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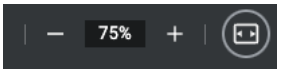
- USE THIS 

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CLIMATE-SMART GROWN IN SC LEAFY GREENS CPS DOCUMENTS

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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. Current NRCS Cover Crop Termination Guidelines are posted in FOTG Sec IV in the 340 Cover Crop CPS folder.

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.

A determination of cover crop stand adequacy must be made to enable practice certification. This adequacy determination will be based on an evaluation concluding: (a) establishment specifications were followed by the producer as closely as possible; and (b) the stand at time of evaluation can be reasonably expected to reach a maturity level and density to address the identified resource concern(s), achieve the practice purpose(s) and associated standard criteria, and meet producer objective. Evaluate stand adequacy at a time after planting when it can be best determined that conditions (a) and (b) have been met. Documentation (photos, cover measurements, map location of evaluation, etc.) that supports stand adequacy determination must be retained in the case file.

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). In NC, the 'critical erosion period' is when the production crop management system provides the least amount of soil cover.

Select cover crops that will have the physical characteristics necessary to provide adequate erosion protection. For cover crop single species selection for this purpose, varieties that have at least ½ circle filled in the Managing Cover Crops Profitably "Performance and Roles" Chart 2 (Appendix A of this standard) column "Erosion Fighter" or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable. For cover crop mix selection for this purpose, species determined to be effective for erosion control must be a substantial part of the mix.

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

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. For cover crop single species selection for this purpose, varieties that have at least ½ circle filled in the Managing Cover Crops Profitably "Performance and Roles" Chart 2 (Appendix A) column "Soil Builder" or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable. For cover crop mix selection for this purpose, species determined to be effective soil builders must be a substantial part of the mix.

The planned crop rotation including the cover crop and associated management activities will score a Soil Conditioning Index (SCI) value > 0, and be increased from the 'benchmark system' SCI 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.

Soil Aggregate Instability and Soil Organism Habitat Loss or Degradation Resource Concerns

Maintaining/Increasing soil organic matter is associated with addressing soil aggregate instability and soil organism habitat loss or degradation (soil biology) resource concerns. Thus, planting and managing cover crops in a manner that will maintain/increase soil organic matter will also be presumed to enhance soil aggregate stability and the environment for soil biological activity.

When “Aggregate Instability” or “Soil Organism Habitat Loss or Degradation” are identified as soil resource concerns, cover crop species with at least ½ circle filled in the MCPP “Performance and Roles” Chart 2 (Appendix A) column “Soil Builder”, or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable to include in establishment specifications.

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). Recent NCSU research indicates that cover crop seeding dates early in the date range windows indicated in the Specifications Development Tables provide better opportunities for sufficient plant growth to optimize nutrient (especially Nitrogen) uptake.

Select cover crop species for their ability to effectively utilize nutrients. For cover crop single species selection for this purpose, varieties that have at least ½ circle filled in the Managing Cover Crops Profitably “Performance and Roles” Chart 2 (Appendix column “N Scavenger” or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable. For cover crop mix selection for this purpose, species determined to be effective nutrient ‘scavengers’ must be a substantial part of the mix.

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.

For cover crop single species selection for this purpose, varieties that have at least ½ circle filled in the Managing Cover Crops Profitably “Potential Advantages” Chart 4A (Appendix B of this standard) “Soil Ecology” heading (or Performance and Roles Chart 2 “Weed Fighter” column for weed pressure) under the column specific to the pest concern or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable. For cover crop mix selection for this purpose, species determined to be effective in pest/weed suppression must be a substantial part of the mix.

When nematodes are the pest concern, consult qualified NC CES, NCDA, or CCA agronomy resources to match cover crop species known to be effective for control/suppression to the specifically identified nematode types.

Select cover crop species that do not harbor pests or diseases of subsequent crops in the rotation. (See MCPP Chart 4B — Potential Disadvantages – Appendix C of this standard)

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.

For cover crop single species selection for this purpose, varieties that have at least ½ circle filled in the Managing Cover Crops Profitably "Potential Advantages" Chart 4A (Appendix B) "Soil Impact – Subsoiler" column or are sufficiently documented as locally effective per relevant resource information and/or collaboration with qualified professional agronomy resources are acceptable. For cover crop mix selection for this purpose, species determined to be effective in addressing soil compaction must be a substantial part of the mix.

CONSIDERATIONS

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

If a farmer elects to use bin run or farmer-saved seed, it should be tested prior to seeding for purity, germination and noxious weeds by a recognized seed laboratory. These tests are performed free of charge for North Carolina residents by the North Carolina Department of Agriculture & Consumer Services.

When developing seeding specifications to achieve practice purposes and meet producer objectives, consider using NRCS ENTSC Plant Material Technical Note 1; "A Tool for Selecting Cover Crops in Row Crop Rotations in the Southeast" (link provided in "References") as a planning companion to standard criteria and other resource information like "Managing Cover Crops Profitably (*MCPP)". Species specific benefits, and seeding rates and dates from the tool are derived from MCPP guidance.

Consider that NRCS Cover Crop Termination Guidelines align well in NC with 'late' termination dates that maximize maturity potential and biomass production, and minimize 'bare soil' periods during production crop establishment.

Maintain an actively growing cover crop as late as feasible to maximize plant growth and biomass production, 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.

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.

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 (NCSU estimated N credits available at: https://content.ces.ncsu.edu/winter-annual-cover-crops) from the legume and reduce nitrogen applications to the subsequent crop accordingly if recommended by qualified agronomy resources.

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.

