fall tillage and knifing operations cut or break the residue into smaller pieces, mix soil and residue, and speed overwinter weathering, thus making the residue more susceptible to decomposition and burial in the spring. University of Nebraska research showed that for the same sequence of field operations used in corn residue, residue cover measured after planting averaged 12 percent less when one or more operations were conducted in the fall, compared to performing all operations in the spring. For fall operations, use values towards the lower end of the ranges in *Table II*, or include an additional weathering reduction factor for fall operations, also listed in *Table II*.

In contrast, when operations are conducted with little elapsed time between them, less reduction of residue occurs. In these cases, values near the upper end of the range are generally appropriate. For example, when disking and field cultivating on the same day, the field cultivator may cause little additional loss of cover; it simply redistributes the residue that is on the soil surface. Under certain conditions, the field cultivator may also bring buried, coarse residue to the surface, resulting in a slight increase in cover, perhaps up to 5 percentage points. However, if there are more than a few days and it rains between disking and field cultivation, field cultivation generally results in reduced levels of cover.

A winter wheat/fallow rotation illustrates the combined effects of weathering and timing of tillage operations. Shortly after harvest, wheat residue often appears quite resistant to breakup and burial by tillage. But, by late the next summer at the end of the fallow period, the residue is quite fragile. Percent residue cover is likely to be less following a tillage operation near the end of a fallow period than what it would be following the same tillage operation done shortly after harvest. However, when additional operations are conducted, greater cover reductions will typically occur where tillage was first done shortly after harvest and the disturbed residue was exposed to the weather, compared to where the residue remained undisturbed during much of the fallow period and operations were delayed until near the end of the fallow period.

Use values at or near the upper end of the ranges listed in *Table II* when performing an operation within two or three days of the previous operation. Use values near the middle of the range if a week or more elapses between operations, especially if more than about one-half inch of precipitation or irrigation also occurs. Use values near the lower end of the ranges if conducting operations over a month apart.

## Chopping or shredding of residue

Chopping or shredding the residue may reduce the amount of cover. In University of Nebraska research on corn residue, tillage and planting systems that included a stalk chopping operation had an average of 22 percent less cover after planting than when the residue was not chopped. Although percent cover appeared to increase immediately after chopping because the residue had been cut into smaller pieces and was redistributed, the chopped residue deteriorated more from the weather and subsequent field operations than non-chopped residue. If the residue is chopped, this additional reduction needs to be included in the calculations to estimate the amount of cover that will remain.

For small grains, if a rotary combine or a combine with a straw chopper is used, the residue should be considered fragile. In these cases, use the values in *Table II* that are for fragile residue.

## Livestock grazing

Livestock grazing will reduce the amount of residue cover. The amount of reduction depends on stocking density (number of animals per acre), size of the animals, length of the grazing period, whether the residue is from irrigated or dryland crops, how much ear drop or other losses occurred during harvest, how much supplemental feed is supplied, and weather conditions. *Table II* presents two formulas that can be used to

estimate the impacts of grazing on residue cover.

Although estimates of cover reduction can be used, the best procedure for grazed residue is to use the line-transect method to measure the percent cover after the grazing period. This value can then be used for the calculations instead of percent cover after harvest.

### Residue cover carry-over

Under certain conditions, residue cover may remain on the soil surface for more than one cropping year. Carry-over is most likely to occur under dry climatic conditions when residue that is classified as non-fragile has received only minimal disturbance, such as with no-till planting. In a long-term experiment using a grain sorghum/soybean rotation, residue cover measured after planting grain sorghum averaged approximately 15 percentage points less for a no-till planting system with row cultivation than no-till without cultivation. Some grain sorghum residue remained on the soil surface during the year that soybeans were grown and was also present the following spring. However, residue cover carry-over is highly variable, and generally should not be relied on to provide significant amounts of cover.

### Using the Calculation Method

An approximation of the percent residue cover after planting can be obtained by multiplying the percent residue cover after harvest by the appropriate values from *Table II* for weathering and for each residue-disturbing operation that is conducted or planned.

Selecting appropriate values to use in the calculation method is a key to obtaining reasonably accurate results. All operations and other factors that affect residue cover need to be accounted for. Think in terms of a complete sequence of operations. For each operation, evaluate how the residue will be affected by both prior and subsequent operations and by weathering.

