Natural Resources Conservation Service

Minnesota Agronomy Technical Note 33

Cover Crop Seeding Guide

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WHAT ARE COVER CROPS

Cover Crops are grasses, legumes, and forbs planted for seasonal vegetative cover.

Cover Crops are typically planted in late summer and fall around harvest or before spring planting of the following year's crops. Common cover crops used in Minnesota include winter hardy plants such as cereal rye and wheat. Other less common, but also effective cover crops include oats, barley, hairy vetch, clover, turnips, rapeseed, radishes, and triticale.

PURPOSE

Cover crops are used to reduce water and wind erosion, utilize excess soil nutrients, suppress weeds, minimize soil compaction, increase soil organic matter, improve soil moisture efficiency, and improve overall soil health.

In addition to the environmental and soil health benefits, several cover crop species may be used for grazing or forage for livestock and wildlife.

CONDITIONS WHERE PRACTICE APPLIES

Cover crops may be used on all lands needing seasonal vegetative cover for natural resource protection or improvement.

SEEDBED PREPARATION AND SEEDING

Site preparation shall be adequate to provide weed suppression and to promote germination and growth of the cover crop species planted. Seedbed preparation and seeding methods are determined by:

- Resource concern and/or objective for planting the cover crop
- Cover crop life cycle (overwintering)
- Current soil surface conditions, moisture level, existing biomass (surface cover)
- Planned harvest date of the primary crop
- Estimated growing degree units remaining prior to the average killing frost
- Availability of labor, time, and equipment.

SEEDING METHODS

Minnesota NRCS Cover Crop (340) Conservation Practice Standard supports several seeding and planting options to establish cover crops. Successful cover crop plantings require seeding within the recommended planting dates, seeding methods that ensure adequate seed to soil contact, and sufficient soil moisture to support seedling growth.

Cover crops may be drilled, no-tilled, broadcast, companion cropping (interseeded), aerial, or frost seeded with or without incorporation depending on field conditions. Incorporation of seed following planting by light shallow tillage, use of a roller, culti-packer or similar tool to embed the seed will result in more uniform seedling emergence.

NO-TILL SEEDING (Drill or Planter):

Ensure the no-till drill or planter is designed to handle heavy crop residue and seed type being planted. This factor is especially important for small seeds or mixtures with varying seed size and/or density. Set and operate the no-till drill or planter to provide an ideal planting depth. No-till drill depth control is not as precise as a no-till planter. Check planting depth often to assure placement doesn't exceed the maximum depth for selected cover crop species. Plant at the incorporated seed rates that are shown on Table 1, Cover Crop Species Recommended for Planting in Minnesota.

Many split row or narrow row planters (15-inch row width or less) can be equipped with small seed plates, such as those used for sugar beets or sorghum, which work well for many cover crop species. Additional adaptation and/or calibration may be necessary due to variation of seed size among cover crop species and varieties. These types of planters should not be used if suppressing weeds is the primary purpose since the cover crop species will be in wider rows than other seeding methods.

BROADCAST SEEDING:

Seed may be broadcast onto the soil surface using a broadcast seeder if the seeder can spread seed in a uniform manner. When broadcasting cover crops, seed germination depends on the presence of adequate moisture at the soil surface or within the crop residue layer. Dry conditions will result in poor germination due to limited seed to soil contact. Expect only fair seed-to-soil contact when seed is broadcast on the soil surface with no incorporation. The broadcast with no incorporation seeding method relies on rain, freeze/thaw cycles, and/or snow to incorporate the seed. Broadcasting cover crop seed with light incorporation is also a viable planting option. This method increases seed-to-soil contact and may increase stand establishment success rate, but seed incorporation depth is critical. Premixing the seed with needed fertilizer or pelletized lime and utilizing an airflow applicator can also be an effective broadcast method. Immediately spread seed blended with fertilizer to prevent seed damage. The following guidelines will reduce the risk of seeding failure when cover crops are planted using the broadcast method:

General Guidelines for Broadcasting Cover Crop Seeds:

1. Assess site for one or more of the following conditions:
   a. Moist, friable soil surface
   b. 30% soil surface residue cover to conserve surface moisture for seed germination and/or,
   c. High probability of rainfall after seeding.
2. Seeding as early as possible within the recommended seeding dates will improve stand density and vigor.

Specific Guidelines for Broadcasting Cover Crops Without Seed Incorporation:

1. Select species known to have the highest germination rates may favor broadcast methods. Below are species groupings, in numeric order, beginning with the highest probability of successfully germinating when planted using the broadcast method:
    - Group 1: Small Grains
    - Group 2: Annual/Perennial Rye Grass
    - Group 3: Small Seed Brassicas
    - Group 4: Small Seed Legumes
2. Plant at the non-incorporated seed rate shown in Table 1, Common Cover Crops Recommended for Planting in Minnesota.

Specific Guidelines for Broadcasting Cover Crops Followed by Seed Incorporation:

1. Seed incorporation depth is critical when using this method of planting cover crops. Tillage depth must not exceed the maximum planting depth for selected cover crop species.
2. Maximum planting depths for each cover crop species is found on Table 1, Common Cover Crops Recommended for Planting in Minnesota.
3. Plant at the incorporated seed rate shown in Table 1, Common Cover Crops Recommended for Planting in Minnesota.

Companion Cropping (Interseeding):

This broadcast seeding method may be used to establish a cover crop into a standing crop scheduled for harvest in the fall. Seed germination and stand success depends on the presence of adequate light and moisture at the soil surface or within the crop residue layer. Dry conditions will result in poor germination due to limited seed to soil contact. Crop row direction may be considered to intercept more sunlight into the crop canopy. Producers should contact their Crop Insurance Agents or the Risk Management Agency to determine if this cover crop seeding method is covered under their crop insurance program. The following guidelines should be considered when companion cropping:

Guidelines for Companion Cropping (Interseeding):

1. Corn for grain: Review Table 2, Identification and Comparison of Cover Crop Performance and Benefits by Species and select shade tolerant cover crop species. When seeding into corn at the V4-V7 vegetative growth stage, make sure to select species that will not compete with the cash crop. Seeding at this growth stage allows enough sunlight for shade tolerant species to germinate and begin growth before canopy closure. Always review the cash crop herbicide program for cover crop compatibility before planting.
2. Corn for silage: Cover crops should not be broadcasted into corn that will be harvested as silage more than two to three weeks prior to the planned harvest date, or the cover crop seedlings will become shaded and die in the understory.

3. Soybeans: Broadcast cover crops into standing, unharvested soybeans, when 50% of the leaves area yellow and/or prior to 50% leaf drop.
4. Red clover into winter wheat: Broadcast red clover into dormant winter wheat by frost seeding during the active freeze and thaw cycle (late February to mid-March).

AERIAL SEEDING:

Broadcast cover crop seed via an airplane or helicopter into existing vegetation or standing crops can be an effective cover crop establishment method, if timed appropriately, and will allow for more cover crop growth in the fall. Aerial seeding cover crops into corn in August through September can be an effective seeding method and allows for more light to reach the soil surface than if seeding earlier in the year. Seeding cover crops just ahead of soybean leaf drop will aid in conserving moisture as the soybean leaves act as a mulch for the seed. Aerial seeding methods rely on rain, freeze/thaw cycles, or snow to incorporate the seed. Generally seed spread on the surface is more rain dependent, requires a higher seeding rate, and takes longer to establish. Aerial Seeding may provide timelier planting for species that require an earlier planting date. Use the non-incorporated seed rates that are found on Table 1, Common Cover Crops Recommended for Planting in Minnesota. **Note:** Large seed legume cover crop species are not recommended for aerial seeding. Producers should contact their Crop Insurance Agents or the Risk Management Agency to determine if this cover crop seeding method is covered under their crop insurance program.

FROST SEEDING:

This seeding method is categorized as broadcast or aerial seeding occurring mid to late March through early April during the active freeze/thaw cycle. Warm daytime temperatures combined with low overnight temperatures cause the soil surface to freeze and crack. Frost seeding takes skill in determining the exact conditions that are favorable and in assuring the crop will not freeze after emergence. Producers should contact their Crop Insurance Agents or the Risk Management Agency to determine if this cover crop seeding is covered under their crop insurance program.

Guidelines when frost seeding cover crops:

1. Seedbed conditions must favor good seed to soil contact:
   a. No-Till small grain or soybean residue fields are ideal seedbed conditions,
   b. Frost seeding SHALL NOT occur on undisturbed heavy residue corn fields or similar conditions,
   c. When seeding preparation is necessary to prepare a uniform seedbed in the fall prior to freeze-up, maintain over 30% residue surface cover.
2. Frost seeding SHALL NOT occur on areas that are ice covered or snow depth is greater than 2 inches.
3. Frost seeding shall be completed before the end of the freeze and thaw cycle. **Note:** Ideal frost seeding conditions vary from year to year, and in certain years the window for seeding may amount to a few days.

