Wisconsin Guidance Document
Cover Crops (340)

What are Cover Crops?

Cover crops are grasses, legumes, and/or forbs established for seasonal vegetative cover and are not harvested for seed or grain.

Nurse crops planted at the same time as a perennial crop to increase the cover and/or success of the perennial crop are not considered cover crops by this standard.

Cover crops can be established between successive production crops, interseeded and overseeded into production crops, and planted in alleyways of perennial trees or vine crops on all lands requiring seasonal vegetative cover for natural resource protection or improvement.

Cover Crop Purpose

The cover crop practice standard should be implemented to support one or more of these purposes:

- Reduce sheet, rill, and wind erosion.
- Maintain or increase soil organic matter.
- Improve soil aggregate stability.
- Improve habitat for soil organisms.
- Reduce water quality degradation by utilizing excess soil nutrients.
- Reduce weed and plant pest pressure.
- Improve moisture management.
- Reduce soil compaction.
- Supply nitrogen to the subsequent crop.
- Improve habitat for pollinators, beneficial organisms, or natural enemies of crop pests.

General Considerations for Cover Crop Establishment

Successful cover crop implementation requires the consideration of several agronomic, climatic, and production system variables, as well as the client's purpose(s) and management objectives and abilities.

***NOTE**:* Additional to this guidance, cover crop selection, implementation, and management should meet the criteria set forth in:

- Wisconsin NRCS Conservation Practice Standard (340), Cover Crops;
- Client's crop insurance program, where applicable;
- NRCS Cover Crop Termination Guidelines; and
- National Organic Program (NOP), where applicable.

Cover Crop Species Selection

Multiple cover crop species and/or species mixes are often suitable to meet a singular cover crop purpose. Additionally, a singular cover crop planting may be used to meet multiple cover crop purposes simultaneously.

General agronomic, conservation, and cultural information for approved Wisconsin cover crop species are found in Tables 1 and 2.

Considerations for cover crop species selection

- Select cover crop species adapted to site-specific soil, climatic, and ecological conditions.
- Select cover crop species likely to achieve the identified purpose(s) within the available planting and termination dates and to achieve adequate growth for winter survival, where applicable.
- Enhance crop rotational diversity by incorporating missing plant functional groups within the planned crop rotation.
- If utilizing a cover crop mix, include species from at least two plant functional groups where practical.
- Consider cover crop species' impact on potential nutrient immobilization and nutrient availability to the subsequent production crop, including the species' estimated C:N ratio at termination.
- Plant certified seed of identified cultivars/varieties rather than variety not stated (VNS) seed when a specific growth trait or plant characteristic specific to a cultivar/variety is desired or required to meet the cover crop purpose.
- Avoid species identified as restricted or prohibited by law.
- Ensure compatibility of selected species with other components of the cropping system, including past and future herbicide applications and soil amendments. Evaluate herbicide applications for the 24 months prior to cover crop establishment for potential carryover issues and/or grazing/harvest restrictions using the manufacturer's product labels, where applicable.
- For organic and transitioning to organic systems, comply with NOP rules, paying particular attention to potential hybrid selection to meet planned purpose and proposed termination methods, seed treatments, and organic certification requirements.

Cover Crop Seed Quality

Wisconsin NRCS cover crop seeding rate recommendations are based upon certified seed obtained from commercial sources. Non-commercial seed can be used for this practice but must meet the seed quality expectations below.

Considerations for ensuring cover crop seed quality

- Use cover crop seed free of plant species on the Wisconsin DNR NR40 Invasive: Regulated Species list and other known noxious weed seed.
- Test non-commercial (bin-run) seed for purity and warm germination by a testing laboratory following the Association of Official Seed Analysts (AOSA) procedures. A copy of the seed quality testing results should be included in the planning file.
- Ensure, at minimum, cover crop seed source contains 85% Pure Live Seed (PLS), as calculated using the general equation –

  *PLS = (% germination * % purity) ÷ 100*

- For cover crop seed achieving less than 85% PLS, the planned seeding rate must be adjusted using the general equation –

  *Adjusted Seeding Rate = (1 + (85 - %PLS)) * recommended seeding rate (Table 3)*

Field/Site Preparation

Proper field/site preparation provides weed suppression and promotes cover crop germination and growth. Ideally, cover crop establishment will occur with minimal soil disruption, where appropriate.

Considerations for field/site preparation

- Select field/site preparation methods compatible with identified resource concerns and to meet cover crop objective(s).
- Consider the availability of labor/time, equipment, and/or availability and potential effectiveness of burndown herbicides for the site.
- Consider current soil surface conditions, moisture levels, and existing biomass (surface cover) when selecting seedbed preparation method and timing to reduce soil erosion by wind and water and soil compaction.
- Balance the time required for seedbed preparation, the harvest date of the preceding crop, and the estimated growing degrees units remaining prior to the average killing frost.

Cover Crop Seeding Dates

Wisconsin is divided into two cover crop planting zones – north and south – based upon average first and last frost dates and average growing season conditions (Figure 1). Recommended planting dates for each zone are found in Table 3.

Cover crop establishment should be planned within the dates listed in Table 3.

Planners with proper Job Approval Authority (JAA), may approve planting the cover crop up to seven days past the dates published in Table 3 with proper documentation of favorable forecasted weather and soil conditions.

Considerations for cover crop seeding dates

- Consider short and long-term (10 days or more) weather forecasts, including both temperature and precipitation forecasts, and cover crop species characteristics to evaluate the potential for successful cover crop germination and establishment.
- Document information used to support the decision to extend planting outside of the published seeding window (maximum 7-day extension).
- Planting cover crops after the 7-day extension requires a waiver from the Area Resource Conservationist (ARC) or State Agronomist.

