

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
FORAGE AND BIOMASS PLANTING

(Ac.)

CODE 512

DEFINITION

Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production.

PURPOSES

This practice may be applied for one or more of the following purposes:

1. To maintain or improve livestock nutrition and/or health;
2. To provide or increase forage supply during periods of low forage production;
3. To reduce soil erosion and improve water quality;
4. To produce feedstock for biofuel or energy production.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on all lands suitable to the establishment of annual, biennial, or perennial species for forage or biomass production.

This practice does not apply to:

1. Establishment of annually planted and harvested food, fiber, or oilseed crops;
2. Plantings primarily intended for wildlife habitat, where livestock grazing and/or mechanical harvesting is a secondary consideration. Refer to the conservation practice standard for Conservation Cover (327);

3. Plantings that will be established on critically eroding areas that usually cannot be stabilized by ordinary conservation treatment. For site stabilization on these areas, refer to the conservation practice standard for Critical Area Planting (342);

4. Herbaceous plantings on field edges or in riparian buffers, for which other standards are applicable. Refer to the conservation practice standards for Field Border (386), Filter Strip (393), and Riparian Herbaceous Cover (390).

CRITERIA

General Criteria Applicable to All Purposes

Site Preparation and Soil Amendments. Site preparation to establish the planting shall be done at a time and manner to insure survival and growth of selected species.

Apply lime and fertilizer, if needed, based on soil test results. The use of commercial fertilizer and other forms of plant nutrients must be in compliance with Delaware nutrient management regulations, as applicable, and shall meet the requirements of the Delaware conservation practice standard for Nutrient Management (590).

Plant Selection. Select plant species to accomplish the intended purpose of the practice and the objectives of the client. Choose species and varieties based on their adaptability to local environmental conditions, intended use, realistic yield goals, maturity stages, compatibility with other species, and level of management that the client is willing and able to provide. For best results, use species and varieties with proven conservation traits.

Plant materials shall either be native to Delaware or introduced and non-invasive (i.e., not likely to spread beyond the planted area and displace native species). When feasible, select locally native plant species and/or species that are beneficial to wildlife. No plant listed by the state of Delaware as an invasive species shall be established in the planting.

All plant materials shall meet state quality standards and be correctly handled before planting. Use certified seed when available.

Use Figure 1 and Table 1 to determine the appropriate planting dates for the different types of plant materials. Refer to Tables 2 – 9 to aid in selecting the appropriate plant species and seeding rates to meet the producer's needs.

Plant Establishment. Use planting techniques suited to achieving proper seeding depths, placement, and seed to soil contact for the selected plant species.

Inoculate legume seeds with the proper, viable *Rhizobium* bacteria before planting. Use planter box treatment or pre-inoculated seed and follow appropriate storage requirements.

Protect the planting from unacceptable impacts due to pests, wildlife, livestock, or wildfire. Exclude livestock as needed to establish the planting.

Control noxious weeds as required by state law.

Additional Criteria to Maintain or Improve Livestock Nutrition and/or Health

Select forage species that are capable of meeting the desired level of nutrition (quantity and quality) for the type and class of livestock to be fed. Forage species planted as mixtures shall exhibit similar palatability to avoid selective grazing.

Additional Criteria to Provide or Increase Forage Supply during Periods of Low Forage Production

Select plants that will produce forage for use during periods when other on-farm forage is insufficient to meet livestock needs.

Refer to Table 2 for recommended annual species, seeding rates, uses, and other information if an extended grazing season or emergency forage production is needed.

Additional Criteria to Reduce Soil Erosion and Improve Water Quality

Select plants that will provide adequate ground cover, canopy cover, and root mass sufficient to protect soil from wind and soil erosion. When a seeding rate is expressed as a range (e.g., 5 to 10 pounds/acre), use the higher rate if erosion is a concern. If needed, add a nurse crop to provide sufficient cover during plant establishment.

Additional Criteria for Producing Feedstock for Biofuel or Energy Production

Select plants that provide adequate types and amounts of above-ground biomass for the intended use.

Note: Specific programs may dictate criteria in addition to or more restrictive than those specified in this standard.

CONSIDERATIONS

When selecting forage and biomass plantings, consider the planned use of the planting (producer's goals), and site conditions including soils, residual herbicides to the extent known, available moisture during the growing season, and existing vegetation on the site and in adjacent areas, including any noxious weeds that may be present.

Consider plant characteristics, such as:

1. Ease of establishment, plant persistence, and time needed for full stand establishment;
2. Season of growth (warm or cool) and life cycle (annual, perennial, or biennial);
3. Suitability of the species to provide desired quality and quantity of forage or biomass;
4. Plant resistance to disease and insect pests common to the area;
5. Fertility and management requirements.

Avoid selecting species that are aggressive and may become weedy in nearby areas. Bermudagrass is an aggressive species, but it is tolerant of close grazing and trampling, and may be a useful component of a pasture management system. If used, bermudagrass should be intensively managed by grazing, clipping, or haying to avoid seedhead maturation and spreading seed to other fields or sensitive areas.

For forage plantings, consider whether the planting will be used primarily for pasture (grazing) or hay (mechanically harvested). Some species are better adapted to a pasture-type management, where plants are harvested at specific vegetative stages or at relatively frequent intervals. Other species and varieties benefit from a hay-type management, where rest periods of 4 to 6 weeks are needed between harvests if stands and production are to be maintained.

For more intensively managed systems, consider species and varieties that are adaptable to both haying and grazing. Fields in these systems are usually hayed in late spring and grazed during the balance of the year.

Consider mixes, as opposed to single species stands, for the diversity of root systems and the benefits to soil health. A mix of grasses and legumes can live symbiotically and share nutrients (e.g., clovers and other legumes can provide nitrogen to grass plants). Having a variety of species also builds resiliency in the pasture, because a diverse mix is more likely to result in some plants growing despite varying conditions during the season. As a result, diverse pastures are usually more productive and higher in nutritional quality than monoculture pastures.

