United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE SPECIFICATIONS

COVER CROP

CODE 340

These specifications supplement the conservation practice standard for Cover Crop (340), and contain additional criteria for species selection, seeding methods and rates, seeding depths, planting dates, and termination methods. In addition to the many references found in this document, refer to the current *PennState Agronomy Guide*, technical bulletins and newsletter articles for the latest information concerning this rapidly developing conservation technology.

Formulating Alternatives and Selecting Species

Formulate cover crop alternatives that address both the identified resource concerns and the planned management objectives of the producer.

Refer to *Table 1* in these specifications to select appropriate cover crops based on the type of crop, life cycle of the crop, intended purpose(s) of the planting, species characteristics, and other uses. Use this table to evaluate the strengths and weaknesses of a cover crop species to ensure that it is compatible with the site conditions and planned cropping system for the area. The term “nurse crop” in this table refers to a rapidly growing crop that can assist with the establishment of a perennial crop or other crop that is slow to establish.

Plant types in *Table 1* include warm-season and cool-season grasses and forbs, including legumes and Brassicas. The life cycle of each cover crop is identified as follows:

- **Winter Annual (WA).** Usually planted in late summer to late fall, winter annuals grow actively during this period, then grow more slowly or go dormant during the winter, depending on weather conditions. They are not frost-sensitive and do not winter-kill, and will resume growth in early spring. A winter annual has the potential to flower and set seed within one year, if not terminated.
- **Summer Annual (SA).** Usually planted in early or late summer to mid fall, depending on the species. Cover crops in this category are expected to winter-kill. Most of the species planted as summer annuals are warm-season plants that are frost-sensitive. However, the cool-season species (such as the Brassicas) may survive a mild winter and resume growth in the spring. A summer annual has the potential to flower and set seed within one year, if not terminated.
- **Biennial (B).** Biennials are used to provide longer-term cover than annuals, but can also be planted and managed as winter annuals (i.e., planted in late summer to late fall, and terminated in the spring). A biennial is a plant that takes two years to complete its life cycle. It grows vegetatively for the first year, then flowers and sets seed in the second year.
- **Short-lived Perennial (SLP).** Similar to biennials, short-lived perennials are used to provide longer-term cover than annuals, but can also be planted and managed as winter annual cover crops. Short-lived perennials have the potential to persist for 3 to 5 years, if not terminated.
- **Perennial (P).** Perennials have the potential to persist for more than 5 years, if not terminated. They can also be planted and managed as winter annual cover crops.

Table 2 provides the recommended seeding rates, seeding depths, planting dates, and termination methods for each species.

Figure 1 shows a map for identifying latest seeding dates for cover crops in Pennsylvania.

Additional information on cover crops can be found in the *References* section at the end of this document.

Site Preparation and Soil Amendments

Site preparation shall be done at a time and in a manner to ensure successful establishment of the cover crop. Before planting with a conventional drill or by broadcasting, prepare a seedbed by chiseling and/or disking. Seedbed preparation is usually not needed when using a no-till drill, and is generally not feasible when broadcasting or aerial seeding into a standing crop or crop residue.

Apply lime only if needed based on recent soil test results. Any use of commercial fertilizer and other forms of plant nutrients must comply with Pennsylvania nutrient management regulations, as applicable.

Do not apply fertilizer prior to planting when the cover crop is intended to benefit water quality by utilizing excess nutrients.

Refer to labels of previously used herbicides to ensure they will not interfere with the planned cover crop.

Establishing Cover Crops

Cover crops may be established using a variety of methods, including drilling, broadcasting with incorporation, interseeding, and aerial seeding. Interseeding refers to the process of broadcasting or drilling a cover crop into a standing crop (e.g., corn).

Seedbed preparation will depend on the species used and the timing and method of planting. It is essential to provide good seed to soil contact. Most cover crops will not perform well if broadcast on a compacted or crusted surface. If seeding the cover crop prior to harvest of the primary crop, no seedbed preparation is required.

For best results, use a planting method that incorporates the seed into the soil. Conventional drilling into a prepared seedbed, no-till drilling, or broadcasting followed by light soil incorporation (e.g., with a cultipacker, vertical tillage, rolling basket, or light disking) are preferred seeding methods because they optimize seed-soil contact.