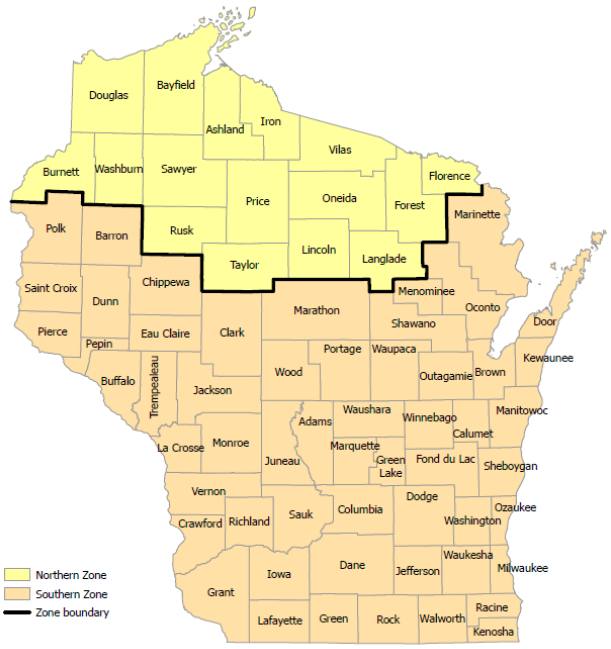

Figure 1. Cover Crop Planting Zones for Wisconsin

Cover Crop General Seeding Methods

Successful cover crop plantings require seeding within the recommended dates using seeding methods to ensure adequate seed-to-soil contact and sufficient soil moisture to support seedling growth.

Drilled or Planted Cover Crops

Drilling or planting cover crops increases seed-to-soil contact, seed access to moisture, and potential establishment success. Calibrate equipment and equipment operation to ensure the proper seeding rate is achieved, particularly when using multi-species seed mixes.

General Considerations for Drilled or Planted Cover Crops

- Ensure proper drill and planter setup, operation, and calibration to:
  - Achieve targeted seeding depth and adequate slot closure, particularly in high residue systems; and
  - Reduce seed mix separation when using mixes containing diverse seed sizes/shapes.
- When using a drill, diverse sized seed mixes should be sorted according to size and shape and placed in the appropriate seed boxes to ensure uniform distribution, spatially and with depth, across the field, when practical.
- If weed suppression is the primary cover crop purpose, choose drilling or narrow row planting to increase the rate and amount of soil coverage with cover crop vegetation and subsequent cover crop residue.
- Plant at an incorporated seeding rate shown in Table 3.

Broadcast Cover Crops, With or Without Incorporation

Broadcast seeding of cover crops can be accomplished using spinners, drop tubes, air pressure, or other methods/techniques to scatter seeds on the soil surface. Broadcasting equipment is commonly mounted to various vehicles/equipment, including ATVs, tractors, combines/harvesters, tillage equipment, airplanes, drones, fertilizer spreaders, and/or high clearance sprayers/spreaders. On a small scale, seeds can also be broadcast by hand.

When broadcasting cover crops, seed germination requires adequate moisture at the soil surface or within the crop residue layer. Incorporation of cover crop seeds increases seed-to-soil contact, seed access to moisture, and potential establishment success. To accommodate for potential decreased germination success, recommended broadcast seeding rates without incorporation are often higher than incorporated seeding rates (Table 3).

Calibrate equipment and equipment operation to ensure cover crop seed is spread uniformly across the field.

General Considerations for Broadcast Cover Crops Without Seed Incorporation

- Select species with an expected high germination rate and highest probability of germination success when broadcast planting without incorporation.
- Consider broadcast seeding when there is a high probability of rainfall within a week after seeding.
- Evaluate potential pest predation of surface-applied seed and consider incorporation if predation is likely.
- Plant at a non-incorporated seed rate outlined in Table 3.

General Considerations for Broadcast Cover Crops Followed by Seed Incorporation

- Broadcasting cover crop seed with light incorporation, via light shallow tillage or use of a ring roller, cultipacker or similar tool, increases seed-to-soil contact as compared to broadcasting alone. In small scale production systems, seed may be lightly incorporated via raking, rolling, or similar method.
- Utilize the least amount of incorporation to achieve adequate seed-to-soil contact.
- Plant at an incorporated seed rate shown in Table 3.

Cover Crop Seeding Methods/Windows within a Crop Rotation

Standard Establishment

Standard seeding refers to cover crop establishment by drilling or broadcasting with or without incorporation between successive production crops.

Guidelines for standard cover crop seeding

- Cover crops may be drilled, planted, or broadcast, with or without incorporation. Incorporation of seed by light shallow tillage or use of a ring roller, cultipacker or similar tool to embed the seed after a broadcast application will result in a more uniform seedling emergence.
- Drilling is the preferred cover crop seeding method. If seeding into heavy crop residue, ensure the drill is designed/set-up to handle crop residue and the seed type being planted, particularly when planting small seeds or mixtures with varying seed size and/or density.

Specialized Establishment

Frost seeding is categorized as broadcast or aerial seeding in mid to late March through early April during the active freezing and thawing cycle. Warm daytime temperatures combined with low overnight temperatures cause the soil surface to freeze and crack, naturally incorporating the seed. Proper planning is required to identify the timing of conditions favorable for frost seeding while assuring the crop will not freeze after emergence. Ideal frost seeding conditions vary from year to year, and in certain years the window for seeding may amount to a few days.

Guidelines when frost seeding cover crops

- Seedbed conditions must favor good seed to soil contact:
- Untilled winter wheat or soybean residue fields are ideal seedbed conditions.
- Frost seeding SHALL NOT occur on undisturbed heavy residue corn fields or similar conditions.
- When seedbed preparation is necessary in the fall prior to freeze-up, maintain 30-70% residue surface cover.
- Frost seeding SHALL NOT occur on areas covered with solid ice or snow cover depth greater than 2 inches.
- Frost seeding shall be completed before the end of the freeze and thaw cycle.

Interseeding refers to seeding a cover crop into a standing production crop during its vegetative growth stages. In Wisconsin, cover crops are most often interseeded into corn at the V2 to V6 growth stage via broadcast or direct seeding.