When planning mixtures, consider the relative maturity dates of plant species and varieties, their growth habits, and palatability for grazing or feeding. Select species and varieties that are expected to mature at approximately the same time.

Consider the need for cool-season grass firebreaks when warm-season grass plantings are planned. Mature plantings of warm-season grasses can be flammable.

In areas where livestock congregate, consider establishing persistent species that can tolerate close grazing and trampling.

For additional information about species selection, refer to the Delaware NRCS fact sheet *Forage and Biomass Planting*.

Consider the need for additional conservation practices, such as Forage Harvest Management (511), Prescribed Grazing (528), Brush Management (314), Herbaceous Weed Control (315), and Nutrient Management (590), as applicable.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail concerning site preparation and establishment to ensure successful management of the practice and may be recorded in narrative form, on Implementation Requirements (IR) worksheets, or on other approved forms.

Follow the establishment recommendations in the Delaware fact sheets *Forage and Biomass Planting*, *Cool-Season Grasses*, and *Warm-Season Grasses*, as appropriate, and complete the 512 IR worksheet. The appropriate fact sheet(s) and IR worksheet can serve as the planting plan and specifications for the practice.

The following items shall be addressed, as appropriate:

1. Methods of site and seedbed preparation;
2. Rate and type of soil amendments to be applied;
3. Species and rates to be seeded/planted;
4. Type of legume inoculant used, when applicable;
5. Method of seeding/planting;
6. Seeding/planting dates;
7. Seed/plant source and seed analysis;
8. Protection of plantings, if needed.

OPERATION AND MAINTENANCE

An Operation and Management (O&M) plan shall be prepared and is the responsibility of the client to implement. The appropriate fact sheet(s) and IR worksheet may serve as the management plan, as well as supporting documentation, and shall be reviewed with and provided to the client.

At a minimum, the following components shall be addressed in the O&M plan, as applicable:

1. Evaluate forage and biomass stands at least once each season, or more frequently as needed to determine appropriate management to achieve the desired purpose(s) of the planting;
2. Apply soil amendments periodically, based on soil test results, to meet desired yield goals, promote plant regrowth, and help maintain the life of the stand. The use of commercial fertilizer and other forms of plant nutrients must be in compliance with Delaware nutrient management regulations;
3. Control undesirable plants by mowing or spraying with a selective herbicide. To the extent feasible, "spot" spray or mow to control weeds, so that desirable plants are not destroyed unnecessarily. Noxious weeds must be controlled as required by state law;
4. Control insects and/or diseases when an infestation threatens stand survival. Follow a pest management plan concerning the timing and methods of treatment;
5. When optimum wildlife habitat is desired, do not mow, burn, or mechanically harvest fields during the nesting season. For Delaware, the primary nesting season is April 15 through August 15. Infrequent grazing may be allowed during the primary nesting season, provided the area is not grazed below 6 to 8 inches. During the establishment period, mowing may be needed during the nesting season to reduce heavy competition from annual weeds;

6. Describe the time of year or frequency of use restrictions, if any. *Pay particular attention to program requirements as they relate to acceptable vs. restricted uses and other management restrictions.*

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location of the practice on the conservation plan map;
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;
3. Completed IR worksheet and copy of the appropriate fact sheet(s) or other specifications and management plans.

REFERENCES

1. Ball, D.M., C.S. Hoveland, G.D. Lacefield. 2007. *Southern Forages: Modern Concepts for Forage Crop Management (4th Edition)*. International Plant Nutrient Institute, Norcross, GA.
2. Johnson, Quintin, Mark VanGessel, Richard W. Taylor. 2014. *Pasture and Hay Weed Management Guide*. Delaware Cooperative Extension, University of Delaware. <http://extension.udel.edu/ag/files/2012/08/PHWeedguide.pdf>
3. Penn State University. 2015. *The Agronomy Guide*. College of Agricultural Sciences. <http://extension.psu.edu/agronomy-guide>
4. Penn State Extension, College of Agricultural Sciences. *Forage Crops*. <http://extension.psu.edu/plants/crops/forages>
5. Rayburn, Edward B. (editor). 2006. *Forage Production for Pasture-Based Livestock Production, Establishing Forage Stands (Chapter 7)*, NRAES-172.
6. USDA, Natural Resources Conservation Service. *Conservation Practice Standards*. Delaware Field Office Technical Guide, Section IV.
7. USDA, Natural Resources Conservation Service. 2009. *Technical Note 3: Planting and Managing Switchgrass as a Biomass Energy Crop*.
8. Virginia Tech Extension. *Pasture & Forage – Crops & Soils*. Publications and Educational Resources. <https://pubs.ext.vt.edu/category/pasture-forage-cs.html>

FIGURE 1: USDA Plant Hardiness Zones for Delaware



TABLE 1: Recommended Planting Dates in Delaware ^{1/}	
Type of Plant Material	Plant Hardiness Zones
	7a and 7b
Seeds - Cool-Season Grasses, Legumes, and Grass-Legume Mixes*	Feb 15 to Apr 30 Aug 15 to Oct 15
Seeds - Warm-Season Grasses	Feb 15 to May 31 ♦ <i>Jun 1 to Jun 30**</i> <i>Dec 15 to Dec 31***</i>
Sprigs - Warm-Season Grasses	Feb 15 to May 31 ♦

TABLE 1 NOTES:

1. The planting dates listed are averages for each zone. These dates may require adjustment to reflect local conditions, especially near the boundaries of the zones.
- ♦ In general, planting during the latter portion of this period allows more time for weed emergence and weed control prior to planting. When selecting a planting date, consider the need for weed control vs. the likelihood of having sufficient moisture for later plantings, especially on droughty sites.
- * Certain legumes such as white/ladino and red clover can be seeded into grass fields using a frost crack seeding from January 15 to March 1. Success is dependent on receiving freeze-thaw cycles and adequate rainfall to germinate the legume seed.
- ** Additional planting dates during which supplemental watering may be needed to ensure plant establishment.
- ***Fall dormant season plantings of warm-season grasses – starting approximately 2 weeks after the first hard freeze (average date based on air temperature reading of 28 degrees F or lower, 50% probability of occurrence). Warm-season grasses need a soil temperature of at least 50 degrees F in order to germinate. If soil temperatures are colder than 50 degrees, or moisture is not adequate, the seeds will remain dormant until conditions are favorable.