Aerial seeding or broadcasting without incorporation may be used, but these methods require higher seeding rates to compensate for poorer seed distribution and/or germination.

Plant cover crops as early as feasible within the time period indicated in *Table 2*. This may be immediately after harvesting the previous crop, or – in the case of a late harvest – overseeding before harvest may be required. When planting near the end of the growing season, select a cover crop that will germinate and grow rapidly to help assure a successful stand.

To maximize plant biomass and nutrient uptake, plant cover crops as early as possible and terminate as late as feasible, considering crop insurance criteria, the time needed to prepare the field for the following crop, and soil moisture depletion.

Inoculants

Inoculate legume seeds with the proper, viable *Rhizobium* bacteria before planting. Keep inoculant as cool as possible before use and do not use it later than the date indicated on the package. For best results, consider using pre-inoculated, coated seed when available.

Seeding Rates

Seeding rates listed in *Table 2* are in pounds per acre needed to establish an adequate stand for a single species cover crop. Seeding rates should be adjusted as follows:

- If aerial seeded or broadcast without incorporation, increase the seeding rate by 30%.
- If the purpose of the seeding is weed suppression, increase the seeding rate by 25%.
- If the field has a frequent manure history, decrease the seeding rate by 25%.

A minimum seed germination rate of 80% is required, unless a PLS seeding rate is used. If the minimum germination rate is less than 80%, increase the seeding rate appropriately to compensate. (Pure Live Seed [PLS] is determined as follows: Percent Purity x Percent Germination / 100 = Percent PLS.)

When using seeding mixtures, the recommended seeding rate (pounds/acre) of each species is reduced proportionally, and the rates for all species are added together to give a total seeding rate for the mix. See pages 3 and 4, *Developing Cover Crop Mixes*, for more information about mixes.

The final plant population stand density in plants per square foot will be less than the seeding rate due to germination that is less than 100% and some seedling mortality.

Seeding Depth

In general, seeding depth is related to seed size: larger seeds should be planted deeper. The recommended seeding depth to obtain optimum germination for each species is provided in *Table 2*. Seed should be planted deeper in sandy soils and less deep in clay soils.

Planting Dates

Cover crop planting dates are located in *Table 2* and are defined according to the map of Pennsylvania shown in *Figure 1*. The optimum planting season is also identified in *Table 2*.

Successful establishment of the planting will vary with environmental conditions, but is more likely to occur if the crop is planted near the beginning of the planting period. Planting before the earliest date is permissible when weather conditions are favorable. In order to allow sufficient time for growth, the latest planting date should rarely be exceeded.

Developing Cover Crop Mixes

Common mixes include a small grain (e.g., cereal rye, wheat, etc.) with a legume (e.g., red clover, hairy vetch, etc.) and/or a brassica (e.g., forage radish). To facilitate planting and termination, select species that have the same life cycle and planting season, and at least one termination method that can be used for the whole mix. Consider the type and availability of equipment that may be needed for different size seeds in a mix, as well as other uses of the planting desired by the producer (e.g., attracting beneficial insects and pollinators).

When calculating a seeding rate for cover crop mixtures, the recommended seeding rate (pounds/acre) of each species is reduced proportionally, and the rates for all species are added together to give a total seeding rate for the mix.

Ensure that the sum of each species rate used equals or exceeds 100%. For example, the full seeding rate of cereal rye is 120 lb/ac and crimson clover is 15 lb/ac. The combination of 60 lb/ac of rye (60/120=50%) and 7.5 lb/ac of crimson clover (7.5/15=50%) would be acceptable because 50% + 50% = 100%. A combination of 56 lb/ac (56/120=47%) of rye and 5 lb/ac (5/15=33%) of crimson clover would not be acceptable because 47% + 33% = 80%.

Many legume components of a mixture tend to be weak competitors and are more safely kept at the base seeding rates to ensure successful establishment in the stand.

The following cover crops can be very competitive in a mix; their seeding rates must be reduced more than others in order to keep them from dominating the mixture. Appropriate seeding rates are:

- Forage radish: 1-2 pounds/acre in a two- or three-species mix.
- Oats: 20-40 pounds/acre in a two- or three-species mix.
- Rapeseed/Canola: 3-4 pounds/acre in a two- or three-species mix.
- Sorghum/Sudangrass: 15-20 pounds/acre in a two- or three-species mix.