Guidelines when interseeding cover crops

- Select shade tolerant cover crop species for the seeding date. Refer to Table 1 and 2 for species selection.
- Select species to not excessively compete with the production crop for water, sunlight, or nutrients, particularly nitrogen.
- Cover crops interseeded into standing crop can be drilled or broadcast, with or without incorporation, with drilling being the preferred establishment method.
- Ensure previous growing season and current season burndown, pre-emergent, and in-season herbicide use will not interfere with cover crop success. Consult current University of Wisconsin recommendations for interseeding compatible herbicides.
- Avoid interseeding in fields with known high weed pressures, particularly those with herbicide-resistant weed populations.
- Early interseeding recommendations are for interseeding into corn planted in 30-inch rows. Additional species may be suitable if corn is planted in wider rows or in skip row systems.
- Adequate soil moisture and/or forecasted rainfall after seeding will likely increase interseeding success. Dry conditions will result in poor germination and growth, particularly in broadcast and non-incorporated systems. Consult the short and long-term precipitation forecasts to gauge potential for cover crop establishment success.
- Plant at the incorporated or unincorporated seed rate, as appropriate, shown in Table 3.

Overseeding is the broadcast seeding of a cover crop into a standing production crop near the time of crop harvest or maturity. Overseeded cover crops can be broadcast via aerial (plane, helicopter, drone) or ground applicators (highboy, seeder/spreaders, etc.).

Guidelines when overseeding cover crops

- Review Tables 1 and 2 and select species suitable for broadcast application and seeding dates.
- Avoid large-seeded cover crops due to reduced rate of germination success.
- Ensure the previous and current growing season's herbicides will not interfere with cover crop success.
- Avoid overseeding cover crops into fields with thick residue cover and/or weed pressures which may impede seed-to-soil contact and/or germination and establishment success.
- Avoid overseeding small grains into fields with historically high slug pressures.
- Adequate soil moisture and/or forecasted rainfall after seeding will likely increase overseeding success. Dry conditions will result in poor germination and growth, particularly in broadcast and non-incorporated systems. Consult the short and long-term precipitation forecasts to gauge potential for cover crop establishment success.
- Corn for grain: Cover crops should be over-seeded after the corn has begun to dry down, silks are brown, and leaves are dried up to the ear in order to minimize trapping of seed by vegetation and to allow sunlight to reach the ground between rows.
- Corn for silage: Cover crops should be overseeded within 21 days of anticipated harvest.
- Soybeans: Overseed cover crops into standing unharvested soybeans when leaf yellowing begins. Soybean row spacing will impact optimal time of seeding, with earlier optimal planting dates for wider rows versus narrow rows.
- Plant at the unincorporated seed rate shown in Table 3. Consider increasing the seeding rate if there is increased likelihood the seed will be intercepted by the standing production crop.

Slurry-enriched seeding combines no or minimal disturbance manure application and the seeding of cover crops into one operation. Cover crop seed is added directly into the manure stream and spread with the manure in a one-pass system. The method carries the risk of reduced seed germination due to ammonia and/or salts within the manure and/or generation of ammonia via volatilization. Therefore, consider increasing the cover crop seeding rate to achieve stand density goals.

General Considerations for Slurry Seeded Cover Crops

- Choose cover crop species compatible with slurry seeding methods, including small grains, annual ryegrass, clovers, and brassicas. Due to the nitrogen content of manure, cover crop mixes should contain legumes as a minor component.
- Application method and equipment should be calibrated and operated to ensure proper spatial and depth distribution of seed at the targeted planting rates.
- Manure should be agitated, as appropriate, to maintain cover crop seed in suspension.

- Rainfall within a week of seeding may increase establishment success, particularly if cover crop seed remains at the soil surface and a low rate of manure was applied.
- Plant at an incorporated or unincorporated seed rate, as appropriate, shown in Table 3.

Cover Crop Seeding Rates

Base Cover Crop Seeding Rate and Adjustments

The “base” cover crop seeding rate is the starting point for planning (Table 3) and can be adjusted up or down within the allowed seeding rate range when warranted to meet the cover crop purpose(s) and/or client’s planned management and objectives. The base rate should be used when few details about the field and/or growing season conditions and/or intended purpose(s) and objectives are known.

The acceptable “range” of seeding rates is the allowed range of seeding populations, where an adjustment to the base rate is likely to increase the potential for the cover crop to meet intended purpose(s) and/or where an adjustment increases the benefits or decreases economic or agronomic risks by accommodating for soil, management system, and/or growing season conditions.

In general, the lower range of the acceptable range of cover crop seeding rates may apply when:

- Establishment occurs in the early part of the seeding date range.
- Soil moisture conservation is of concern.
- Seed prices or availability compromise higher seeding rates.
- Increased biomass production is expected on high fertility soils or after manure applications.
- Seeding after small grain harvest where volunteer growth is maintained.
- Increased residue accumulation could impede planting into a live or recently terminated cover crop (planting green).
- Developing a multispecies cover crop mix to accommodate species architecture and competitiveness.

In general, the upper range of the acceptable range of cover crop seeding rates may apply:

- Establishment occurs in the later part of the seeding date range.
- Rapid biomass production is needed to meet immediate cover crop purposes or objectives, such as weed suppression, erosion reduction, nutrient scavenging, or grazing potential.
- High biomass production is needed to meet long-term cover crop purpose and objectives, such as increasing soil organic matter, soil biofumigation, soil moisture extraction, forage production, or soil health maintenance or improvement.
- Soil and/or weather conditions are suboptimal, challenging seed germination and survival, but soil moisture deficient is not the primary concern.
- Client is prepared to manage potential agronomic risks/challenges of high biomass cover crop systems.

Cover Crop Seeding Considerations – Single vs Multi Species

Single Species Cover Crops

When agronomic and growing conditions allow, a properly designed multispecies cover crop is often preferred to a single species cover crop, depending on the desired cover crop purpose(s). However, due to the typical timing of production crop harvest in Wisconsin, a solid-seeded cereal grain is often the only viable cover crop option. Additionally, single species cover crops are potentially simpler to plan and manage, a key benefit when client is less experienced with cover crops and/or there are limited options for cover crop establishment, management, and/or termination.

Single species cover crops can provide many agronomic and soil health benefits, particularly when managed for increased biomass production. Cereal rye, winter triticale, and winter wheat are commonly used overwintering, single species cover crops in Wisconsin grain production systems, each having their own benefits and challenges. When selecting an overwintering small grain cover crop, consider the long-term forecast and the soil temperature required for germination. Cereal rye will germinate in cooler soils and should be prioritized over winter triticale and winter wheat in later fall plantings. Timing and method of cover crop termination will vary depending on desired benefit. See Tables 1 and 2 for additional information.