Before using a fall dormant seeding, consider whether competition from winter annual weeds is likely to be a problem the following spring. If strong competition from winter annuals is expected, it is generally preferable to use a late spring planting so that weeds can emerge and be adequately controlled before planting. Carefully planned pre-plant or post-plant herbicides should be used as appropriate.

TABLE 2: Forage and Biomass Plantings—Annual Plantings for an Extended Grazing Season or Emergency Forage Production^{1/}

Plant Species	Seeding Rate ^{2/} (lbs/ac)	Seeding Depth (inches)	Seeding Dates	Harvest Season	Time to First Harvest	Growth Stage at First Harvest		Regrowth After Grazing	Yield Range (Dry Matter)
						<i>If Grazed</i>	<i>If Mechanically Harvested</i>		
GRASSES									
Annual Ryegrass <i>Lolium perenne</i> spp. <i>multiflorum</i>	30 - 45	0.25 - 0.5	8/15 - 10/15	Fall, spring, early summer	30 - 45 days	At 6 inches	At 15 - 20 inches	Yes	2 - 5 tons
Barley <i>Hordeum vulgare</i>	100 - 150	1.0 - 1.5	9/1 - 10/1	Fall, spring	40 - 60 days	Vegetative stage, at 3 - 5 inches	Late boot – early head	Yes	1 - 2 tons
Cereal Rye <i>Secale cereale</i>	120 - 180	1.0 - 1.5	8/15 - 11/15	Fall, spring	40 - 60 days	Vegetative stage, at 3 - 5 inches	Late boot – early head	Yes	2 - 3 tons
Corn <i>Zea mays</i>	25,000 - 45,000 seeds/acre	1.0 - 2.0	4/15 - 6/1	Summer	40 - 100 days	Above 20 inches	Milk line 1/3 - 1/2 down kernel	No	3 - 8 tons
Oats <i>Avena sativa</i>	100 - 150	1.0 - 1.5	3/1 - 4/15, 8/1 - 8/30	Spring, early summer, fall	35 - 50 days	Vegetative stage, at 3 - 5 inches	Late boot - head	Yes	2 - 4 tons
Pearl Millet <i>Pennisetum glaucum</i>	25 - 30	0.5 - 1.0	5/1 - 8/1	Summer	30 - 45 days	At 18 inches	Above 18 inches, early head - early bloom	Yes	3 - 5 tons
Sudangrass Sudan x Sorghum <i>Sorghum bicolor</i>	20 - 30	1.0 - 1.5	5/1 - 7/15	Summer	30 - 45 days	Minimum of 18 inches, wait 7 days after frost	At 36 - 48 inches, early head - early bloom	Yes	3 - 8 tons
Triticale <i>Triticale hexaploide</i>	120 - 180	1.0 - 1.5	8/15 - 11/15	Fall, spring	40 - 60 days	Vegetative stage, at 3 - 5 inches	Late boot - head	Yes	1 - 3 tons
Wheat <i>Triticum aestivum</i>	120 - 180	1.0 - 1.5	10/1 - 10/15	Fall, spring	40 - 60 days	Vegetative stage, at 3 - 5 inches	Late boot - head	Yes	1 - 2 tons
BRASSICAS									
Kale <i>Brassica oleracea</i>	3 - 4	0.25 - 0.5	5/1 - 6/15	Late summer, fall	120 - 180 days	150 days after seeding	----	No	1 - 5 tons
Rape <i>Brassica napus</i>	3 - 4	0.25 - 0.5	5/1 - 8/15	Summer, fall	80 - 90 days	80 - 90 days after establishment	----	Yes	1 - 5 tons
Swede <i>Brassica napus</i>	1 - 2	0.25 - 0.5	5/1 - 6/15	Fall	150 - 180 days	150 days after seeding	----	No	1 - 5 tons
Turnips <i>Brassica rapa</i>	2	0.25 - 0.5	5/1 - 8/15	Summer, fall	60 - 90 days	70 - 90 days after establishment	----	Yes	1 - 5 tons

TABLE 2 NOTES:

1. Animal Health Concerns: Caution--Livestock consumption of sorghum, sudangrass, and sudan-sorghum hybrids (and to some extent, other plants) can result in nitrate poisoning and prussic acid (hydrogen cyanide) poisoning. Plant growth stage, plus environmental and management factors, affect nitrate and prussic acid concentrations in foliage. To minimize health risks to livestock, use careful management when feeding with emergency and late-season forages, and know when to expect potential problems and how to avoid them. Before feeding any suspect forage, have representative samples tested for nitrate and prussic acid content.
2. Seeding rate shall be calculated on a pure live seed (PLS) basis.