Terminating Cover Crops

Terminate seasonal cover crops by frost or winter-kill, mowing, tillage, crimping, and/or herbicides in preparation for the next crop. Herbicides used with cover crops must be compatible with the following crop.

The cover crop can be terminated at various growth stages, but timely termination is required to prevent soil moisture depletion, nitrogen immobilization, allelopathy, and undesired reseeding. Timing of cover crop termination and managing cover crop surface residue should meet the criteria for the purpose(s) of the cover crop. Do not burn cover crop residue.

Timing and method of termination should allow for maximum efficiency of nitrogen utilization by the following crop, considering soil type and conditions, season and weather conditions, cropping system, C:N ratio of the cover crop at termination, and anticipated nitrogen needs of the subsequent crop.

In most cropping systems, it is not desirable to allow the cover crop to produce seed. Terminate a grass cover crop no later than the late joint to early boot stage, or no later than 2 to 4 weeks prior to planting the next crop. Legumes that are terminated while succulent decompose more rapidly than grasses, so terminating a legume cover crop 1 to 2 weeks before planting the next crop is usually sufficient.

In addition, the cover crop termination must be at or before the time periods specified in the *NRCS Cover Crop Termination Guidelines* located in the FOTG, Section IV, Conservation Practice Standards, Cover Crop (340). To meet crop insurance requirements for a following crop on non-irrigated cropland, cover crops must be terminated before crop emergence.

Carbon to Nitrogen Ratio (C:N)

The C:N ratio of cover crop residue is a good indicator of whether immobilization or mineralization will occur. Values exceeding 30 parts carbon to one part nitrogen (C:N ratio of 30:1) are generally expected to immobilize N during the early stages of the decomposition process.

The C:N ratio of small grain residues is mostly dependent on time of termination. Early termination of grass cover crops results in a narrower C:N ratio and results in rapid decomposition of a smaller amount of residue, reducing ground coverage. Small grain cover crops should be allowed to grow as long as possible to increase the amount of residue. It is beneficial to wait one to three weeks after killing a low-N cover before planting the next crop to allow nitrogen to become available for the crop. When small grain cover crops are killed at flowering, the C:N ratio is usually greater than 30:1.

Annual legumes have low C:N ratios, such as 10:1 or 15:1. When pure stands of annual legumes are plowed down, the N tie-up may be very brief.

Cover crop mixes, such as legume-grass mixtures, allow nitrogen to be mineralized (released) more rapidly than a single species grass cover crop.