Additional Considerations for Reading and Understanding Key Concepts in "Managing Cover Crops Profitably" (MCCP) Resource Information

- MCPP is a resource meant to be consulted repeatedly when seeking information about cover crop management, purposes, benefits, and how they may fit into addressing resource concerns and achieving producer objectives. Key charts for assistance in planning cover crops to meet standard criteria and practice purposes are posted in FOTG Sec IV with this standard. Reading the book in its entirety is neither necessary nor practical.
- To gain a better understanding of key general concepts for cover crops use and management, and known effective functions and their alignment with conservation purposes, planners should focus on

specific articles and charts:

- "Benefits of Cover Crops"
- "Building Soil Fertility and Tilth"
- Chart 2, "Performance and Roles"
- Chart 4A, "Potential Advantages
- Species summary descriptions for cover crop varieties commonly prescribed in the local area—such as cereal rye, crimson clover, and brassicas. MCPP pages numbers species that have available summary descriptions are noted in Specifications Development Table 1.

PLANS AND SPECIFICATIONS

During development of site-specific producer specifications for establishment and management, complete the conservation planning process to associate identified resource concerns with practice purpose(s). Utilize technical resource materials provided with this standard (Appendices A-C), and process noted in standard criteria and Specifications Development Tables 1-3 to recommend cover crop species determined effective to achieve practice purpose(s).

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) and producer objective. If the cover crop is not meeting the purpose(s) and objectives, adjust the management, change the species of cover crop, or choose a different technology.

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Chart 3A

CULTURAL TRAITS

	Species	Aliases	Type[1]	Hardy through Zone[2]	Tolerances: heat	drought	shade	flood	low fert	Habit[3]	pH (Pref.)	Best Established[4]	Min. Germin. Temp.
NONLEGUMES	Annual ryegrass *p. 55*	Italian ryegrass	WA	6	◔	◔	◕	◕	◔	U	6.0–7.0	Esp, LSu, EF, F	
NONLEGUMES	Barley *p. 58*		WA	7	◕	◕	◑	◔	◕	U	6.0–8.5	F, W, Sp	
NONLEGUMES	Oats *p. 62*	spring oats	CSA	8	◔	◔	◔	◑	◑	U	4.5–6.5	LSu, ESP W in 8+	
NONLEGUMES	Rye *p. 65*	winter, cereal, or grain rye	CSA	3	◑	◕	◕	◑	●	U	5.0–7.0	LSu-F	34F
NONLEGUMES	Wheat *p. 72*		WA	4	◑	◑	◑	○	◑	U	6.0–7.5	LSu, F	
NONLEGUMES	Buckwheat *p. 77*		SA	NFT	◑	○	◔	◔	◔	U to SU	5.0–7.0	Sp to LSu	50F
NONLEGUMES	Sorghum–sudan. *p. 80*	Sudax	SA	NFT	●	●	◑	◑	◑	U	6.0–7.0	LSp, ES	65F
LEGUMES	Berseem clover *p. 87*	BIGBEE, multicut	SA, WA	7	◕	◑	◕	◑	◑	U to SU	6.2–7.0	ESp, EF	42F
LEGUMES	Cowpeas *p. 95*	crowder peas, southern peas	SAL	NFT	●	◕	◑	◔	●	SU/C	5.5–6.5	ESu	58F
LEGUMES	Crimson clover *p. 100*		WA, SA	7	◑	◔	◕	◔	◑	U/SU	5.5–7.0	LSu/ESu	
LEGUMES	Field peas *p. 105*	winter peas, black peas	WA	7	◔	◑	◔	◔	◔	C	6.0–7.0	F, ESp	41F
LEGUMES	Hairy vetch *p. 112*	winter vetch	WA/CSA	4	◔	◑	◑	◔	◔	C	5.5–7.5	EF, ESp	60F
LEGUMES	Medics *p. 119*		SP/SA	4/7	●	◕	◕	◔	◑	P/Su	6.0–7.0	EF, ESp, ES	45F
LEGUMES	Red clover *p. 127*		SP, B	4	◔	◔	◕	◑	◔	U	6.2–7.0	LSu; ESp	41F
LEGUMES	Subterranean cl. *p. 132*	subclover	CSA	7	◑	◕	◕	◑	●	P/SP	5.5–7.0	LSu, EF	38F
LEGUMES	Sweetclovers *p. 139*		B/SA	4	◕	●	◔	◔	●	U	6.5–7.5	Sp/S	42F
LEGUMES	White clover *p. 147*	white dutch ladino	LP/WA	4	◑	◑	◕	◕	◑	P/SU	6.0–7.0	LW, E to LSp, EF	40F
LEGUMES	Woollypod vetch *p. 151*	Lana	CSA	7	◕	◕	◑	◑	◕	SP, C	6.0–8.0	F	

[1]B=Biennial; CSA=Cool season annual; LP=Long-lived perennial; SA=Summer annual; SP=Short-lived perennial; WA=Winter annual
[2]See USDA Hardiness Zone Map, inside front cover. NFT=Not frost tolerant. [3]C=Climbing; U=Upright; P=Prostrate; SP=Semi-prostrate; SU=Semi-upright. [4]E=Early; M=Mid; L=Late; F=Fall; Sp=Spring; Su=Summer; W=Winter
○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