TABLE 3: Warm-Season Pasture and Hay Plantings—Establishment, Management, and Use Characteristics

Species	Seedling Growth Rate ^{1/}	Plant Growth Habit	Stand Persistence ^{2/}	Forage Quality ^{3/}		Relative Maturity ^{4/}	Suitability for Grazing Management ^{5/}		Suitability for Mechanical Harvest ^{6/}	
				Palatability	Digestibility		Rotational Grazing	Continuous Grazing	Hay	Silage
Bermudagrass ^{7/} <i>Cynodon dactylon</i>	Moderate	Sod	Moderate - Long	High	Moderate	Late	Good	Good	Good	Good
Big Bluestem <i>Andropogon gerardii</i>	Slow	Bunch	Long	High	High	Very Late	Good	Poor	Good	Poor
Caucasian Bluestem <i>Bothriochloa bladhii</i> (<i>B. caucasica</i>)	Slow	Bunch	Long	High	High	Late	Good	Poor	Good	Poor
Eastern Gamagrass <i>Tripsacum dactyloides</i>	Slow	Bunch	Long	Very High	High	Very Late	Good	Poor	Good	Good
Indiangrass <i>Sorghastrum nutans</i>	Slow	Bunch	Long	High	Moderate	Very Late	Good	Poor	Good	Poor
Little Bluestem <i>Schizachyrium scoparium</i>	Slow	Bunch	Long	Moderate	Moderate	Very Late	Fair	Poor	Poor	Poor
Switchgrass <i>Panicum virgatum</i>	Slow	Bunch	Long	Moderate	High	Very Late	Good	Poor	Good	Poor

TABLE 3 NOTES:

1. **Seedling Growth Rate (Slow, Moderate, Fast):** Vigor and competitiveness of the species, as compared to other grasses or legumes. Slow-growing seedlings tend to have more problems with weed competition than faster growing species.
2. **Stand Persistence (Short, Moderate, Long):** Persistence of the species (without replanting) as compared to other grasses or legumes. This is an indication of how soon the planting will need to be renovated or overseeded. Long - Generally 5 years or more; Moderate - 3 to 5 years; Short - 1 or 2 years.
3. **Forage Quality (Low, Moderate, High):** Values of each species for palatability and digestibility, as compared to other forages. When developing pasture mixes, select species that have similar palatability to minimize selective grazing.
4. **Relative Maturity (Early, Medium, Late, Very Late):** Relative time of maturity for each species during the growing season. When developing pasture or hay mixes, select species and varieties that are expected to mature at approximately the same time.
5. **Suitability for Grazing Management (Poor, Fair, Good, Excellent):** Describes the suitability of each species for grazing, depending on the type of grazing system used. **Rotational Grazing** – A system that provides a rest and regrowth period for pastures. **Continuous Grazing** – A system that allows livestock to have continuous access to pastures.
6. **Suitability for Mechanical Harvest (Poor, Fair, Good, Excellent):** Describes the suitability of each species as a mechanically harvested forage crop, depending on whether the forage will be harvested and stored as hay or as silage.
7. **Bermudagrass: Caution**—This species can spread into other pasture plantings, lawns, and cropland fields. **Do not plant unless containment of the planting is feasible, as determined and approved by NRCS.**

TABLE 4: Warm-Season Forage and Biomass Plantings—Plant Suitability for Site Conditions

Plant Species	Plant Hardiness Zones ^{1/}	Soil Drainage Class ^{2/}	Soil pH ^{3/}	Fertility Requirements ^{4/}	Flooding or Ponding Tolerance ^{5/}	Drought Tolerance ^{6/}	Salinity Tolerance ^{7/}	Winter Hardiness ^{8/}
Bermudagrass ^{9/} <i>Cynodon dactylon</i>	All	E - SP	5.0 - 7.5	Moderate - High	Moderate	High	Moderate	Depends on the variety
Big Bluestem <i>Andropogon gerardii</i>	All	E - MW	5.0 - 7.5	Low - Moderate	Low	Very High	Low	Good
Caucasian Bluestem <i>Bothriochloa bladhii</i> (<i>B. caucasica</i>)	All	E - MW	5.0 - 8.0	Moderate	None	High	Low	Good
Eastern Gamagrass <i>Tripsacum dactyloides</i>	All	W - P	5.0 - 7.5	Moderate - High	Moderate	High	None	Good
Indiangrass <i>Sorghastrum nutans</i>	All	E - MW	5.0 - 7.5	Low - Moderate	None	Very High	Moderate	Good
Little Bluestem <i>Schizachyrium scoparium</i>	All	E - MW	5.5 - 8.5	Low - Moderate	None	Very High	None	Good
Switchgrass <i>Panicum virgatum</i>	All	E - P	4.5 - 7.5	Low - Moderate	Low - High (depends on the variety)	Low - Very High (depends on the variety)	Moderate	Good

TABLE 4 NOTES:

1. The Plant Hardiness Zones designate where a species can be successfully grown in Delaware, as shown on the Plant Hardiness Zone map (Figure 1).
2. Soil Drainage Class (refer to the county soil survey for further information): E - Excessively Drained; W - Well Drained; MW - Moderately Well Drained; SP - Somewhat Poorly Drained; P - Poorly Drained.
3. Soil pH: Preferred soil pH range for fair to excellent forage production.
4. Fertility Requirements (Low, Moderate, High): Indicates the relative need of each species for nutrients to support plant growth. Species with relatively high fertility requirements will require more frequent nutrient applications.
5. Flooding or Ponding Tolerance (None, Low, Moderate, High): Describes the ability of each species to tolerate anaerobic conditions associated with extended ponding or flooding (generally more than 24 hours, continuously).
6. Drought Tolerance (Low, Moderate, High): Describes the ability of each species to withstand long periods of hot, dry weather. For each plant species, some varieties may be more (or less) tolerant than others.
7. Salinity Tolerance (None, Low, Moderate, High): Describes the ability of each species to withstand and flourish in saline soils. For each plant species, some varieties may be more (or less) tolerant than others.
8. Winter Hardiness (Poor, Fair, Good, Excellent): Describes the ability of each species to survive typical winters in Delaware. For each plant species, some varieties may be more (or less) winter hardy than others.
9. Bermudagrass: Caution—This species can spread into other pasture plantings, lawns, and cropland fields. **Do not plant unless containment of the planting is feasible, as determined and approved by NRCS.**