CAUTION: *Because the risk for failure is high, this practice requires a waiver from the Area Resource Conservationist (ARC) or the State Agronomist except for cases where red clover is seeded into dormant winter small grains.*

Refer to Minnesota NRCS Agronomy Technical Note #27, Attachment 2—University of Wisconsin Publication—"Frost Seeding Red Clover into Winter Wheat" for additional details: https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022529.pdf

FERTILIZATION

Cover crops usually follow fertilized crops and do not require fertilization. Fertilizer is not recommended (this includes nitrogen) for the establishment of the cover crop but may be used to increase biomass production on poor or damaged sites, or for grazing. The cover crop may be used to sequester or trap nutrients from manure or fertilizer applied for the subsequent crop. Fall planted fibrous rooted grasses or small grains will scavenge leftover nitrogen from the previous crop. Legume cover crops will add nitrogen to the soil for the following crop. Adjust nitrogen application rates for the subsequent crop based on nitrogen credits for specific cover crop species from University of Minnesota nutrient guidelines, when available. Lime application in conjunction with a cover crop is advantageous to improve soil quality benefits where pH is less than 6.4. Apply all soil amendments prior to seedbed preparation where possible, or before planting if a no-till drill is used.

Manure can be applied on cover crops and incorporation is allowed. Follow Best Management Practices in your area. Any soil disturbance for nutrient (including commercial fertilizer or manure) application must meet the Residue and Tillage Management No-Till (329) standard which states that fertilizer placement shall disturb no more than one fourth of the row width.

SPECIES SELECTION AND SEED QUALITY

- Select cover crop species that are adapted to soil, climatic, and ecological site conditions.
- Select cover crop species suited for the planned purpose, maximize the desired benefits, and appropriate for the specific site conditions. Refer to Table 2, Identification and Comparison of Cover Crop Performance and Benefits by Species, for more information.
- Utilize cover crops to enhance crop diversity by adding crop types that are missing from the cash crop rotation (cool-season grass, cool-season broadleaf, warm-season grass, warm-season broadleaf)
- Do not plant cover crop species identified as restricted or prohibited by law.
- Use certified seed (tested) that has been cleaned and is free from noxious weeds.
- Select a species that is adapted to the desired planting date with ample time to germinate and reach an acceptable growth stage prior to a killing freeze or adequate root growth to survive the winter.

- Seeding dates have been divided into North of Interstate 94 and South of Interstate 94. Species have been highlighted where caution should be used when seeding later in the season.
- Inoculate legumes with the proper Rhizobium bacteria. This inoculation helps legumes produce nodules that fix atmospheric nitrogen into nitrogen that the plant can use. Producers should consult with their local agronomist on what type of Rhizobia species they should utilize.
- Non-commercial (Bin-run) seed can be used, if the seed has been tested for germination and purity by a USDA Accredited Seed Laboratory along with scale tickets provided. Be aware of considerations to remain compliant with the Plant Variety Protection Act.
- Seeding rates are based on certified seed tags obtained from commercial sources.
- Follow all state and federal seed and weed seed laws. All seed shall be of high quality and be labeled in accordance with Minnesota Seed Law, section 21.82 including limits on noxious weeds. If Amaranth species is found in the test results, it must be identified on the seed test report. The Minnesota Department of Agriculture (MDA) requires that a genetic test must be done to determine if the Amaranth species are Palmer amaranth.
- Cover crop seed must be planted within 24 months of the germination test date. If seeding will exceed these time limits, the seed shall be re-tested for germination and purity to ensure seed quality. Variances may be granted by the State Resource Conservationist or State Agronomist on a case-by-case basis.

SEED MIXTURES FOR COVER CROPS

The seeding mixture used will depend on the objective and identified resource concern. Cover crops can include a diverse mix of grass, non-legume broadleaves (brassicas, buckwheat, etc.), and legume plants. The seed mixture should create a balanced stand of above ground biomass and below ground root structure to enhance soil building and soil biological activity. A diverse cover crop seed mixture also feed beneficial organisms, improve soil structure, reduce compaction, improve water infiltration/water holding capacity, and increase the root structure to allow for more nutrient exchange sites in the soil. Cover crop seed mixtures that develop a full canopy will maximize snow retention, soil surface coverage, reduce soil erosion, and may be utilized for livestock forage. Seed mixtures often have different seeding dates. When using multi-species mixtures, the average seeding date range should be applied.

Cover crop mixtures are often recommended when the goal is to address multiple objectives and resource concerns. When considering multi-species mixtures, consider the influence of species growth characteristics, anticipated growing conditions, nutrient needs, planned seeding rate, seed size, and the termination method and date.

Use the following reference to evaluate cover crop species for growth characteristics and conservation benefits:

- Table 2— “Identification and Comparison of Cover Crop Performance and Benefits by Species”.
- “Midwest Cover Crop Decision Tool” http://mccc.msu.edu/
- Other cover crop references listed in the reference section of this technical note.

SINGLE AND MULTIPLE SPECIES SEEDING RATE

When designing cover crop seed mixtures, the seeding rate recommendations is based on the seeding method selected. Use the minimum recommended seeding rate or higher when planning cover crops that are drilled, no-tilled, or broadcast/incorporated. When cover crop seed is broadcasted, frost seeded or other methods where seed to soil contact is of concern, a higher seeding rate is recommended. When designing multiple cover crop species mixtures, multiply the minimum 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 and is not a direct calculation of seeds per square foot or an estimate of canopy cover or plant dominance of a given species. Refer to Table 1, Common Cover Crops Recommended for Planting in Minnesota, for the recommended seeding rate by species.

A waiver is granted on a limited basis. Producers will need to provide justification and documentation on why a waiver from the standard and technical note is warranted. Waivers that are granted will have follow-up from the field office. This needed follow-up may delay certification and payment. A waiver from the NRCS State Agronomist or NRCS Area Resource Conservationist (ARC) is required when:

- Cover crops are planted earlier or later than the recommended seeding date.
- When planning/designing a cropping system with a cover crop that is not listed in Table 1, Common Cover Crops Recommended for Planting in Minnesota.

CALCULATING SEEDING RATES AND MIXES

Table 1—Common Cover Crops Recommended for Planting in Minnesota lists the minimum seeding rate by species. The table has two seeding rates for Incorporated Seed and Non-Incorporated Seed. Choose the seeding rate column that is best suited to the chosen seeding method. The planner can use the seeding rates and multiply by the planned percentage of each species. This will determine the pounds of seed per cover crop species to be planted per acre. Round up to the next full pound of seed if the seeding rate calculation results in a decimal of 0.5 or larger. All planting rates listed on Table 1, Common Cover Crops Recommended for Planting in Minnesota are in pure live seed (PLS). For single species and multi-species mixtures, 100% will be used for the seeding rate.

Example Seeding Mixture Calculation Results

Cover crop will be drilled into soybean stubble. The landowner selected the seed mixture below:

40% oats…. minimum seeding rate 30lbs/acre from Table 1 Incorporated Seed Column

40% oilseed radish…minimum seeding rate 4 lbs/acre from Table 1 Incorporated Seed Column

20% field pea…minimum seeding rate of 30 lbs/acre from Table 1 Incorporated Seed Column

Actual Seeding Rates:

Oats=30 lbs x 40% =12 lbs for the mix per acre

Radish=4 lbs x 40%=1.6 lbs which would be rounded up to 2 lbs for the mix per acre

Pea=30 lbs x 20%=6 lbs for the mix per acre

Total mixture= 100% and 20 pounds PLS

COVER CROPS FOR LIVESTOCK USE

Research has shown that cover crop grazing can improve soil health more rapidly than cover crops alone as part of a cropping system. Livestock converts above ground biomass to urine and manure, creating a beneficial environment that increases organic matter in the soil. Grazing should be used as a tool primarily in the later part of the cover crop growth cycle to: terminate the cover crop, convert biomass into urine and manure, and potentially create another feed source. Generally, the cover crop should be six inches or taller to begin grazing. Higher density strip grazing, or similar method will maximize the benefit by ensuring even distribution of animal waste. See Table A for further recommendations.

Herbicide rotation restrictions

When a cover crop will be grazed or hayed, ensure the selected cover crop complies with pesticide label crop rotation restrictions and that the planned management will not compromise the selected conservation purpose(s). Please review herbicide application records for at least the past two or more cropping seasons. Some herbicides maintain long-term residual soil activity for months or years after application and could impact cover crop establishment and/or their use for forage. **Always check the herbicide labels for planting, harvesting, or grazing restrictions.** See University of Wisconsin Extension publication "Herbicide Rotation Restrictions in Forage and Cover Cropping Systems". Also see Iowa State University Publication Crop 3082 "Herbicide Use May Restrict Grazing Options for Cover Crops".

Grazing cautions

- Sorghum, sudangrass, and sorghum-sudan grass: Prussic acid can build during or after a frost. After a killing frost, wait 10-14 days before turning livestock out onto sorghum-sudan. Do not graze below 18 inches after a light frost. Nitrate can also occur and should be tested for during drought conditions (usually severe).
- Sweet clover: Sweet clover contains coumarin, which can turn into dicoumarin, which is a blood-thinner. This increases in concentration as the plant matures and becomes more of an issue if the plant becomes moldy. If poisoning is severe enough, it can lead to death.
- Legumes: Grazing fields that are predominantly legumes (greater than 40-50% dry matter) can lead to bloat. Caution should be used when grazing high legume fields and take precautions to minimize the risk of bloat as bloat can lead to death.