Chart 3B

PLANTING

	Species	Depth	Seeding Rate					Cost ($/lb.)[1]	Cost/A (median)[2]		Inoc. Type	Reseeds[3]
			Drilled		Broadcast				drilled	broadcast		
			lb./A	bu/A	lb./A	bu/A	oz./100 ft²					
NONLEGUMES	Annual ryegrass	0–½	5–10	.2–.4	15–30	.6–1.25	1	.50	3.75	11.25		R
	Barley	¾–2	50–100	1–2	80–125	1.6–2.5	3-5	.05–.20	9.38	12.81		S
	Oats	½–2	80–110	2.5–3.5	110–140	3.5–4.5	4–6	.10–.20	14.25	18.75		R
	Rye	¾–2	60–120	1-2	90–160	1.5–3.0	4–6	.05–.20	6.75	9.38		R
	Wheat	½–1½	60–120	1–2	60–150	1–2.5	3–6	.05–.25	13.50	15.75		S
	Buckwheat	½–1.5	48–70	1–1.4	60–96	1.2–1.5	3–4	.28–.70	29–	38–		R
	Sorghum-sudangrass	½-1.5	35	1	40–50	1–1.25	2	.21–.66	15.05	19.35		S
LEGUMES	Berseem clover	¼–½	8–12		15–20		2	1.50	15.00	27.00	crimson, berseem	N
	Cowpeas	1–1½	30–90		70–120		5	.50	30	47.50	cowpeas, lespedeza	S
	Crimson clover	¼–½	15-20		22–30		2–3	1.50	26	39	crimson, berseem	R
	Field peas	1½–3	50–80		90–100		4	.25	16.25	26.25	pea, vetch	S
	Hairy vetch	½-1½	15–20		25–40		2	1.25	22	41	pea, vetch	S
	Medics	¼–½	8–22		12–26		2/3	1.50	22.50	28.50	annual medics	R
	Red clover	¼–½	8–10		10–12		3	1.85	16.65	20.35	red cl, wht cl	S
	Subterranean clover	¼–½	10–20		20–30		3	2.50	37.50	62.50	clovers, sub, rose	R
	Sweetclovers	¼–1.0	6–10		10–20		1.5	.70	5.60	10.50	alfalfa, swt cl	R
	White clover	¼–½	3–9		5–14		1.5	3.10	18.60	29.50	red cl, wht cl	R
	Woollypod vetch	½–1	10–30		30–60		2-3	1.05	21	47.25	pea, vetch	R,S

[1]Per pound in 50-lb. bags as of summer/fall 1997; legumes especially subject to price changes due to supply variability. To locate places to buy seed, see *Seed Suppliers* (p. 166). [2]Mid-point price at mid-point rate, seed cost only. [3]**R**=Reliably; **U**=Usually; **S**=Sometimes; **N**=Never (reseeds).

Chart 4A

POTENTIAL ADVANTAGES

	Species	Soil Impact			Soil Ecology				Other		
		subsoiler	Frees P&K	Loosen Topsoil	nematodes	disease	allelopathic	choke weeds	attract beneficials	bears traffic	short windows
NONLEGUMES	Annual ryegrass *p. 55*	◑	◑	●	◑	◑	◑	●	◔	●	●
	Barley *p. 58*	◑	◑	◕	◔	◔	◕	◕	◑	◑	●
	Oats *p. 62*	○	◔	◕	○	◑	◕	●	○	◑	●
	Rye *p. 65*	◔	◕	●	◑	◑	●	●	◔	◕	●
	Wheat *p. 72*	◑	◕	◕	◔	◔	◔	◕	◔	◑	◑
	Buckwheat *p. 77*	○	●	◕	◔	○	◕	●	●	○	●
	Sorghum–sudangrass *p. 80*	●	◑	◑	◕	◕	●	●	◑	◑	●
LEGUMES	Berseem clover *p. 87*	◔	◕	◕	○	○	◔	◕	◑	◔	◕
	Cowpeas *p. 95*	◑	◑	◕	○	○	○	●	◕	○	●
	Crimson clover *p. 100*	◔	◑	◑	◔	◑	◔	◑	◕	◔	◑
	Field peas *p. 105*	◔	◔	◕	◑	◕	◔	◕	◕	◔	◕
	Hairy vetch *p. 112*	◑	◑	◕	◔	◑	◑	◕	●	○	○
	Medics *p. 119*	◑	◔	◔	◑	◑	◔	◕	◔	◔	●
	Red clover *p. 127*	◕	◕	◑	◔	◔	◑	◑	◕	◑	◑
	Subterranean clover *p. 132*	○	◔	◑	◔	◔	◕	●	◕	◕	◕
	Sweetclovers *p. 139*	●	●	●	◔	◔	◔	◑	◕	◑	○
	White clover *p. 147*	◔	◔	◕	○	○	◑	◕	◑	●	◑
	Woollypod vetch *p. 151*	◕	◑	◕	◔	◔	◑	●	◕	◔	◑

○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

Chart 4B

POTENTIAL DISADVANTAGES

	Increase Pest Risks			Management Challenges					
Species	weed potential	insects/ nematodes	crop disease	hinder crops	establish	till-kill	mow-kill	mature incorp.	**Comments Pro/Con**
NONLEGUMES									
Annual ryegrass	○[1]	◕	◕	◑	●	●	●	◑	If mowing, leave 3-4" to ensure regrowth.
Barley	◔	◔	◔	◑	●	●	●	○	Can be harder than rye to incorporate when mature.
Oats	●	◑	◕	◑	●	●	◔	◑	Cleaned, bin-run seed will suffice.
Rye	○	◑	◕	◔	◕	◕	●	○	Can become a weed if tilled at wrong stage.
Wheat	◑	◔	◔	◑	●	●	◕	◑	Absorbs N and H_20 heavily during stem growth, so kill before then.
Buckwheat	○	◕	●	●	●	●	●	●	Buckwheat sets seed quickly.
Sorghum–sudangrass	◑	◕	●	◔	●	◕	◕	◔	Mature, frost-killed plants become quite woody.
LEGUMES									
Berseem clover	●	◑	◕	●	●	◔	◔	◕	Multiple cuttings needed to achieve maximum N.
Cowpeas	●	◑	◕	●	●	●	●	●	Some cultivars, nematode resistant.
Crimson clover	◑	○	◕	●	◕	◕	◕	◕	Good for underseeding, easy to kill by tillage or mowing.
Field peas	●	◑	◔	●	●	●	●	◕	Susceptible to *sclerotinia* in East.
Hairy vetch	◑	◑	●	●	◑	◔	●	◑	Tolerates low fertility, wide pH range, cold or fluctuating winters.
Medics	◑	◔	●	◕	◕	◔	◕	◕	Perennials easily become weedy.
Red clover	◑	◔	◕	●	◕	◑	◔	◕	Grows best where corn grows well.
Subterranean clover	◑	○	◑	◑	●	◔	○	◕	Cultivars vary greatly.
Sweetclovers	◔	◔	●	◑	●	◑	◕	◔	Mature plants become woody.
White clover	◑	◑	◕	◔	◕	○	◑	◕	Can be invasive; survives tillage.
Woollypod vetch	◑	◑	◔	◑	◑	◕	●	◔	Hard seed can be problematic; resident vegetation eventually displaces.

