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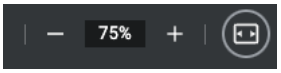
- USE THIS 

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CLIMATE-SMART GROWN IN SC PEANUT CPS DOCUMENTS

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Residue and Tillage Management, No Till (Code 329)

The residue and tillage management, no till practice addresses the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round. Crops are planted and grown in narrow slots or tilled strips established in the untilled seedbed of the previous crop.

Practice Information

This practice includes maintaining most of the crop residue on the soil surface throughout the year, commonly referred to as no till. The common characteristic of this practice is that the only tillage performed is a very narrow strip prepared by coulters, sweeps, or similar devices attached to the front of the planter.

Benefits to soil include increasing organic matter, improving soil tilth, and increasing productivity as the constant supply of organic material left on the soil surface is decomposed by a healthy population of earthworms and other organisms.

Operations and maintenance for this practice includes evaluating the crop-residue cover and orientation for each crop to ensure the planned amounts, orientation, and benefits are being achieved. Weeds and other pests must be monitored to ensure pest populations do not exceed thresholds.

Common Associated Practices

Residue and Tillage Management, No Till (Code 329) is commonly applied with practices such as Conservation Crop Rotation (Code 328), Nutrient Management (Code 590), Integrated Pest Management (Code 595), and Irrigation Water Management (Code 449).

For further information, contact your local NRCS field office.

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

RESIDUE AND TILLAGE MANAGEMENT, NO TILL

CODE 329

(ac)

DEFINITION

Limiting soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface year around.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce sheet, rill and wind erosion, and excessive sediment in surface waters.
- Reduce tillage-induced particulate emissions.
- Maintain or increase soil health and organic matter content.
- Increase plant-available moisture.
- Reduce energy use.
- Provide food and escape cover for wildlife.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland.

CRITERIA

General Criteria Applicable to All Purposes

Residue shall not be burned.

Distribute all residues uniformly over the entire field. Removing residue from directly within the seeding or transplanting area prior to or as part of the planting operation is acceptable.

This practice only involves an in-row soil disturbance operation during strip tillage, the planting operation, and a seed row/furrow closing device. There is no full-width soil disturbance performed from the time immediately following harvest or termination of one cash crop through harvest or termination of the next cash crop in the rotation regardless of the depth of the tillage operation. The soil tillage intensity rating (STIR) value shall include all field operations that are performed during the crop interval between harvest and termination of the previous cash crop and harvest or termination of the current cash crop (includes fallow periods). ***The crop interval STIR value shall be no greater than 20.***

Additional Criteria to Reduce Sheet, Rill and Wind Erosion, Reduce Excessive Sediment in Surface Waters, and Reduce Tillage-Induced Particulate Emissions

Use the current approved water and wind erosion prediction technology to determine the if field operations planned provide the amount of randomly distributed surface residue needed, time of year residue needs to be present in the field, and amount of surface soil disturbance allowed to reduce erosion to the desired level. Calculations shall account for the effects of other practices in the management system.

Additional Criteria to Maintain or Increase Soil Health and Organic Matter Content

Ensure the soil condition index (SCI) for the cropping system results in a positive rating.

Additional Criteria to Increase Plant-Available Moisture

Maintain a minimum of 70 percent residue cover on the soil surface throughout the year.

Additional Criteria to Reduce Energy Use

Reduce the total energy consumption associated with field operations by at least 25 percent compared to the benchmark condition. Use the current approved NRCS tool for determining energy use to document energy use reductions.

Additional Criteria to Provide Food and Escape Cover for Wildlife

Use an approved habitat evaluation procedure to determine when residue needs to be present, and the amount, orientation, and stubble height needed to provide adequate food and cover for target species.

CONSIDERATIONS

General Considerations

Removal of crop residue, such as by baling or grazing, can have a negative impact on resources. These activities should not be performed without full evaluation of impacts on soil, water, animal, plant, and air resources.

Production of adequate crop residues to achieve the purpose(s) of this practice can be enhanced through the use of high residue crops and crop varieties, use of cover crops, double cropping, and adjustment of plant populations through seeding rates and row spacing.

When providing technical assistance to organic producers, ensure residue and tillage management, activities are consistent with the USDA Agricultural Marketing Service National Organic Program regulations.

Residue should not be shredded after harvest. Shredding residue makes it more susceptible to movement by wind or water, and areas where residue accumulates may interfere with planting the next crop.

Using residue management - no till for all crops in the rotation or cropping system can enhance the positive effects of this practice by—

- Increasing the rate of soil organic matter accumulation.
- Keeping soil in a consolidated condition and improved aggregate stability.
- Sequestering additional carbon in the soil.
- Further reducing the amount of particulate matter generated by field operations.
- Reduce energy inputs to establish crops.
- Forming root channels and other near-surface voids that increase infiltration.

Considerations to Increase Soil Health and Organic Matter Content

Carbon loss is directly related to the volume of soil disturbed, intensity of the disturbance and soil moisture content and soil temperature at the time the disturbance occurs. To make this practice more effective—

- 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.
- Planting with a single disk or slot opener no-till drill will release less CO_2 and oxidize less organic matter than planting with a wide-point hoe/chisel opener seeder drill.
- Soil disturbance that occurs when soil temperatures are below 50 °F will oxidize less organic matter

and release less CO_2 than operations done when the soil is warmer.

- Maximizing year-round coverage of the soil with living vegetation (e.g., cover crops) and crop residues, if applicable, builds organic matter and reduces soil temperature, thereby slowing organic matter oxidation.
- Use a diverse crop rotation, incorporating multiple crop types (cool-season grass, cool-season legume/forb, warm-season grass, warm-season legume/forb) into the crop rotation.
- Plant a cover crop after every cash crop in the rotation. Multispecies cover crop mixes provide greater benefits than single-specie cover crops.

Considerations to Increase Plant-Available Moisture

Performing all field operations on the contour will slow overland flow and allow more opportunity for infiltration.

Considerations for Wildlife Food and Cover

Leaving rows of unharvested crop standing at intervals across the field or adjacent to permanent cover will enhance the value of residues for wildlife food and cover. Leaving unharvested crop rows for two growing seasons will further enhance the value of these areas for wildlife.

Leave crop residues undisturbed after harvest (e.g., no shredding or baling) to maximize the cover and food source benefits for wildlife.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit. Record the specifications using the practice implementation requirements document. The specifications shall identify, as appropriate—

- Purpose for applying the practice.
- Planned crop(s).
- Amount of residue produced by each crop.
- All field operations or activities that affect the—
  - Residue orientation including height (where applicable).
  - Surface disturbance.
  - Amount of residue (pounds/acre or percent surface cover) required to accomplish the purpose, and the time of year it must be present.
- Planned soil tillage intensity rating STIR value, soil condition index value, and erosion rate.
- Target species of wildlife, if applicable.
- Benchmark and planned fuel consumption, if applicable.