Table A: Recommended Harvest Management Strategies for Cover Crops*

Primary Objective**	Cover Crop Type	Fall Grazing Recs	Spring Grazing Recs	Mechanical Harvest Recs
Mulch for Subsequent Crop	Small grain	4" residual	4" residual***	4" residual***
Break up Compaction Layer	Brassica	No residual	No residual	N/A
Weed Suppression	Small grain	4" residual	6" residual***	N/A
Feed Soil Microorganisms	Cocktail mix	4" residual	No residual	N/A
Reduce Erosion	Small grain	4" residual	2" residual	2" residual
Nitrogen Fixation	Legume	No grazing	No residual	2" residual
*This table is meant to provide harvest recommendations for cover crops. Typically cover crops are used to accomplish multiple objectives. Benefits may still be achieved if these strategies are not followed. Specific requirements should be laid out in the Individual Cover Crop Plan.				
**Other objectives exist that are not shown above, and may require alternative harvest management strategies. Refer to MN Practice Standard 340 for additional considerations.				
***Stubble heights higher than 3" may restrict no-till planting equipment and may reduce effectiveness of herbicides.				

COVER CROPS FOR WILDLIFE AND POLLINATOR USE

Generally, the more diversity of habitat types provided and the more interspersed those habitats are, the more potential a property has for wildlife. Providing diversity ensures that wildlife have ample choices to locate their required resources. Cover crops contribute to habitat diversity.

Cover crops can provide important areas to forage, areas of cover from both predators and the elements, and areas in which to breed and nest. Migratory birds passing through the region use cover crop fields to forage and rest. High-quality stopover sites are also important as birds that arrive on their breeding grounds earlier in the year typically have greater reproductive success. Cereal grains and legumes will provide nesting habitat if allowed to grow over 12 inches tall before termination. Moreover, cover crop fields can provide food in the winter and brood-rearing habitat in the spring for foraging chicks. Plant diversity produces insect diversity, and thus, a mix of cover crops can be beneficial for young birds that require insects as their main food source in the spring.

Flowering cover crops can be especially attractive to pollinators and beneficial insects because they provide pollen, nectar, and shelter. Many natural enemies of crop pests also benefit from these habitat resources for at least one stage of their life cycle. Attracting pollinators and beneficial insects has the potential to boost yields through increased pollination services, natural pest control, and

improved soil health. Utilizing a diverse cover crop mixture will maximize beneficial insect activity by generating season-long blooms and variation in vegetative structure.

Cover crop termination has the potential to be detrimental to wildlife, but careful management can reduce harmful impacts. For example, delaying termination of cover crops to late spring can allow successful nesting of early breeding birds. Also, waiting until peak bloom before termination will maximize forage potential for pollinators and other floral visitors. Increased management will be needed when allowing cover crops to bloom to limit seed set and potential invasiveness of cover crop to current crop or crop rotation. Leaving cover crop residue and as much physical structure as possible will benefit insects, ground-nesting pollinators, and other wildlife. Finally, minimizing insecticide use in successive cash crops will also reduce harm to beneficial insects that are using cover crop residue.

Annual cover crops can provide significant wildlife benefits, but they should be viewed as a supplement to a comprehensive wildlife management plan, rather than a replacement for perennial cover. Permanent conservation areas (e.g. grasslands, wetlands, field borders, hedgerows of trees and shrubs, etc.) should be composed of primarily high-quality native species to maximize the diversity of beneficial insects and wildlife on the farm.

See Table B for wildlife and pollinator suggestions:

Table B: Generalized Use of Common Cover Crops by Wildlife, Bees, and Beneficial Insects

SPECIES	WILDLIFE - BIRDS AND MAMMALS							BEES AND BENEFICIAL INSECTS		
	COVER				FOOD		GREEN BROWSE			
	Nesting	Brood	Fall	Winter	Fall	Winter				
GRASSES								**Honey Bee**	**Wild Bees**	**Predator Parasitoid**
SPRING BARLEY			X		X		1,2,3	None	None	Low
WINTER BARLY	X	X					1,2,3	None	None	Low
MILLETS			X		X	X		None	None	Low
OATS			X				1,2,3	None	None	Low
WINTER CEREAL RYE	X		X				1,2,3	None	None	Low
SORGHUM-SUDANGRASS			X	X	X	X		None	None	Moderate
SPRING WHEAT			X		X		1,2,3	None	None	Low
WINTER WHEAT	X	X	X				1,2,3	None	None	Low
NON-LEGUMES BROADLEAF										
BUCKWHEAT		X			X			High	High	High
FLAX								Moderate	Moderate	Moderate
KALE								High	High	High
MUSTARD		X	X		X	X		High	High	High
PHACELIA								High	High	High
RADISH (oilseed/forage)			X		X	X		High	High	High
RAPESEED/CANOLA			X	X	X	X		High	High	High
SAFFLOWER								Moderate	Moderate	Moderate
SUNFLOWER					X	X		High	High	High
FORAGE-TYPE TURNIP			X	X	X	X		High	High	High
LEGUMES										
ALFALFA		X	X		X		1,2,3,4	High	High	Moderate
CHICKPEA								Low	Low	Low
CLOVER; Berseem, Crimson, White		X	X		X		1,2,3,4	High	High	Moderate
CLOVER, Red		X	X		X		1,2,3,4	Moderate	High	Low
COWPEA		X	X		X			High	High	High
FAVA BEAN								Low	Moderate	Moderate
FIELD/WINTER PEA			X		X		1,2,3,4	Low	Low	Low
LUPIN								Low	Moderate	Moderate
SANFOIN								High	High	Moderate
SUNNHEMP								Moderate	High	Moderate

Key to Green Browse Use

1 – Deer 2 – Geese 3 – Small Mammals
4 – Grassland/Upland Birds

TERMINATION OF COVER CROPS

Cover crops will be terminated by frost, harvest or grazing for forage, roller crimping, tillage, and/or with proper herbicide selection. Harvest of grain is not a purpose of this practice standard. Timing of cover crop termination must meet the purpose of the cover crop as specified in the conservation plan. Higher levels of management may be needed to ensure that the cover crops do not reduce soil moisture depletion, nitrogen immobilization, allelopathy, and to prevent unwanted reseeding. Manage cover crop surface residue and biomass production to meet objectives specified in the conservation plan. During the cover crop planning process, determine how and when the cover crop will be terminated. Cover crops should be terminated as late as feasible to maximize plant growth and soil protection, but there is some risk in waiting too long, because a vigorously growing cover crop can deplete soil moisture, negatively affecting the following crop. A period of 7-21 days between termination and planting is usually sufficient if there is rainfall to replenish the seed zone and hasten decomposition of the cover crop residue. The exception would be if planting a cover crop to control wind erosion on the emerging cash crop. Termination of the cover crop in this case usually occurs after the fourth to fifth leaf stage or when the cash crop is not susceptible to wind erosion. In vineyards and small fruit operations, grow cover crops in aisles, mow as necessary for mulch cover and maintain as short stubble.

Herbicide Termination:

If the cover crop is to be terminated with herbicides, assure that timing and selection of herbicides achieve a complete kill. Translocated herbicides will normally perform better under conditions that are ideal for active growth. Make sure herbicides are compatible with the following crop. Follow all federal, state, and local guidelines as well as the manufacturer's label rates and guidelines when applying herbicides. Always apply herbicides according to labeled directions. For additional information to herbicide controls, contact your local agronomist, or Minnesota Extension Specialist.

Winter Kill Termination:

Ensure that planned cover and biomass production levels can be achieved for the specific cover crop purpose from the conservation plan when using cover crop species that terminate by frost or winter kill. Non-winter hardy species of cover crops are primarily terminated by cold winter temperatures. However, some species may have hard seed that will germinate in the spring prior to the planting of the primary cash crop, or growing plants may over-winter in mild winters, especially if there is snow cover.

Grazing/Haying Termination:

Cover crops grazed or harvested for forage as a termination method will have a specified amount of target residual biomass left in the field to meet the cover crop objective(s) outlined in the conservation plan. Employ additional termination methods as needed once grazing/haying has concluded and target biomass is achieved and documented. When cover crops are grazed, potential adverse reactions from cover crops consumption by grazing animals

must be monitored always. Caution that grazing/haying termination does not always result in complete removal.

Mechanical Termination:
Most cereal grains can be terminated by mowing, crimping, haying, tillage, or heavy grazing once the cover crop has reached a reproductive growth stage. Caution that mechanical termination does not always result in complete removal.

Roller/Crimper Termination:
Rolling/crimping will take place at the proper cover crop growth stage to limit regrowth potential. For small grains, the proper termination growth state is the boot or grain head stage, for legumes the flowering stage. Direction of rolling/crimping will coincide with planting direction when no-till planting the subsequent crop. Crimpers must break the plant stems in three or more places to be effective. Crimping must be done prior to seed set stage to prevent tillering or reseeding of the cover crop.

Ensure cover crops are managed and compatible with Risk Management Agency (RMA) crop insurance and/or USDA program criteria. For additional NRCS cover crop termination criteria refer to: "NRCS Cover Crop Termination Guidelines".
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/

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

The cover crop should be integrated as part of a soil health conservation cropping system with practices such as: Residue and Tillage Management, No-Till (329), Nutrient Management (590), Integrated Pest Management (595), and Conservation Crop Rotation (328).

Herbicide rotation restrictions
Please review herbicide application records for at least the past two or more cropping seasons. Some herbicides maintain long-term residual soil activity for months or years after application and could impact cover crop establishment and/or their use for forage. Always check the herbicide labels for planting, harvesting, or grazing restrictions. See University of Wisconsin Extension publication "Herbicide Rotation Restrictions in Forage and Cover Cropping Systems". Also see Iowa State University Publication Crop 3082 "Herbicide Use May Restrict Grazing Options for Cover Crops".