[1]Symbols, this page only: ○ =Could be a major problem. ◔ =Could be a moderate problem. ◑ =Could be a minor problem. ◕ =Occasionally a minor problem. ● =Rarely a problem

Chart 1

TOP REGIONAL COVER CROP SPECIES[1]

Bioregion	N Source	Soil Builder	Erosion Fighter	Subsoil Loosener	Weed Fighter	Pest Fighter
Northeast	red cl, hairy v, berseem, swt cl	ryegrs, swt cl, sorghyb, rye	rye, ryegrs, wht cl, oats	sorghyb, swt cl	sorghyb, ryegrs, rye, buckwheat	rye, sorghyb
Mid-Atlantic	hairy v, red cl, berseem, crim cl	ryegrs, rye, swt cl, sorghyb	wht cl, cowpeas, rye, ryegrs	sorghyb, swt cl	rye, ryegrs, oats, buckwheat	rye, sorghyb
Mid-South	hairy v, sub cl, berseem, crim cl	ryegrs, rye, sub cl, sorghyb	wht cl, cowpeas, rye, ryegrs	sorghyb, swt cl	buckwheat, ryegrs, sub cl, rye	rye, sorghyb
Southeast Uplands	hairy v, red cl, berseem, crim cl	ryegrs, rye, sorghyb, swt cl	wht cl, cowpeas, rye, ryegrs	sorghyb, swt cl	buckwheat, ryegrs, sub cl, rye	rye, sorghyb
Southeast Lowlands	winter peas, sub cl, hairy v, berseem, crim cl	ryegrs, rye, sorghyb, sub cl	wht cl, cowpeas, rye, sorghyb	sorghyb, swt cl	berseem, rye, wheat cowpeas oats	rye, sorghyb
Great Lakes	hairy v, red cl, berseem, crim cl	ryegrs, rye, sorghyb, swt cl	oats, rye, ryegrs	sorghyb, swt cl	berseem, ryegrs, rye, oats	rye, sorghyb
Midwest Corn Belt	hairy v, red cl, berseem, crim cl	rye, barley, sorghyb, swt cl	wht cl, rye, ryegrs, barley	sorghyb, swt cl	rye, ryegrs, wheat, oats	rye, sorghyb
Northern Plains	hairy v, swt cl, medics	rye, barley, medic, swt cl	rye, barley	sorghyb, swt cl	medic, rye, barley	rye, sorghyb
Southern Plains	winter peas, hairy v	rye, barley, medic	rye, barley	sorghyb, swt cl	rye, barley	rye, sorghyb
Inland Northwest	winter peas, hairy v	medic, swt cl, rye, barley	rye, barley	sorghyb, swt cl	rye, wheat, barley	rye, sorghyb
Northwest Maritime	berseem, sub cl, lana v, crim cl	ryegrs, rye, sorghyb, lana v	wht cl, rye, ryegrs, barley	sorghyb, swt cl	ryegrs, lana v, oats, wht cl	rye
Coastal California	berseem, sub cl, lana v, medic	ryegrs, rye, sorghyb, lana v	wht cl, cowpeas, rye, ryegrs	sorghyb, swt cl	rye, ryegrs, berseem, wht cl	sorghyb, crim cl, rye
Calif. Central Valley	winter peas, lana v, sub cl, medic	medic, sub cl	wht cl, barley, rye, ryegrs	sorghyb, swt cl	ryegrs, wht cl, rye, lana v	sorghyb, crim cl, rye
Southwest	medic, sub cl	sub cl, medic, barley	barley, sorghyb		medic, barley	

[1]ryegrs=annual ryegrass. sorghyb=sorghum-sudangrass hybrid. berseem=berseem clover. winter peas=Austrian winter pea. crim cl=crimson clover. hairy v=hairy vetch. red cl=red clover. sub cl=subterranean clover. swt cl=sweetclover. wht cl=white clover. lana vetch=LANA woollypod vetch.

Chart 2

PERFORMANCE AND ROLES

Species	Legume N Source	Total N (lb./A)[1]	Dry Matter (lb./A/yr.)	N Scavenger[2]	Soil Builder[3]	Erosion Fighter[4]	Weed Fighter	Good Grazing[5]	Quick Growth
NONLEGUMES									
Annual ryegrass *p. 55*			2,000–9,000	◕	●	●	◕	◕	●
Barley *p. 58*			3,000–10,000	◕	◕	●	◕	◕	◕
Oats *p. 62*			2,000–10,000	◕	◑	◕	●	◑	●
Rye *p. 65*			3,000–10,000	●	●	●	●	◑	●
Wheat *p. 72*			3,000–7,000	◕	◕	◕	◕	◕	◑
Buckwheat *p. 77*			2,000–3,000	○	◑	◔	●	○	●
Sorghum–sudan. *p. 80*			8,000–10,000	●	●	●	◕	◕	●
LEGUMES									
Berseem clover *p. 87*	●	75–220	6,000–10,000	◕	◕	◕	●	●	●
Cowpeas *p. 95*	●	100–150	2,500–4,500	◔	◑	●	●	◑	◕
Crimson clover *p. 100*	◕	70–130	3,500–5,500	◑	◕	◕	◕	●	◔
Field peas *p. 105*	●	90–150	4,000–5,000	◔	◑	◕	◑	◕	◕
Hairy vetch *p. 112*	●	90–200	2,300–5,000	◔	◕	◕	◕	◑	◔
Medics *p. 119*	◑	50–120	1,500–4,000	◔	◑	◑	◕	◕	●
Red clover *p. 127*	◕	70–150	2,000–5,000	◑	◕	◑	◕	●	◔
Subterranean clover *p. 132*	●	75–200	3,000–8,500	◔	◕	◕	●	◕	◑
Sweetclovers *p. 139*	●	90–170	3,000–5,000	◔	●	◕	◕	◕	◑
White clover *p. 147*	●	80–200	2,000–6,000	◔	◑	◕	◕	●	◔
Woollypod vetch *p. 151*	●	100–250	4,000–8,000	◑	●	◑	●	◑	◕

[1]**Total N**—Total N from all plant. [2]**N Scavenger**—Ability to take up/store excess nitrogen. [3]**Soil Builder**—Organic matter yield and soil structure improvement. [4]**Erosion Fighter**—Soil-holding ability of roots and total plant. [5]**Good Grazing**—Production, nutritional quality and palatability.

