ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

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Soil Management To Protect Water Quality

Reduced Tillage Practices For Soil Management

Tillage has been defined as any mechanical, soil-stirring action carried out for the purpose of nurturing crops. The benefits of tillage are many. In fact, some tillage is absolutely essential for certain soil amendments. Contrary to previous beliefs, much land is over-tilled, and this can lead to excessive erosion. During recent years, interest in avoiding unnecessary tillage for labor, energy, time, moisture, and soil conservation benefits has increased tremendously.

The effectiveness of tillage systems in reducing soil erosion depends on soil, climatic, and topographic conditions. Erosion can be greatly reduced, however, by simply adopting tillage practices which limit the intensity of soil disturbance and leave more of the previous crop's residues (stalks, leaves, etc.) on the surface.

Types Of Reduced Tillage Practices

Reduced tillage includes a variety of tillage practices that conserve soil and water and leave residue on the surface. In the list that follows, reduced tillage systems are defined in relation to conventional tillage.

Conventional Tillage: Seedbed preparation using cultivation instruments such as harrows, moldboard plows, offset harrows, subsoilers, and rippers. Conventional tillage methods, involving extensive seedbed preparation, cause the greatest soil disturbance and leave little plant residues on the surface.

Chiseling And Subsoiling: Deep tillage to shatter compacted soil layers or traffic pans. Chiseling and subsoiling permits more effective development of plant roots, increases water infiltration rates, and reduces runoff. This practice is most effective on sandy soils with traffic pans.

Conservation Tillage: Any form of minimum or reduced tillage, where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture. After planting, at least 30 percent of the soil surface remains covered by residue to reduce soil erosion by water.

Minimum Tillage: A cultivation operation whereby soil is disturbed as little as possible to produce a crop. Mulch residue from the previous crop is left on the soil surface which aids in retarding weed growth, conserving moisture, and controlling erosion.

No-Till, Zero Tillage, Slot Planting: A form of minimum tillage where a slot is opened in the soil only sufficiently deep and wide to properly deposit and cover seeds. This is a once-over crop planting system where the seed is planted in a slot created with a coulter in an otherwise undisturbed soil surface. This system makes maximum use of crop residue.

Slot planting can also be used to plant row crops in sod without plowing. Where growing season and soil water allow, row crops can be slot planted in a cover crop, in standing small grain, or in the stubble of already harvested small grain, allowing for double cropping.

Ridge Tillage: A method of preparing the seedbed and planting in the same operation on a preformed ridge remaining from the previous year's crop. The soil is left undisturbed before planting. Ridge tillage differs from no-till planting in that some cultivation is required during the growing season to form the ridge for the following year's crop.

The major advantage of ridge-planting is that it both reduces erosion and adapts well to poorly drained soils. Because the ridges provide drainage and are not covered with residue, the soil dries quickly. That is why ridge-planting can work well on poorly drained soil.

Strip Tillage: A method of preparing the seedbed and planting on a strip 2 to 8 inches wide and 2 to 4 inches deep in the row area. The soil is left undisturbed before planting. A conventional planter may be used. Strip tillage differs from no-till planting in that there is more soil disturbance in the row. In some cases the prepared strip may be wider than 8 inches, but the wider the strip the greater the erosion hazard.

Mulch Tillage: Disturbance of the entire soil surface by tillage before planting. Tillage tools such as chisels, field cultivators, disks, sweeps, or blades are used. At least 30 percent of the surface must be covered by residue after planting to qualify as conservation tillage.

Managing Crop Residues With Reduced Tillage

Crop residue, which protects the soil from rainfall and reduces the velocity of runoff, is the key to erosion control with minimum tillage. Minimum tillage is often practiced in combination with multiple cropping where the second crop is planted in the residue of the first crop. This residue acts as a mulch to conserve moisture and protect the soil.

In addition to protecting the soil and reducing the velocity of runoff, crop residues also increase water infiltration, thus eliminating runoff from small storms and reducing it from all storms. Crop residues provide the organic materials that through decay become the soil's humus. This humus binds particles together, improves structure, and increases aggregate stability and water-holding capacity. A pound of humus is said to hold seven and one-half times as much total moisture as a pound of sandy loam soil and to provide three and one-half times the plant-available water. Thus, soil organic matter not only tends to hold soil particles in place, preventing them from becoming silt in waterways, it also provides for more water storage in the soil, leaving less water to carry away precious soil in runoff.