In many row crop situations, it is not recommended to plant single species legumes or brassicas, except for frost-seeding red clover into winter wheat. However, small scale, specialty crop, and/or organic production systems may choose to use solid seeded legumes and/or brassicas as a nitrogen source or for pest suppression, respectively.

Multispecies Cover Crop Mixes

Multispecies cover crop mixes are often used to address multiple resource concerns and achieve multiple purposes and objectives simultaneously. While multispecies cover crop plantings may not produce more biomass than a single cover crop species, mixes may provide a more reliable source of plant biomass due to the ability of included cover crop species to thrive under diverse field and weather conditions.

Often, multispecies mixes may be more expensive than single species cover crop plantings. Seed cost versus expected benefit should be evaluated when designing a multispecies cover crop mix. Additionally, multispecies mixes may require a higher level of management to achieve successful establishment and termination, as compared to single species cover crop plantings.

Clients may choose a commercial multispecies cover crop pre-mix or a custom blend to meet the cover crop purpose. Multispecies mixes often include species to emphasize diversity in species' growth habits (vining, prostrate, upright, etc.), root architectures (fibrous vs taproot), winterhardiness, and ecosystem services (erosion reduction, nitrogen fixation, nutrient scavenging, beneficial insect support, etc.). Species competitiveness within a mix must be considered to increase the likelihood all included species will be expressed in the planting at targeted levels. However, even with careful planning, cover crop mixture performance can vary from site-to-site and year-to-year depending on various biological and weather factors.

Multispecies Cover Crop Seeding Rates

As with single species plantings, the general seeding rate recommendation for multispecies mixes is based on the seeding method selected (Table 3).

General Considerations When Designing Multispecies Cover Crop Mixes

- Document the current crop rotation and identify which, if any, of the plant functional groups are missing. Attempt to include the missing or least represented plant functional group(s) in the cover crop mix.
- Ensure missing or underrepresented plant functional groups are sufficiently represented within a cover crop mix to meet the identified purpose.
- Consider species competition. In general, species in the grass and broadleaf functional groups are more competitive than species in the legume functional group and may crowd-out other plants, reducing overall plant species expression in a diverse mix. When adding species to a mix, ensure all species meet the planned purpose(s) and will produce sufficient biomass to justify the additional seed cost.
- When above and below ground biomass accumulation is fundamental to meeting a cover crop purpose, consider including grasses as a majority of the mix.
- In most situations, total seeding rate of combined brassica species should not comprise more than 4 pounds per acre within a cover crop mix. Consider a maximum of 1 to 2 pounds per acre maximum within a cover crop mix in high fertility situations.
- To aid in balancing the cover crop C:N ratio, include sufficient legumes within the cover crop mix. Consider the estimated C:N ratio of the cover crop at termination, as well as remaining production crop residue, when planning the cover crop mix.
- Where nutrient scavenging and retention is a primary goal, include a majority of overwintering grass species in the mix.
- If cover crop is to be grazed, select species to meet the desired level of nutrition (quantity and quality) for the kind and class of livestock to be fed. Avoid potential palatability and/or toxicity issues (e.g. prussic acid, nitrates, etc) when selecting cover crop species for grazing.
- Consider cost mix estimates, when possible, to provide an economical mix to meet the cover crop purpose and objectives. Legumes are often the most expensive component of a cover crop mixture on a cost per acre basis.
- When using multispecies mixtures, all species should be seeded with their identified planting date range (Table 3).
- Refer to Tables 1 and 2 to evaluate cover crop species for growth characteristics and conservation benefits.

Multiple Species Seeding Rate Calculations

Calculating a Cover Crop Mix Seeding Rate – Planned Percentage Approach

When designing cover crop seed mixtures, multiply the base seeding rate for each selected plant species by the planned percentage of each species. The "planned percentage" represents a general proportion of the seed to be planted per species. An example calculation is found on the next page.

Step 1. – Divide 100% by the number of species to be included in the mix. The resulting percentage is a starting point for determining species composition in a mix.

Example – Client wants a three-way cover crop mix of oats, radish, and field pea.

100% / 3 species = 33.3%

Step 2. – Identify the base seeding rates for each species in the mix from Table 3 to develop a general seeding rate by species

Example – The client plans to drill the cover crop. Therefore, use the incorporated seeding rates from Table 3.

Oats	30 lbs
Radish	5 lbs
Field Pea	50 lbs

Step 3. – Multiply the base seeding rate for each species identified in Step 2 by the general percentage of the mix identified in Step 1. This will be the pounds of each species to include in a mix on a per acre basis.

Example – Multiply the base rates for each species identified in the example above by 33%.

Oats	30 lbs	x	33.3%	= 10.0 lbs / acre
Radish	5 lbs	x	33.3%	= 1.7 lbs / acre
Field Pea	50 lbs	x	33.3%	= 16.7 lbs / acre
Total mixture			100%	28.4 lbs / acre

Step 4. – Adjust the percentages of each species contained within the mix, where necessary and practical, to meet client's cover crop purpose(s) and objectives while meeting cover crop design guidance.

Example – If the primary cover crop purpose addressed by this mix is erosion reduction, the planner could consider increasing the percentage of oats in the mix to increase the production of slower to decompose residue while decreasing the percentage of radish, field pea, or both. The seeding rate calculations would be adjusted to reflect this change. To illustrate the concept, the following calculations increase the percent oats in the mix to 50% and reduce percent of both radish and field pea to 25%. This mix meets cover crop design guidance and potentially better addresses the client's purpose.

Oats	30 lbs	x	50%	= 15.0 lbs / acre
Radish	5 lbs	x	25%	= 1.3 lbs / acre
Field Pea	50 lbs	x	25%	= 12.5 lbs / acre
Total mixture			100%	28.8 lbs / acre

The final total seeding rate must be 100% or greater when using the minimum seeding rate for each species listed in Table 3 and adjusting by the planned mix percentage.

Calculating a Cover Crop Mix Seeding Rate – WI Seeding Rate Calculator

The WI Seeding Rate Calculator can be used to assist with species selection and seeding rate considerations. The WI Seeding Rate Calculator is recommended when the number of cover crop species included in the cover crop mix complicates the Planned Percentage Approach.