○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

Chart 2

PERFORMANCE AND ROLES continued

	Species	Lasting Residue[1]	Duration[2]	Harvest Value[3] F*	Harvest Value[3] S*	Cash Crop Interseed[4]	Comments
NONLEGUMES	Annual ryegrass	◕	◑	◑	◔	●	Heavy N and H_20 user; cutting boosts dry matter significantly.
	Barley	●	◑	◕	◑	◕	Tolerates moderately alkaline conditions but does poorly in acid soil < pH 6.0.
	Oats	◑	◔	◑	◑	●	Prone to lodging in N-rich soil.
	Rye	●	◕	◔	◔	◕	Tolerates triazine herbicides.
	Wheat	◕	◕	◑	◕	◔	Heavy N and H_20 user in spring.
	Buckwheat	○	◔	○	◔	◕	Summer smother crop; breaks down quickly.
	Sorghum–sudangrass	◕	●	●	○	○	Mid-season cutting increases root penetration.
LEGUMES	Berseem clover	◑	●	●	◕	◑	Very flexible cover crop, green manure, forage.
	Cowpeas	◔	●	◑	◑	◑	Season length, habit vary by cultivar.
	Crimson clover	◑	◔	●	◕	●	Established easily, grows quickly if planted early in fall; matures early in spring.
	Field peas	◔	◑	●	◕	●	Biomass breaks down quickly.
	Hairy vetch	◔	◕	◔	◕	◑	Bi-culture with small grain expands seasonal adaptability.
	Medics	◑	◕	◑	◑	◑	Use annual medics for interseeding.
	Red clover	◔	◑	●	◕	●	Excellent forage, easily established; widely adapted.
	Subterranean clover	◕	◕	◕	○	●	Strong seedlings, quick to nodulate.
	Sweetclovers	◕	◕	◕	◑	◑	Tall stalks, deep roots in second year.
	White clover	◔	●	◕	◑	◕	Persistent after first year.
	Woollypod vetch	◔	◕	◔	◕	◑	Reseeds poorly if mowed within 2 months of seeddrop; overgrazing can be toxic.

[1]**Lasting Residue**—Rates how long the killed residue remains on the surface. [2]**Duration**—Length of vegetative stage.
[3]**Harvest Value**—Economic value as a forage (F) or as seed (S) or grain. [4]**Cash Crop Interseed**—Rates how well the cover crop will perform with an appropriate companion crop.

○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

Chart 3A

CULTURAL TRAITS

	Species	Aliases	Type[1]	Hardy through Zone[2]	Tolerances: heat	drought	shade	flood	low fert	Habit[3]	pH (Pref.)	Best Established[4]	Min. Germin. Temp.
NONLEGUMES	Annual ryegrass *p. 55*	Italian ryegrass	WA	6	◔	◔	◕	◕	◔	U	6.0–7.0	Esp, LSu, EF, F	
	Barley *p. 58*		WA	7	◕	◕	◑	◔	◕	U	6.0–8.5	F, W, Sp	
	Oats *p. 62*	spring oats	CSA	8	◔	◔	◔	◑	◑	U	4.5–6.5	LSu, ESP W in 8+	
	Rye *p. 65*	winter, cereal, or grain rye	CSA	3	◑	◕	◕	◑	●	U	5.0–7.0	LSu-F	34F
	Wheat *p. 72*		WA	4	◑	◑	◑	○	◑	U	6.0–7.5	LSu, F	
	Buckwheat *p. 77*		SA	NFT	◑	○	◔	◔	◔	U to SU	5.0–7.0	Sp to LSu	50F
	Sorghum–sudan. *p. 80*	Sudax	SA	NFT	●	●	◑	◑	◑	U	6.0–7.0	LSp, ES	65F
LEGUMES	Berseem clover *p. 87*	BIGBEE, multicut	SA, WA	7	◕	◑	◕	◑	◑	U to SU	6.2–7.0	ESp, EF	42F
	Cowpeas *p. 95*	crowder peas, southern peas	SAL	NFT	●	◕	◑	◔	●	SU/C	5.5–6.5	ESu	58F
	Crimson clover *p. 100*		WA, SA	7	◑	◔	◕	◔	◑	U/SU	5.5–7.0	LSu/ESu	
	Field peas *p. 105*	winter peas, black peas	WA	7	◔	◑	◔	◔	◔	C	6.0–7.0	F, ESp	41F
	Hairy vetch *p. 112*	winter vetch	WA/CSA	4	◔	◑	◑	◔	◔	C	5.5–7.5	EF, ESp	60F
	Medics *p. 119*		SP/SA	4/7	●	◕	◕	◔	◑	P/Su	6.0–7.0	EF, ESp, ES	45F
	Red clover *p. 127*		SP, B	4	◔	◔	◕	◑	◔	U	6.2–7.0	LSu; ESp	41F
	Subterranean cl. *p. 132*	subclover	CSA	7	◑	◕	◕	◑	●	P/SP	5.5–7.0	LSu, EF	38F
	Sweetclovers *p. 139*		B/SA	4	◕	●	◔	◔	●	U	6.5–7.5	Sp/S	42F
	White clover *p. 147*	white dutch ladino	LP/WA	4	◑	◑	◕	◕	◑	P/SU	6.0–7.0	LW, E to LSp, EF	40F
	Woollypod vetch *p. 151*	Lana	CSA	7	◕	◕	◑	◑	◕	SP, C	6.0–8.0	F	

[1]B=Biennial; CSA=Cool season annual; LP=Long-lived perennial; SA=Summer annual; SP=Short-lived perennial; WA=Winter annual
[2]See USDA Hardiness Zone Map, inside front cover. NFT=Not frost tolerant. [3]C=Climbing; U=Upright; P=Prostrate; SP=Semi-prostrate; SU=Semi-upright. [4]E=Early; M=Mid; L=Late; F=Fall; Sp=Spring; Su=Summer; W=Winter
○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

USDA
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Cover crops on a field in Black Hawk County, Iowa.
Photo: Lynn Betts, NRCS

NRCS Cover Crop Termination Guidelines

December 2013

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 and 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.