Residue is measured as a percentage of surface cover. For example, "40 percent surface cover" means that residue covers 40 percent of the ground. And, with this percentage of cover, the amount of erosion is roughly half of that on land with no residue cover.

Estimating Residue. As Table 1 illustrates, every tillage operation you perform reduces the remaining cover somewhat. The tillage practices you select should be such that there is at least 30 percent residue cover on your fields after planting. Some conservation compliance plans require 40 to 50 percent residue on the soil surface.

You can use this table to figure the amount of residue cover remaining after your tillage and planting operations. Simply multiply the percentages of each operation you plan to use. For example, following corn you plan to use three operations: anhydrous application followed by disking (tandem and shallow) and planting. To figure the final residue cover you can expect, start with losses without tillage. Take 0.95 (initial cover corn) x 0.90 (over-winter losses) = 0.85 (expected spring residue). Then multiply: 0.85 (expected spring residue) x 0.80 (anhydrous application) x 0.70 (disking) x 0.90 (planting) = 43 percent expected residue cover.

Table 1. Estimating Crop Residue.

	Percent Residue Cover	
Tillage Practice	Soybeans	Corn
Over-winter residue decomposition	70 to 80	80 to 90
After harvest residues	80 to 90	90 to 95
Plowing	0 to 2	2 to 7
Disking (offset, deep)	5 to 15	25 to 40
Disking (tandem, shallow)	25 to 35	65 to 75
Chiseling (twisted shanks)	10 to 20	40 to 50
Chiseling (straight shanks)	30 to 40	60 to 75
Paraplowing	35 to 45	65 to 75
Field cultivating	55 to 65	80 to 90
Anhydrous application	45 to 55	75 to 85
Planting	80 to 90	80 to 90
Till-planting	40 to 50	55 to 65

Source: Protecting Surface Water By Managing Crop Residues, 1991.

Since plowing removes almost all surface residue, many farmers think giving up moldboard plowing will bring them into compliance. On more erosive land, however, fall tillage of any kind will make it a challenge to have enough residue after planting. You will also expose soil to wind and water erosion over a longer period of time with fall tillage. Control your urge to do "recreational tillage" on a beautiful, dry fall or early spring day. Remember, every time you go over a field, you're getting a net residue loss.

Measuring Residue. Measuring the residue on your field is an easy way to check that your tillage operations are conserving the residue amounts called for in your compliance plan. The most accurate method is to measure with either a 50-foot rope, cable, or tape with marks every 6 inches or a 100-foot length with marks every 12 inches.

Follow these steps:

1. Choose part of your field that is typical of the whole field.

2. Stretch the rope or tape diagonally across the crop rows so that each end of the rope or tape is over a row.

3. Walk the rope or tape and count the number of times there is a piece of crop residue directly under a mark. The number of times a mark was directly over a piece of residue is equal to the percentage of cover that field has. For example, if you counted forty-five marks, you have about 45 percent crop residue on your field.

4. Take measurements from three or more locations in the field and average them for your final estimate.

After a while you'll know what a certain residue level looks like. Of course, your compliance plan may also require contouring, strip-cropping, waterways, and buffer strips as well as structures like terraces. But residue management will be the cheapest, most effective choice for most farmers to meet compliance requirements and protect water quality.

Managing Fertilizers With Reduced Tillage

Careful management of fertilizer is essential for the success of minimum tillage cropping systems because fertilizer is often placed on or near the surface of the soil, not in it. There is a growing interest in the design of equipment for more accurate and deeper placement of fertilizer in reduced-tillage systems. When legumes like soybeans and peanuts are part of a multi-cropping operation, less fertilizer is needed because legumes take nitrogen from the air, enriching the soil for the next crop as well. Depending on the soil, many multi-crop systems can be fertilized effectively for two crops with a one-time application of lime, phosphorus, and potassium in the fall. In extremely sandy soils, more fertilizer may need to be applied with the second crop as well.

