# Crop Residue Management

***Crop residue management is the planned use of crop residue to protect the soil surface.***

Crop residue management is one of the most cost-effective conservation practices. Crop residues may include corn or soybean stalks, small grain straw or the residue from vegetables and other crops. Although there are many benefits from leaving crop residue to protect the soil surface, one of the most common is to reduce soil erosion.

Any level of residue can help reduce soil erosion. In some situations, levels in excess of 50%-75% may be needed. USDA recognizes conservation tillage only when surface residues exceed 30% after planting.

## Benefits:

- Increased water absorption
- Reduced volume and velocity of surface runoff
- Improved soil moisture from mulching effects
- Improved biological activity from populations of earth worms, night crawlers and other forms of soil life

## Tillage Makes a Difference

There is a direct relationship between the amount of tillage done and the amount of crop residue left on the surface after planting. The most effective method to maximize surface residue is to use no-till planting. Many of today's producers use complete cropping systems with no tillage at all. This maximizes the residue amounts accumulated on the surface through a complete crop rotation. Continuously maintaining soil cover levels of 50-75% or more tends to improve the effectiveness of no-till systems and soil quality.

Other producers mix no-till and reduced-till with the use of a moldboard plow. These combinations will increase, to some extent, the amount of crop residue when compared to the singular use of a moldboard plow. Continuous use of a moldboard plow represents maximum tillage and the smallest amount of surface residue left to protect the soil and build soil organic matter.

## Producer Guidelines

- Use complete no-till systems whenever possible or combine no-till with other systems that increase residue on the surface.
- Reduce the number of tillage passes.
- Select tillage implements that leave more residue. Chisels and field cultivators with straight points or sweeps will maximize surface residues as compared to disks and equipment with twisted shanks.
- Operate tillage tools at shallower depths (3"- 4") to increase residue and save fuel.
- Do fall tillage only when necessary and when the surface is left rough with residues over 50%. If tillage leaves low residue amounts, consider planting a winter grain for cover.
- Use cover crops to supplement low residue crops such as soybeans and vegetables or to replace removed residue.
- Spread all residue evenly at harvest.
- Chop corn stalks in the spring just prior to planting to allow the soil to warm more quickly or only when more even distribution is necessary to protect the soil.
- Fall chopping provides better winter soil protection.
- No-till planting into corn stalks helps retain surface residue for 2 years.
- Surface applied manure in no-till systems can supplement surface cover especially when bedded manure is used.

## General Management Considerations:

- Current planters and drills do an excellent job of planting directly into high levels of residue and create a smooth, uniform seedbed even in uneven soil conditions.
- When beginning high residue and/or no-till planting, it is best to plant a small amount of acreage until you are familiar with the operation and adjustment of the planting equipment.
- Used planters and drills are available for purchase and can save a producer money.
- It is essential to find a producer or equipment dealer familiar with the equipment when getting started.

All equipment is similar but each may require slightly different adjustment techniques.

- If you tried no-till planting in the past and were not successful, don't be afraid to try it again. There are improved products today such as better seed varieties, weed control, equipment, etc.
- Whether a system is no-till or reduced-till, a continual surface of 50% residue with cover crop as needed provides excellent erosion control and will provide an effective mulch to improve water absorption and preserve moisture in the soil.
- All field crops and many specialty crops such as vegetables can be no-till planted. Cover crops, oats, wheat and forages are quite easy to no-till and offer a good starting point for beginners.

Residue is managed in many ways.

No-till corn into manure, soybean residue and previous corn residue.

No-tilling vegetables into cover crop.

## What is No-Till?

No-till is the planting of crops directly into existing crop residue or cover crops without using tillage. Soil disturbance is limited to a narrow band which can be as wide as 8-10 inches in zone tillage or may be barely visible. In no-till planting, soil is commonly disturbed using 1-3 coulters which may differ in size and configuration. Deep tillage which does not disturb the soil surface may be used occasionally with no-till to reduce soil compaction. Other forms of conservation tillage which leave the USDA required 30% or more residue include using combinations of chisels, disks and field cultivators, etc., as well as specialized equipment to accomplish ridge tillage.