The guidelines apply to non-irrigated cropland, including systems that contain a fallow period. Termination of cover crops utilized in an irrigated cropping system is not restricted to a given cover crop termination zone. Cover Crops in irrigated cropping systems should be terminated based on the crop system and conservation purpose, but before the planted crop emerges.
See map on page 2.

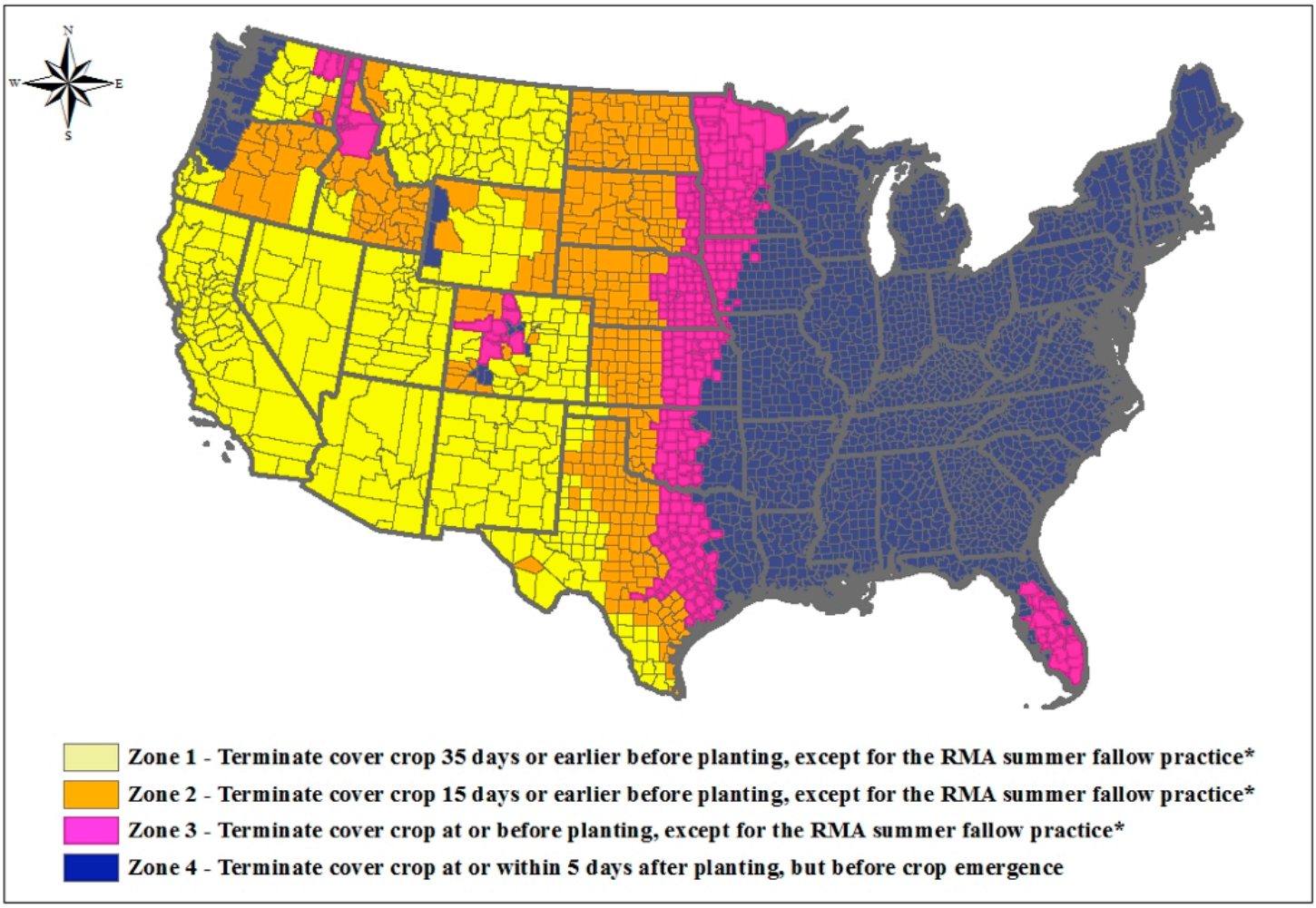
NRCS Cover Crop Termination Guidelines for Management Zones

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 - Terminate cover crops 35 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)	**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 Summer Fallow Practice * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	**RMA Designated Summer Fallow Practice** * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	**RMA Designated Summer Fallow Practice** * For summer seeded or fall seeded crops terminate the cover crop at least 90 days prior to planting. * For early spring seeded crops terminate the cover crop either in late fall or as early as possible in the spring prior to planting.	

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

* Cover Crop Termination Zones

Produced by: NRCS | ESD
December 2013



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

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.

Photo: Justin Fritsher, NRCS

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

Additional Cover Crop Termination Considerations (Continued):

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). Later spring crops include such crops as dry beans and soybeans.

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, the cover crop may be terminated closer to planting, if recommended by the experts.