Grazing and Haying Stubble Height Recommendations
When utilizing either grazing or mechanical harvest on cover crops, a residual stubble height may be needed. Contact your area grazing specialist and refer to Table A for minimum stubble heights.

MEASURING THE BENEFITS OF THE COVER CROP PRACTICE

One of the goals of conservation planning is to consider the effects of conservation practices and systems on soil quality. Several assessment tools exist to measure the impact of the cover crop practice.

1. The most current NRCS wind and water erosion tools is used to evaluate the impact of cover crop management decisions have on soil loss levels. In addition, the tools have Soil Conditioning Index (SCI) that determines a relative value for anticipated Organic Matter based on management of the cover crop.
2. A soil health assessment is used to determine existing soil characteristics. Typical soil health assessments include soil organic matter levels, soil respiration rates, soil bulk density, soil penetrometer readings, soil infiltration rates and observation of soil cohesion utilizing the slake test.
3. Observable reduction in soil erosion (sheet, rill, ephemeral, and gully). Cover crops increase vegetative and residue cover during periods when erosion energy is high. The addition of cover crops to low residue cropping systems such as corn silage and vegetables can substantially decrease soil erosion.
4. Observable soil porosity improvements due to an increase of biomass, that when decomposed, increases soil organic matter content promoting increased microbial activity and aggregation of soil particles. As a result, soil porosity is increased, and bulk density is decreased.

   CAUTION: avoid planting cover crops when soils are saturated to avoid compaction or use alternative establishment methods such as aerial seeding.
5. Observable soil aggregate stability which results in less soil crusting. Cover crops reduce soil crusting by protecting the soil surface from direct impact of rain drops. The resulting increase of soil organic matter, improved infiltration, and increased aggregate stability will further reduce soil crusting and improve the uniformity of seed germination.
6. Adequate soil surface cover and the improved aggregate stability will reduce erosion and surface water run-off and increase water infiltration rates. Channels created by cover crop roots and earthworms form macropores that further improve infiltration. Cover crops, especially small grains, can effectively capture and utilize excess nitrogen to prevent infiltration below the crop root zone.
7. Cover crops reduce the volume of surface runoff resulting in reduced nutrient losses. Decomposition of cover crops or green manure biomass provides a slow release of nutrients to the root zone. Legume crops fix atmospheric nitrogen and provide nitrogen for the main crop. Legumes also capture more phosphorus than grass or small grains. Small grains are useful as catch crops to utilize end of season nitrogen, which reduces

the potential for nitrogen leaching. Planting cover crops on continuous corn silage fields with a history of repeated manure applications during late summer is highly beneficial.

8. Nutrient immobilization can be observed when decomposition releases available nitrogen to the next crop. The carbon-to-nitrogen (C: N) ratio is a relative estimate of the nitrogen necessary to decompose an organic matter (crop residue) source. A C: N ratio of 24:1 or higher will temporarily "immobilize" soil nitrogen. The immobilization is a result of microbes consuming readily available soil nitrogen during the decomposition of crop residue. The nitrogen will remain immobilized until the microbes deplete the crop residue or other organic matter sources. Young cereal plants have a 14:1 C: N ratio as compared to corn stalks with a 60:1 C: N ratio. The C: N ratio for most clover plants is generally 15:1, which allows nitrogen to quickly become available to the following crop.
9. Cover crops can reduce pesticide loss by reducing surface water runoff resulting in reduced pesticide losses. Increased organic matter increases soil biological activity that can increase the breakdown of pesticide residues.
10. Visible reduction in weed pressure is due to reduced light, seed/soil contact, and soil temperatures. The release of chemical compounds by the cover crop (allelopathy) may also inhibit weed growth. The potential for a negative impact on the primary crop can be reduced by killing the cover crop two or three weeks prior to planting and ensuring good seed/soil contact during seed placement.
11. Soil moisture can be improved when cover crops and green manure crops remove excess moisture from wet soils, resulting in reduction of "waterlogging" in poorly drained soils.

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Table 1

Common Cover Crops Recommended for Planting in Minnesota

SPECIES	FULL SEEDING RATES		PLANTING DEPTH (inches)	CROP TYPE	SEEDING DATES	
	[1]Minimum Seeding Rate in lbs./ac PLS (Incorporated Seed)	[2]Minimum Seeding Rate in lbs./ac PLS (Non-Incorporated Seed)			NORTH OF INTERSTATE 94	SOUTH OF INTERSTATE 94
GRASSES						
SPRING BARLEY*	50 lbs/acre PLS	75 lbs/acre PLS	0.75-1.5	CG	April 15-September 15	April 1-October 1
WINTER BARLEY	50 lbs/acre PLS	75 lbs/acre PLS	0.75-1.5	CG	July 15-October 15	July 15-November 1
OATS*	30 lbs/acre PLS	45 lbs/acre PLS	0.5-1	CG	April 15-September 15	April 1-October 1
ANNUAL RYEGRASS	15 lbs/acre PLS	23 lbs/acre PLS	0-0.5	CG	April 15-September 15	April 1-October 1
WINTER CEREAL RYE†	50/55 lbs/acre PLS	75/83 lbs/acre PLS	0.75-1.5	CG	July 15-October 15	July 15-November 1
WINTER TRITICALE	50 lbs/acre PLS	75 lbs/acre PLS	0.75-1.5	CG	July 15-October 15	July 15-November 1
SPRING WHEAT*	50 lbs/acre PLS	75 lbs/acre PLS	0.75-1.5	CG	April 15-September 15	April 1-October 1
WINTER WHEAT	50 lbs/acre PLS	75 lbs/acre PLS	0.75-1.5	CG	July 15-October 15	July 15-November 1
FOXTAIL MILLET [3]	20 lbs/acre PLS	30 lbs/acre PLS	0.5-1	WG	June 1-August 1	May 15-September 1
JAPANESE MILLET [3]	20 lbs/acre PLS	30 lbs/acre PLS	0.5-0.75	WG	June 1-August 1	May 15-September 1
PEARL MILLET [3]	20 lbs/acre PLS	30 lbs/acre PLS	0.5-1	WG	June 1-August 1	May 15-September 1
PROSO MILLET [3]	20 lbs/acre PLS	30 lbs/acre PLS	0.5-1	WG	June 1-August 1	May 15-September 1
SORGHUM-SUDANGRASS [3]	25 lbs/acre PLS	38 lbs/acre PLS	0.5-1.5	WG	June 1-August 1	May 15-September 1
SUDANGRASS [3]	25 lbs/acre PLS	38 lbs/acre PLS	0.5-1	WG	June 1-August 1	May 15-September 1
NON-LEGUME BROADLEAVES [5]						
BEETS (Non GMO)	3 lbs/acre PLS	5 lbs/acre PLS	0.25-0.5	CB	April 15-September 15	April 1-October 1
CABBAGE	5 lbs/acre PLS	8 lbs/acre PLS	0.25-0.5	CB	April 15-September 15	April 1-October 1
FLAX [3]	30 lbs/acre PLS	45 lbs/acre PLS	0.25-0.75	CB	July 15-September 1	July 15-September 15
KALE	3 lbs/acre PLS	5 lbs/acre PLS	0.25-0.5	CB	April 15-September 15	April 1-October 1
MUSTARD [3]	4 lbs/acre PLS	6 lbs/acre PLS	0.25-0.75	CB	April 15-September 15	April 1-October 1
PHACELIA	5 lbs/acre PLS	8 lbs/acre PLS	0.12-0.25	CB	April 15-September 15	April 1-October 1
RADISH	4 lbs/acre PLS	6 lbs/acre PLS	0.5-0.75	CB	April 15-September 15	April 1-October 1
RAPESEED/CANOLA	2 lbs/acre PLS	3 lbs/acre PLS	0.25-0.5	CB	April 15-September 15	April 1-October 1
TURNIP	1 lb/acre PLS	2 lbs/acre PLS	0.25-0.5	CB	April 15-September 15	April 1-October 1
WINTER CAMELINA	3 lbs/acre PLS	5 lbs/acre PLS	0.12-0.25	CB	July 15-October 15	July 15-November 1
BUCKWHEAT 1/[3]	45 lbs/acre PLS	68 lbs/acre PLS	0.5-1	WB	June 15-August 15	June 1-September 1
SAFFLOWER	25 lbs/acre PLS	38 lbs/acre PLS	1-1.5	WB	April 15-August 1	April 15-August 1
SUNFLOWER	1 lb/acre PLS	2 lbs/acre PLS	1-3.5	WB	June 1-August 1	June 1-August 1
LEGUMES [5]						
ALFALFA [3]	12 lbs/acre PLS	18 lbs/acre PLS	0.25-0.5	CB	April 15-September 1	April 1-September 15