Applying Nutrients to a Cover Crop

Manure and/or commercial fertilizer applications intended to solely fertilize the cover crop are typically not recommended. However, manure and/or fertilizer applications to meet the needs of the cover crop should be considered on low fertility fields where increased cover crop biomass is required to meet the cover crop's primary purpose(s) or objectives.

Manure and/or commercial fertilizer applications intended to fertilize the subsequent production crop may be applied prior to cover crop establishment and/or into/to the cover crop itself. Nutrient use by the cover crop may reduce potential nutrient losses during the non-production crop growing season but will also impact nutrient availability to the following production crop. Selection of cover crop species to moderate the cover crop biomass C:N ratio may minimize potential nitrogen immobilization within the subsequent production crop.

General Considerations When Applying Nutrients to a Cover Crop

- All applications should be included in the client's nutrient management plan, including manure applied via pasturing.
- Apply nutrients using regional best management practices to meet all local, state, and federal requirements and minimize risk to surface and groundwater.
- If nutrients will be applied prior to cover crop seeding, seed the cover crop as soon as practical after the nutrient application.
- If using low disturbance, injection, or surface applications of manure, consider applying manure once the cover crop is sufficiently established and at rates to minimize cover crop smothering. If surface applying liquid manure to a standing cover crop, reduce ponding or runoff risks by only applying to no-till fields with limited slope using manure containing less than 4% dry matter and applying at rates to allow for rapid infiltration at the given soil conditions.

Cover Crop Termination

Cover crops can be terminated by frost, harvest or grazing for forage, roller crimping, tillage, and/or with proper herbicide selection. Timely termination of cover crops is required to reduce soil moisture depletion, nitrogen immobilization, and allelopathy and/or to prevent unwanted reseeding. Timing of cover crop termination must meet the purpose of the cover crop as specified in the conservation plan. Manage cover crop surface residue and biomass production to meet objectives specified in the conservation plan.

Adjust nitrogen application rates for the subsequent crop based on nitrogen credits for specific cover crop species from University of Wisconsin nutrient guidelines.

Ensure termination methods comply with requirements outlined in clients' crop insurance, NRCS Cover Crop Termination Guidelines, and NOP, where applicable. Follow the request process in the Risk Management Agency Good Farming Practice Handbook where an exception to the NRCS Cover Crop Termination Guidelines is supported as a good farming practice.

Timing of cover crop termination must meet the cover crop purpose(s). Delayed termination of cover crops to maximize above and belowground biomass accumulation may require higher levels of management to reduce potential crop production challenges associated with heavy residue, excessive soil moisture utilization or retention, nutrient tie-up, input application rates and timing, allelopathy, and/or unintended cover crop seed production/reseeding.

General Considerations for Terminating Cover Crops

- Identify cover crop growth stage recommended at termination to meet established purpose(s) and objectives, while adjusting for cover crop growth stage and biomass accumulation impacts on:
    - Set-up and operation of planting equipment to ensure proper planting depth and seed trench closure, and
    - Cover crop C:N ratio at termination and time required for cover crop residue decomposition and nutrient cycling, including potential early-season nitrogen immobilization, and
    - Potential for disease transmission (green bridging), pest promotion, and/or allelopathic effects to subsequent production crop,
    - Potential efficacy of selected termination strategy, including the availability of equipment and/or custom applicators.
    - Impacts to crop insurance, if applicable.
- Identify approximate calendar date when targeted growth stage will likely occur and evaluate the impact of timing on:
    - Subsequent production crop establishment and management, and
    - Soil moisture conditions, including excess moisture utilization and reduced soil moisture loss.
    - Availability of necessary equipment, labor, etc.
- Select a cover crop termination strategy consistent with maintaining potential accrued soil health and/or conservation benefits and to meet client's objectives.
- Planting the primary crop into a standing, living cover crop (also known as planting green) is allowed. Clients should be aware of the higher level of management required with this termination strategy and potential implications to their crop insurance coverage. Cover crop seeding rates may need to be adjusted to increase potential success of this practice.

Herbicide Termination

Herbicide selection for termination must be made by a Certified Pesticide Applicator, Certified Crop Advisor or qualified Extension Specialist following pesticide labeling and must be compatible with the following main crop to grown.

If the cover crop is to be terminated with herbicides, the client's selection, rate, and timing of herbicides should achieve complete termination of the cover crop at the growth stage in which the herbicide will be applied. Translocated herbicides typically perform better under conditions ideal for active plant growth, including repeated daytime temperatures above 50° F and nighttime temperatures above 40° F degrees and both day and nighttime temperatures below 85° F.

Herbicides used for cover crop termination should be compatible with the following production crops and their intended use.

All federal, state, and local guidelines as well as the manufacturer's label rates and guidelines must be followed when applying herbicides. Appropriate surfactants, adjuvants, and other spray modifier agents should be used to increase herbicide efficacy as identified on the herbicide label.

Consult current University of Wisconsin and/or pertinent peer-reviewed, research publications for recommendations on herbicide selection and use.

Winter Kill Termination

Non-winter hardy species of cover crops are typically killed by below freezing fall and winter temperatures and require no additional termination strategy. However, when early and sustained snow cover is received before the cover crops are terminated by cold and/or if the soil temperature is above freezing throughout the winter, non-winter hardy cover crops may persist to spring. In this situation, alternative termination strategies, via herbicide or mechanical means, may be required.

When the objective of the conservation plan is to allow fall manure applications to in high nitrogen leaching soils, winter kill termination is not an option and winter hardy cover crops must be used.

Grazing/Haying Termination

Cover crops grazed or mechanically harvested for forage as a termination strategy often requires plant biomass removal at a particular crop growth stage (early reproduction or later) to achieve adequate termination. However, grazing/harvest termination may not result in complete cover crop eradication and an additional termination strategy may be needed.

Termination by grazing or mechanical harvest should leave sufficient residue on the soil surface to provide adequate cover and/or be followed directly with the planting of the subsequent production crop, where practical.

Consult current University of Wisconsin, NRCS guidance documents, and/or pertinent peer-reviewed, research publications for recommendations on best management practices for terminating cover crops via grazing or mechanical harvest.

Monitor cover crop growth and environmental conditions and manage grazing and/or harvest practices to avoid potential issues with forage quality and/or toxicity (e.g. prussic acid, nitrates, etc).