8. Cover Crop Grazing or Forage Harvest – In all areas, except for the RMA summer fallow practice in Zones 1, 2 and 3, cover crops may be grazed or harvested as hay or silage as long as the planned amount of biomass is available at the time of termination to meet the conservation purpose. For the RMA designated summer fallow practice, cover crops should not be hayed or grazed. A cover crop harvested for grain or seed will not be considered to have been planted for conservation purposes, and will be considered a "crop".

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 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.

Stripcropping with Cover Crops, Lancaster County, PA.

Photo: Bob Nichols

Additional Cover Crop Termination Considerations (Continued):

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).

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 of corn or soybeans about the time of physiological maturity (leaves beginning to yellow) to get the cover crop started a few weeks earlier. Neither of these examples of over- seeding/interseeding would interfere with harvest of the main 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 it is harvested. The relay cropping strategy is used to enable production of a second crop in areas where time 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: Harvesting at least 2 crops from the same land in the same year. This does not include cover crops.
5. Cover Crop - Crops including grasses, legumes and forbs for seasonal cover and other conservation purposes. A cover crop managed and terminated according to these guidelines is not considered a “crop”.
6. 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 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.
7. Late Planting Period – RMA term - The period of time following the date considered as the final planting date for an insured crop. The late planting period may vary from a week up to a few weeks.
8. Prevented Planting – RMA term - Failure to plant the insured crop by the final planting date designated in the Special Provisions for the insured crop in the county, or within any applicable late planting period, due to an insured cause of loss that is general to the surrounding area and that prevents other producers from planting acreage with similar characteristics.
9. Continuous Cropping – RMA Term – A practice of growing crops annually in a rainfall limited area (where summer fallow is also a practice).

Introduction and Purpose

Adaptive management is a systematic process to collect, monitor, analyze, and learn from results of evaluations of practices conducted on growers' fields. The goal of the adaptive management approach is to test and evaluate how a practice can best be applied on a given farming operation or site condition.

The purpose of this guide sheet is to provide guidance to plan and implement adaptive management of the NRCS Conservation Practice Standard (CPS) Code 345, Residue and Tillage Management, Reduced Till. An NRCS payment schedule scenario was developed within the CPS Code 345, Residue and Tillage Management, Reduced Till, to provide financial assistance to support adaptive management.

Guidelines for Adaptive Management Application for Reduced Till:

1. Follow the guidance in the Agronomy Technical Note 190-AGR-10, Adaptive Management for Conservation Practices.
2. The evaluation should be carried out for at least 3 years and preferably on the same area each year. There may be cases where this is not practical.
3. The application and hypothesis of at least one variable must address and meet the criteria and specifications of the CPS Code 345, Residue and Tillage Management, Reduced Till, for at least one of the purposes. Example trials/evaluations may include:
    a. Compare no till vs reduced till.
    b. Compare reduced till with a cover crop to mulch till without a cover crop.
    c. Compare different mulch tillage tools or configurations to compare yield and surface residue management.
    d. Evaluate different high disturbance drills or configurations of the drills.
    e. Evaluate different chisel points or rolling baskets.
    f. Evaluate reduced till vs conventional till.
4. The evaluation should include the services of a consultant with knowledge of reduced till (residue management) farming to help plan the evaluation, layout the plots, monitor the plots during the season, assist in gathering the required data (yield, soil tests, residue counts, soil health measurements, etc.), and analyze the data that will support the purpose of the evaluation.
5. The evaluation can focus on one or more results, e.g., may collect data to not only address yield but also changes in soil health parameters (aggregate stability, infiltration, organic matter, etc.).
6. Analyze the data each year and at the end of the trial period, usually 3 years.
7. The annual and final results and analysis should be jointly reviewed with NRCS, the grower, and consultant involved.

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 (Code 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 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 wind) in the field, spread the residue prior to planting so it does not interfere with planter operation.

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United States Department of Agriculture

Conservation Practice Overview

October 2017

CPS Mulching (Code 484)

Mulching is applying plant residues or other suitable materials to the land surface.

Practice Information

This practice is used on all lands subject to erosion and high runoff that need the additional protection. Mulching can be applied to achieve one or a combination of purposes. Purposes for utilizing this practice are—

- To help control soil erosion.
- Protect crops.
- Improve moisture management.
- Reducing irrigation energy.
- Prevent excessive bank erosion from water conveyance channels.
- Maintain or increase organic matter.
- Improve plant productivity and health.

Mulch materials may consist of natural or artificial materials of sufficient dimension (depth or thickness) and durability to achieve the intended purpose for the required time period.

Common Associated Practices

Conservation Practice Standard (CPS) Mulching (Code 484) is commonly applied with practices associated with a vegetation establishment such as CPSs Critical Area Planting (Code 342), Diversion (Code 362), Tree/Shrub Establishment (Code 612), Windbreak/Shelterbelt Establishment (Code 380), and others.

For further information, contact your local NRCS field office.

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

MULCHING

Code 484

(Ac)

DEFINITION

Applying plant residues or other suitable materials to the land surface.

PURPOSE

This practice is applied to achieve the following purpose(s):

- Improve the efficiency of moisture management
- Reduce irrigation energy used in farming/ranching practices and field operations
- Improve the efficient use of irrigation water
- Prevent excessive bank erosion from water conveyance channels
- Reduce concentrated flow erosion
- Reduce sheet, rill, & wind erosion
- Improve plant productivity and health
- Maintain or increase organic matter content
- Reduce emissions of particulate matter

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where mulches are needed.

CRITERIA

General Criteria Applicable to All Purposes

The selection of mulching materials will depend primarily on the purpose(s) for the mulch application, site conditions, and the material's availability. The mulch materials may consist of natural or artificial materials of sufficient dimension (depth or thickness) and durability to achieve the intended purpose for the required time period.

Prepare the soil surface to achieve its desired purpose prior to mulching.

Apply the mulch material evenly. Use tackifiers, emulsions, pinning, netting, crimping or other methods of anchoring, if needed, to hold the mulch in place for specified periods.