Table 1

Common Cover Crops Recommended for Planting in Minnesota

SPECIES	FULL SEEDING RATES: [1] Minimum Seeding Rate in lbs./ac PLS (Incorporated Seed)	FULL SEEDING RATES: [2] Minimum Seeding Rate in lbs./ac PLS (Non-Incorporated Seed)	PLANTING DEPTH (inches)	CROP TYPE	SEEDING DATES: NORTH OF INTERSTATE 94	SEEDING DATES: SOUTH OF INTERSTATE 94
LEGUMES [5] (continued)						
CHICKPEA	80 lbs/acre PLS	120 lbs/acre PLS	0.25-0.5	CB	June 1-September 1	May 15-September 15
BALANSA CLOVER	5 lbs/acre PLS	8 lbs/acre PLS	0.25-0.5	CB	May 15-September 1	May 1-September 15
BERSEEM CLOVER	8 lbs/acre PLS	12 lbs/acre PLS	0.25-0.5	CB	May 15-September 1	May 1-September 15
CRIMSON CLOVER	10 lbs/acre PLS	15 lbs/acre PLS	0.25-0.5	CB	May 15-September 1	May 1-September 15
RED CLOVER[4]	8 lbs/acre PLS	12 lbs/acre PLS	0.25-0.5	CB	April 15-September 1	April 1-September 15
WHITE CLOVER	5 lbs/acre PLS	8 lbs/acre PLS	0.25-0.5	CB	April 15-September 1	April 1-September 15
FAVA BEAN	80 lbs/acre PLS	120 lbs/acre PLS	2-4	CB	June 15-August 15	June 1-September 1
FIELD/WINTER PEA [3]	30 lbs/acre PLS	45 lbs/acre PLS	1-1.5	CB	April 15-September 15	April 1-October 1
LENTILS	50 lbs/acre PLS	75 lbs/acre PLS	1-1.5	CB	April 15-September 15	April 1-October 1
LUPIN	40 lbs/acre PLS	60 lbs/acre PLS	1-2	CB	April 1-June 1	April 1-June 15
SAINFOIN	40 lbs/acre PLS	60 lbs/acre PLS	0.25-0.75	CB	April 15- September 1	April 1-September 15
SWEETCLOVER[4]	6 lbs/acre PLS	9 lbs/acre PLS	0.25-0.5	CB	April 15-September 1	April 1-September 15
VETCH	15 lbs/acre PLS	23 lbs/acre PLS	0.5-1.5	CB	April 15-September 1	April 1-September 15
COWPEA [3]	30 lbs/acre PLS	45 lbs/acre PLS	1-1.5	WB	June 1-August 15	May 15-September 1
SOYBEANS [3]	30 lbs/acre PLS	45 lbs/acre PLS	0.5-1	WB	June 15-August 15	June 1-September1
SUNNHEMP	20 lbs/acre PLS	30 lbs/acre PLS	0.5-2.5	WB	June 1-August 1	June 1-August 1
LEGEND						
CROP TYPE: CG=COOL SEASON GRASS, CB= COOL SEASON BROADLEAF, WG=WARM SEASON GRASS, WB=WARM SEASON BROADLEAF						
***Consider these species when planting spring cover crops for wind erosion protection at .75 of a bushel/acre. Barley-36lbs, Oats-24lbs, Wheat-45lbs**						
[1] Incorporated seed--Seeding methods used that provide good seed to soil contact. PLS=Pure Live Seed						
[2] Non-incorporated seed--Seeding methods used when broadcasting seed without mechanical incorporation. PLS=Pure Live Seed						
[3] CAUTION is due to risk for establishment with aerial seeding.						
[4] FROST SEEDING DATES: December 15-March 1 (Entire State)						
[5] All Non-Legume Broadleaves and Legume species should always be considered as part of a multi-species cover crop and rarely planted as a single species						
CAUTION is due to possible freeze risk to establishment						
1/ Plantings containing buckwheat may not be seeded within 30 feet of an existing commodity wheat field, or in a field with a planned rotation to commodity wheat within two years.						
INFORMATION from Midwest Cover Crops (MCCC) Website, MCCC Cover Crop Field Guide, Green Cover Seed, SARE-Managing Cover Crops Profitably, SARE-Cover Cropping for Pollinators and Beneficial Insects, USDA-ARS Cover Crops Chart, and USDA-NRCS PLANTS Guide						
†Rye seeded as a single species cover crop between July 15th and October 1st whether incorporated or non-incorporated can be seeded at 40 lbs per acre. October 2nd and after should be planted at posted rates. Multi-species mixes should still utilize recommended rates of 55 and 83 as a baseline for all planting periods.						

Table 2

Identification and Comparison of Cover Crop Performance and Benefits by Species

Identification and Comparison of Cover Crop Performance and Benefits by Species

ATTRIBUTE RATINGS: 0=POOR, 1= FAIR, 2=GOOD, 3=VERY GOOD, 4=EXCELLENT

	Performance and Roles I								Performance and Roles II						Cultural Traits										Potential Advantages							
SPECIES	Nitrogen Source	Total Nitrogen (lb/ac)	Dry Matter (lbs/ac/yr)	Nitrogen Scavenger	Soil Builder	Erosion Fighter	Weed Fighter	Quick Growth	Lasting Residue	Grain/Seed Harvest Value	Grazing	Mechanical Forage Harvest Value	Companion Cropping (Interseeding) Performance	winter Survival	Heat Tolerance	Drought Tolerance	Shade Tolerance	Flood Tolerance	Salinity Tolerance	Life Cycle	Growth Habit	Preferred Soil pH	Water Use	Low Fert Tolerance	Subsoiler	Nematodes	Disease	Allelopathic	Choke Weeds	Attracts Beneficials	Bears Traffic	Short Windows
GRASSES																																
SPRING BARLEY	0	0	2000-5000	3	3	3	3	3	3	0	3	2	4	Never	2	2	1	2	2	Cool Season, Annual	Upright	6-8	Low	2	2	1	1	3	3	2	2	4
WINTER BARLEY	0	0	2000-10,000	4	3	4	3	3	4	4	3	2	3	Seldom	2	2	1	2	N/A	Cool Season, Annual	Upright	6-8	N/A	3	2	1	1	3	4	2	2	4
OATS	0	0	2000-6000	3	3	3	2	4	2	1	4	3	4	Never	2	2	2	2	1	Cool Season, Annual	Upright	4.5-7	Medium	3	2	0	2	2	3	0	3	4
ANNUAL RYEGRASS	0	0	1000-6000	3	3	3	2	3	3	1	4	3	3	Seldom	1	1	3	3	N/A	Cool Season, Annual	Upright	5.5-7	N/A	2	2	2	2	2	4	1	3	3
WINTER CEREAL RYE	0	0	2500-6000	4	4	4	4	4	4	4	4	3	3	Expected	2	3	2	3	2	Cool Season, Annual	Upright	5-7	High	3	2	2	2	4	4	1	3	4
WINTER TRITICALE	0	0	2000-5000	4	3	4	3	3	4	4	4	3	4	Expected	2	2	2	2	2	Cool Season, Annual	Upright	5.2-7	High	2	2	1	2	2	4	1	3	4
SPRING WHEAT	0	0	1200-3000	3	3	3	2	3	3	1	3	3	4	Never	2	2	2	2	2	Cool Season, Annual	Upright	6-7	Medium	2	2	1	1	1	3	1	3	4
WINTER WHEAT	0	0	2000-5000	4	3	4	3	3	4	4	4	3	4	Expected	2	2	2	2	N/A	Cool Season, Annual	Upright	6-7	N/A	2	2	1	1	1	4	1	3	4
FOXTAIL MILLET	0	0	4000-8000	3	3	3	3	4	3	0	2	2	0	Never	4	4	1	1	0	Warm Season, Annual	Upright	5.5-7	Low	3	2	3	3	2	4	1	3	4
JAPANESE MILLET	0	0	1500-3500	3	3	3	3	4	3	0	3	2	0	Never	4	4	1	1	N/A	Warm Season, Annual	Upright	4.6-7	N/A	3	2	3	3	2	4	1	3	4
PEARL MILLET	0	0	2000-6000	3	3	3	3	4	3	0	4	2	0	Never	4	4	1	1	0	Warm Season, Annual	Upright	5.5-7	Low	3	2	3	3	2	4	1	3	3
PROSO MILLET	0	0	2000-4000	3	3	3	3	4	3	0	3	2	0	Never	4	4	2	2	0	Warm Season, Annual	Upright	5.5-7	Medium	3	2	3	3	2	4	1	3	4
SORGHUM-SUDANGRASS	0	0	3000-8000	4	4	3	4	4	4	0	3	4	0	Never	4	4	1	2	1	Warm Season, Annual	Upright	5.5-7	Medium	2	2	3	3	2	4	2	3	4