OPERATION AND MAINTENANCE

Evaluate/measure the crop residues cover and orientation after each crop to ensure the planned amounts and orientation are being achieved. Adjust management as needed to either plan a new residue amount and orientation or adjust the planting and/or harvesting equipment.

Limited tillage is allowed to close or level ruts from harvesting equipment. *No more than 10 percent of the field may be tilled for this purpose.*

If there are areas of heavy residue accumulation (because of movement by harvest, water, or wind) in the field, spread the residue prior to planting so it does not interfere with planter operation.

REFERENCES

Bolton, Ryan. 2003. Impact of the surface residue layer on decomposition, soil water properties and nitrogen dynamics. M.S. thesis. Univ. of Saskatchewan, Saskatoon, Saskatchewan, Canada

Reicosky, D.C., M.J. Lindstrom, T.E. Schumacher, D.E. Lobb, and D.D. Malo. 2005. Tillage-induced CO_2 loss across an eroded landscape. Soil & Tillage Research 81:183–194.

Reicosky, D.C. 2004. Tillage-induced soil properties and chamber mixing effects on gas exchange. Proceedings 16th Triennial Conference, International Soil Tillage Research Organization Conference (ISTRO).

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. 1997. Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). USDA Agriculture Research Service (ARS), Agriculture Handbook No. 703.

Shaffer, M.J., and W.E. Larson (ed.). 1987. Tillage and surface-residue sensitive potential evaporation submodel. In NTRM, a soil-crop simulation model for nitrogen, tillage and crop residue management. USDA Conserv. Res. Rep. 34-1. USDA ARS.

Skidmore, E.L. and N.P. Woodruff. 1968. Wind erosion forces in the United States and their use in predicting soil loss. USDA ARS, Agriculture Handbook No. 346.

USDA NRCS. 2011. National Agronomy Manual (Title 190). 4th Ed. Washington, D.C.

S.J. van Donk, D. L. Martin, S. Irmak, S. R. Melvin, J. L. Petersen, D. R. Davison, 2010. Crop Residue Cover Effects on Evaporation, Soil Water Content, and Yield of Deficit-Irrigated Corn in West-Central Nebraska. digitalcommons.unl.edu/westcentralresext/66/

Soil Tillage Intensity Rating STIR

The STIR rating is a replacement for the Soil Disturbance Rating component in the Soil Conditioning Index and functions as a stand-alone rating to evaluate tillage and/or planting systems on parameters other than the traditional ground cover and surface disturbance parameters. It replaces the subjective ratings contained in the Soil Disturbance Rating component of the SCI with more scientifically supported parameters. It utilizes the various operations database parameters in RUSLE2 to calculate a tillage intensity rating for the system used in growing a crop or a rotation. STIR ratings are calculated for cropping systems in WEPP, WEPS and the Integrated Erosion Tool. STIR ratings tend to show the differences between systems across the spectrum from true no-till all the way to conventional plow systems. It does so, better than surface cover or surface disturbance criteria since the kind, severity and number of ground disturbing passes are evaluated rather than only result or a snapshot of soil conditions after planting.

The parameters used in the STIR rating are derived from the RUSLE2 operations database that are now incorporated into CRLMOD used for WEPP and WEPS. Those values are based on a set of ARS core operations which the RUSLE2 model developers obtained from various research studies. In creating operation record several things need to be known when used under typical soil, residue and crop conditions including: range of operating speeds, range of operating depths, tillage type, amount of surface disturbance, residue burial and resurfacing fractions for five residue classes ranging from fragile residues to stones, standing residue flattening fractions, random roughness and ridge roughness and tillage intensity parameters. The ARS core operations were used as a starting point and the values for a new operation are adjusted based on observations, pictures, and on-site measurements, as provided by manufacturers, researchers and technical specialists.

The STIR rating for an individual operation is calculated by multiplying the individual parameter values and by applying "weighting" factors for each. They are speed times 0.5; tillage type times 3.25; average depth times 1; and surface soil disturbance times 1. This was done in order to calibrate the STIR component of the SCI back to the original systems and the base location and calibration sites so the resulting SCI answer would be the same as the original SCI before the Soil Disturbance Rating (SDR) parameter was replaced by the STIR rating.

The STIR rating applies to the entire tillage system used in producing a crop. All operations involved in tilling, fertilizing, planting, controlling pests, harvesting the crop and managing residues are evaluated in the STIR rating for a tillage system for a given crop. STIR ratings can be calculated for single crop intervals or for crop rotations. Higher STIR ratings are shown for systems with greater disturbance and more frequent operations. Comparison of STIR ratings for different tillage and planting systems provide insight into soil carbon loss, moisture depletion, and fugitive dust issues related to soil tillage.

The components of the STIR rating are the following parameters from the land management operations database.

1. Recommended Operating Speed:
This process represents the recommended speed for this operation. RUSLE2 can compute how speed of an implement affects residue burial. Speed between the range of a minimum and maximum can be entered in the management screen. The recommended speed is the generally is the recommend speed that the manufacturer suggests for the implement. This speed is the default speed for this operation, and indicates the assumed condition under which the flattening, burial, and re-surfacing values are defined.

2. Tillage Type:
Tillage type describes how the operation mixes the soil and associated residue. This variable refers to the type of mechanical disturbance on the soil, and how that affects the distribution of residue within the soil. The distribution of material, like plant residue, incorporated into the soil depends on the type of mechanical disturbance, referred to as tillage type. Also, tillage type affects the distribution of material within the soil as subsequent mechanical disturbances, i.e. tillage operations, occur.

The following values are assigned to individual tillage types in the STIR rating:
1.0 Inversion some mixing
0.8 Mixing + some inversion
0.4 Lifting and fracturing
0.7 Mixing only
0.15 Compression

Inversion with some mixing places most of the surface material in the lower half of the depth of soil disturbance (tillage depth). In effect, the soil in disturbance depth is “flipped over” with some mixing in the soil. Several subsequent operations result in the material being somewhat uniformly distributed in the soil. A moldboard plow is an example of an implement that inverts the soil with some mixing.

Mixing with some inversion places most of the surface material in the upper half of the depth of soil disturbance (tillage depth). The next operation leaves a somewhat uniform distribution of the material in the soil. The material becomes increasingly concentrated with subsequent operations and moves down in the soil in a “lump” as illustrated in the figure. Tandem disk, chisel plows, and field cultivators are examples of implements that are a tillage type of mixing with some inversion.

Mixing only places most of the surface material in the upper three tenths of the depth of soil disturbance (tillage depth). The next operation or two leaves a somewhat uniform distribution of the material in the soil. The material becomes

increasingly concentrated with subsequent operations and moves down in the soil in a “lump” as illustrated in the figure. Rotary tillers are examples of implements of mixing only.