## Measuring Residue

Residue is generally measured following planting. Residue measurements after harvest determine residue losses from tillage. To measure crop residue, stretch a line or tape with equally spaced points, usually at 1 foot or 6 inch increments, diagonally across the rows and count the number of marks which have residue directly under them. The total number of marks in the line divided by the number of marks with residue directly beneath them will provide the percentage of residue. This procedure should be repeated on 3-5 representative locations within the field. Contact NRCS, Cooperative Extension or your county conservation district for assistance.

Crop residue management works very well with contour and cross slope farming and the use of grassed waterways. Stripcropping and cropland terraces may also be used with this practice.

# Contour Farming

***Contour farming involves conducting tillage, planting and harvesting operations around a hill or slope as near to the contour as is practical to reduce erosion.***

Contour farming is most effective on moderate slopes of 3-8% when there are measurable ridges left from tillage and/or planting operations. These small ridges (usually 1-3 inches high) serve as miniature terraces to slow runoff and increase water absorption into the soil.

Contour farming is more effective where some form of tillage is used because tilling results in more numerous and larger ridges. However, there are benefits from using contour farming in no-till planting.

Contour farming is typically used on moderate slopes when land is intensively cropped. The practice is most effective on shorter slopes or on longer slopes with cropland terraces.

## Benefits:

- Reduced water runoff
- Increased moisture absorption into the soil
- Improved water quality
- Reduced soil erosion

## Producer Guidelines

- The shape and steepness of your land determines the row pattern for your contours. Land with uniform, gentle slopes will result in well-rounded, gentle lines for farming operation. In these instances, contouring can start from a single contour baseline near the middle of the slope.
- On land more rolling in nature, several baselines and some point rows will be needed to retain conformance close to the contour. It is generally suggested that you request assistance from NRCS or your local conservation district to establish a contour system.
- Deviation from the contour should not exceed a 4% row grade for a minimum distance of 150 feet. This amount of variance is allowed on fields with irregular slopes or rolling topography.
- Contour farming can be combined with high residue tillage or no-till systems and/or crop rotations with small grains/forages to reduce soil loss and improve water quality.
- Grassed waterways should be used in areas where runoff concentrates. They are needed more commonly in concentrated flow areas that are deep and narrow and drain more acres.
- In some instances, row direction cannot meet the minimum guidelines for contour farming due to extremely irregular slopes. In these instances, a practice referred to as cross-slope farming may be used. Due to a greater deviation from the contour, the use of grassed waterways becomes even more important in areas of concentrated water flow.

# Contour Stripcropping

***Contour stripcropping is a system of growing crops in strips or bands on or near the contour to reduce soil erosion.***

Contour strips are generally an even width although uneven widths may improve "farmability" in areas with rolling or irregular topography. Uneven width correction strips may also be used. Strip widths generally range from 90 to 120 feet in width, based on the land slope and cropping system being used.

Traditionally, stripcropping was defined as alternating strips of row crop with strips of either small grain or hay. Today, strips with high levels of residue on the surface (>50%) may be used as substitutes for alternate hay or small grain strips.

When land is very irregular or rolling and contour strips cannot be used, either field strips or contour farming may be more appropriate. When field strips are used on irregular land, they are less effective in controlling soil erosion and retaining surface runoff for absorption into the soil because they deviate more from the contour. The use of field strips may also require more grassed waterways because the rows will lead water toward swales or drainageways. Contour farming would be more effective in these instances, but would result in uneven width fields with some short rows.

## Benefits:

- Reduced soil erosion
- Reduced water runoff
- Improved water quality
- Improved air quality

## Producer Guidelines

- Contour strips are generally established by running a contour baseline somewhere near the middle of the slope. After the base contour line is run, even-width strips will be measured until the field is finished or the contour line is too far from the contour.
- For contour strips to be effective, strips of hay, small grain or heavy residue must be alternated with strips of row crop or crop with low residues.
- When all strips have similar crop or residue cover, they provide no additional protection against sheet and rill erosion. They do provide the flexibility to use tillage on alternate strips.
- Stripcropping may be combined with conservation tillage and residue management as well as the use of hay and small grains in rotation.
- Stripcropping is commonly supported by grassed waterways and diversions.
- Contour stripcropping may reduce the potential for gully erosion.