Mechanical Termination

Many cover crop species can be terminated by mowing or tillage once the cover crop has reached its reproductive growth stage or via tillage during its early vegetative growth stage. Tillage intensity (tool and number of passes used) should balance termination effectiveness with soil health preservation, using as minimal tillage intensity as possible. Depending on cover crop growth stage and soil and weather conditions, mechanical termination may not result in complete cover crop termination and a secondary termination strategy or repeated tillage may be needed.

Mechanical termination should be followed directly with the planting of the subsequent production crop, where practical.

Consult current University of Wisconsin, NRCS guidance documents, and/or pertinent peer-reviewed, research publications for recommendations on best management practices for terminating cover crops via tillage or other mechanical termination methods.

Ensure the planned tillage termination equipment selection and operation achieves the required soil tillage intensity rating (STIR) value and soil conditioning index (SCI) to meet the cover crop purpose(s) and any practices outlined in the conservation plan.

Roller-Crimper Termination

Roller-crimping must take place at the proper cover crop growth stage to limit cover crop regrowth and should utilize equipment that both flattens the cover crop (roller) and breaks the stem in three or more places (crimper).

In general, for small grains, cover crops should be rolled and crimped when a majority of the field is at anthesis or later, but before seed set. General recommendations for legumes are to roller-crimp at flowering or later, but before seed set, to optimize termination potential.

Direction of roller-crimping should coincide with planting direction when no-till planting of the subsequent crop into cover crop residue.

Roller crimping can be successful after the planting of the cash crop. Pay particular attention to Risk Management Agency termination requirements.

If incomplete cover crop termination occurs, a secondary termination strategy should be used, where possible.

Consult current University of Wisconsin, NRCS guidance documents, and/or pertinent peer-reviewed, research publications for recommendations on best management practices for terminating cover crops via roller-crimping.

References

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Table 1. Cover Crop Species Performance by Purpose

			Reduce Erosion*			Improve Soil Health					N Management		Reduce Weed and Plant Pest Pressure			
Type	Season	Species	Erosion Fighter	Quick Growth	Lasting Residue	Soil Builder	Loosens Subsoil	Loosens Topsoil	Short Window	Bears Traffic	N Source	N Scavenger	Weeds	Nematodes	Crop Pathogens	Allelopathic
Grasses	Cool Season	Barley, Winter	5	4	5	4	2	4	5	3	1	4	4	2	2	3
		Rye, Cereal/Winter	5	5	5	5	2	4	5	4	1	5	5	2	3	5
		Triticale, Winter	5	5	5	4	2	4	4	4	1	4	5	2	3	3
		Wheat, Winter	5	5	5	4	2	4	4	4	1	4	5	2	3	3
		Annual Ryegrass	4	5	3	4	2	5	5	5	1	4	3	2	3	3
		Barley, Spring	4	4	5	4	2	4	5	3	1	4	4	2	2	3
		Oats	4	5	3	4	2	4	5	4	1	4	4	2	3	2
		Triticale, Spring	4	5	5	4	2	4	4	5	1	4	4	4	4	3
		Wheat, Spring	4	4	5	4	2	4	4	4	1	4	4	2	3	3
	Warm Season	Corn	4	4	5	4	3	3	4	1	1	5	4	1	1	2
		Millet, German	4	5	4	4	3	4	5	4	1	4	4	4	4	3
		Millet, Japanese	5	5	5	4	3	4	5	5	1	4	4	4	4	3
		Millet, Pearl	4	5	5	4	3	4	4	4	1	4	5	4	4	3
		Millet, Proso	4	5	4	4	3	4	5	4	1	4	4	4	4	3
		Sorghum	4	5	5	5	3	5	5	4	1	5	5	4	4	4
		Sorghum-Sudangrass	4	5	5	5	3	5	5	4	1	5	5	4	4	3
		Sudangrass	4	5	5	5	3	5	5	4	1	5	5	4	4	3
Non-Legume Forbs	Cool Season	Collards, Winter	3	5	2	3	4	3	4	3	1	4	4	-	-	4
		Camelina, Winter	3	3	2	3	3	2	4	3	1	3	2	-	-	3
		Flax	3	3	3	2	2	3	3	2	1	3	1	2	-	3
		Kale	2	2	3	3	4	3	4	3	1	3	5	-	-	3
		Mustard	2	4	2	3	3	3	3	3	1	3	2	4	3	3
		Phacelia	3	1	2	3	2	5	3	2	1	4	2	3	2	2
		Radish	2	4	2	2	4	4	5	2	1	5	4	3	1	1
		Rapeseed	2	4	2	2	3	4	4	3	1	4	4	3	1	1
		Turnip	2	4	2	2	3	3	4	1	1	4	4	2	1	1
	Warm Season	Buckwheat	4	5	1	3	2	5	5	1	1	4	4	3	1	2
		Safflower	2	3	3	2	4	2	2	2	1	3	2	-	-	2
		Sunflower	3	4	3	3	4	3	4	2	1	4	3	1	2	1
Legumes	Cool Season	Alfalfa (Annual)	3	3	3	4	5	3	3	4	5	4	3	2	1	1
		Clover, Red	3	3	3	4	4	5	3	4	5	4	3	4	2	2
		Clover, White	4	2	2	4	2	5	2	3	3	3	3	2	2	2
		Hairy Vetch	3	2	3	3	2	4	1	2	5	4	3	4	3	3
		Clover, Balansa	2	2	2	1	2	3	2	4	3	1	2	-	-	1
		Clover, Berseem	3	4	3	3	2	4	3	3	5	4	3	2	2	2
		Clover, Crimson	3	4	1	3	2	4	3	3	4	4	3	4	2	2
		Faba Bean	3	3	3	3	3	4	3	2	4	2	3	1	-	1
		Lentil, Winter	2	2	2	2	2	2	2	2	3	2	2	-	3	1
		Pea, Field	2	3	2	3	2	4	4	2	3	3	2	3	2	1
		Pea, Winter	2	3	2	3	2	4	4	2	3	3	2	3	2	1
	Warm Season	Cowpea	3	4	2	3	2	4	5	1	4	4	3	1	1	1
		Soybean	2	4	2	2	3	2	3	2	3	3	2	1	1	1
		Sunn Hemp	3	3	4	3	5	5	2	5	3	4	2	1	1	1