	Potential Disadvantages									
SPECIES	Weed Potential	Insect/Nematode	Crop Disease	Hinders Crops	C:N Ratio	Crude Protein	Arbuscular Mycorrhizal Associations	Seed Count (seeds/lb)	Germination Temperature (F)	Notes
GRASSES										
SPRING BARLEY	Rarely a problem	Could be a moderate problem	Could be a moderate problem	Occasionally a minor problem	20:1	hay 10-15%, Grain 11-15%	Benefits from	13,600	35	If small grains are planted too early in the fall, depending on the crop rotation there can be disease problems (especially with tan spot) Self Pollinator (wind).
WINTER BARLEY	Could be a minor problem	Could be a moderate problem	Could be a moderate problem	Could be a minor problem	20:1	12%	Benefits from	13,600	35	Tolerates moderately alkaline conditions but does poorly in acid soils of less than 6 pH. If small grains are planted too early in the fall, depending on the crop rotation there can be disease problems (especially with tan spot).
OATS	Rarely a problem	Occasionally a minor problem	Occasionally a minor problem	Occasionally a minor problem	33:1	Hay 9-15%, Grain 13-18%	Forms	19,600	38	Prone to lodging in N rich soil. Self Pollinator (wind). Non-host for root knot nematode, soybean cyst nematode, and sugarbeet cyst nematode. Host for Penetrans Root-Lesion Nematode. Slow to release Nitrogen to following crop unless growth terminated in mid-vegetative stage (12-18 in).
ANNUAL RYEGRASS	Could be a major problem	Occasionally a minor problem	Occasionally a minor problem	Could be a minor problem	20:1-31:1	9%	N/A	190,280	40	Heavy Nitrogen and water user. Cutting boosts dry matter significantly. Not advised for wheat rotations. May take two applications to chemically terminate. Must be killed before it joints. Host for Penetrans Root-Lesion Nematode.
WINTER CEREAL RYE	Could be a moderate problem	Could be a moderate problem	Occasionally a minor problem	Could be a moderate problem	14:1 young 40:1 boot	Straw 4%, Grain 14%	Forms	18,160	34	Kill 1.5-2 weeks before planting corn. Not recommended before corn due to allelopathy. Corn seed maggot/armyworm, cutworm could be issues. Tolerates triazine herbicides. Self Pollinator (wind). Non-host for root knot nematode, soybean cyst nematode, and sugarbeet cyst nematode. Host for Penetrans Root-Lesion Nematode.
WINTER TRITICALE	Could be a minor problem	Could be a moderate problem	Could be a minor problem	Could be a minor problem	20:1	Hay 9-16%, Grain-17%	Forms	22,700	38	Self Pollinator (wind). Non-host for sugarbeet cyst nematode, soybean cyst nematode, and root knot nematode. Host for Penetrans Root-Lesion Nematode.
SPRING WHEAT	Rarely a problem	Could be a moderate problem	Could be a moderate problem	Occasionally a minor problem	15-95:1	Straw 4-10%, Grain 12-16%	Benefits from	11,360	38	Heavy Nitrogen and water user in spring. Absorbs Nitrogen and Water heavily during stem growth, so kill before then. Carbon: Nitrogen Ratio--Leaf 15-29, Stem 31-65, Root 24-74, Straw 80-95 (end of season). Self Pollinator (wind). Southern MN has Hessian Fly-free planting dates to be heeded. Host for Penetrans Root-Lesion Nematode.
WINTER WHEAT	Could be a minor problem	Could be a moderate problem	Could be a moderate problem	Could be a minor problem	20:1	9%	N/A	11,360	38	Kill 1.5-2 weeks before planting corn. Corn seed maggot, armyworm, and cutworm could be insect issues. Heavy Nitrogen and water user in spring. Southern MN has Hessian Fly-free planting dates to be heeded. Non-host for sugarbeet nematode, soybean cyst nematode, and root knot nematode. Wheat curl mite can spread wheat streak mosaic virus. Use 2 weeks of broken green bridge to break the pest cycle (cover crops can harbor the pest, allowing transfer from spring to winter crops). If small grains are planted too early in the fall, depending on the crop rotation there can be disease problems (especially with tan spot).
FOXTAIL MILLET	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	44:1	15%	Forms	220,000	65	Self Pollinator (wind). Do not feed to horses as it may have a laxative effect.
JAPANESE MILLET	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	42:1	16%	N/A	142,880	65	Does not germinate or thrive in cold soil. Non-host for root knot nematode, soybean cyst nematode, and sugarbeet cyst nematode. Host for Penetrans Root-Lesion Nematode
PEARL MILLET	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	50:1	13%	Forms	82,320	65	Self Pollinator (wind). Slower to establish than sudan or sorghum-sudangrass. Does not germinate or thrive in cold soil. Non-host for root knot nematode, soybean cyst nematode, and sugarbeet cyst nematode. It is the best known cover crop for reduction of population densities of Penetrans Root-Lesion Nematode, but this can be variety specific.
PROSO MILLET	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	12-35:1	10%	Forms	80,000	65	Carbon: Nitrogen Ratio--Leaf 12-16, Stem 12-35, Root 17-26. Self Pollinators (wind).
SORGHUM-SUDANGRASS	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Could be a moderate problem	10-30:1	Hay 7%, Stover 5%, Grain 10%	Forms	17,280	65	Alternate Name Grain Sorghum. Carbon: Nitrogen Ratio--Leaf 11-17, Stem 10-27, Root 22-30. Self Pollinator (wind). Mature, frost-killed plants become quite woody. Stress conditions that limit growth (e.g. drought, frost) can contribute to prussic acid accumulation in leaves. Don't graze until it's 24" tall and for 2 weeks after a killing frost-prussic acid Be wary of prussic acid toxicity if using for forage/grazing. Mid-season cutting increase yield and root penetration. Has been used in tree fruit, small fruit and vegetable production systems since the middle 1960s for management of Penetrans Root-Lesion Nematode and root knot nematode. Non-host for soybean cyst nematode and sugarbeet cyst nematode.

Table 2

Identification and Comparison of Cover Crop Performance and Benefits by Species

ATTRIBUTE RATINGS: 0=POOR, 1= FAIR, 2=GOOD, 3=VERY GOOD, 4=EXCELLENT

	Performance and Roles I								Performance and Roles II						Cultural Traits										Potential Advantages							
SPECIES	**Nitrogen Source**	**Total Nitrogen (lb/ac)**	**Dry Matter (lbs/ac/yr)**	**Nitrogen Scavenger**	**Soil Builder**	**Erosion Fighter**	**Weed Fighter**	**Quick Growth**	**Lasting Residue**	**Grain/Seed Harvest Value**	**Grazing**	**Mechanical Forage Harvest Value**	**Companion Cropping (Interseeding) Performance**	**winter Survival**	**Heat Tolerance**	**Drought Tolerance**	**Shade Tolerance**	**Flood Tolerance**	**Salinity Tolerance**	**Life Cycle**	**Growth Habit**	**Preferred Soil pH**	**Water Use**	**Low Fert Tolerance**	**Subsoiler**	**Nematodes**	**Disease**	**Allelopathic**	**Choke Weeds**	**Attracts Beneficials**	**Bears Traffic**	**Short Windows**
GRASSES (continued)																																
SUDANGRASS	0	0	3000-8000	4	4	3	4	4	4	0	4	4	0	Never	4	4	1	2	1	Warm Season, Annual	Upright	5.5-7	Medium	2	2	3	3	2	4	2	3	4
NON-LEGUME BROADLEAVES																																
BEETS	1	N/A	N/A	3	1	1	N/A	4	1	0	4	3	4	N/A	1	2	3	3	1	Cool Season, Biennial	Upright and Spreading	N/A	High	1	2	0	2	2	1	N/A	4	4
CABBAGE	1	N/A	N/A	2	3	3	N/A	3	3	0	4	3	4	N/A	3	2	3	4	N/A	Cool Season, Annual	Upright and Spreading	N/A	N/A	1	1	3	2	1	3	N/A	1	3
FLAX	0	0	500-1000	2	1	1	0	1	4	0	1	0	0	Never	2	2	1	1	1	Cool Season, Annual	Upright	6-7	Medium	2	2	1	0	2	2	2	2	2
KALE	0	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	4	N/A	N/A	Seldom	N/A	N/A	N/A	0	1	Cool Season, Annual	Upright and Spreading	N/A	Medium	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A
MUSTARD	0	30-100	1200-3000	3	2	2	3	3	1	1	0	0	0	Never	2	2	1	1	0	Cool Season, Annual	Upright	5.5-8	Low	2	2	3	2	2	3	3	1	4
PHACELIA	0	N/A	N/A	2	2	3	N/A	3	1	0	4	1	4	Seldom	3	3	2	4	0	Cool Season, Annual	Upright	N/A	Low	1	1	1	2	1	2	4	1	3
RADISH	0	30-100	1200-3000	3	3	2	3	4	0	0	3	0	2	Never	2	2	2	1	0	Cool Season, Annual	Upright	6-7	High	2	3	3	2	2	3	1	1	3
RAPESEED/CANOLA	0	30-100	1000-2500	3	2	2	2	3	1	2	0	1	0	Seldom	2	2	1	1	2	Cool Season, Annual	Upright	5.5-8	Medium	2	2	3	2	2	2	2	1	2
TURNIP	0	30-100	1200-3000	3	2	2	2	2	1	0	4	1	2	Never	2	1	1	1	0	Cool Season, Annual	Upright	5.3-6	High	1	0	3	2	2	2	1	0	2
WINTER CAMELINA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A	Expected	N/A	N/A	N/A	N/A	1	Cool Season, Annual and Biennial	Upright	N/A	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BUCKWHEAT	0	0	1500-2500	3	2	2	3	4	0	3	2	0	0	Never	4	2	1	1	0	Warm Season, Annual	Upright to Semi-Upright	5-7	Medium	3	1	1	0	1	4	4	0	4
SAFFLOWER	0	N/A	N/A	4	3	1	N/A	3	1	0	3	3	2	N/A	4	4	1	0	2	Warm Season, Annual	Upright	N/A	High	3	4	3	3	2	3	4	1	0
SUNFLOWER	0	N/A	N/A	4	3	3	N/A	3	3	0	3	3	0	Seldom	3	2	0	0	1	Warm Season, Annual	Upright	N/A	High	3	4	2	2	0	2	4	0	4