# Conservation Buffers

***Conservation buffers are areas or strips of land maintained in permanent vegetation to help control pollutants and manage other environmental problems.***

Conservation buffers of permanent vegetation, including trees and shrubs, can address a number of environmental concerns. Buffers enhance our environment by removing sediment from runoff and providing wildlife habitat. They can also provide a natural and pleasing divider between agricultural production and urban industrial/ residential development.

Land use conversions to intensive agricultural production and intensive urban and industrial development have led to public concern for water quality, wildlife habitat and other ecological conditions. Well-planned conservation buffers can play a role in addressing problems associated with these trends.

## Benefits:

- Improved water quality
- Stable and productive soils
- Improved wildlife populations
- Improved recreational opportunities
- Improved aesthetics and sustainable landscapes

## Producer Guidelines

The selection of an appropriate buffer for your farm or tract of land is a reflection of your objectives in treating the resource concern. Each type of buffer can be tailored to fit your situation. Below are some typical situations.

1. Your concern is soil erosion. Your farm operation includes the production of corn and soybeans with conservation tillage (chisel and field cultivator). Your objective is to control the erosion without making significant changes in your farm operation and with minimal costs. Contour buffer strips would be an excellent choice in this situation. This practice would be cost-effective and require the conversion of a minimal amount of cropland to grass or a grass/legume mixture.
2. Your concern is soil erosion on the headlands of some fields as well as the loss of crops along the field edge due to shading and wildlife feeding. Your selection could be a field border of grass or grass/legume. This practice would address the erosion concern and provide a field border to help minimize wildlife damage to annual crops.
3. Your concern is sediment coming from a farm lane which is already protected by small diversions at appropriate intervals. The runoff flows across a small section of a field before entering a small stream. You are also interested in providing habitat for pheasants and rabbits. You select a filter strip as the conservation buffer to address your concerns. The proper selection of grasses and legumes allow the filter to trap the sediment while also providing wildlife habitat.
4. You own a property with cropland immediately adjacent to a trout stream. Even with conservation treatment on the cropland, sediment occasionally reaches this stream. In certain locations, the streambank itself is unstable. A forested riparian buffer would provide multiple benefits in this instance. Plantings to stabilize the streambank and a combination of trees, shrubs and grasses next to the cropland and adjacent to the stream will reduce sediment and other attached pollutants entering the stream. The trees will eventually provide shade and reduce the stream temperature during the summer months improving the aquatic habitat.
5. Your cropland includes a limestone soil with frequent shallow areas and rock outcrops. Erosion has been reduced through field stripcropping and a crop rotation but still occurs during periods of intense runoff. Diversions and terraces cannot be constructed due to rock outcrops and the lack of a suitable outlet. A cost-effective solution is the use of a vegetative barrier. This barrier would significantly reduce the potential for soil erosion.

## Types of Conservation Buffers

1. **Contour Buffer Strips** — permanently vegetated strips which are located between larger crop strips on sloping land.
2. **Field Borders** — bands or strips of permanent vegetation established at the edge of a cropland field.
3. **Filter Strips** — strips or areas of permanent vegetation used to reduce sediment, organic materials, nutrients, pesticides and other contaminants from runoff.
4. **Riparian Forest Buffers** — areas of trees and/or shrubs located adjacent to streams, lakes, ponds or wetlands.
5. **Vegetative Barriers** — a narrow permanent strip of stiff-stemmed, tall, dense perennial vegetation established in parallel rows perpendicular to the dominant field slope.
6. **Windbreaks** — a planting of single or multiple rows of trees and/or shrubs that are established to protect sensitive plants, livestock and structures, and to create or enhance wildlife habitat.