Lifting, fracturing places most of the surface material in the upper three tenths of the depth of soil disturbance (tillage depth). The next operation or two leaves a somewhat uniform distribution of the material in the soil. The material becomes increasingly concentrated with subsequent operations and moves down in the soil in a “lump” as illustrated in the figure. Subsoilers, fertilizer and manure injectors, and scarifiers are examples of implements of lifting, fracturing.

Compression “pushes” surface material into the soil without the soil being disturbed. The initial distribution of material in the soil is the same as the mixing only tillage type. Examples of implements that are a compression type include sheep foot’s rollers used on construction sites and cattle trampling.

When an operations fits into multiple tillage type categories the highest rated tillage type is used for calculating STIR values. In addition, many tillage, planting and fertilizer operations have multiple devices or processes that need to be accounted when determining STIR value. For example, a “Seedbed Conditioner” has three devices/processes that must be accounted for including a coulter caddy, field cultivator, and a spike toothed harrow which must be accounted for.

3. Recommended Tillage Depth:

Many site operations disturb the soil, causing changes in soil physical properties and incorporation and mixing of residue. One of the key parameters is the depth to which the residue is incorporated, and soil is disturbed. Note that database values are average and may or may not be the same as the actual depth of tillage. Typical implements work best at a tillage depth recommended by the manufacturer.

4. Surface area disturbed:
This value is used to determine the impact of an operation on long-term soil consolidation. A plow assumed to completely invert the surface layer would receive a value of 100%, while a no-till planter which cuts a 3-inch slot every 30 inches could be assumed to disturb 10% of the surface.

Disturbing the soil causes erosion to increase and reduces soil aggregation. Soil that has not been disturbed for an extended period, (the time to soil consolidation—typically assumed to be seven years), is assumed in RUSLE2 to only be about 45% as erodible as soil that has been recently disturbed. Operations like planters, strip tillage tools, and drills typically disturb the soil in strips. The fraction (percent) of the total soil surface that is disturbed is the value entered.

Selection of a value for the fraction of the surface disturbed sometimes requires special consideration. In general, the area disturbed plus the area receiving soil "thrown" (displaced termed splash) by the soil disturbance is used for the input. However, if the displaced soil is very thin, the area of disturbance may be limited to the fraction of the soil surface (source area) that produces (generates) the displaced soil. This consideration is especially important in certain no-till cropping systems where the displaced soils doesn't interfere with long-term no-till which can facilitate the buildup of organic matter and improve surface soil physical properties.

The fraction of surface disturbed is an important variable for disturbed forestland and similar lands that are disturbed in a "patchy" pattern. This input is used to represent the portion of the surface disturbed and it should not be used to represent percent ground cover. Percent ground cover should be based on the entire area, not just on the area disturbed.

All the operations involved in tilling, fertilizing, planting, controlling pests, harvesting the crop and managing residues are evaluated in the STIR rating for a tillage system for a given crop. STIR ratings can be calculated for single crops or for crop rotations. Higher STIR ratings are shown for systems with greater disturbance and more frequent operations. Comparison of STIR ratings for different tillage and planting systems provides insight into the carbon loss, moisture depletion, and fugitive dust issues related to tillage of the soil. However, STIR ratings are only qualitative and are not a substitute for more quantitative models.

As an example of how STIR ratings work the "Stalk chopper, rolling" operation represents a machine consisting of typically 5 heavy blades that rotate around a heavy shaft. The shaft is mounted to a heavy frame which is typically attached to the tractor's rear 3-point hitch system. This machine is full width meaning that the blades are continuous across the width and thus tills in a continuous swath. The machine is typically used to cut, size, and partially incorporate corn residue to improve decomposition and reduce planter plugging. However, stand uniformity and germination may be adversely impacted by mixing the residue near the surface.

A variation of this operation is produced by the same manufacturers consisting of short rotor gangs of the same blade type but are 18 to 24 inches wide with adjustable spacing between gangs. The individual gangs can be angled to create more aggressive action. When only one gang is used there is an area between the gangs that is not tilled. However, it receives considerable "displaced" or thrown soil particles. If this thrown soil is deeper than 0.5 inch then that area is included in the surface disturbed because it impacts the erosion rates, residue decomposition, and water movement processes. When two ranks of these short gangs are mounted in a staggered pattern the disturbance is 100%. Both operations are available in single and double rotor designs and can

be equipped with various leveling board, spiked, coiled tine and linked tine harrows.

Manufacturers pictures and specifications information from Bessler, Buffalo and McFarlane manufacturers were referenced. Typical conditions were assumed to be in the spring on soils with acceptable moisture content to allow traffic and tillage without significant compaction and residues that were reasonably dry and easily cut. Pictures of the soil and corn residue appeared to be disturbed in a fashion like that of a light disking. At least one manufacturer's literature described the machine as eliminating a disking operation.

In creating the "Stalk chopper, rotary operation" record, the ARS core operation that was used as a starting point was the light tandem disk. Values selected were speed 8 MPH; depth 3 inches; a tillage type of mixing with some inversion; and surface disturbance of 100% based on manufacture's literature and pictures of the machine under typical operating conditions. Depth, amount of disturbance and residue burial is like that of a light tandem disk as shown by the manufacturer's pictures except that the speed of operation is faster, and soil and residue is thrown more than by a light tandem disk. The only significant difference in the values between the light tandem disk and the "Stalk chopper, rotary operation" when operated on un-ridged soil is the speed. The light tandem disk has a STIR of 19.1 while the stalk chopper has a STIR of 31.2. Although one manufacturer recommends speeds of 12 to 15 mph, a faster speed would significantly increase the STIR calculation based on the STIR formula.

Operation Name	Rec. speed	Rec. speed	Surf. area disturbed	Rec. till. depth	Tillage type	Component STIR
Disk, tandem light finishing	5	**5**	100	3	0.8	**19.5**
Stalk chopper, rotary	8	**8**	100	3	0.8	**31.2**

STIR Calculation

All operation STIR values are consistently calculated using the following formula based on the RUSLE2 operations parameters described previously: (speed times 0.5; tillage type times 3.25; average depth times 1; and surface soil disturbance times 1)

(8mph x.5) x (tillage type 0.8x 3.25) x (3-inch depth x 1) x (surface disturbance 100%/100 x1) = 31.2 STIR Value

These operations were assumed to be operated on un-ridged soils. Other conditions such as operation on beds or ridge tilled corn, fall operation on green or fresh residues, wet or muddy conditions or frozen soils were not considered in creating these operations records. At the time of CSP signup no requests were

pending to create additional stalk chopper operations to represent operation on ridges or on frozen soil or on fresh residue. However, such conditions are to be evaluated this fall, winter and spring and additional operations records developed to represent such different conditions. As with all requests for additional operations, these will be developed and added to the database as the information becomes available. There is no plan to change the values for the existing stalk chopper operations unless the data indicates it is necessary.