FIGURE 1: Area Map for Identifying Latest Seeding Dates

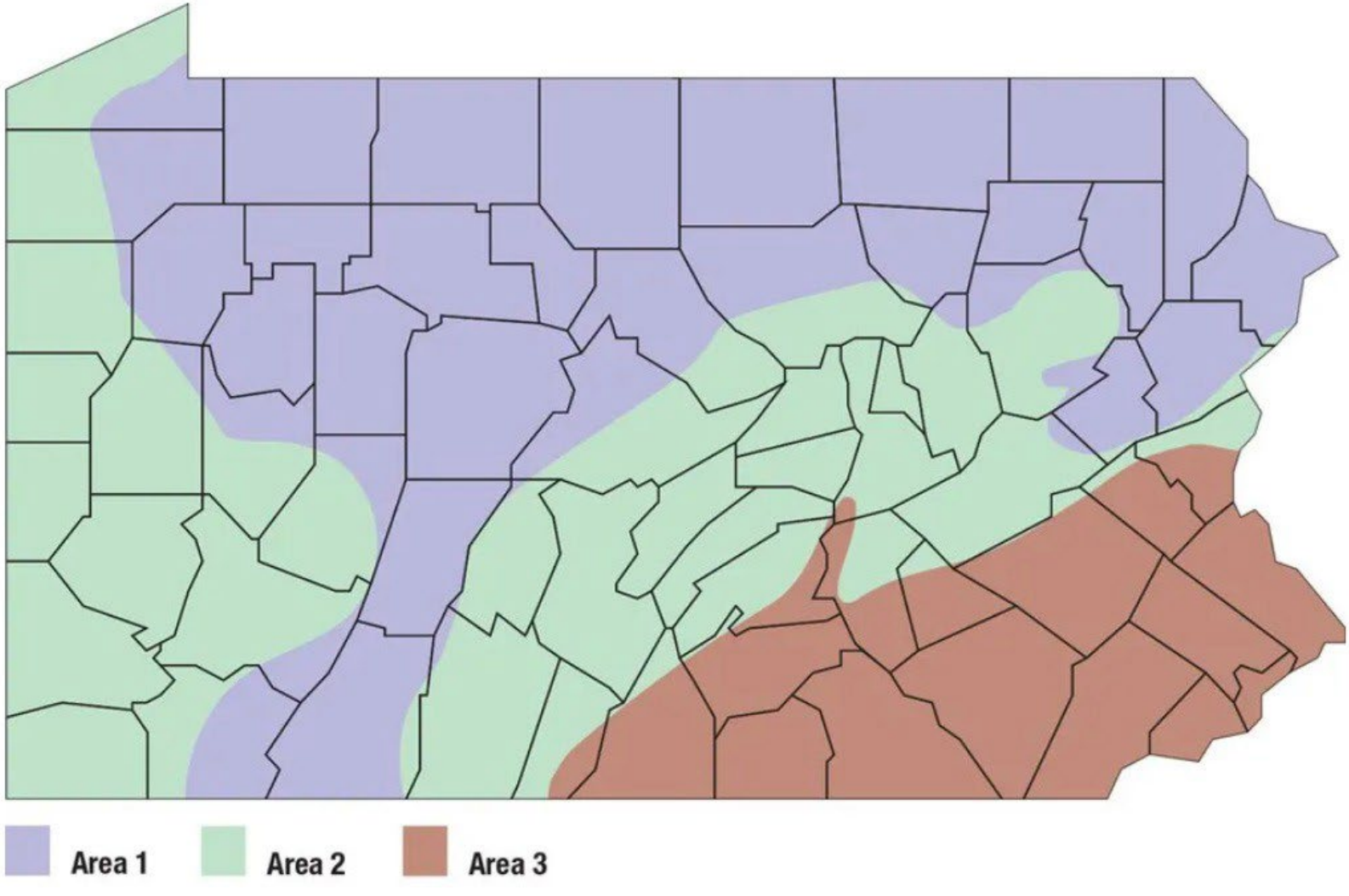

TABLE 1: Recommended Cover Crops by Plant Type, Life Cycle, Uses, and Plant Characteristics

Cover Crop	Plant Type [1/]	Life Cycle [2/]	Uses [3/]													Plant Characteristics [3/]			
			Reduce Erosion	Increase Soil Organic Matter	Utilize Excess Nutrients	Fix Nitrogen	Suppress Weeds / Pests	Reduce Surface Compaction	Reduce Subsurface Compaction	Companion Crop	Nurse Crop	Reduce Soil Diseases	Improve Soil Structure	Attract Beneficial Insects	Pollinator Food Source [4/]	Allelopathic	Drought Tolerant	Lasting Residue	Rapid Growth
Cool-Season Covers																			
Winter Rye (Cereal Rye)	CSG	WA	✓	✓	✓		✓	✓	◆		◆	◆	✓			✓	◆	✓	◆
Winter Triticale	CSG	WA	✓	✓	✓		✓	✓	◆		✓		✓					✓	◆
Winter Wheat	CSG	WA	◆	◆	◆		◆	✓	◆		✓		✓					✓	◆
Winter Barley	CSG	WA	✓	◆	◆		◆	✓	◆		✓		✓	◆		✓	◆	✓	◆
Oats	CSG	SA*	◆	◆	◆		✓	✓		✓	✓		◆			✓		◆	✓
Ryegrass, Annual [5/]	CSG	WA	✓	✓	✓		✓	✓	◆	✓	✓		✓			◆		✓	◆
Red Clover	CSF(L)	SLP	◆	✓	◆	✓	◆	◆	✓	✓			✓	✓	●	◆			