### Examples

The following examples illustrate how to use information from *Table II* to estimate residue cover by the calculation method.

Assume that a tillage and planting system used in a field of irrigated corn residue in southeast Nebraska consists of three field operations:

1. knife application of anhydrous ammonia in the fall;
2. tandem disking in the spring; and
3. planting soon after disking using a conventional planter with double-disk openers and no coulters.

$$\begin{array}{rclclclclcl}
 95\% & \times & & 0.75 & \times & & 0.90 & \times & & 0.60 & \times & & 0.95 & = & & \\
 \text{initial} & & & \text{knife} & & & \text{winter} & & & \text{disk} & & & \text{planter} & & & \\
 \text{cover} & & & \text{applicator} & & & \text{weathering} & & & & & & & & & 
 \end{array}$$

Using the same tillage and planting system in soybean residue would result in only about 9 percent cover, which is not enough for effective erosion control.

$$\begin{array}{rclclclclcl}
 70\% & \times & & 0.45 & \times & & 0.85 & \times & & 0.40 & \times & & 0.85 & = & & \\
 \text{initial} & & & \text{knife} & & & \text{winter} & & & \text{disk} & & & \text{planter} & & & \\
 \text{cover} & & & \text{applicator} & & & \text{weathering} & & & & & & & & & 
 \end{array}$$

If the corn residue example was changed to dryland production on highly erodible land in northeast Nebraska, and rainfall occurred between the disking and planting operations, less than 20 percent cover would remain after planting.

$$\begin{array}{ccccccccc}
 80\% & \times & 0.75 & \times & 0.99 & \times & 0.35 & \times & 0.85 & = & \\
 \text{initial} & & \text{knife} & & \text{winter} & & \text{disk} & & \text{planter} & & \\
 \text{cover} & & \text{applicator} & & \text{weathering} & & & & & & \\
 \end{array}$$

Consider the calculation method to be only a rough estimate since the variables involved prevent accurate determination of percent residue cover. However, this method can be useful in residue management planning by offering a general idea of how much residue cover will remain after a specific sequence of operations. There are also computer programs available to predict percent residue cover. However, these programs use the calculation method and average values for residue cover reduction, and as such should be used only when a rough estimate is satisfactory.

<b>Table II. Estimated percentage of residue remaining on the soil surface after specific implements and field operations.<sup>1</sup> (Change to decimal value before multiplying. Example: 90% is changed to 0.90.)</b>		
<b>Implement</b>	<b>Percentage of Residue Remaining</b>	
	<b>Non-Fragile Residue</b>	<b>Fragile Residue</b>
<b>Plows:</b>		
Moldboard plow	0-10	0-5
Disk plow	10-20	5-15
<b>Machines that fracture soil:</b>		
Paratill/Paraplow	70-90*	60-85*
V ripper/subsoiler (12" to 14" deep; 20" shank spacing)	60-80*	40-60*
<b>Combination tools:</b>		
Chisel-subsoiler	50-70	40-50
Disk-subsoiler	30-50	10-20
<b>Chisel plows with:</b>		
Sweeps	70-85	50-60
Straight spike points	35-75*	30-60*
Twisted points or shovels	25-65*	10-30*
<b>Combination chisel plows:</b>		
<i>Coulter chisel plows with:</i>		
Sweeps	60-80	40-50
Straight spike points	35-70*	25-40*
Twisted points or shovels	25-60*	5-30*
<i>Disk chisel plows with:</i>		
Sweeps	60-70	30-50