	Potential Disadvantages									
SPECIES	**Weed Potential**	**Insect/Nematode**	**Crop Disease**	**Hinders Crops**	**C:N Ratio**	**Crude Protein**	**Arbuscular Mycorrhizal Associations**	**Seed Count (seeds/lb)**	**Germination Temperature (F)**	**Notes**
GRASSES (continued)										
SUDANGRASS	Occasionally a minor problem	Occasionally a minor problem	Rarely a problem	Could be a moderate problem	48-63:1	Hay 7-11%, Silage 6-17%	Forms	42,240	65	Self Pollinator (wind). Stress conditions that limit growth (e.g. drought, frost) can contribute to prussic acid accumulation in leaves. Be wary of prussic acid toxicity if using for forage/grazing. Drought stressed plants can cause nitrate poisoning. Known allelopathic effects on annual ryegrass. Non-host for root knot nematode, soybean cyst nematode, and sugarbeet cyst nematode. Host for Penetrans Root-Lesion Nematode.
NON-LEGUME BROADLEAVES										
BEETS	Could be a moderate problem	Occasionally a minor problem	Occasionally a minor problem	Could be a minor problem	Tops 11-14:1	Tops 12-15%, Root 7-10%	Does Not Form	N/A	40	Self Pollinator (wind)
CABBAGE	Could be a minor problem	Occasionally a minor problem	Occasionally a minor problem	Occasionally a minor problem	12-30:1	N/A	N/A	N/A	42	
FLAX	Rarely a problem	Occasionally a minor problem	Could be a minor problem	Occasionally a minor problem	20-50:1	22%	Benefits from	81,000	48	Prussic acid poisoning can be a problem if fed to livestock.
KALE	N/A	N/A	N/A	N/A	10-30:1	30%	Does Not Form	N/A	45	Introduce slowly to livestock because it is highly digestible. Should never be more than 35% of diet. Likes seed to soil contact so incorporated seeding at a shallow depth is best.
MUSTARD	Could be a moderate problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	10-30:1	Hay 10%, Grain 24-35%	Does Not Form	180,000	40	Host soybean cyst nematode, don't plant with other brassicas, can be harmful to livestock. Surpasses nematodes and weeds.
PHACELIA	Could be a moderate problem	Occasionally a minor problem	Occasionally a minor problem	Occasionally a minor problem	10-15:1	N/A	Forms	235,000	42	
RADISH	Could be a minor problem	Occasionally a minor problem	Rarely a problem	Occasionally a minor problem	19-20:1	26-30%	Does Not Form	34,000	45	Good Nitrogen scavenging and weed control; Nitrogen released rapidly. Winter kills at 25 degrees F. Odor during decay. Attracts earthworms. Non-host for soybean cyst nematode. Some species are commonly used as a trap crop for sugarbeet cyst nematode. Host for root knot nematode, Penetrans Root-Lesion Nematode and sugarbeet cyst nematode.
RAPESEED/CANOLA	Could be a moderate problem	Could be a minor problem	Rarely a problem	Could be a minor problem	12-37:1	Shoots 20-30%, Hay 16%, Grain 21%, Silage 12%, Pasture 17%	Does Not Form	156,960	41	Suppresses Rhizoctonia. Carbon: Nitrogen Ratio-Leaf 12-16, Stem 21-37, Root 24-43 Rapeseed is a non-host for root knot nematode and sugarbeet cyst nematode. Essex rape is used as a non-host for control of dagger nematodes in tree fruit production. Rapeseed is a host for Penetrans Root-Lesion Nematode.
TURNIP	Could be a moderate problem	Could be a minor problem	Rarely a problem	Rarely a problem	20-30:1	Tops 16%, Roots 12-14%	Does Not Form	192,800	45	High producing late-season forage for grazing. Can become a serious weed if let to go to seed. Non-host for soybean cyst nematode. Carbon: Nitrogen Ratio-shoots 20-30, Roots 10-20. Host for root knot nematode. Penetrans Root-Lesion Nematode and sugarbeet cyst nematode.
WINTER CAMELINA	Could be a moderate problem	N/A	N/A	N/A	40-95:1	46%	Does Not Form	400,000	32	Mainly a self pollinator but benefits from pollinators. Sensitive to soil herbicide imidazolinones and sulfentrazaone. Volunteer plants can become problematic. Potentially allelopathic for flax. Grows as a rosette in the fall and overwinters as a rosette. Bolts in the spring. Likes seed to soil contact so incorporated seeding at a shallow depth is best.
BUCKWHEAT	Could be a major problem	Occasionally a minor problem	Rarely a problem	Could be a minor problem	8-32:1	Straw 5%, Grain 13%	Does Not Form	20,400	50	Cool Season but has Warm Season Growth Characteristics. Enhances soil Phosphorus availability. Carbon: Nitrogen Ratio--Leaf 8-10, Stem 12-32, Root 28-47. Summer smother crop, breaks down quickly. Buckwheat sets seed quickly. Potential honey income. Very frost sensitive. Does not germinate or thrive in cold soil. One variety of buckwheat has been successfully developed for use as a sugarbeet cyst nematode trap crop.
SAFFLOWER	Rarely a problem	Occasionally a minor problem	Could be a minor problem	Could be a moderate problem	21-56:1	Hay 10-13%, Grain 18%	Forms	N/A	40	Deep Rooted. Effective at mining mobile nutrients deep in the soil profile. Carbon: Nitrogen Ratio--Leaf 21, Stem 56, Root 73.
SUNFLOWER	Could be a minor problem	Could be a moderate problem	Could be a minor problem	Could be a minor problem	11-46:1	Silage 11-12%., Grain 20-28%	Forms	N/A	39	Deep Rooted. Effective at mining mobile nutrients deep in the soil profile. Carbon: Nitrogen Ratio--Leaf 11-14, Stem 41-46, Root 50-68, Flower 14-19.

