Natural Resources Conservation Service

Minnesota Agronomy Technical Note 33

Cover Crop Seeding Guide

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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Midwest Cover Crop Decision Tool: http://mccc.msu.edu/covercroptool/covercroptool.php

Midwest Cover Crop Field Guide, second edition: MCCC Cover Crop Field Guide

NRCS Cover Crop Termination Guidelines: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/

National Agricultural Aviation Association: http://www.agaviation.org/

Northern Great Plains Research Laboratory: Mandan, ND: USDA-ARS Cover Crop Chart

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University of Wisconsin Publications: Herbicide Rotation Restrictions in Forage and Cover Cropping Systems

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								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
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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								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
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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.

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	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

	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 (continued)																																										
COWPEA	3	50-100	2000-3600	1	2	2	2	2	1	0	3	2	0	Never	4	3	2	1	1	Warm Season, Annual	Semi-Upright to Climbing	5.5-6	Low	2	2	0	0	0	4	3	0	4	Rarely a problem	Could be a minor problem	Occasionally a minor problem	Rarely a problem	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	2	20-50	3000-6000	2	2	0	2	2	2	2	2	2	0	Never	3	3	2	1	0	Warm Season, Annual	Upright	5.8-7	Medium	2	2	0	0	0	3	3	1	3	Rarely a problem	Could be a moderate problem	Could be a minor problem	Rarely a problem	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	4	50-100	2000-5000	2	3	3	1	3	3	0	3	1	1	Never	4	3	1	2	0	Warm Season, Annual	Upright	5-8	Low	2	2	4	3	3	3	1	2	3	Could be a minor problem	Occasionally a minor problem	N/A	N/A	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																																									