Filter Strips

Riparian Forest Buffers

Contour Buffer Strips

Vegetative Barriers

Field Borders

Windbreaks

# Cover Crops

***Cover crops reduce soil erosion and add organic matter to the soil.***

Cover crops are annual or perennial crops that protect the soil from erosion and offer the opportunity for additional forage production and an additional income source. They can improve soil health, take up excess plant nutrients and reduce weed pressures which may reduce herbicide use. It is important to consider the purpose of the cover crop when selecting the plant specie(s).

## Benefits:

- Reduced soil erosion
- Improved water quality
- Reduced nutrient loss following primary crop harvest
- Reduced potential for weeds
- Increased soil organic matter
- Improved soil structure and porosity

## Producer Guidelines

- Mixtures provide benefits over single species.
- Seed in time to achieve desired plant growth.
- Use cover crops as a supplemental forage (Harvest or use as pasture).
- Cover crops provide rotational effects when growing continuous corn.
- Consider the long- and short-term benefits – economics.
- Select plant specie(s) and variety(ies) based on primary and secondary purpose.
- For winter soil protection, plants should cover 50% of the soil surface or be at least 4 inches high.
- No-till planting of cover crops retains existing crop residue and soil moisture to achieve maximum soil cover.
- Cover crops are particularly effective following crops which produce low amounts of residue (vegetables or soybeans) or when crop residues are removed (corn silage).

# Soil Quality

***Agricultural soil health or quality is the ability of the soil, using it's chemical, physical and biological properties, to support plant life and to maintain and/or enhance water and air quality.***

Soil is a living, dynamic resource made of different-size particles (sands, silts and clays), organic matter and numerous species of living organisms. Soil biological, chemical and physical properties may change constantly in response to both natural conditions and the activities of man.

## Benefits:

- Improved water quality
- Reduced soil erosion and sedimentation
- Improved nutrient balance and retention
- Increased soil moisture for plant growth
- Conversion of carbon dioxide to organic carbon in the soil
- Increased profits from reducing inputs and/or increasing production

## Producer Guidelines

Do an initial evaluation of your soil to establish baseline data. Use the soil test results, including soil organic matter content, and the Pennsylvania soil health card to evaluate easy-to-measure soil health indicators. Contact your local Cooperative Extension or NRCS office for more specific information.

Common Soil Quality Indicators:

1. Physical indicators -- depth of topsoil, porosity, aggregate stability, soil organic matter, compaction and crusting. Physical indicators primarily affect seedling emergence, plant vigor, water movement and the moisture-holding capacity of the soil.
2. Chemical indicators -- pH, cation exchange capacity (CEC) and concentrations of soil nutrients and potentially toxic materials. These conditions usually affect soil-plant relationships and the availability of nutrients to plants or soil organisms.
3. Biological indicators -- micro- and macro-organisms, their activity, and end- or by-products. The microorganisms (ones we cannot see with the naked eye) far outnumber those which we can see such as earthworms, night crawlers and nematodes.

Common management techniques to improve soil health and quality include: crop residue management, conservation tillage and no-till planting, the use of cover crops and crop rotations which provide significant plant biomass (including roots), as well as the addition of organic matter such as manure, compost and biosolids. Contact your local conservation district or NRCS for assistance.

# Managing Your Soil's Health

There has been much interest and research in soil quality over the years, especially related to the physical and chemical aspects of soil health and quality. There is currently much interest in relating biology in the soil to the physical and chemical aspects.

There also appears to be a very close link between soil quality and the effectiveness of continuous no-till planting systems. A common link between the two appears to be the continuous maintenance of a high degree of soil cover which results in a successful no-till system as well as a soil that reflects the properties representative of good health and quality. Contact your local Conservation District, Cooperative Extension or NRCS office for more information.