In cases where furrow erosion may occur due to concentrated flows from mulches (e.g., plastic mulches on beds), take appropriate measures to protect the furrows and the furrow outlets.

Apply manufactured mulches according to the manufacturer's specifications.

Remove synthetic mulches from the field prior to the next crop. Do not incorporate (e.g., disk) synthetic mulches into the soil.

When mulching with wood products such as wood chips, bark, or shavings or other wood materials, apply a minimum 2-inch thickness of particles that will remain in place during heavy rainfall or strong wind events, or both if applicable.

The minimum size of mulching material consisting of gravel or other inorganic mulching is 0.75 inches and applied to a minimum depth of 2 inches.

When mulching with cereal grain straw or grass hay, apply at a rate to achieve a minimum 70-percent ground cover. Determine the mulch rate using the current erosion prediction technology for the intended purpose.

Do not apply plant-based mulch materials with a carbon (C) to nitrogen (N) ratio less than 20:1 to watercourses.

Additional Criteria to Improve the Efficiency of Moisture Management, to Reduce Irrigation Energy Used in Farming/Ranching Practices and Field Operations or to Improve the Efficient Use of Irrigation Water

Apply mulch materials to cover at least 90 percent of the soil surface to reduce potential evaporation.

Fine-textured mulches (e.g., rice hulls) that allow less oxygen penetration than coarser materials should not be thicker than 2 inches.

Additional Criteria to Improve Plant Productivity and Health

When establishing vegetative cover, apply mulch at a rate that achieves a minimum of 70-percent ground cover to provide protection from erosion and runoff and yet allow adequate light and air penetration to the seedbed to ensure proper germination and emergence.

Additional Criteria to Maintain or Increase Organic Matter Content

Use plant-based mulching materials of suitable quantity and quality to add organic matter, provide food and shelter for soil biota, and protect the soil surface from raindrop impact and crusting, while allowing for adequate soil aeration.

An evaluation of the system using the current approved soil conditioning index (SCI) procedure results in zero or higher.

CONSIDERATIONS

Evaluate the effects of mulching on evaporation, infiltration, and runoff. Mulch material may affect microbial activity in the soil surface, increase infiltration, and decrease runoff, erosion, and evaporation. The temperature of the surface runoff may also be lowered.

Mulch materials with low permeability may adversely affect the water needs of plants.

Avoid excessively thick or tightly packed mulches that can result in soggy, anaerobic conditions at the soil surface during wet weather; or prevent rainfall or overhead irrigation from reaching the soil during times of moisture deficit

Organic materials with C:N ratios of less than 20:1 will release nitrate-nitrogen that could cause water quality impairments.

Finely divided plant residues (e.g., sawdust) and those rich in soluble carbohydrates (e.g., fresh green-chopped sorghum-sudangrass, corn, or other grasses) that have a C:N ratio greater than 30 can tie up

soil N and necessitate supplemental N applications on crops. Coarser materials such as grain straw and chipped brush usually do not reduce crop-available soil N levels unless and until they are incorporated into the soil by tillage or cultivation.

Mulching may also provide habitat for beneficial organisms and provide pest suppression.

In attempting to provide habitat for ground beetles, spiders, and other predators of weed seeds and crop pests, use mulch of sufficient ground cover and suitable thickness and texture for the target species. Avoid excessively thick or tightly packed mulches, which can interfere with the movement of ground beetles and other beneficial organisms, and may increase the incidence of crop pests and diseases. Consider mulching crops only if the selected mulching materials, and rates of application do not contribute to pest problems.

During the period when weed seed predation is desired and predators are most active, avoid pesticide applications or pesticide exposures that could adversely affect weed seed consumers.

Low permeability mulches (e.g., plastic) may increase concentrated flow and erosion on the nonmulched areas.

Light-reflecting mulches such as white or aluminized plastic film or bright straw can repel some pests.

Consider potential beneficial or detrimental effects of mulching materials on the biotic community surrounding the crop, including beneficial soil micro- and macro-organisms, as well as plant pathogens and plant pests. These effects are specific to site, mulch, and crop, and may include enhanced soil microbial activity, increased or reduced levels of crop diseases, and toxic (allelopathic) activity against the crop, weeds, or other beneficial or pest organisms.

Keep mulch 3 to 6 inches away from plant stems and crowns to prevent disease and pest problems. Additional weed control may be needed around the plant base area.

Deep mulch provides nesting habitat for ground-burrowing rodents that can chew extensively on tree trunks and tree roots. Light mulch applied after the first cold weather may prevent rodents from nesting.

Some mulch material may adversely affect aquatic environments through changes in water chemistry or as waterborne debris. Consider placing mulch in locations that minimize these risks.

Consider potential effects of soil physical, chemical, and biological properties. Refer to soil survey data as a preliminary planning tool for assessment of areas. Consult a resource soil scientist or the Web Soil Survey at: http://websoilsurvey.nrcs.usda.gov/app/ to obtain soil properties and qualities information.

For all organic or transitioning to organic operations, follow all National Organic Program rules.

PLANS AND SPECIFICATIONS

Prepare specifications for each site and purpose on the implementation requirements document. Documentation must include—

- Purpose of the mulch.
- Type of mulch material used.
- Percent cover or thickness of mulch material, as applicable.
- Timing of application.
- Site preparation.
- Listing of netting, tackifiers, or method of anchoring.
- Operation and maintenance.

OPERATION AND MAINTENANCE

Periodically inspect the mulched areas and reinstall mulch or repair as needed to accomplish the intended purpose.

Evaluate the effectiveness of the mulch (application, amount of cover provided, durability, etc.) and adjust the management or type of mulch to better meet the intended purpose(s).

Remove or incorporate mulch materials to be consistent with the intended purpose and site conditions.

Do not operate equipment near the mulched site that would compromise the intended purpose of the mulch.

Prevent or repair any fire damage to the mulch material.

Properly collect and dispose of synthetic mulch material after intended use.

Monitor and control undesirable weeds in mulched areas.

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