The STIR used for certain program eligibility or contained in conservation practice standards is typically the composite STIR for the entire cropping system. For example, a ridge-till system involving the use of a rolling stalk chopper, planter with row clearing devices or trash whippers and one or two cultivations to re-form the ridges, has a significantly higher STIR rating than No-till or Strip till. For example, a typical ridge-till system on continuous corn with two ridge-till cultivations will have a STIR rating in the high 30's to low 40's while the same system with the additional stalk chopper operation in the spring will score in the low to mid 60's.

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Conservation Practice Overview

Cover Crop (Code 340)

Cover crop is growing a crop of grass, small grain, or legumes primarily for seasonal protection and soil improvement.

Practice Information

Cover and green manure crops are grown on land where seasonal or long-term benefits of a cover crop are needed.

This practice is used to control erosion, add fertility and organic material to the soil, improve soil tilth, increase infiltration and aeration of the soil, and improve overall soil health. The practice is also used to increase populations of bees for pollination purposes. Cover and green manure crops have beneficial effects on water quantity and quality. Cover crops have a filtering effect on movement of sediment, pathogens, and dissolved and sediment-attached pollutants.

Operation and maintenance of cover crops include: controlling weeds by mowing or by using other pest management techniques, and managing for the efficient use of soil moisture by selecting water-efficient plant species and terminating the cover crop before excessive transpiration. Use of the cover crop as a green manure crop to cycle nutrients will impact when to terminate the cover to match release of nutrient with uptake by following cash crop.

Common Associated Practices

Cover Crop (340) is commonly applied with practices such as Conservation Crop Rotation (328); Residue and Tillage Management, No Till (329); Residue and Tillage Management, Reduced Till (345); Nutrient Management (590), and Integrated Pest Management (595).

For further information, contact your local NRCS field office.

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

COVER CROP

CODE 340

(ac)

DEFINITION

Grasses, legumes, and forbs planted for seasonal vegetative cover.

PURPOSE

This practice is applied to support one or more of the following purposes:

- Reduce erosion from wind and water
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress excessive weed pressures and break pest cycles
- Improve soil moisture use efficiency
- Minimize soil compaction

CONDITIONS WHERE PRACTICE APPLIES

All lands requiring seasonal vegetative cover for natural resource protection or improvement.

CRITERIA

General Criteria Applicable to All Purposes

Plant species, seedbed preparation, seeding rates, seeding dates, seeding depths, fertility requirements, and planting methods will be consistent with applicable local criteria and soil/site conditions.

Select species that are compatible with other components of the cropping system.

Ensure herbicides used with crops are compatible with cover crop selections and purpose(s).

Cover crops may be established between successive production crops, or companion-planted or relay-planted into production crops. Select species and planting dates that will not compete with the production crop yield or harvest.

Do not burn cover crop residue.

Determine the method and timing of termination to meet the grower's objective and the current NRCS Cover Crop Termination Guidelines.

When a cover crop will be grazed or hayed ensure that crop selection(s) comply with pesticide label rotational crop restrictions and that the planned management will not compromise the selected conservation purpose(s).

Do not harvest cover crops for seed.

If the specific rhizobium bacteria for the selected legume are not present in the soil, treat the seed with the appropriate inoculum at the time of planting.

Additional Criteria to Reduce Erosion from Wind and Water

Time the cover crop establishment in conjunction with other practices to adequately protect the soil during the critical erosion period(s).

Select cover crops that will have the physical characteristics necessary to provide adequate erosion protection.

Use the current erosion prediction technology to determine the amount of surface and/or canopy cover needed from the cover crop to achieve the erosion objective.

Additional Criteria to Maintain or Increase Soil Health and Organic Matter Content

Cover crop species will be selected on the basis of producing higher volumes of organic material and root mass to maintain or increase soil organic matter.

The planned crop rotation including the cover crop and associated management activities will score a Soil Conditioning Index (SCI) value > 0, as determined using the current approved NRCS Soil Conditioning Index (SCI) procedure, with appropriate adjustments for additions to and or subtractions from plant biomass.

The cover crop shall be planted as early as possible and be terminated as late as practical for the producer's cropping system to maximize plant biomass production, considering crop insurance criteria, the time needed to prepare the field for planting the next crop, and soil moisture depletion.

Additional Criteria to Reduce Water Quality Degradation by Utilizing Excessive Soil Nutrients

Establish cover crops as soon as practical prior to or after harvest of the production crop. (i.e. before or after harvest)

Select cover crop species for their ability to effectively utilize nutrients.

Terminate the cover crop as late as practical to maximize plant biomass production and nutrient uptake. Practical considerations for termination date may include crop insurance criteria, the amount of time needed to prepare the field for planting the next crop, weather conditions, and cover crop effects on soil moisture and nutrient availability to the following crop.

If the cover crop will be harvested for feed (hay/balage/etc.), choose species that are suitable for the planned livestock, and capable of removing the excess nutrients present.

Additional Criteria to Suppress Excessive Weed Pressures and Break Pest Cycles

Select cover crop species for their life cycles, growth habits, and other biological, chemical and or physical characteristics to provide one or more of the following:

- To suppress weeds, or compete with weeds.
- Break pest life cycles or suppress of plant pests or pathogens.
- Provide food or habitat for natural enemies of pests.
- Release compounds such as glucosinolates that suppress soil borne pathogens or pests.

Select cover crop species that do not harbor pests or diseases of subsequent crops in the rotation.

Additional Criteria to Improve Soil Moisture Use Efficiency

In areas of limited soil moisture, terminate growth of the cover crop sufficiently early to conserve soil moisture for the subsequent crop. Cover crops established for moisture conservation shall be left on the soil surface.

In areas of potential excess soil moisture, allow the cover crop to grow as long as possible to maximize soil moisture removal.

Additional Criteria to Minimize Soil Compaction

Select cover crop species that have the ability to root deeply and the capacity to penetrate or prevent compacted layers.

CONSIDERATIONS

General Considerations

Plant cover crops in a timely matter and when there is adequate moisture to establish a good stand.

When applicable, ensure cover crops are managed and are compatible with the client's crop insurance criteria.

Maintain an actively growing cover crop as late as feasible to maximize plant growth, allowing time to prepare the field for the next crop and to optimize soil moisture.

Select cover crops that are compatible with the production system, well adapted to the region's climate and soils, and resistant to prevalent pests, weeds, and diseases. Avoid cover crop species that harbor or carry over potentially damaging diseases or insects.

