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Tillage and Crop Residue Management

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One heavy rain on a sloping field that has just been tilled can remove the equivalent of 50 tons of topsoil per acre. In just a matter of minutes, the work of hundreds of years of natural soil formation can be totally wiped out. That land's productivity would not likely be restored within the life span of anyone living at the time.
Topsoil lost by erosion is not only a loss to the land owner; it also creates problems where it is deposited. It covers crops in low areas, fills road ditches, clogs drains and covers roads. It muddies streams and leaves a slimy layer of silt on the stream bed. Gravel beds and rocks which serve as habitat for many of the water-dwelling organisms are covered with mud and the habitats destroyed.

Tillage

Perhaps the single most important factor contributing to erosion of sloping cropland is tillage. Clearing the land exposes the soil to the actions of weather. Each time the land is tilled, this exposure is repeated which increases the chance of soil loss by erosion. The amount of soil erosion that occurs depends on:

1)The kind of tillage, or the particular tillage implement being used.
2)The amount of tillage, or the number of times a particular implement or combination of implements is used on a piece of land within a year's time.
3)The direction of tillage operations in relation to the slope of the land.
4)The timing of tillage, or the time of year and how long the land will be left bare until a crop grows large enough to provide cover.

What Kind

The most effective tillage system for controlling soil erosion while producing grain crops on sloping land is no-till. Soil disturbance is limited to a narrow slit which serves as the seedbed when the crop is planted. The remainder of the soil surface should be covered with a good mulch of small grain stubble, cover crop or the residue from the previous crop. This mulch serves to reduce the impact of raindrops and slows the movement of water across the soil surface. Less soil is detached by the falling raindrops and the slower moving water carries less sediment and has more time to soak into the soil. The soil itself is more stable since it hasn't been broken loose by tillage. Also, natural channels left in the soil by decaying plant roots and soil organisms allow the water to penetrate more easily. The result is that more of the water moves into the soil instead of running off. The water that does run off contains very few plant nutrients and soil particles.
Many experiments have been conducted to evaluate the effectiveness of no-till in controlling soil erosion. Table 1 shows the results of one experiment which was done in southern Illinois at the Dixon Springs Agricultural Center. Similar results have been obtained from studies conducted in other states.

Table 1.--Effect of no-till vs. conventional tillage on soil loss in southern Illinois.[1]

Tillage System	**Soil Loss[2](tons/A/yr)**	
	5% Slope	**9% Slope**
Conventional Tillage, wheat and corn double-cropped	3.04	8.42
No-Till, wheat and corn double-cropped	0.34	0.54
No-Till, continuous corn	0.25	0.36

[1] *L. E. Gard. Ill. Agr. Exp. Sta. DSCA 1, April 1973*
[2] *Average of 4 years (1969-72)*

If no-till is best for erosion control, what is at the other extreme? Most will agree it is the use of a moldboard plow and a disk or other implement to pulverize the soil surface. This is generally what is called "conventional" tillage. This system effectively reduces surface mulch to zero. The finely pulverized surface soil is easily detached by raindrops and becomes suspended in water. At the same time, soil pores become clogged with the suspended soil particles. The result is more soil-laden water moving off the land. Soil, water and fertility are lost from the land and streams are polluted.
This kind of tillage is seldom justified on sloping land susceptible to erosion. However, there are situations where no-till should not be used either. When special weed problems, certain soil conditions or farmer preference rule out no-till, there are reduced-tillage systems that can be used. Certain tillage implements such as rippers and chisel plows break up the soil but leave most of the residue on the surface. This, combined with less disking or other types of soil mixing, can reduce erosion rates by 50 percent.

How Much
The amount of tillage is almost as important as what kind of implement is used. For example, chisel plowing and disking is an effective minimum tillage system for erosion control. However, if two or three diskings are used, crop residue is buried and the soil is left loose and smooth and just ready to wash away.
Tillage should only be enough to control weeds and provide good conditions for planting the crop. More than this simply wastes money and time and increases the risk of soil erosion.

What Direction
The direction of tillage operations in relation to slope is critical in limiting soil erosion. The erosion potential associated with any type of tillage system can be significantly decreased by working across the slope rather than up and down the slope. In many cases, this is simply a matter of planning ahead. Contour tillage and strip cropping systems are more involved, but many farmers are using them to effectively reduce soil erosion.

When
The timing of tillage operations is also important in reducing soil erosion. Many farmers prefer to do their major tillage operations in the fall for the following reasons: better weed, insect and disease control; good weather conditions; and reduced workload at planting time. The problem is that fall tillage can leave the soil bare and open to soil erosion during the time that rainfall is likely to be greatest. You can minimize this problem by using cover crops and implements such as rippers or chisel plows which break up the soil but leave most of the previous crop's residue on the surface. All tillage operations should be done across the slope as much as is practical and the soil left rough and porous. Disking and other seedbed preparing tillage should not be done until just before planting.

Crop Residue Management
Using residue from the previous crop to reduce erosion has already been mentioned several times as it relates to tillage. However, crop residue management is so important that it needs to be considered separately. In addition to reducing erosion, crop residues increase the soil's water holding capacity and rate of water infiltration and decrease its water evaporation rate. The benefits provided by crop residues are directly related to the percentage of soil surface that is covered. More cover equals better protection. Crop residues are most effective when left evenly distributed on the soil surface. Some combines do a good job of spreading the residue as the crop is being harvested. These are especially useful with soybeans since it is almost impossible to spread the residue after harvest. With small grain crops such as

wheat, most of the residue is in the stubble which is already evenly distributed. Corn stubble needs to be shredded with a rotary mower to be most effective.

The amount of residue left behind after a crop is harvested depends on the particular crop grown and the growing conditions. For example, an average corn crop might produce 6,000 pounds of residue (stalks, leaves and cobs) per acre. However, under adverse conditions such as drought, the residue might only be half as much. Typical amounts of residue produced by other crops in pounds per acre are: rye--4,500, wheat--4,000, hairy vetch--4,000, and soybeans--3,000.[1] Soybeans alone do not produce enough residue to provide adequate soil protection over the winter, but it is much better than no residue at all. The combined residues produced by double-cropped wheat and no-till soybeans should amount to about 5,000 pounds per acre and provide excellent soil erosion protection.

The amount of crop residue decreases with time as decomposition takes place. The residues of certain crops such as corn, wheat and rye are much more persistent than others. If left on the soil surface, these residues continue to provide protection from soil erosion for at least a year. Under continuous no-till conditions, they tend to accumulate for several years. Soybean residue is probably the least persistent of the crops grown in Kentucky. Hairy vetch which is grown as a winter legume cover crop is intermediate in persistence. However, because it is produced in the spring, it provides excellent cover for no-till corn during the summer.

The amount of residue on the soil surface is also reduced when any kind of tillage is done and how much reduction occurs depends on the kind of tillage. Turn-plowing buries most of the crop residue and leaves the soil surface almost totally bare. Chisel plowing leaves 70 to 90 percent of residues on the surface. Chiseling plus one disking reduces residue on the surface by one-third. No-till planting leaves almost all of the residue on the soil surface.

[1]R.L. Blevins. Cover Crops and Crop Residues, Soil Science News & Views, Univ. of Ky. Coll. of Ag., Dept. of Agronomy, Vol. 2, No. 9, Sept. 1981.