TABLE 5: Warm-Season Forage and Biomass Plantings—Seeding Recommendations

Plant Species	Recommended Cultivar(s)	Seeding Rate (PLS lbs/ac) ^{1/}	Seeding Depth (inches)	Planting Implement
Bermudagrass ^{2/} <i>Cynodon dactylon</i>	Quickstand, Ozark, Tifton 44	20 bushels/acre, sprigged	N/A	Sprigger
Big Bluestem <i>Andropogon gerardii</i>	Niagara	8 - 10	0.25 - 0.5	Warm-Season Grass Drill
Caucasian Bluestem <i>Bothriochloa bladhii</i> (<i>B. caucasica</i>)	Common	6 - 8	0.25 - 0.5	Warm-Season Grass Drill
Eastern Gamagrass ^{3/} <i>Tripsacum dactyloides</i>	Iuka, Pete, PMK-24	10	0.75 - 1.0	Corn Planter
Indiangrass <i>Sorghastrum nutans</i>	Rumsey	8 - 10	0.25 - 0.5	Warm-Season Grass Drill
Little Bluestem <i>Schizachyrium scoparium</i>	Blaze, Camper	7	0.25 - 0.5	Warm-Season Grass Drill
Switchgrass <i>Panicum virgatum</i>	<u>Lowland Ecotypes:</u> Cave-in-Rock, Kanlow <u>Upland Ecotypes:</u> Blackwell, Carthage	8 - 10	0.25 - 0.5	Conventional Grass Drill or Broadcast and Cultipack

TABLE 5 NOTES:

- Seeding Rate:** Seeding rates for the warm-season grasses are in pounds of Pure Live Seed (PLS). Actual planting rates shall be adjusted to reflect percent seed germination and purity, as tested. Adjustments are usually not needed for the cool-season grasses or legumes. Whenever possible, optimize seed distribution by using a brilliant or cultipacker-seeder. If drilling, it is recommended to split rates and apply seed twice, with the second pass going perpendicular across the first drill rows. Chaffy, warm season seeds require a specialized seed drill or native grass drill.
- Bermudagrass: Caution**—This species can spread into other pasture plantings, lawns, and cropland fields. **Do not plant unless containment of the planting is feasible, as determined and approved by NRCS.**
- For Eastern Gamagrass, recommend using dry, stable seed that is pre-treated to break dormancy.

TABLE 6: Cool-Season Forage and Biomass Plantings—Establishment, Management, and Use Characteristics

Species	Seedling Growth Rate ^{1/}	Plant Growth Habit	Stand Persistence ^{2/}	Forage Quality ^{3/}		Relative Maturity ^{4/}	Suitability for Grazing Management ^{5/}		Suitability for Mechanical Harvest ^{6/}		Compatible Species for Mixtures ^{7/}
				Palatability	Digestibility		Rotational Grazing	Continuous Grazing	Hay	Silage	
GRASSES											
Kentucky Bluegrass <i>Poa pratensis</i>	Moderate	Sod	Long	High	Moderate	Early	Excellent	Excellent	Poor	Poor	Timothy Birdsfoot Trefoil Ladino Clover
Orchardgrass <i>Dactylis glomerata</i>	Fast	Bunch	Moderate	Moderate	Moderate	Early	Excellent	Good	Excellent	Excellent	Alfalfa Birdsfoot Trefoil Ladino Clover Red Clover
Perennial Ryegrass ^{8/} <i>Lolium perenne</i> (Diploid and Tetraploid types)	Very Fast	Bunch	Short	High	High	Early	Excellent	Poor	Good	Excellent	Alfalfa Birdsfoot Trefoil Ladino Clover Red Clover
Prairiegrass ^{8/} <i>Bromus catharticus</i>	Fast	Bunch	Short	High	High	Late	Good	Poor	Excellent	Excellent	Alfalfa
Smooth Bromegrass ^{8/} <i>Bromus inermis</i>	Moderate	Sod	Short	High	Moderate	Late	Good	Poor	Excellent	Excellent	Alfalfa Birdsfoot Trefoil Ladino Clover
Tall Fescue ^{9/} (endophyte-free or novel endophyte) <i>Schedonorus arundinaceus</i> (formerly <i>Festuca arundinacea</i>)	Moderate	Bunch	Moderate	Moderate	Moderate	Medium	Excellent	Poor	Good	Excellent	Alfalfa Ladino Clover Red Clover
Timothy <i>Phleum pratense</i>	Slow	Bunch	Short	Moderate	Moderate	Late	Good	Poor	Excellent	Excellent	Ky. Bluegrass Alfalfa Birdsfoot Trefoil Ladino Clover Red Clover

TABLE 6: Cool-Season Forage and Biomass Plantings—Establishment, Management, and Use Characteristics

Species	Seedling Growth Rate ^{1/}	Plant Growth Habit	Stand Persistence ^{2/}	Forage Quality ^{3/}		Relative Maturity ^{4/}	Suitability for Grazing Management ^{5/}		Suitability for Mechanical Harvest ^{6/}		Compatible Species for Mixtures ^{7/}
				Palatability	Digestibility		Rotational Grazing	Continuous Grazing	Hay	Silage	
LEGUMES											
Alfalfa ^{10/} <i>Medicago sativa</i>	Fast	Bunch	Long	High	High	Early	Excellent	Poor	Excellent	Excellent	Orchardgrass, Perennial Ryegrass, Smooth Bromegrass, Tall Fescue, Timothy.
Annual Lespedeza: Korean <i>Kummerowia stipulacea</i> ^{or} Common <i>K. striata</i> (both species formerly in genus <i>Lespedeza</i>)	Moderate	Spreading	Moderate	Moderate	High	Medium	Excellent	Poor	Good	Poor	Orchardgrass, Tall Fescue, Timothy, Red Clover.
Birdsfoot Trefoil <i>Lotus corniculatus</i>	Slow	Bunch	Long	High	High	Late	Good	Good	Good	Good	Ky. Bluegrass, Orchardgrass, Perennial Ryegrass, Smooth Bromegrass, Tall Fescue, Timothy.
Ladino (White) Clover ^{10/} <i>Trifolium repens</i>	Moderate	Spreading	Moderate	High	High	Early	Excellent	Good	Good	Good	Ky. Bluegrass, Orchardgrass, Perennial Ryegrass, Smooth Bromegrass, Tall Fescue, Timothy, Red Clover.
Red Clover ^{10/} <i>Trifolium pratense</i>	Fast	Bunch	Short	Moderate	High	Medium	Good	Poor	Good	Good	Orchardgrass, Perennial Ryegrass, Tall Fescue, Timothy, Ladino Clover.