Cover crops may be used to improve site conditions for establishment of perennial species.

When cover crops are used for grazing, select species that will have desired forage traits, be palatable to livestock, and not interfere with the production of the subsequent crop.

Use plant species that enhance forage opportunities for pollinators by using diverse legumes and other forbs.

Cover crops may be selected to provide food or habitat for natural enemies of production crop pests.

Cover crops residues should be left on the soil surface to maximize allelopathic (chemical) and mulching (physical) effects.

Seed a higher density cover crop stand to promote rapid canopy closure and greater weed suppression. Increased seeding rates (1.5 to 2 times normal) can improve weed-competitiveness.

Cover crops may be selected that release biofumigation compounds that inhibit soil-borne plant pests and pathogens.

Species can be selected to serve as trap crops to divert pests from production crops.

Select a mixture of two or more cover crop species from different plant families to achieve one or more of the following: (1) species mix with different maturity dates, (2) attract beneficial insects, (3) attract pollinators, (4) increase soil biological diversity, (5) serve as a trap crop for insect pests, or (6) provide food and cover for wildlife habitat management.

Plant legumes or mixtures of legumes with grasses, crucifers, and/or other forbs to achieve biological nitrogen fixation. Select cover crop species or mixture, and timing and method of termination that will maximize efficiency of nitrogen utilization by the following crop, considering soil type and conditions, season and weather conditions, cropping system, C:N ratio of the cover crop at termination, and anticipated nitrogen needs of the subsequent crop. Use LGU- recommended nitrogen credits from the legume and reduce nitrogen applications to the subsequent crop accordingly. "If the specific rhizobium bacteria for the selected legume are not present in the soil, treat the seed with the appropriate inoculum at the time of planting.

Time the termination of cover crops to meet nutrient release goals. Termination at early vegetative stages may cause a more rapid release compared to termination at a more mature stage.

Both residue decomposition rates and soil fertility can affect nutrient availability following termination of cover crops

Allelopathic effects to the subsequent crop should be evaluated when selecting the appropriate cover crop.

Legumes add the most plant-available N if terminated when about 30% of the crop is in bloom.

Additional Considerations to Reduce Erosion by Wind or Water

To reduce erosion, best results are achieved when the combined canopy and surface residue cover attains 90 percent or greater during the period of potentially erosive wind or rainfall.

Additional Considerations to Reduce Water Quality Degradation by Utilizing Excessive Soil Nutrients

Use deep-rooted species to maximize nutrient recovery.

When appropriate for the crop production system, mowing certain grass cover crops (e.g., sorghum-sudangrass, pearl millet) prior to heading and allowing the cover crop to regrow can enhance rooting depth and density, thereby increasing their subsoiling and nutrient-recycling efficacy.

Additional Considerations to Increase Soil Health and Organic Matter Content

Increase the diversity of cover crops (e.g., mixtures of several plant species) to promote a wider diversity of soil organisms, and thereby promote increased soil organic matter.

Plant legumes or mixtures of legumes with grasses, crucifers, and/or other forbs to provide nitrogen through biological nitrogen fixation.

Legumes add the most plant-available N if terminated when about 30% of the crop is in bloom.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each field or treatment unit according to the planning criteria and operation and maintenance requirements of this standard. Specifications shall describe the requirements to apply the practice to achieve the intended purpose for the practice site. Plans for the establishment of cover crops shall, as a minimum, include the following specification components in an approved Cover Crop, 340, Implementation Requirements document:

- Field number and acres
- Species of plant(s) to be established.
- Seeding rates.
- Seeding dates.
- Establishment procedure.
- Rates, timing, and forms of nutrient application (if needed).
- Dates and method to terminate the cover crop.
- Other information pertinent to establishing and managing the cover crop e.g., if haying or grazing is planned specify the planned management for haying or grazing.

OPERATION AND MAINTENANCE

Evaluate the cover crop to determine if the cover crop is meeting the planned purpose(s). If the cover crop is not meeting the purpose(s) adjust the management, change the species of cover crop, or choose a different technology.

REFERENCES

A. Clark (ed.). 2007. Managing cover crops profitably. 3rd ed. Sustainable Agriculture Network Handbook Series; bk 9.

Hargrove, W.L., ed. Cover crops for clean water. SWCS, 1991.

Magdoff, F. and H. van Es. Cover Crops. 2000. p. 87-96 *In* Building soils for better crops. 2nd ed. Sustainable Agriculture Network Handbook Series; bk 4. National Agriculture Library. Beltsville, MD.

Reeves, D.W. 1994. Cover crops and erosion. p. 125-172 *In* J.L. Hatfield and B.A. Stewart (eds.) Crops Residue Management. CRC Press, Boca Raton, FL.

NRCS Cover Crop Termination Guidelines:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/climatechange/?cid=stelprdb1077238

Revised Universal Soil Loss Equation Version 2 (RUSLE2) website:
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/tools/rusle2/

Wind Erosion Prediction System (WEPS) website:
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/tools/weps/

USDA, Natural Resources Conservation Service, National Agronomy Manual, 4th Edition, Feb. 2011. Website: http://directives.sc.egov.usda.gov/ Under Manuals and Title 190.

Cover crops on a field in Black Hawk County, Iowa.

Photo: Lynn Betts, NRCS

NRCS Cover Crop Termination Guidelines

September 2014, Version 3

Background:

To ensure that USDA policies are coordinated and up to date with evolving cover crop practices, the administrators of the Natural Resources Conservation Service (NRCS), Risk Management Agency (RMA) and Farm Service Agency (FSA) organized an interagency workgroup to develop consistent, simple and flexible policy across the three agencies. National and local experts, along with multiple stakeholders, were involved in the process. Research literature, plant growth, soil hydrology models, and input from national/local experts in cover crop management provided the basis for developing cover crop termination guidelines to achieve their conservation benefits while minimizing risk of reducing yield to the following crop due to soil water use. These guidelines will be applicable to all USDA programs.

These guidelines only apply to non-irrigated cropland, including systems that contain a fallow period. The cover crops in irrigated cropping systems should be terminated based on the crop system and the conservation purpose, but before the planted crop emerges.