Managing Pesticides With Reduced Tillage

A minimum tillage/multi-crop system may require more pesticides. The reduction of intervals between crops may not leave enough time for roots of the previous crop to decompose and cause root pests to flourish. Although timing may eliminate the need for pesticides in some cases, wise selection of herbicides, insecticides, and nematicides is vital.

Before applying pesticide, be sure to READ THE LABEL CAREFULLY. Some pesticides are prohibited in combination with other crops or there are EPA restrictions on maximum application. Other pesticides may react adversely with the second crop or with pesticides on the residues of the first crop. Many combinations of pesticides may be used on individual crops, but they may drastically reduce yields in multicrop systems.

Choosing the proper sequence of crops can also reduce pest problems. For example, if a summer crop of soybeans in a field lightly infested with root-knot nematodes (microscopic worms) is to follow a small grain, rye grass, or other crop upon which the worms reproduce poorly, no nematicide will be needed.

Managing Crop Yields With Reduced Tillage

Overall profitability of reduced tillage depends primarily on how it affects yields, which may be highly variable, especially in the first few years. When yields are affected not at all or only slightly, reduced tillage systems are generally more profitable and contribute to water quality improvement. The benefits for water quality may be enormous but difficult to measure on an annual basis.

Farmers can compare tillage system costs with crop yields to determine profit differences among these practices. On heavy soils (clays) yields are often lower with no-till than with conventional systems. One theory is that the insulating effect of the surface residue slows soil warm-up, which reduces early growth and yield. Depending on the actual yield differences between the two methods, the lower operating costs of no-till can offset the lower yields so that profits are often competitive with conventional tillage.

On light-textured soils (sands and sandy loams) yields from no-till can equal or exceed those from conventionally tilled fields. On these soils, no-till usually has a profit advantage over conventional systems. Alabama's sandy and medium-textured soils are well suited for minimum tillage.

Getting Help With Reduced Tillage

Minimum tillage systems require an innovative, highly skilled, and informed farmer who wants to make minimum tillage work. If you are considering minimum tillage, learn before, not after, you make mistakes. Attend short courses, conferences, field days, and demonstrations. Test minimum tillage on a small acreage first.

The Natural Resources Conservation Service (NRCS) in your district may know of cost-share funds for small-scale learning available through the Consolidated Farm Service Agency (CFSA). Minimum tillage sprayers and planters are being made available for use on small acreage through some Soil and Water Conservation Districts. Call your local NRCS office or county Extension agent to see if such equipment is available in your county.

Because planning is so important for successful minimum tillage, you will benefit from the guidance of your county Extension agent. The agent can advise you of the minimum tillage/multi-cropping system best suited to your land and crops. Several publications related to minimum tillage and multi-cropping are available through the county Extension service.

Benefits Of Reduced Tillage

Soil and water are conserved.

Fuel is saved because fewer trips over a field are necessary.

Higher profits often result because of compatibility with multiple cropping.

Land use is intensified since it is possible to plant a second cash crop without delay for elaborate seedbed preparation.

Lower-cost land can be farmed because it is possible to plant row crops on sloping soils more commonly used for pasture land.

Soil structure is improved because of decomposing organic material in crop residues.

Time and labor are saved throughout the season because of fewer field operations.

Machinery costs are lower since fewer implements are required.

Stress of drought is reduced because of increased infiltration, reduced evaporation, and a more vigorous root system.

Pesticide and nutrient losses associated with transported sediment are decreased. While overall nutrient losses are lower, dissolved fractions may increase.

Problems With Reduced Tillage

More pesticides and fertilizers may be required than for conventional methods. In addition, plant residues left on the surface may leach out phosphorus in late fall and early spring.

Weed control may not be effective. Herbicides, which have been adapted for better control of grass and broadleaf weeds, have lessened this problem to a large extent.

Herbicides, which are necessary to make minimum tillage a success, are costly.

Insect populations may increase. This can result in reduced or inconsistent yields.

Some pests can be more troublesome in reduced tillage systems because crop residues are a haven for breeding insects. A spraying program may have to accompany the practice of minimum tillage. For some pests, such as the lesser cornstalk borer, damage is reduced in minimal tillage systems.

Soil warm-up may be slow.

Farmers must plant 10 percent more seed since seeds often are not uniformly buried in rough seedbeds; however, subsoiler attachments can alleviate this problem.

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For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

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