NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

RESIDUE AND TILLAGE MANAGEMENT
NO TILL/STRIP TILL/DIRECT SEED

(Ac.)

CODE 329

DEFINITION

Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

PURPOSE

- Reduce sheet and rill erosion.
- Reduce wind erosion.
- Improve soil organic matter content.
- Reduce carbon dioxide (CO_2) loss from the soil.
- Reduce soil particulate emissions.
- Increase plant-available moisture.
- Provide food and escape cover for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland and other land where crops are planted.

This practice includes planting methods commonly referred to as no-till, strip till, direct seed, zero till, slot till or zone till. Approved implements are: no-till and strip-till planters; certain drills and air seeders; strip-type fertilizer and manure injectors and applicators; in-row chisels; and similar implements that only disturb strips and slots. All others are considered to be full-width or capable of full-width disturbance and therefore not compatible.

CRITERIA

General Criteria Applicable to All Purposes

Residue shall not be burned.

All residues shall be uniformly distributed over the entire field prior to planting.

No full-width tillage shall be performed regardless of the depth of the tillage operation.

The Soil Tillage Intensity Rating (STIR) value associated with any no-till, strip-till, or direct-seeded crop shall be no greater than 30. This STIR value shall reflect the sum of all soil-disturbing activities that occur during the interval between harvest of the previous crop and harvest or termination of the current crop (includes fallow periods).

"Continuous no-till system" or "continuous NT" refers to a cropping system in which the above criteria are continuously met.

Additional Criteria to Reduce Sheet and Rill Erosion

Revised Universal Soil Loss Equation, Version 2 (RUSLE2) shall be used to determine the amount of surface residue that is needed and the amount of soil disturbance that is allowed in order for the overall cropping system to achieve planned soil loss objectives. Calculations shall account for the effects of all management practices (crop rotation, tillage, residue removal, etc.) as well as field-specific factors (climate, soil, topography, etc.) pertinent to the cropping system.

Additional Criteria to Reduce Wind Erosion

The current approved wind erosion prediction technology shall be used to determine the

amount and orientation of standing and surface residue that is needed and the amount of soil disturbance that is allowed in order for the overall cropping system to achieve planned soil loss objectives. Calculations shall account for the effects of all management practices as well as field-specific factors pertinent to the cropping system.

Additional Criteria to Improve Soil Organic Matter Content

Surface residues and soil disturbance shall be managed to ensure that the overall cropping system achieves the soil loss and Soil Conditioning Index (SCI) criteria listed below.

A cropping system predicted to *improve* soil organic matter content shall satisfy the following criteria:

1. RUSLE2 must predict a soil loss for conservation planning at or below the soil loss tolerance value (T).
2. The Soil Conditioning Index must predict an SCI score of +0.25 or greater.

A cropping system that meets the above criteria for soil organic matter improvement shall be referred to as an "Organic Matter Building Cropping System."

A cropping system that meets the above criteria and also continuously satisfies the General Criteria under this Standard shall be referred to as an "Organic Matter Building Continuous No-till System."

Performance beyond these minimum criteria for soil organic matter improvement can be achieved. See "Considerations" for targets for higher levels of performance.

Additional Criteria to Reduce Carbon Dioxide (CO_2) Losses from the Soil

Soil disturbance shall be reduced sufficiently to ensure that the annual average STIR value for the overall cropping system is no greater than 10.

Additional Criteria to Provide Food and Cover for Wildlife

The time that residue is present, the amount and orientation of residue, and the height of stubble needed to provide adequate food and cover for the target species shall be determined using an approved habitat evaluation procedure.

CONSIDERATIONS

General

"No-till" or "NT" refers to planting crops into a narrow slot or opening in the soil created by coulters, row-openers, or other devices for the purpose of inserting seed or transplants.

"Strip-till" or "ST" refers to planting crops into a cultivated or tilled strip no wider than one-third of the row spacing. Strips may be tilled as part of the planting operation or in a separate, earlier operation.

The terms no-till and strip-till are used interchangeably in this Standard. Quantitative criteria for distinguishing between them are not provided. Both techniques can potentially meet all criteria established in this Standard.

Whether no-till or strip-till is being used, producers should always strive to minimize soil disturbance as much as possible in order to maximize the benefits of this practice. STIR values should be used to assess soil disturbance and gauge progress in reducing it.

"Rotational tillage system" or "rotational tillage" refers to a cropping system in which different tillage methods are used to establish different crops during the rotation. When describing a rotational tillage system, the different tillage methods used should be indicated. For example, "Rotational tillage system, NT & MT" refers to a cropping system in which both no-till and mulch-till methods are used (see Virginia Conservation Practice Standard for *Residue & Tillage Management, Mulch-till, Code 345*).

Well-managed cropping systems that include full-width tillage have the potential to achieve high levels of conservation performance. This is especially true of rotational tillage systems that include no-till and all tillage systems that include regular rotation to perennials. Calculated soil loss rates, Soil Conditioning Index (SCI) scores, and STIR values should be used to evaluate these cropping systems and to gauge progress in improving them.

Notwithstanding the previous paragraph, continuous no-till should be promoted as the optimal tillage system for conservation purposes in the vast majority of cases. Properly-managed continuous no-till cropping systems in Virginia often provide soil conservation and soil quality benefits not fully accounted for by RUSLE2 or the Soil Conditioning Index. Therefore, even in cases where soil loss rates or SCI scores are not predicted to improve significantly, conversion to continuous no-till should be encouraged.