Notes for this table are located on page 15.

TABLE 6 NOTES:

1. Seedling Growth Rate (Slow, Moderate, Fast): Vigor and competitiveness of the species, as compared to other grasses or legumes. Slow-growing seedlings tend to have more problems with weed competition than faster growing species.
2. Stand Persistence (Short, Moderate, Long): Persistence of the species (without replanting) as compared to other grasses or legumes. This is an indication of how soon the planting will need to be renovated or overseeded. Long - Generally 5 years or more; Moderate - 3 to 5 years; Short - 1 or 2 years.
3. Forage Quality (Low, Moderate, High): Values of each species for palatability and digestibility, as compared to other forages. When developing pasture mixes, select species that have similar palatability to minimize selective grazing.
4. Relative Maturity (Early, Medium, Late, Very Late): Relative time of maturity for each species during the growing season. When developing pasture or hay mixes, select species and varieties that are expected to mature at approximately the same time.
5. Suitability for Grazing Management (Poor, Fair, Good, Excellent): Describes the suitability of each species for grazing, depending on the type of grazing system used. Rotational Grazing – A system that provides a rest and regrowth period for pastures. Continuous Grazing – A system that allows livestock to have continuous access to pastures.
6. Suitability for Mechanical Harvest (Poor, Fair, Good, Excellent): Describes the suitability of each species as a mechanically harvested forage crop, depending on whether the forage will be harvested and stored as hay or as silage.
7. Compatible Species for Mixtures: If desired, one or more of these species may be combined with the primary species to make a mixture. When making mixtures, select species that are suited for the geographic location (plant hardiness zone) and local site characteristics and have the desired plant characteristics for establishment, maintenance, and use of the forage. Simple mixtures, such as one species of grass and one or two legumes are generally recommended versus a mix with many species.
8. Perennial Ryegrass, Prairiegrass, and Smooth Brome: In Delaware, stand persistence is significantly reduced for these species due to disease and climate factors.
9. Tall Fescue Varieties: To avoid fescue toxicosis, use certified varieties that are endophyte-free or are novel endophyte-infected. Fescue with the novel endophyte is not toxic to livestock, and has the adaptive advantages of being more resistant to drought, disease, and insects than endophyte-free varieties.
10. Animal Health Issues Associated with Legumes: **Caution**--Livestock consumption of some legume species may result in adverse health effects. To minimize health risks to livestock, use careful management with these species, and know when to expect potential problems and how to avoid them. The following health concerns have been associated with specific legumes:
 - Bloat** - Associated with consumption of alfalfa, various clovers, cowpeas, and other legumes (but not birdsfoot trefoil);
 - Alsike Clover Poisoning** - Associated with consumption of alsike clover. This type of poisoning is known to occur in horses and occasionally in cattle, resulting in photodermatitis and long-term liver damage. Alsike clover should not be planted where pastures and hay will be used by horses;
 - "Slobbers" (Excessive Salivation)** - Associated with consumption of fungal-infected red clover (and sometimes white clover and other legumes) by horses and cattle.

TABLE 7: Cool-Season Pasture and Hay Plantings—Plant Suitability for Site Conditions

Plant Species	Plant Hardiness Zones ^{1/}	Soil Drainage Class ^{2/}	Soil pH ^{3/}	Fertility Requirements ^{4/}	Flooding or Ponding Tolerance ^{5/}	Drought Tolerance ^{6/}	Salinity Tolerance ^{7/}	Winter Hardiness ^{8/}
GRASSES								
Kentucky Bluegrass <i>Poa pratensis</i>	All	W - SP	5.5 - 7.0	Moderate	Low	Low	Low	Good
Orchardgrass <i>Dactylis glomerata</i>	All	E - SP	5.5 - 7.0	Moderate	None	Moderate	Low	Good
Perennial Ryegrass <i>Lolium perenne</i>	7a (Piedmont only)	W - P	5.0 - 8.0	Moderate-High	Low	Low	Low	Poor
Prairiegrass <i>Bromus catharticus</i>	7a (Piedmont only)	E - MW	5.5 - 8.0	Moderate-High	None	Low	Moderate	Fair
Smooth Bromegrass <i>Bromus inermis</i>	7a (Piedmont only)	E - P	5.5 - 8.0	High	Low	Moderate	Low	Fair
Tall Fescue (endophyte-free or novel endophyte) <i>Schedonorus arundinaceus</i> (formerly <i>Festuca arundinacea</i>)	All	E - P	4.5 - 9.0	Moderate	Low	Moderate	Moderate	Good
Timothy <i>Phleum pratense</i>	7a (Piedmont only)	W - SP	5.0 - 7.5	Moderate	Low	Low	Low	Good
LEGUMES								
Alfalfa <i>Medicago sativa</i>	All	E - W	6.5 - 7.0	High	None	High	Low	Excellent
Annual Lespedeza: Korean <i>Kummerowia stipulacea</i> or Common <i>K. striata</i>	All	E - P	4.5 - 7.0	Low - Moderate	Low	High	Low	None (Annual)
Birdsfoot Trefoil <i>Lotus corniculatus</i>	7a (Piedmont only)	W - P	5.0 - 7.5	Moderate	Moderate	Moderate	Moderate	Excellent
Ladino (White) Clover <i>Trifolium repens</i>	All	W - P	5.5 - 7.5	Moderate-High	Moderate	Low	Low	Good
Red Clover <i>Trifolium pratense</i>	All	W - SP	6.0 - 7.5	Moderate	None	Low	Low	Good

Notes for this table are located on page 17.