NRCS Cover Crop Termination Guidelines for Management Zones

Zone 1 - See Map	Zone 2 - See Map	Zone 3 - See Map	Zone 4 - See Map
NRCS Cover Crop Termination Period Guidance - Non-Irrigated Cropland:			
For Late Spring to Fall Seeded Crops - For Late Spring to Fall Seeded Crops - Terminate cover crops 35 days or earlier prior to planting the crop. **Early Spring Seeded Crops** - Terminate cover crops as soon as practical prior to planting the crop. (Additional Cover Crop Termination Considerations 4 and 8)	**For Late Spring to Fall Seeded Crops** - Terminate cover crops 15 days or earlier prior to planting the crop. **For Early Spring Seeded Crops** - Terminate cover crops as soon as practical prior to planting the crop. (Additional Cover Crop Termination Considerations 4 and 8)	Terminate cover crop at or before planting the crop.	Terminate cover crop, at, or within 5 days after planting, but before crop emergence.
RMA Designated Summerfallow Practice (See "Consideration #13" for additional guidance)	**RMA Designated Summer Fallow Practice (See Consideration #13" for additional guidance)**	**RMA Designated Summer Fallow Practice (See Consideration #13" for additional guidance)**	

Note: These guidelines can be used as a stand alone document, if needed.

* Cover Crop Termination Zones

Produced by: NRCS | ESD
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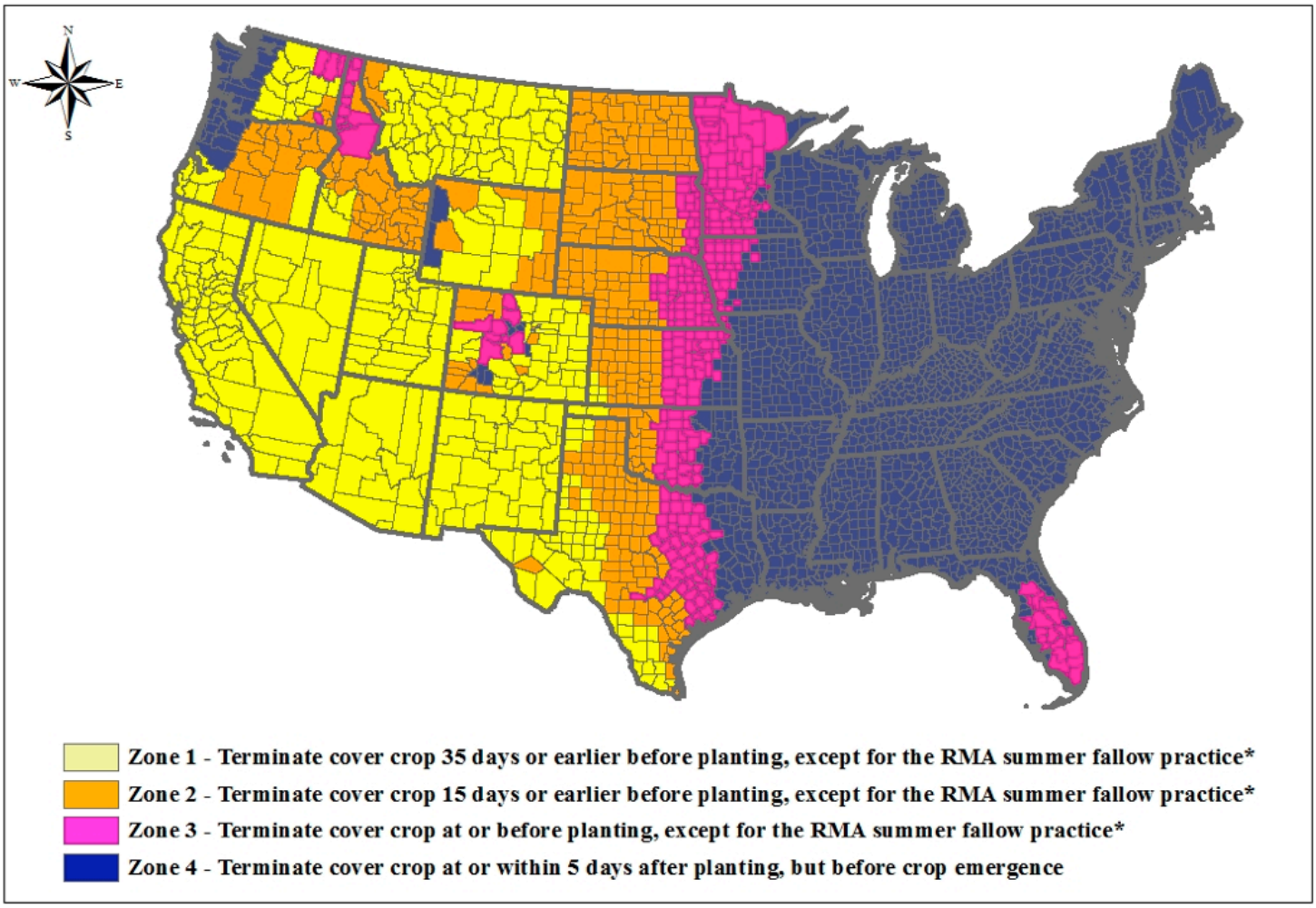

*See guidelines for details on the RMA summer fallow practice.

No-till planting of corn into cover crop of barley. Washington County, Virginia.
Photo: Jeff Vanuga

Photo: Justin Fritsher, NRCS

Cover crops in an orchard reduce soil erosion.
Photo: Gary Kramer

Additional Cover Crop Termination Considerations:

1. If the season is drier than normal nearing cover crop termination time, consider an earlier termination to conserve soil moisture.

2. If the spring season is wetter than normal at cover crop termination time, consider a later termination to use excess soil moisture and improve seedbed condition.

3. If the cover crop is part of a no-till system, termination can be delayed up to 7 days from the above termination period guideline, but terminated prior to crop emergence for all zones and systems.

4. In zones 1 and 2, fall seeded cover crops will have limited growth in the spring prior to "early" spring seeded crops (e.g., spring wheat, sugar beets, corn), and therefore the cover crop may be terminated at or just prior to planting.

5. Cover crop termination zones 1 and 2, in the largely mountainous regions in the Western U.S. (from Montana south to New Mexico and west to California), were refined by NRCS and other local university experts to identify proper cover crop management due to wide variability in climate and cropping systems in those areas.

6. Early vs. Later Spring Seeded Crops – Crops planted as early as possible after the spring thaw are considered early spring crops (e.g., spring wheat, spring barley, sugar beets, corn).

7. New Technology – Where new technology has at least three years of satisfactory performance (achieves historical yield) based on farm records and the written approval of two "agricultural experts" as defined by RMA or recommended by Extension or Ag Industry, the cover crop may be terminated closer to planting or planted during a different time period.

8. Cover Crop Grazing or Forage Harvest – Cover crops may be grazed or harvested as hay or silage, unless prohibited by RMA crop insurance policy provisions. Cover crops cannot be harvested for grain or seed.

9. Herbaceous Wind Barriers – There are specific cropping situations when seasonal cover is needed to protect young seedlings from wind erosion abrasion. The typical seasonal covers may include such crops as wheat, rye, or oats that are planted in rows, e.g., 20 feet apart (single or double row of small grain). These seasonal covers fall under the NRCS Conservation Practice Code 603 – Herbaceous Wind Barriers. These barriers are not considered cover crops.