*Ratings: 5-excellent, 4-very good, 3-good, 2-fair, 1-poor, and "-", information lacking

Table 2. Cover Crop Species Performance and Cultural Considerations

			Habitat	Forage Potential		Tolerance to Growing Extremes					Cultural Factors		
Type	Season	Species	Attract Beneficials	Grazing	Mechanical Harvest	Heat	Drought	Flooding	Shade	Low Fertility	pH Range	Min Germ Temp (F)	Seed Count (lb)
Grasses	Cool Season	Barley, Winter	3	4	4	2	3	3	2	4	6.0-8.5	38	13,500
		Rye, Cereal/Winter	2	5	4	2	3	4	3	5	5.0-7.0	34	18,000
		Triticale, Winter	2	5	5	2	3	3	2	3	5.2-7.2	38	20,000
		Wheat, Winter	2	5	5	2	3	3	2	3	6.0-7.0	38	11,000
		Annual Ryegrass	2	5	4	3	3	4	4	3	5.5-7.0	40	190,000
		Barley, Spring	3	4	4	2	3	3	2	4	6.0-8.5	38	13,500
		Oats	3	5	4	2	3	4	3	4	5.5-7.0	38	19,500
		Triticale, Spring	2	4	4	3	3	2	3	3	5.5-7.0	38	22,500
		Wheat, Spring	2	5	5	2	3	3	2	3	6.0-7.0	38	11,500
	Warm Season	Corn	2	5	5	5	3	2	3	3	5.8-7.5	52	2,500
		Millet, German	2	4	3	5	5	4	4	4	5.5-7.5	65	190,000
		Millet, Japanese	3	4	5	5	5	4	4	4	4.6-7.4	65	143,000
		Millet, Pearl	3	5	5	5	5	4	4	5	5.5-7.5	65	80,000
		Millet, Proso	2	4	3	5	5	4	3	4	5.5-7.5	65	120,000
		Sorghum	3	4	5	5	5	3	4	4	5.5-7.0	65	16,000
		Sorghum-Sudangrass	3	5	5	5	5	3	4	3	5.5-7.0	65	17,500
		Sudangrass	3	5	5	5	5	3	4	4	5.5-7.0	65	42,000
Non-Legume Forbs	Cool Season	Collards, Winter	3	5	1	4	3	4	3	3	6.0-7.5	40	175,000
		Camelina, Winter	3	1	1	4	4	4	4	3	5.5-7.5	38	400,000
		Flax	3	2	2	4	3	4	4	3	6.0-7.5	48	80,000
		Kale	2	5	1	4	3	4	3	3	6.0-7.5	45	175,000
		Mustard	3	1	1	4	3	4	4	3	5.5-8.3	40	180,000
		Phacelia	5	2	1	5	5	4	4	4	6.4-7.0	37	235,000
		Radish	4	5	1	3	4	4	3	3	6.0-7.5	45	34,000
		Rapeseed	4	5	1	3	3	4	3	3	5.5-8.0	41	157,000
		Turnip	2	5	1	3	4	4	3	3	5.3-6.8	45	193,000
	Warm Season	Buckwheat	5	2	2	5	3	4	4	4	5.0-7.0	50	20,500
		Safflower	5	1	1	5	5	5	4	4	6.0-7.5	45	15,000
		Sunflower	4	3	3	5	5	4	3	4	5.7-8.1	44	7,000
Legumes	Cool Season	Alfalfa (Annual)	2	4	5	5	4	4	3	3	6.5-7.5	38	200,000
		Clover, Red	4	5	5	4	3	3	4	4	5.5-8.0	41	272,000
		Clover, White	3	4	2	4	3	4	3	3	5.5-7.5	42	784,000
		Hairy Vetch	2	2	2	4	3	4	3	3	6.0-7.0	60	16,500
		Clover, Balansa	4	3	3	3	3	3	4	3	6.0-8.0	48	500,000
		Clover, Berseem	4	5	5	4	3	4	4	4	5.5-7.5	42	207,000
		Clover, Crimson	4	5	4	4	3	4	4	4	5.5-7.0	42	150,000
		Faba Bean	3	4	1	4	5	4	4	3	6.5-8.5	41	3,500
		Lentil, Winter	2	2	1	5	4	5	4	3	5.5-7.5	41	15,000
		Pea, Field	3	3	4	4	4	4	4	4	6.0-7.0	41	2,000
		Pea, Winter	3	3	4	4	4	4	4	4	6.0-7.0	41	1,800
	Warm Season	Cowpea	4	3	4	5	4	4	4	4	5.5-6.5	58	3,600
		Soybean	3	4	3	5	4	5	3	3	5.8-7.0	50	3,000
		Sunn Hemp	2	2	2	5	5	4	4	5	5.0-7.5	65	15,000

*Ratings: 5-excellent, 4-very good, 3-good, 2-fair, 1-poor, and "-", information lacking