Additional resource benefits often seen in well-managed continuous no-till systems include:

- Increase in rate of soil organic matter accumulation/carbon sequestration, especially near the soil surface.
- Improvements in soil structure, including a consolidated surface condition that better resists erosion, as well as improved infiltration due to accumulation of root channels and other macropores.
- Improvements in soil biological activity associated with reduced physical disturbance of the soil environment.

The soil quality benefits of continuous no-till take time to develop. A "transition period" of three to five years or more may be needed before the producer notices improvements in tilth near the surface, improved infiltration, increased resistance to compaction, etc.

Starting the continuous no-till process by no-tilling annuals into the residue of a killed perennial crop such as alfalfa is one way to shorten the transition period described above.

Incorporating complementary practices into the cropping system is often critical to the success of no-till, especially continuous no-till.

Crop rotation is a key complementary practice for successful implementation of no-till (see Virginia Conservation Practice Standard for *Conservation Crop Rotation, Code 328*). Recommended strategies include:

- Producing large amounts of crop biomass and residue.
- Including perennial crops in the rotation.
- Maintaining a continuous cycle of living vegetation.
- Maintaining a diverse crop rotation that includes nitrogen-fixing legumes.

Cover cropping may also be used to increase crop residue, continuity, and diversity (see Virginia Conservation Practice Standard for *Cover Crop, Code 340*).

Soil compaction prevention is important for successful no-till. It is particularly crucial during the transition period after continuous no-till is first adopted. Key strategies for compaction prevention include:

- Staying off wet ground.
- Minimizing axle loads (e.g., keep road trucks and grain carts out of the field) and minimizing tire-to-soil contact pressure (e.g., use flotation tires, keep road tires out of the field, etc.).
- Minimizing the percentage of the field tracked over time (e.g., use controlled traffic to keep tires in the same tracks on every pass).

Pre-existing soil compaction may require remediation before no-till can be successfully adopted. In severe cases, multiple years of improved organic matter management and gradual tillage reduction may be required before soil structure has improved sufficiently to support the transition to continuous no-till.

The transition to a continuous no-till system often requires adjustments to nutrient and pest management practices, both at the beginning of the process and over time (see Virginia Conservation Practice Standards for *Nutrient Management, Code 590* and *Pest Management, Code 595*). Maintaining a diverse crop rotation will often facilitate such adjustments.

Reducing soil sampling depth as well as adjusting rate and frequency of lime applications are also recommended after conversion to continuous no-till.

Not all soils are equally well suited to continuous no-till management. Typically, successful adoption of continuous no-till on poorly-drained soils requires a higher degree of management and complementary practices.

Soil Organic Matter Improvement

SCI Score

An SCI score of +0.25 is the lowest level of performance acceptable in an Organic Matter Building Cropping System. The following ranges may be used when setting SCI targets for higher levels of performance:

Soil Conditioning Index (SCI) Score	Performance Level – Soil Organic Matter Building
+0.25 to +0.49	Minimum
+0.50 to +0.74	Intermediate
+0.75 or greater	Optimum

Soil Disturbance

Minimizing soil disturbance can enhance soil organic matter and soil quality in ways that are not fully accounted for by an SCI Score. Therefore, soil disturbance should be minimized as much as possible. The following are performance criteria that should be used to evaluate cropping systems based on degree of soil disturbance:

- A first key measure of performance involves the tillage system being used. Well-managed continuous no-till is the optimal tillage system for the purpose of soil quality improvement.

- A second key measure of performance involves Soil Tillage Intensity Rating (STIR). In general, cropping systems should be designed so that STIR values are as low as possible. This applies to STIR values for each crop as well as to the average annual STIR value for the overall cropping system.

- Producers should be encouraged to strive for an annual average STIR value of 10 or less for the overall cropping system. This is the optimal STIR value for purposes of soil quality improvement.

- It is possible to meet either of the performance targets described above (continuous NT and STIR of 10 or less) without achieving the other. A cropping system that qualifies as continuous no-till may not necessarily achieve optimal STIR; optimal STIR can be achieved in certain limited cases in cropping systems that include full-width tillage. Meeting both performance targets simultaneously should be encouraged.

Carbon Dioxide (CO_2) Loss Reduction

Loss of CO_2 from the soil is a key pathway of soil organic matter loss as well as a contributor to atmospheric greenhouse gas accumulation.

Loss of soil CO_2 is directly related to the volume of soil disturbed, the intensity of the disturbance, and the soil moisture content and soil temperature at the time the disturbance occurs. The following guidelines should be used to complement the STIR criterion established under Additional Criteria for minimizing CO_2 loss:

- Shallow soil disturbance (1-3 inches) releases less CO_2 than deeper operations.
- When deep soil disturbance is performed, such as by subsoiling or fertilizer injection, make sure the vertical slot created by these implements is closed at the surface.
- Soil disturbance that occurs when soil temperatures are below 50° F will release less CO_2 than operations done when the soil is warmer.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or Conservation Management Unit (CMU). At a minimum, specifications shall include the following information:

- Tillage method to be used.
- Implementation date.

Additional information shall be included as necessary to ensure that all planned conservation objectives shall be met.

Specifications shall be recorded using approved specification sheets, narrative statements in the Conservation Plan, or other equivalent forms of documentation.

OPERATION AND MAINTENANCE

No operation and maintenance requirements have been identified for this practice.

REFERENCES

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