## Common Management Activities to Improve Soil Health and Quality

Common management activities to improve soil health and quality may be placed into two categories:

1. Tillage to retain maximum amounts of plant biomass (surface residue plus roots) and organic matter within the soil. To retain plant biomass and soil organic matter:
   a) Modify or reduce tillage operations. Each tillage pass causes existing soil organic matter and decaying residue to further break down and produce carbon dioxide. The first tillage pass results in the largest single loss.
   b) The use of no-till planting with a narrow band of disturbed soil will result in maximum reductions in the loss of plant biomass and soil organic matter. This will increase the potential for building organic matter in the soil.
   c) Leave as much plant residue as possible on the surface after harvesting.
2. Organic matter management to add plant biomass and organic matter to the soil to supplement existing amounts of the same. To add organic matter or plant biomass:
   a) Use cover crops to provide additional roots and surface biomass. Consider above-ground biomass as well as root mass and characteristics. Mixtures of cover crops will provide diversity in biomass and root production. Even if cover crops are harvested, they have still provided soil cover, some surface residue and all of the root mass.
   b) Use manure to provide both nutrients and soil organic matter. Rates of application should be based on existing soil nutrient levels as well as nutrient requirements to grow the specific crop or crops. The greater the amount of bedding with the manure, the greater the amount of organic matter added. If used in a no-till system, manure can help supplement surface cover and residue. If incorporated into the soil, the addition can help offset potential losses of carbon due to tillage.
   c) Use compost and other organic sources such as bio-solids to provide organic matter to the soil. Since compost is already in the process of being broken down, it does not provide microbes their normal opportunity to do the initial breakdown of plant residues. However, the advantage of compost over raw organic matter is that nutrients and organic residues will be available to plants more quickly. Producers using bio-solids and other organic materials should have them tested for nutrient content as well as contaminants such heavy metals.
   d) Modify cropping systems to produce more biomass that will be left on the field after harvest. For example, add small grain to a corn/soybean rotation or use 2 years of corn/grain and 1 year of soybeans. The addition of a grass or grass/hay to alfalfa/hay will result in more fibrous roots to produce underground biomass as grasses generally produce more biomass on the soil surface throughout the year. In other words, substitute a high residue-producing crop for a low one. Even certain varieties of corn, for example, will produce more stalks and leaves than other varieties.

# Establishing Permanent Vegetation on Areas Subject to Erosion

***Soil in all areas can be protected from erosion by using vegetation.***

Using vegetation to reduce soil erosion and sedimentation is a commonly accepted practice in both agriculture and urban situations. The key to using vegetation is properly selecting the plant(s) and using proper techniques to establish them. In most instances, the cost of establishing vegetation will compare very favorably with other possible solutions. The following guidelines are applicable to establishing cover on sloping areas subject to erosion, conservation practices needing to be seeded, conservation buffers, filter strips and other areas.

## Benefits:

- Reduced soil erosion
- Improved water quality
- Reduced sedimentation
- Reduced cost of treatment
- Enhanced wildlife habitat
- Improved aesthetics

## Producer Guidelines

Evaluate the primary and secondary purposes in establishing vegetation. Even when reducing soil erosion is the primary purpose, there may be other benefits that can be achieved by selecting the proper plant specie(s).

Site Considerations:

1. What are the soil characteristics such as drainage, subjectivity to drought, slope, or aspect?
2. Is the area subject to concentrated water flows?
3. Does the area receive surface water from a large drainage area?
4. Is there a sensitive area such as a spring or high quality stream downslope?

Key Steps in Establishing Cover:

1. Select proper plant species and varieties for the site and desired objectives.
2. Limit site preparation to the least amount of soil disturbance necessary to establish the cover. Use a no-till drill to minimize soil disturbance and retain existing soil cover when possible.
3. Temporarily divert concentrated flows from the area or use jute netting to protect the site from scouring.
4. Seed at the proper time. A temporary cover such as a small grain or millet can be used to protect any disturbed area until the proper time to establish the permanent cover. Since seed and mulching is expensive, this will reduce the potential need for reseeding the permanent cover.
5. Mulching is an essential part of establishing vegetation. Mulch that is free from weed seeds should be used. The extra cost of mulching is nominal compared to other seeding costs and the risks associated with not using mulch.
6. On sloping areas with concentrated flows or areas subject to wind, anchor the mulch with netting or other methods to insure the establishment of a good vegetative cover.

For additional information, refer to publications such as the current *Pennsylvania State University Agronomy Guide* for agricultural seeding, and *Erosion Control and Conservation Plantings on Non-Cropland* for urban areas. Contact your local NRCS, Conservation District or Cooperative Extension office for additional assistance.