Straight spike points	30-60*	25-40*
Twisted points or shovels	20-50*	5-30*
<b>Undercutters:</b>		
<i>Stubble-mulch sweeps or blade plows with:</i>		
V-blades greater than 30" wide	75-95*	60-80*
with mulch treader attached	60-90*	45-80*
V-blades 20" to 30" wide	70-90*	50-75*
with mulch treader attached	55-85*	40-70*
<b>Disks:</b>		
<i>Tandem or offset</i>		
Heavy plowing	25-50	10-25
Primary tillage	30-60	20-40
Secondary tillage	40-70	25-40
Light tandem disk after harvest, before other tillage	70-80	40-50
<i>One-way disk with:</i>		
12" to 16" diameter blades	40-50	20-40
18" to 30" diameter blades	20-40	10-30
Single disk gang	50-70	40-60
<b>Field cultivators (including leveling attachments):</b>		
<i>Used as primary tillage:</i>		
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
<i>Used as secondary tillage:</i>		
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
<b>Finishing tools:</b>		
<i>Combination finishing tools with:</i>		
Disks, shanks, and leveling attachments	50-70	30-50
Spring teeth and rolling basket	70-90	50-70
<i>Harrows:</i>		
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
<b>Rotary tiller:</b>		
Primary operation 6" deep	15-35	5-15
Secondary operation 3" deep	40-60	20-40
Strip tiller (12" tilled on 40" rows)	60-75	50-60
<b>Rodweeders:</b>		
Plain rotary rod	80-90	50-60
Rotary rod with semi-chisels or shovels	70-80	60-70
<b>Row-crop planters:</b>		
<i>Conventional planters with:</i>		
Runner openers	85-95	80-90
Staggered double-disk openers	90-95	85-95
Double-disk openers	85-95	75-85
<i>Planters with:</i>		
Smooth coulters	85-95	75-90
Ripple or bubble coulters	75-90	70-85
Fluted coulters	65-85	55-80
<i>Strip-till planters with:</i>		
2 or 3 fluted coulters	60-80	50-75
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
<b>Drills:</b>		
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
<b>Drills with the following attachments used in residue laying on the soil surface:</b>		
Smooth coulters	65-85	50-70
Ripple or bubble coulters	60-75	45-65
Fluted coulters	50-70*	35-60*
<b>Drills with the following attachments used in standing stubble:</b>		
Smooth coulters	85-95	70-85
Ripple or bubble coulters	80-85	65-85
Fluted coulters	50-80*	40-70*

<b>Air seeders:</b>		
<i>(Refer to appropriate field cultivator or chisel plow depending on the type of ground-engaging device used.)</i>		
<b>Air drills:</b>		
<i>(Refer to corresponding type of drill opener.)</i>		
<b>Row cultivators: (30" and wider)</b>		
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
<b>Unclassified machines:</b>		
Knife applicator	75-85	45-70
Knife applicator with closing disks	60-75	30-50
Subsurface manure applicator	50-80*	40-60
Rotary hoe	85-90	80-90
Bedders, listers, and hippers	15-30	5-20
Furrow diker	85-95	75-85
Mulch treader	70-85	60-75
Stalk chopper*	65-95*	60-95*
<b>Climatic effects of overwinter weathering:</b>		
Summer harvested crops	70-90	65-90*
Fall harvested crops	80-100*	75-100*
Fall operations (additional weathering)*	85-95*	80-95*
Weathering losses are highly dependent on precipitation and temperature. In winters with long periods of snow cover and frozen conditions, weathering may reduce residue levels only slightly. In warmer winters without much snow or during wet years, weathering losses may reduce residue levels significantly.		
<b>Grazing impacts:</b>		
Estimate reduction of residue cover for either fragile or non-fragile residue at 15 percent per 1,000 pound cow per acre per month, or 0.5 percent per cow per acre per day. Use the following formulas to estimate residue cover reduction due to grazing and the percentage of residue remaining factor.		
Percent Grazing Reduction =	$(0.5) \times (\text{number of animals}) \times (\text{average animal weight in pounds}) \times (\text{number of days grazed}) \div (\text{number of acres grazed}) \times 1000$	
Percentage of Residue = Remaining Factor	$(100 - \text{Percent Grazing Reduction})$	
<small><sup>1</sup>Adapted from the pamphlet "Estimates of Residue Cover Remaining After Single Operation of Selected Tillage Machines," published by the Soil Conservation Service and Equipment Manufacturers Institute, February 1992. *Values adjusted based on University of Nebraska research and field observations.</small>		

## **Related publications:**

NebGuide G81-544, *Residue Management for Soil Erosion Control*

NebGuide G95-1132, *Estimating Percent Residue Cover*

NebGuide G93-1133, *Estimating Percent Residue Cover Using the Line-Transect Method*

NebGuide G95-1134, *Estimating Percent Residue Cover Using the Photo Comparison Method*

Extension Circular, EC 92-128, *Estimating Winter Wheat Residue Cover* NRCS Publication NE-MP-10, *Crop Residue Estimator*

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