White or Alsike Clover	CSF(L)	P	◆	◆		✓	✓	✓		◆			◆	◆	●	◆			
Berseem Clover	CSF(L)	SA	✓	✓	✓	✓	◆	✓		◆	◆		✓	◆	●			◆	✓
Sweetclover	CSF(L)	B	◆	✓	◆	✓	✓	✓	✓				✓	✓	●	◆	✓	✓	
Crimson Clover	CSF(L)	SA/WA	✓	✓	◆	✓	✓	◆		✓			✓	✓	●			◆	
Hairy Vetch	CSF(L)	WA	◆	✓	◆	✓	◆	✓	◆	◆			✓	✓	●	◆			
Austrian Winter Pea	CSF(L)	SA/WA	✓	◆		✓	◆	✓		✓	◆	◆	◆	✓	●				◆
Forage Radish	CSF	SA*/WA	✓	✓	✓		✓	◆	✓				✓		●	✓			◆
Forage Turnip	CSF	SA*/WA		◆	✓		✓	✓	✓				✓		●	✓			
Mustard	CSF	SA*	✓	◆	◆		✓	✓				✓	✓	◆	●	✓	◆		◆
Rapeseed/Canola	CSF	SA/WA	✓	◆	✓		✓	◆	◆			✓	◆	◆	●	✓	◆	◆	◆
Warm-Season Covers																			
Sorghum/Sudangrass	WSG	SA	✓	✓	✓		✓	◆	✓			◆	✓	◆		✓	✓	✓	✓
Japanese/Foxtail Millet	WSG	SA	✓	✓	◆		✓	◆			◆		✓				✓	◆	◆
Pearl Millet	WSG	SA	✓	✓	◆		✓	✓					✓				✓	◆	◆
Teff	WSG	SA	✓	✓	✓		✓	◆			◆		✓				✓	◆	
Sunn Hemp	WSF(L)	SA	◆	✓	◆	✓	✓	◆	✓				✓		●			◆	
Soybean	WSF(L)	SA			◆	✓	◆	◆		✓			◆		●		◆		
Cowpea	WSF(L)	SA	✓	◆		✓	✓	◆	◆	◆			◆	✓	●		◆		◆
Buckwheat	WSF	SA	◆		◆		✓	✓				✓	◆	✓	●	✓			✓
Sunflower	WSF	SA	◆	◆	✓		◆	✓	◆				✓	✓	●	◆		◆	