TABLE 7 NOTES:

1. The Plant Hardiness Zones designate where a species can be successfully grown in Delaware, as shown on the Plant Hardiness Zone map (Figure 1).
2. Soil Drainage Class (refer to the county soil survey for further information): E - Excessively Drained; W - Well Drained; MW - Moderately Well Drained; SP - Somewhat Poorly Drained; P - Poorly Drained.
3. Soil pH: Preferred soil pH range for fair to excellent forage production.
4. Fertility Requirements (Low, Moderate, High): Indicates the relative need of each species for nutrients to support plant growth. Species with relatively high fertility requirements will require more frequent nutrient applications.
5. Flooding or Ponding Tolerance (None, Low, Moderate, High): Describes the ability of each species to tolerate anaerobic conditions associated with extended ponding or flooding (generally more than 24 hours, continuously).
6. Drought Tolerance (Low, Moderate, High): Describes the ability of each species to withstand long periods of hot, dry weather. For each plant species, some varieties may be more (or less) tolerant than others.
7. Salinity Tolerance (None, Low, Moderate, High): Describes the ability of each species to withstand and flourish in saline soils (i.e., soils that contain water-soluble salts. For each plant species, some varieties may be more (or less) tolerant than others.
8. Winter Hardiness (Poor, Fair, Good, Excellent): Describes the ability of each species to survive typical winters in Delaware. For each plant species, some varieties may be more (or less) winter hardy than others.

TABLE 8: Cool-Season Forage and Biomass Plantings—Seeding Recommendations

Plant Species	Recommended Cultivar(s)	Seeding Rate (lbs/ac)			Seeding Depth (inches)	Suitability for Frost Seeding ^{1/}
		Alone	Pasture Mix	Hay Mix		
GRASSES						
Kentucky Bluegrass <i>Poa pratensis</i>	Ginger, Ken Blue, Park, Slezanka, Troy	15	5 - 15	----	0.25	Poor
Orchardgrass <i>Dactylis glomerata</i>	Numerous cultivars available	10 - 15	5 - 15	2 - 6	0.25 - 0.5	Poor
Perennial Ryegrass <i>Lolium perenne</i>	Numerous cultivars available	30	10 - 15	4 - 8	0.25 - 0.5	Good
Prairiegrass <i>Bromus catharticus</i>	Matua	25 - 40	----	20 - 30	0.25 - 0.5	Poor
Smooth Bromegrass <i>Bromus inermis</i>	Baylor, Saratoga	15	4 - 15	6 - 10	0.25 - 0.5	Poor
Tall Fescue (endophyte-free or novel endophyte) <i>Schedonorus arundinaceus</i>	<u>Endophyte-free</u> : Numerous cultivars available <u>Novel endophyte</u> : Jesup MaxQ, BarOptima PLUS E34 <u>Endophyte-infected</u> : Not recommended for forage purposes	15 - 35	10 - 15	5 - 10	0.25	Poor
Timothy <i>Phleum pratense</i>	Numerous cultivars available	10 - 15	4 - 10	2 - 6	0.25 - 0.5	Poor
LEGUMES						
Alfalfa <i>Medicago sativa</i>	Numerous cultivars available	15 - 20	10 - 15	10 - 15	0.25 - 0.5	Poor
Annual Lespedeza: Korean <i>Kummerowia stipulacea</i> or Common <i>K. striata</i> (both species formerly in genus <i>Lespedeza</i>)	<u>Korean</u> : Climax or Rowan <u>Common</u> : Kobe	15 - 25	10 - 15	10 - 15	0.25 - 0.5	Good
Birdsfoot Trefoil <i>Lotus corniculatus</i>	<u>Pasture</u> : Dawn, Empire <u>Hay</u> : Fergus, Norcen, Tretana, Viking	10	6 - 10	2 - 6	0.25	Good
Ladino (White) Clover <i>Trifolium repens</i>	Alice (a tall variety), Durana	----	1 - 3	1 - 3	0.25	Excellent
Red Clover <i>Trifolium pratense</i>	Cultivars resistant to both northern and southern strains of anthracnose	10 - 15	4 - 8	4 - 8	0.25	Excellent

TABLE 8 NOTE:

1. Suitability for Frost Seeding (Poor, Fair, Good, Excellent): Describes the suitability of each species for broadcast-overseeding during late winter to reestablish it in an established stand.

TABLE 9: Selected Mixes for Cool-Season Forage and Biomass Plantings ^{1/}

Mix	Seeding Rate ^{2/} (lbs/ac)		Plant Hardiness Zones ^{3/}	Soil Drainage Class ^{4/}	Remarks
	Pasture	Hay			
GRASS-ALFALFA MIXES					
1. SELECT ONE GRASS: Orchardgrass <i>Dactylis glomerata</i> Tall Fescue <i>Schedonorus arundinaceus</i> AND ADD: Alfalfa <i>Medicago sativa</i>	8 - 10 10 - 15	2 - 6 5 - 10	All	W - MW	Use an endophyte-free or novel endophyte-infected variety of Tall Fescue.
2. SELECT ONE GRASS: Perennial Ryegrass <i>Lolium perenne</i> Smooth Bromegrass <i>Bromus inermis</i> Timothy <i>Phleum pretense</i> AND ADD: Alfalfa <i>Medicago sativa</i>	10 - 15 8 - 15 N/A	4 - 8 6 - 10 2 - 6	7a (Piedmont only)	W - MW	Perennial Ryegrass is useful for quick reseeding – high quality pasture, but is short lived. Smooth Bromegrass and Timothy are suitable for one-cut hay. Timothy is not recommended for pasture. Smooth Bromegrass can be used for less intensive pasturing, as compared to Mix 1.
GRASS-BIRDSFOOT TREFOIL MIXES					
3. SELECT ONE GRASS: Orchardgrass <i>Dactylis glomerata</i> Smooth Bromegrass <i>Bromus inermis</i> Timothy <i>Phleum pretense</i> AND ADD: Birdsfoot Trefoil <i>Lotus corniculatus</i>	8 - 10 8 - 15 N/A	2 - 4 6 - 8 4 - 6	7a (Piedmont only)	W - P	Good for wet sites. "No bloat" mix.
4. USE TWO GRASSES: Kentucky Bluegrass <i>Poa pratensis</i> Timothy <i>Phleum pretense</i> AND ADD: Birdsfoot Trefoil <i>Lotus corniculatus</i>	5 - 15 5 - 10	N/A	7a (Piedmont only)	W - SP	"No bloat" mix.