Table 3. Cover Crop Species Recommended for Planting in Wisconsin

Type	Season	Species	Seeding Rates[1] (lb/acre)				Seeding Rates[1] (oz/1000 sq ft)		Seeding Depth (in)	Seeding Method[2]					Seeding Date Range by Zone[3, 4]	
			Incorp		Non-Incorp		All Seeding									
			Base	Range	Base	Range	Base	Range		Standard	Interseed	Overseed	Slurry Seed	Frost Seed	North	South
Grasses	Cool Season	**LIKELY TO OVERWINTER**														
		Barley, Winter	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X			7/15-9/15	7/15-10/1
		Rye, Cereal/Winter	50	30-120	65	55-120	20	10-45	0.75-1.5	X		X	X		7/15-10/25	7/15-11/1
		Triticale, Winter	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X			8/1-10/1	8/1-10/10
		Wheat, Winter	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X	X		8/1-10/1	8/1-10/10
		LIKELY TO WINTERKILL														
		Annual Ryegrass*	15	10-30	20	15-40	7	3-16	0-0.5	X	X	X	X		4/15-8/15	4/15-9/1
		Barley, Spring	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X			4/15-9/1	4/15-9/15
		Oats	30	25-100	45	30-100	24	10-45	0.5-1	X		X	X		4/15-9/1	4/15-9/15
		Triticale, Spring	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X			4/15-9/1	4/15-9/15
		Wheat, Spring	50	40-120	65	55-120	24	10-45	0.75-1.5	X		X			4/15-9/1	4/15-9/15
	Warm Season	Corn**	20	15-40	-	-	7	6-15	1.5-3	X					6/1-8/8	5/15-8/15
		Millet, German	15	7-25	20	15-35	7	3-16	0.5-1	X					6/1-8/8	6/1-8/15
		Millet, Japanese	15	7-25	20	10-35	7	3-16	0.5-0.75	X					6/1-8/8	6/1-8/15
		Millet, Pearl	15	7-25	20	10-35	7	3-16	0.5-1	X					6/1-8/8	6/1-8/15
		Millet, Proso	15	7-25	20	15-35	7	3-16	0.5-1	X					6/1-8/8	6/1-8/15
		Sorghum	15	7-25	20	15-35	7	3-16	0.5-1.5	X					6/1-8/8	6/1-8/15
		Sorghum-Sudangrass	20	15-40	30	15-50	16	6-23	0.5-1.5	X					6/1-8/8	6/1-8/15
		Sudangrass	20	15-40	30	15-50	16	6-23	0.5-1	X					6/1-8/8	6/1-8/15
Non-Legume Forbs	Cool Season	**LIKELY TO OVERWINTER**														
		Collards, Winter**	2	2-5	5	3-8	2	1-4	0.25-0.5	X	X	X	X		9/15-10/1	9/15-10/1
		Camelina, Winter**	5	3-8	7	5-10	3	1-4	0.12-0.25	X					9/1-10/1	9/1-10/15
		LIKELY TO WINTERKILL														
		Flax, **	15	7-25	20	10-30	7	3-16	0.25-0.75	X	X	X			6/15-8/25	6/15-9/1
		Kale*, **	2	2-5	5	3-8	2	1-4	0.25-0.5	X	X	X			4/15-8/25	4/15-9/1
		Mustard***	2	2-5	5	3-8	2	1-4	0.25-0.75	X	X	X			4/15-8/25	4/15-9/1
		Phacelia**	5	3-8	7	5-15	2	1-4	0.12-0.25	X					5/15-8/1	5/15-8/15
		Radish*, **	5	3-8	7	3-15	3	1-8	0.5-0.75	X	X	X	X		5/15-8/25	4/15-9/1
		Rapeseed*, **	2	2-5	5	3-8	2	1-4	0.25-0.5	X	X	X	X		5/15-8/25	4/15-9/1
		Turnip*, **	2	2-5	5	3-8	2	1-4	0.25-0.5	X	X	X	X		5/15-8/25	4/15-9/1
	Warm Season	Buckwheat	20	15-60	25	20-70	10	6-32	0.5-1	X					5/15-8/8	5/15-8/15
		Safflower**	10	5-15	15	10-30	7	3-16	1-1.5	X					6/1-8/8	6/1-8/15
		Sunflower**	5	2-8	-	-	7	3-16	1-3.5	X					6/1-8/8	6/1-8/15
Legumes	Cool Season	**LIKELY TO OVERWINTER**														
		Alfalfa (Annual)	15	10-30	20	15-40	7	3-16	0.25-0.5	X	X	X			4/15-8/15	4/15-9/1
		Clover, Red	10	5-20	15	10-30	4	2-12	0.25-0.5	X	X	X	X	X	4/15-8/15	4/15-8/25
		Clover, White	5	3-10	7	5-15	4	1-12	0.25-0.5	X	X	X	X	X	4/15-8/15	4/15-8/25
		Hairy Vetch**	15	10-30	20	15-40	12	6-20	0.5-1.5	X	X	X	X		4/15-9/1	4/15-9/15
		LIKELY TO WINTERKILL														
		Clover, Balansa*	5	3-10	7	5-15	2	1-6	0.25-0.5	X		X	X		6/1-8/15	5/15-8/25
		Clover, Berseem	10	5-20	15	10-30	6	2-12	0.25-0.5	X	X	X	X		6/1-8/15	5/15-8/25
		Clover, Crimson*	10	5-20	15	10-30	6	2-12	0.25-0.5	X	X	X	X		6/1-8/15	5/15-8/25
		Faba Bean	60	40-100	75	60-100	30	20-48	2-3	X	X				4/15-8/1	4/15-8/15
		Lentils, Winter*, **	20	15-40	30	20-60	12	6-20	1-1.5	X					7/1-9/1	7/1-9/15
		Peas, Field**	50	40-100	-	-	22	15-48	1-1.5	X	X				4/15-8/25	4/15-9/1
		Peas, Winter*, **	50	40-100	-	-	22	15-48	1-1.5	X	X				8/1-9/1	8/1-9/15
	Warm Season	Cowpea**	30	20-90	-	-	18	7-36	1-1.5	X	X				6/1-8/8	6/1-8/15
		Soybean**	50	40-100	-	-	32	15-64	0.5-1	X	X				5/1-8/8	5/1-8/15
		Sunn Hemp**	10	5-20	15	10-25	12	6-20	0.5-2.5	X	X				6/1-8/8	6/1-8/15

1. See Guidance Document (GD) text for additional information on base and seeding rate range. Seeding rate recommendations are for a single species planting. Incorporated includes seeding methods which provide good seed to soil contact (drilling, planting, and broadcast with incorporation). Non-incorporated includes any method that broadcasts seed without mechanical incorporation.

2. See GD text for additional information on seeding method.

3. See GD text for additional information on seeding zones and seeding dates.

4. If using cover crops in a greenhouse, high tunnel system, or other growing season extending structure, cover crop planting is allowed 30 days before and/or 30 days after the identified seeding date by zone.

* Species may overwinter, paricularly in mild winters and/or with insulating snow cover, when: planted early, areas adjacent to Lake Michigan, and/or in the southern portion of the state.

** Only plant in mixes. Corn, sunflowers, and soybeans should not compose more than 20% of the mix, individually.□

***Plant mustard spp. only when pest suppression via biofumigation is the primary cover crop purpose in vegetable crops.□