Table 1 Notes: 1. CSF = Cool-Season Forb; CSG = Cool-Season Grass; WSF = Warm-Season Forb; WSG = Warm-Season Grass; L = Legume.
2. See page 1 for more info. WA = Winter Annual; SA = Summer Annual; B = Biennial; SLP = Short-lived Perennial; P = Perennial. *Expected to winter-kill, but may survive a mild winter.
3. Rating: (✓) Above average/excellent; (◆) Fair/good. No rating: Poor, not recommended; or inadequate information available.
4. Pollinator Food Source: (●) Cover crop can provide nectar and pollen for one or more pollinator species.
5. Annual Ryegrass can be a weed problem in cereal grains and other crops, especially if it persists and produces seed. Do not confuse Annual Ryegrass with Winter Rye.

TABLE 2: Recommended Planting Rates, Planting Dates, and Termination Methods

Cover Crop	Seeding Rate (lb/ac) [1]	Seeding Depth (inches)	Optimum Planting Season [2]					Latest Seeding Dates by Map Area (see Figure 1)			Termination Method [2]					
			Spring	Early Summer	Summer	Early Fall	Fall	Area 1	Area 2	Area 3	Frost	Winter	Mow	Till	Crimp	Chemical
Cool-Season Covers																
Winter Rye (Cereal Rye)	84	1.0 - 1.5				◆	✓	10/10	10/15	10/25			◆	◆	✓	◆
Winter Triticale	75	1.0 – 1.5				◆	✓	10/1	10/5	10/15			◆	✓	◆	◆
Winter Wheat	90	1.0 – 1.5	◆			✓	✓	10/1	10/5	10/15			◆	✓	◆	◆
Winter Barley	72	1.0 – 1.5	◆			✓		9/20	9/25	10/5			◆	✓	◆	◆
Oats	80	1.0 – 1.5	◆			✓		9/1	9/10	9/15		◆		✓	◆	◆
Annual Ryegrass	18	0.125 – 0.5	✓	◆		✓		8/15	9/1	9/15			◆	✓		◆
Red Clover	10	0.25 – 0.5	✓			✓		Fall: 9/1 Spring: 4/10	Fall: 9/15 Spring: 4/5	Fall: 10/1 Spring: 4/1				◆		◆
White or Alsike Clover	6	0.25 – 0.5	✓	◆		✓								◆		◆
Berseem Clover	15	0.25 – 0.5	◆	◆	◆			9/15	10/1	10/15		◆				◆
Sweetclover	5	0.25 – 0.5	◆			◆		5/1	4/20	4/10				◆		◆
Crimson Clover	15	0.25 – 0.5	◆	◆	◆	◆		8/15	9/1	9/15			◆	◆	✓	◆
Hairy Vetch	20	0.5 – 1.0				✓	◆	8/15	9/1	9/15		◆			✓	◆
Austrian Winter Pea	50	1.0 – 1.5	✓	◆		✓		8/15	8/25	9/15		◆	✓	✓	◆	◆
Forage Radish	5	0.25 – 0.5	✓	◆		✓		9/1	9/7	9/15		◆	◆	✓	◆	◆
Forage Turnip	5	0.25 – 0.75	✓	◆		✓		9/1	9/7	9/15		◆	◆	✓	◆	◆
Mustard	8	0.25 – 0.75	✓	◆		✓		9/15	10/1	10/15		◆		◆	◆	◆
Rapeseed/Canola	6	0.25 – 0.75	✓	◆		✓		9/1	9/7	9/15		◆		◆	◆	◆
Warm-Season Covers																
Sorghum/Sudangrass	20	0.5 – 1.0		✓	✓			7/15	7/1	6/15	◆	✓		◆		◆
Japanese/Foxtail Millet	20	0.5 – 1.0		◆	◆			8/1	7/15	7/1	◆	✓		◆		◆
Pearl Millet	15	0.5 – 1.0		◆	◆			8/1	7/15	7/1	◆	✓	◆	◆	◆	◆
Teff	8	0.125 – 0.25		◆	◆			7/15	7/15	7/1	◆	✓		◆		◆
Sunn Hemp	10	0.5 – 1.5		◆	✓			7/25	8/5	8/15	◆	✓	◆	◆	◆	◆
Soybean	105	1.0 – 1.5	◆	◆				7/1	7/1	7/1		◆	◆	✓		◆
Cowpea	30	1.0 – 1.5		◆	✓			7/25	8/5	8/15		◆		✓		◆
Buckwheat	50	0.5 – 1.0	◆	✓	◆			7/5	7/15	7/31	✓	✓	◆	✓	◆	◆
Sunflower	5	0.5 – 1.0		✓	✓			8/20	8/15	8/15	◆	✓	◆	✓	◆	◆

Table 2 Notes: 1. Seeding Rate – The seeding rate listed is for a single species planting, drilled or broadcast with incorporation.
If aerial seeded or broadcast without incorporation, increase the seeding rate by 30%.
If the purpose of the seeding is weed suppression, increase the seeding rate by 25%.
If the field has a frequent manure history, decrease the seeding rate by 25%.
When seeding as part of a mix, adjust the seeding rate accordingly for each species (see *Developing Cover Crop Mixes*, pages 3-4).

2. Rating: (✓) Above average/excellent; (◆) Average/good. No rating: Poor, not recommended; or no information available.

References

Cornell University. *Cover Crop Guide for NY Growers.*
https://covercrop.org/

Magdoff, F. and H. van Es. *Building Soils for Better Crops* (2021).
https://www.sare.org/resources/building-soils-for-better-crops/

Penn State Extension. *Cover Crops*.
https://extension.psu.edu/forage-and-food-crops/cover-crops

Penn State Extension. *Agronomy Guide* (2025).
https://extension.psu.edu/the-penn-state-agronomy-guide

SARE. *Managing Cover Crops Profitably* (2007).
https://www.sare.org/resources/managing-cover-crops-profitably-3rd-edition/

USDA-ARS. *Cover Crop Chart*.
https://www.ars.usda.gov/arsuserfiles/30640000/pdf/cccv1-2.pdf

USDA-NRCS. *Adaptive Management for Conservation Practices* (2014).
https://directives.sc.egov.usda.gov/landingpage/28855a48-080c-43d0-994d-6c0205fe9e56

USDA-NRCS. *Cover Crop Termination Guidelines* (2019).
https://www.nrcs.usda.gov/sites/default/files/2022-09/
Termination_Guidelines_Designed_6.28_10.24am_%28002%29.pdf

USDA-NRCS. *National Agronomy Manual* (2011).
https://www.nrcs.usda.gov/sites/default/files/2022-10/National-Agronomy-Manual.pdf