TABLE 9: Selected Mixes for Cool-Season Forage and Biomass Plantings ^{1/}

Mix	Seeding Rate ^{2/} (lbs/ac)		Plant Hardiness Zones ^{3/}	Soil Drainage Class ^{4/}	Remarks
	Pasture	Hay			
GRASS-CLOVER MIXES					
5. SELECT ONE GRASS: Perennial Ryegrass <i>Lolium perenne</i> Smooth Bromegrass <i>Bromus inermis</i> Timothy <i>Phleum pratense</i> AND ADD: Ladino (White) Clover <i>Trifolium repens</i> Red Clover <i>Trifolium pratense</i>	10 - 15 8 - 15 5 - 10	N/A	7a (Piedmont only)	W - SP	Perennial Ryegrass is sensitive to drought. Timothy is sensitive to high temperatures. Ladino (White) Clover is intolerant of droughty soils. Red Clover is short-lived and has low winter hardiness. A fungus associated with Red Clover can cause livestock (especially horses) to slobber or drool excessively. When used in horse pastures, plant the Red Clover at 50% of the specified rate if "slobbers" is a concern, or use an all grass mix (e.g., Mix 9 or 10) instead.
6. USE ALL THREE GRASSES: Kentucky Bluegrass <i>Poa pratensis</i> Perennial Ryegrass <i>Lolium perenne</i> Timothy <i>Phleum pratense</i> AND ADD: Ladino (White) Clover <i>Trifolium repens</i> Red Clover <i>Trifolium pratense</i>	5 - 15 5 - 10 5 - 10	N/A	7a (Piedmont only)	W - SP	Tall Fescue (endophyte-free or novel endophyte-infected variety) can be substituted for Perennial Ryegrass or Timothy. Perennial Ryegrass is sensitive to drought. Timothy is sensitive to high temperatures. Red Clover is short-lived and has low winter hardiness. For Red Clover in horse pastures, see Remarks for Mix 5.
7. SELECT ONE GRASS: Orchardgrass <i>Dactylis glomerata</i> Tall Fescue <i>Schedonorus arundinaceus</i> AND ADD: Ladino (White) Clover <i>Trifolium repens</i> Red Clover <i>Trifolium pratense</i>	8 - 10 10 - 15	2 - 6 5 - 10	All	W - SP	Use an endophyte-free or novel endophyte-infected variety of Tall Fescue. For Red Clover in horse pastures, see Remarks for Mix 5.
8. SELECT ONE GRASS: Orchardgrass <i>Dactylis glomerata</i> Tall Fescue <i>Schedonorus arundinaceus</i> AND ADD: Korean Lespedeza <i>K. stipulacea</i> Red Clover <i>Trifolium pratense</i>	8 - 10 10 - 15	2 - 6 5 - 10	All	W - SP	Use an endophyte-free or novel endophyte-infected variety of Tall Fescue. For Red Clover in horse pastures, see Remarks for Mix 5. The Lespedeza component makes this an especially good mix because lespedeza is more heat-tolerant than most of the other legumes.
AND ADD: Korean Lespedeza <i>K. stipulacea</i> Red Clover <i>Trifolium pratense</i>	10 - 15 4 - 6	10 - 15 N/A			

TABLE 9: Selected Mixes for Cool-Season Forage and Biomass Plantings ^{1/}

Mix	Seeding Rate ^{2/} (lbs/ac)		Plant Hardiness Zones ^{3/}	Soil Drainage Class ^{4/}	Remarks
	Pasture	Hay			
GRASS MIXES WITHOUT LEGUMES					
9. USE ALL THREE GRASSES: Kentucky Bluegrass <i>Poa pratensis</i> Smooth Bromegrass <i>Bromus inermis</i> Timothy <i>Phleum pratense</i>	5 - 15 4 - 8 4 - 8	N/A	7a (Piedmont only)	W - SP	Good grass base for pastures; especially suited for horse pastures.
10. USE TWO GRASSES: Kentucky Bluegrass <i>Poa pratensis</i> Tall Fescue <i>Schedonorus arundinaceus</i>	5 - 10 15 - 20	N/A	All	W - SP	For heavily grazed horse pastures or other loafing lots, use this mix with a novel endophyte variety of Tall Fescue. It will withstand abuse better than the endophyte-free varieties. Follow the Tall Fescue manufacturer's guidelines for establishment.

TABLE 9 NOTES:

- Selected Mixes:** These mixes have been selected based primarily on recommendations in the *Penn State Agronomy Guide* and in *Forage Production for Pasture Based Livestock Production, Establishing Forage Stands (Chapter 7)*. Due to page limitations, this list of mixes is not all-inclusive. There are many other combinations of grasses and/or legumes that may be suitable for pasture or hay, depending on site conditions and the producer's needs. All legume seeds shall be inoculated before planting with the appropriate *Rhizobium* bacteria.
- Seeding Rates:** Whenever possible, optimize seed distribution by using a brillion or cultipacker-seeder. If drilling, it is recommended to split rates and apply seed twice, with the second pass going perpendicular across the first drill rows. If broadcast planting, increase the seeding rate by 50%.
- The Plant Hardiness Zones** designate where a species can be successfully grown in Delaware, as shown on the Plant Hardiness Zone map (Figure 1).
- Soil Drainage Class** (refer to the county soil survey for further information): E - Excessively Drained; W - Well Drained; MW - Moderately Well Drained; SP - Somewhat Poorly Drained; P - Poorly Drained.