10. Short Season Cover Crops – There are specific cropping situations where the producer will plant the intended crop, plus a short term seasonal cover crop (NRCS Conservation Practice Code 340 – Cover Crop) prior to or at the same time as planting the main or insured crop. In this case the seasonal cover emerges first and provides short term wind erosion protection until the main crop becomes established and provides its own protection from wind erosion. These seasonal cover crops are terminated by cultivation, frost /winterkill, or herbicides once the main crop is established. The seasonal covers used for the purpose of early crop establishment must be appropriate species for the area and the planned purpose.

11. Early Crop Planting – When earlier than normal planting occurs due to favorable weather or soil conditions, cover crop termination will naturally occur closer to planting. For example, in zone 2, if planting occurs 2 weeks earlier than normal, the cover crop termination period may be 2 weeks closer to planting.

12. Multiple Climates Within a County – Some counties may have multiple climate areas. In these situations, producers may request a different cover crop termination zone management or timeframe due to unique geographical and topographical features that reflect a different climate. Producers should contact either Extension or the local NRCS for management guidance. If the guidance includes practices other than indicated by the zones in this document, the producer must inform FSA and their crop insurance agent, as appropriate, and provide copies of the recommended management practice(s).

Additional Cover Crop Termination Considerations (Continued):

13. RMA Summerfallow Practice – If a crop, or a cover crop, is planted on summerfallow acreage in a fallow year, the following planted crop will not meet the RMA Summerfallow Practice definition until the acres lie fallow for a full crop year. For the 2015 crop year, if a cover crop was planted during the fallow year, the acreage may be insured under the "continuous cropping practice" (if available in your county), or by written agreement (if continuous cropping is not available in your county). For the 2016 and succeeding crop years, if a cover crop is planted during the fallow year, the acreage may be insured under the "continuous cropping practice" (if available in your county), or by written agreement (if continuous cropping is not available in your county) provided the cover crop is terminated at least 90 days prior to planting for summer and fall seeded crops. For early spring seeded crops, terminate the cover crop in the fall or as early as possible in the spring. Please contact your crop insurance agent for more information.

Definitions:

1. Over-Seeding/Interseeding – Both terms can be defined as planting one or more cover crop species into an existing or established crop. Common uses that involve over-seeding or interseeding include: (1) over-seeding a grass and/or legume cover crop into an existing stand of small grain at an appropriate time for the cover and germination, or (2) seeding a cover crop into an existing crop (e.g., corn or soybeans) at a time that will not impact the yield or harvest of the insured crop.

2. Interplanted – This involves multiple crop species grown together, with no distinct row pattern and does not permit separate agronomic maintenance or management. For RMA purposes, this means if a cover crop and cash crop are planted in a way that does not permit separate agronomic maintenance or management, then RMA will not insure the cash crop. This would also apply to cover crops if interplanted into the main crop and the cover crop interfered with the agronomic management and harvest of the main crop.

3. Relay Cropping – The practice of interseeding a second crop into the first crop well before the first crop is harvested. The relay cropping strategy is used to enable production of a second crop in areas where time for seeding the second crop following harvest of the first is considered inadequate for double cropping. This is not considered a cover cropping practice, but a method of double cropping and may fall under the RMA 1st / 2nd crop rules.

4. Double-Cropping – RMA and NRCS term: Producing at least 2 crops for harvest from the same acreage in the same crop year. This does not include cover crops.

5. Cover Crop – Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes. Cover crops are primarily used for erosion control, soil health improvement, and water quality improvement. A cover crop managed and terminated according to these guidelines is not considered a "crop" for crop insurance purposes. The cover crop may be terminated by natural causes such as frost, or intentionally terminated through chemical application, crimping, rolling, tillage, or cutting.

6. Termination – Termination means growth has ended.

7. Good Farming Practice – RMA term - The production methods utilized to produce the insured crop and allow it to make normal progress toward maturity and produce at least the yield used to determine the production guarantee or amount of insurance, including any adjustments for late planted acreage, which are: (1) for conventional or sustainable farming practices, those generally recognized by agricultural experts for the area; or (2) for organic farming practices, those generally recognized by organic agricultural experts for the area or contained in the organic plan.

8. Continuous Cropping – RMA Term – Any non-irrigated production practice that does not qualify as a summer fallow practice.

Definitions

11. **Nurse crop (companion crop)** – A crop planted into the same acreage as another crop, that is intended to be harvested or terminated separately, and which is planted to improve growing conditions for the crop with which it is grown. Short season cover crops are nurse crops in specific cropping situations, where the producer will plant the intended crop, plus a short-term seasonal cover crop (NRCS CPS Cover Crop, (Code 340)) prior to or at the same time as planting the main or insured crop. In this case the seasonal cover emerges first and provides short term wind erosion protection until the main crop becomes established and provides its own protection from wind erosion. These seasonal cover crops are terminated by cultivation, frost /winterkill, or herbicides once the main crop is established. The seasonal covers used for the purpose of early crop establishment must be appropriate species for the area and the planned purpose and permit separate agronomic maintenance or management that will not impact the yield or harvest of the insured crop and in accordance with applicable crop provisions.

12. **Cover Crop Haying, Grazing, or Forage Harvest** – Cover crops may be hayed, grazed, or harvested as silage, unless prohibited by RMA crop insurance policy provisions. Cover crops cannot be harvested for grain or seed.

13. **RMA Summerfallow Practice** – If a cover crop is planted during the fallow year, the acreage may be insured under the summerfallow practice for the current crop year provided the cover crop was not hayed, grazed, or otherwise harvested, and terminated in accordance with the Guidelines but no later than June 1 preceding the insured crop. RMA summerfallow practice is an insurability requirement and cover crops planted on summerfallow acreage must be terminated in accordance with this definition. Producers should contact their local NRCS office for appropriate cover crops that can be grown in summerfallow regions. Examples of high water use cover crops are alfalfa, sugar beets, cereal rye, corn, mustard, radishes, and turnips.

    For the 2020 and succeeding crop years, if a cover crop was planted during the fallow year was hayed, grazed, or otherwise harvested, or not terminated by June 1, the acreage may be insured under the “continuous cropping practice” (if available in your county), or by written agreement (if continuous cropping is not available in your county).

References

NRCS Conservation Practice Standard (Code 603) – Herbaceous Wind Barriers -
https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd340685&ext=pdf
NRCS Conservation Practice Standard Cover Crop (Code 340) – Cover Crop -
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263176.pdf
RMA Good Farming Practice Handbook -
https://www.rma.usda.gov/en/Policy-and-Procedure/Program-Administration---14000
NRCS State FOTG for list of approved cover crop species -
https://efotg.sc.egov.usda.gov/#/details

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

RESIDUE AND TILLAGE MANAGEMENT, REDUCED TILL

CODE 345

(ac)

DEFINITION

Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce sheet, rill, and wind erosion, and excessive sediment in surface waters (soil erosion)
- Reduce tillage-induced particulate emissions (air quality impact)
- Improve soil health and maintain or increase organic matter content (soil quality degradation)
- Reduce energy use (inefficient energy use)

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland.