Table 2

Identification and Comparison of Cover Crop Performance and Benefits by Species

ATTRIBUTE RATINGS: 0=POOR, 1= FAIR, 2=GOOD, 3=VERY GOOD, 4=EXCELLENT

	Performance and Roles I								Performance and Roles II						Cultural Traits										Potential Advantages								Potential Disadvantages								
SPECIES	Nitrogen Source	Total Nitrogen (lb/ac)	Dry Matter (lbs/ac/yr)	Nitrogen Scavenger	Soil Builder	Erosion Fighter	Weed Fighter	Quick Growth	Lasting Residue	Grain/Seed Harvest Value	Grazing	Mechanical Forage Harvest Value	Companion Cropping (Interseeding) Performance	winter Survival	Heat Tolerance	Drought Tolerance	Shade Tolerance	Flood Tolerance	Salinity Tolerance	Life Cycle	Growth Habit	Preferred Soil pH	Water Use	Low Fert Tolerance	Subsoiler	Nematodes	Disease	Allelopathic	Choke Weeds	Attracts Beneficials	Bears Traffic	Short Windows	Weed Potential	Insect/Nematode	Crop Disease	Hinders Crops	C:N Ratio	Crude Protein	Arbuscular Mycorrhizal Associations	Seed Count (seeds/lb)	Germination Temperature (F)	Notes
LEGUMES																																										
ALFALFA	4	50-120	600-2000	4	3	4	2	2	2	1	4	4	2	Expected	3	3	2	1	0	Cool Season, Perennial	Upright	6-8	High	1	4	1	1	1	3	2	4	1	Could be a minor problem	Could be a minor problem	Occasionally a minor problem	Occasionally a minor problem	11-13:1	14-22%	Forms	200,000	34	Non-Dormant Cultivars can perform like an annual. Slower to establish than red clover. May cause grazing animals to bloat. If managed as an annual rather than a perennial, it is not as effective at suppressing weeds. Likewise, it is an excellent soilbuilder if left for more than one year. Likes a firm seedbed. Can become a serious weed if let to go to seed as when tillage or herbicide application is not done in a timely/efficient way. Cutworm can also be a problem.
CHICKPEA	3	N/A	N/A	2	2	3	N/A	3	2	0	4	3	4	N/A	3	2	3	4	2	Cool Season, Annual	Upright and Spreading	N/A	Low	1	1	0	2	1	1	4	1	3	Could be a moderate problem	Occasionally a minor problem	Occasionally a minor problem	Occasionally a minor problem	10-56:1	Straw 6%, Grain 22%	Forms	N/A	42	Carbon: Nitrogen Ratio-Leaf 10-15, Stem 25-56, root 16-27.
BALANSA CLOVER	3	N/A	N/A	2	3	3	N/A	2	2	0	4	4	4	N/A	3	2	3	3	2	Cool Season, Annual	Upright, Spreading, or Prostrate	4-8	N/A	1	1	2	2	1	4	4	1	3	Occasionally a minor problem	Could be a moderate problem	Could be a minor problem	Could be a minor problem	15:1	15-20%	N/A	N/A	42	Multibranched Rosette but Prostrate when grazed. Requires inoculation with root-nodule bacterium Rhizobium sp. at planting.
BERSEEM CLOVER	4	70-100	1200-3000	2	3	3	2	1	2	0	4	3	4	Never	3	2	2	1	1	Cool Season, Annual	Upright	6-8	Low	1	1	1	1	1	2	3	1	1	Occasionally a minor problem	Could be a minor problem	Occasionally a minor problem	Rarely a problem	18-23:1	27-29%	Forms	206,880	42	May cause bloat. Excellent as greenchop, less impressive as dry harvested forage.
CRIMSON CLOVER	3	50-90	3500-5500	2	3	2	2	2	2	0	2	3	4	Never	3	2	2	1	0	Cool Season, Annual	Upright to Semi-Upright	5.5-7	Medium	2	2	1	2	1	3	3	1	1	Could be a minor problem	Could be a minor problem	Occasionally a minor problem	Occasionally a minor problem	16-19:1	18%	Forms	149,760	42	Establishes easily, grows quickly if planted early in fall; matures early in spring. May cause bloat. Excellent as greenchop, less impressive as dry harvested forage. Good for interseeding, easy to kill by tillage or mowing. Non-host for sugarbeet cyst nematode. Host for root knot nematode, soybean cyst nematode, and Penetrans Root-Lesion Nematode.
RED CLOVER	4	70-100	2000-5000	3	3	4	3	3	2	3	4	3	4	Expected	3	2	3	2	0	Cool Season, Perennial	Upright	5.5-7	Medium	2	2	1	1	1	3	3	2	2	Could be a minor problem	Could be a minor problem	Occasionally a minor problem	Occasionally a minor problem	15-23:1	15%	Forms	272,160	42	Can cause bloat in livestock. Excellent forage, easily established; widely adapted. Excellent as a greenchop, less impressive as dry harvested forage. Excellent for interseeding into small grains, less reliable in corn and soybeans. Great option for frost seeding/rapid establishment. Non-host for sugarbeet cyst nematode and a poor host for soybean cyst nematode. Host for root knot nematode and Penetrans Root-Lesion Nematode.
WHITE CLOVER	2	50-90	2000-6000	2	3	3	2	1	1	0	3	3	4	Expected	3	2	3	3	0	Cool Season, Perennial	Upright	5.5-7	Medium	2	1	1	1	1	3	3	2	1	Could be a minor problem	Could be a minor problem	Occasionally a minor problem	Occasionally a minor problem	13-23:1	24-30%	Forms	784,000	42	Causes bloat in horses. May cause bloat in cattle/sheep. Excellent as a greenchop, less impressive as dry harvested forage. Aggressive growth in some regions or habitats.
FAVA BEAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	2	Cool Season, Annual	Upright Vine	N/A	Medium	N/A	N/A	N/A	N/A	N/A	N/A	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17%	Forms	N/A	N/A	
FIELD/WINTER PEA	2	50-100	1200-3000	2	2	2	1	3	1	2	2	3	2	Never	1	1	1	1	0	Cool Season, Annual	Climbing	6-7	Low	1	2	2	3	1	3	2	1	3	Rarely a problem	Could be a minor problem	Could be a moderate problem	Rarely a problem	13-83:1	Hay 14%, Grain 24%, Silage 15%	Forms	1,840	41	Poor host for soybean cyst nematode. Carbon: Nitrogen Ratio---Leaf 13-25, Stem 27-83, root 17-27. Biomass breaks down quickly; early planting reduces winter survival. Mixes well with grains when grown for forage. Late planting increases heaving/overcrowding. Host for root knot nematode, Penetrans Root-Lesion Nematode and sugarbeet cyst nematode.
LENTILS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	Cool Season, Annual	Upright and Spreading	N/A	Low	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	11-49:1	Hay 14%, Grain 28%, Silage 15%	Forms	N/A	N/A	Carbon: Nitrogen Ratio--leaf 11-21, Stem 25-49, Root 22-30
LUPIN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Cool Season, Annual	Upright	N/A	Low	N/A	N/A	N/A	N/A	N/A	N/A	4	N/A	N/A	N/A	N/A	N/A	N/A	12-49:1	Silage 15%	Does Not Form	N/A	N/A	Prefers acids soils. Carbon: Nitrogen Ratio--Leaf 12-30, Stem 25-49. Alkaloids make lupin seed and forage unpalatable for livestock, but also play a major role in resistance to disease, insects, and nematodes.
SAINFOIN	4	N/A	N/A	2	3	3	N/A	3	1	0	4	4	4	N/A	3	3	1	4	0	Cool Season, Perennial	Upright	6-8.5	Medium	1	1	1	2	1	4	4	1	3	Could be a moderate problem	Occasionally a minor problem	Occasionally a minor problem	Occasionally a minor problem	N/A	13-20%	Forms	18,000	42	Is nonbloating and preferred forage for cattle, sheep, deer and elk.
SWEETCLOVER	3	30-70	2500-4000	2	3	3	2	2	3	2	1	1	2	Expected	4	4	3	3	1	Cool Season, Biennial	Upright	6.5-7	Moderate	4	4	1	1	1	3	3	4	2	Could be a major problem	Could be a moderate problem	Rarely a problem	Could be a minor problem	12:-23:1	11-18%	Forms	258,560	42	Good for wildlife, harmful to livestock. Tall stalks, deep roots in second year. Mature plants become woody. Hard seed will reseed. Moldy hay can cause livestock death. Non-host for sugarbeet cyst nematode. Host for root knot nematode, soybean cyst nematode, and Penetrans Root-Lesion Nematode.
VETCH	4	50-120	1800-4000	2	2	2	2	1	1	0	0	1	2	Expected	1	2	2	2	0	Cool Season, Annual	Climbing	5.5-7	Low to Medium	2	1	1	2	2	3	4	1	1	Could be a major problem	Could be a minor problem	Rarely a problem	Occasionally a minor problem	10-19:1	13-20%	Forms	16,320	60	Host soybean cyst nematode, high % of hard seed-can become weedy. Seeds are toxic to livestock. Tolerates low fertility, wide pH range, cold or fluctuating winters. Non-host for sugarbeet cyst nematode. Do not plant in fields where small grains are grown for a cash crop since seed contamination decreases small grain value. Hairy vetch is a host for root knot nematode, soybean cyst nematode, and Penetrans Root-Lesion Nematode. Cutworm can also be a problem.

Table 2

Identification and Comparison of Cover Crop Performance and Benefits by Species

ATTRIBUTE RATINGS: 0=POOR, 1= FAIR, 2=GOOD, 3=VERY GOOD, 4=EXCELLENT

LEGUMES (continued)

SPECIES	Performance and Roles I								Performance and Roles II					
	Nitrogen Source	Total Nitrogen (lb/ac)	Dry Matter (lbs/ac/yr)	Nitrogen Scavenger	Soil Builder	Erosion Fighter	Weed Fighter	Quick Growth	Lasting Residue	Grain/Seed Harvest Value	Grazing	Mechanical Forage Harvest Value	Companion Cropping (Interseeding) Performance	winter Survival
COWPEA	3	50-100	2000-3600	1	2	2	2	2	1	0	3	2	0	Never
SOYBEANS	2	20-50	3000-6000	2	2	0	2	2	2	2	2	2	0	Never
SUNNHEMP	4	50-100	2000-5000	2	3	3	1	3	3	0	3	1	1	Never

SPECIES	Cultural Traits									
	Heat Tolerance	Drought Tolerance	Shade Tolerance	Flood Tolerance	Salinity Tolerance	Life Cycle	Growth Habit	Preferred Soil pH	Water Use	Low Fert Tolerance
COWPEA	4	3	2	1	1	Warm Season, Annual	Semi-Upright to Climbing	5.5-6	Low	2
SOYBEANS	3	3	2	1	0	Warm Season, Annual	Upright	5.8-7	Medium	2
SUNNHEMP	4	3	1	2	0	Warm Season, Annual	Upright	5-8	Low	2

SPECIES	Potential Advantages								Potential Disadvantages			
	Subsoiler	Nematodes	Disease	Allelopathic	Choke Weeds	Attracts Beneficials	Bears Traffic	Short Windows	Weed Potential	Insect/Nematode	Crop Disease	Hinders Crops
COWPEA	2	0	0	0	4	3	0	4	Rarely a problem	Could be a minor problem	Occasionally a minor problem	Rarely a problem
SOYBEANS	2	0	0	0	3	3	1	3	Rarely a problem	Could be a moderate problem	Could be a minor problem	Rarely a problem
SUNNHEMP	2	4	3	3	3	1	2	3	Could be a minor problem	Occasionally a minor problem	N/A	N/A

SPECIES	C:N Ratio	Crude Protein	Arbuscular Mycorrhizal Associations	Seed Count (seeds/lb)	Germination Temperature (F)	Notes
COWPEA	18-22:1	Grain and Leaves 19-30%, Stems 13-17%	Forms	3,600	58	Season length, habit vary by cultivar. Some cultivars, nematode resistant. Host soybean cyst nematode.
SOYBEANS	14-39:1	Hay 17%, Grain 42%	Forms	3,000	50	Self-Pollinated but flowers may attract pollinators. Host plant for soybean cyst nematode Carbon: Nitrogen Ratio--Leaf 14, Stem 39, root 34.
SUNNHEMP	14-30	N/A	Forms	15,000	42	Self Pollinates (wind) as well as cross pollinates (insects/birds). Certain Cultivars contain alkaloids which are poisonous to livestock. Avoid grazing after flowering. Has an extensive taproot.

INFORMATION from Midwest Cover Crops Council (MCCC) Website, MCCC Cover Crop Field Guide, Green Cover Seed, SARE-Managing Cover Crops Profitably, SARE Cover Cropping for Pollinators and Beneficial Insects, USDA-ARS Cover Crops Chart, and USDA-NRCS PLANTS Guide