CRITERIA

General Criteria Applicable to All Purposes

This practice includes tillage methods commonly referred to as mulch tillage or conservation tillage where the entire soil surface may be disturbed by tillage operations such as chisel plowing, field cultivating, tandem disking, or vertical tillage. It also includes tillage/planting systems with few tillage operations (e.g., ridge till) but which do not meet the soil tillage intensity rating (STIR) criteria for conservation practice Residue and Tillage Management, No Till (329).

Uniformly distribute residues over the entire field. Removing residue from the row area prior to or as part of the planting operation is acceptable.

Do not burn residues.

The STIR value shall include all soil disturbance field operations that are performed during the crop interval (i.e., from the time immediately following harvest or termination of one cash crop through harvest or termination of the next cash crop in the rotation, including fallow periods). ***The crop interval STIR value rating shall be no greater than 80, and no primary inversion tillage implements (e.g., moldboard plow) shall be used.***

Additional Criteria to Reduce Sheet, Rill and Wind Erosion, and Excessive Sediment in Surface Waters

Use the current approved water and wind erosion prediction technology to document/determine the field operations to achieve the amount of randomly distributed surface residue needed, time of year residue needs to be present in the field, and the planned field operations allowed to reduce erosion to the desired level. Calculations shall account for the effects of other practices in the management system.

In ridge-till systems, plan ridge height and ridge orientation to manage runoff and minimize erosion, with a maximum row grade not to exceed four percent.

Additional Criteria to Reduce Tillage-Induced Particulate Emissions

Reduce or modify tillage operations that create dust, especially during critical air quality periods.

Additional Criteria to Improve Soil Health and Maintain or Increase Organic Matter Content

Ensure the soil condition index (SCI) for the cropping system results in a rating of greater than zero.

Additional Criteria to Reduce Energy Use

Reduce the total energy consumption associated with field operations by at least 25 percent compared to the benchmark condition. Use the current approved NRCS tool for determining energy use to document energy use reductions.

CONSIDERATIONS

General Considerations

Removal of crop residue, such as by baling or grazing, can have a negative impact on resources. These activities should not be performed without full evaluation of impacts on soil, water, animal, plant, and air resources.

Reduced till may be practiced continuously throughout the crop sequence, or may be managed as part of a residue management system that includes other tillage methods such as no till.

Production of adequate amounts of crop residue necessary for the proper functioning of this practice can be enhanced by selection of high residue-producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

When providing technical assistance to organic producers, ensure residue and tillage management activities are consistent with the USDA Agricultural Marketing Service National Organic Program regulations.

Additional Considerations for Maintaining or Improving Soil Organic Matter Content and Soil Health

Carbon loss is directly related to the volume of soil disturbed, intensity of the disturbance and soil moisture content, and soil temperature at the time the disturbance occurs. The following guidelines can make this practice more effective:

- 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.
- Planting with a single disk opener no-till drill will release less carbon dioxide (CO2) and oxidize less organic matter than planting with a wide-point hoe/chisel opener seeder drill.
- Soil disturbance that occurs when soil temperatures are below 50° F will oxidize less organic matter and release less CO2 than operations done when the soil is warmer.
- Maximizing year-round coverage of the soil with living vegetation and/or crop residues builds organic matter and reduces soil temperature, thereby slowing organic matter oxidation.
- Use a diverse crop rotation by incorporating multiple crop types (cool-season grass, cool-season

legume/forb, warm-season grass, warm-season legume/forb) into the crop rotation.

- Plant a cover crop after every cash crop in the rotation. Multispecies cover crop mixes provide greater benefits than single-specie cover crops.
- Using undercutting tools rather than burying tools will enhance accumulation of organic material in the surface layer.
- Conducting any soil-disturbing field operation when soil moisture is optimal, neither excessive nor too dry, will help maintain soil tilth, and reduce the need for additional tillage in the future.

Additional Considerations for Providing Food and Escape Cover for Wildlife

Avoid tillage and other soil- and residue/stubble-disturbing operations during the nesting season and brood-rearing period for ground-nesting species.

Forgo fall shredding or tillage operations to maximize the amount of wildlife food and cover during critical winter months.

Leaving rows of unharvested crop standing at intervals across the field or adjacent to permanent cover will enhance the value of residues for wildlife food and cover. Leaving unharvested crop rows for two growing seasons will further enhance the value of these areas for wildlife.

Use an approved habitat evaluation procedure to determine the appropriate time and amount of residue and stubble needed to provide adequate food and cover for target wildlife species.

PLANS AND SPECIFICATIONS

Specifications shall be prepared for each site and purpose and recorded in the approved implementation requirements document.

- Purpose for applying the practice.
- Planned crop(s).
- Amount of residue produced by each crop.
- All field operations or activities that affect—
  - Residue orientation.
  - Surface disturbance.
  - The field operations and amount of residue (pounds/acre or percent surface cover) required to accomplish the purpose, and the time of year it must be present.
- Planned STIR value, SCI value, and erosion rate.
- Benchmark and planned energy consumptions.

OPERATION AND MAINTENANCE

Evaluate/measure the crop residue cover and orientation for each crop to ensure the planned amounts and orientation are being achieved. Adjust management as needed to either plan a new residue amount or orientation; or adjust the planting, tillage, or harvesting equipment.

If there are areas of heavy residue accumulation (because of movement by water or harvest operations) in the field, spread the residue prior to planting so it does not interfere with planter operation.

REFERENCES

Kuepper, George, 2001. Pursuing conservation tillage systems for organic crop production. ATTRA. http://attra.ncat.org/attra-pub/organicmatters/conservationtillage.html.

Reicosky, D.C., M.J. Lindstrom, T.E. Schumacher, D.E. Lobb, and D.D. Malo. 2005. Tillage-induced CO2 loss across an eroded landscape. Soil Tillage Res. 81:183-194.

Reicosky, D.C. 2004. Tillage-induced soil properties and chamber mixing effects on gas exchange. Proc. 16th Triennial Conf., Int. Soil Till. Org. (ISTRO).

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. 1997. Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). USDA, Agricultural Handbook 703.

USDA-ARS. Skidmore, E.L. and N.P. Woodruff. 1968. Wind erosion forces in the United States and their use in predicting soil loss. USDA, Agriculture Handbook 346.

USDA, NRCS. 2011. National Agronomy Manual. 190-V. 4th Ed.