# Chapter 7
# Forage Production

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The forage industry plays a major role in Ohio agriculture. Approximately 16 percent of the total value of agricultural products sold in Ohio is derived from ruminant meat and milk products ($1.6 billion). In Ohio there are 1.25 million cattle and calves, with Ohio ranking 11th in the nation in value of milk production and 25th in value of all cattle and calves. Ohio ranks 14th in the nation in value of sheep, goats, and their products. About 34 percent of Ohio farms have cattle and calves, 5 percent have sheep and lambs, 6 percent have goats, and 21 percent have horses and ponies. In 2014, 2.7 million tons of hay was produced (19th in the nation) on 1.03 million acres and pastures comprise more than 1.4 million acres of Ohio's total farmland.

Forages are environmentally friendly. They protect soils from erosion, improve soil tilth, help reduce pesticide use, and enhance agricultural profitability. Forages are vital to Ohio agriculture, protect our soil and water resources, and add beauty to the state.

All forage crops respond positively to good management practices. Higher yields, improved nutritive value, and longer stand persistence result from paying attention to the basics of good forage management. This guide is designed to help producers achieve the high potential of forages grown in Ohio.

## Perennial Forages

### Species Selection

The selection of forages for hay, silage, pasture, and conservation is an important decision requiring knowledge of agronomic characteristics, forage species adaptation to site and soil characteristics, and potential feeding value of forage plants. The intended use of forages, dry matter and nutritional requirements of livestock to be fed, seasonal feed needs, harvest and storage capabilities, and seasonal labor availability influence which species to grow.

#### *Agronomic Adaptation and Intended Use*

Tables 7-1 and 7-2 outline the agronomic adaptation and characteristics of the primary forages grown in Ohio. The choice of species is limited to those adapted to the soils on the farm, so evaluate the soil adaptation factors in Table 7-1 first when selecting species. Useful soil information describing the limitations of a particular soil for forage production can be found at NRCS offices or online through the *USDA-NRCS Web Soil Survey* (**websoilsurvey.sc.egov.usda.gov/**). Keep in mind that soil pH can be increased with lime; soil fertility can be improved with fertilizers and manure; and soil drainage can be modified with tiling. Soil drainage is usually the most difficult soil characteristic to modify. The following is a brief discussion of individual species that can help determine which species are best suited to a particular enterprise. Table 7-3 gives commonly recommended species to consider for general soil fertility classes and utilization methods.

#### *Pure Stands versus Mixtures*

The decision to establish a pure stand or a mixture species should be made before deciding which species to plant. Advantages of pure grass or legume stands include simpler management and more herbicide options. Pure legume stands decline in forage quality more slowly with advancing maturity than do grasses, providing a wider window of opportunity for harvesting good quality forage. Pure grass stands are usually more resilient, able to withstand more abuse, and persist longer than pure legume stands.

Legume-grass mixtures are common in Ohio and can exploit the relative strengths of grasses and legumes. Mixtures are generally more satisfactory for pastures than pure stands. Grass-legume mixtures are often more stable in yield and have more uniform seasonal production than pure stands. Including legumes in a mixture reduces the need for nitrogen fertilizer, improves forage nutritive value and animal performance, and reduces the potential for nitrate poisoning and grass tetany compared with pure grass stands. Including grasses in a mixture usually lengthens the life of a stand because they persist longer and are more tolerant of mismanagement and variable soils than legumes. Grasses reduce the incidence of bloat, improve hay drying, are usually more tolerant of lower fertility, reduce losses to insect pests and diseases, and compete with weeds more than legumes. The fibrous root system of grasses helps control erosion on steep slopes and reduces legume heaving.

*Table 7-1: Agronomic Adaptation and Characteristics of Perennial Forages Grown in Ohio.*

| Forage Species | Minimum Adequate Drainage[1] | Tolerance to pH < 6.0 | Adequate Soil Fertility | Drought Tolerance | Persistence | Seedling Vigor | Growth Habit |
|---|---|---|---|---|---|---|---|
| **Legumes** | | | | | | | |
| Alfalfa | WD | Low | High to medium | High | High | High | Bunch |
| Alsike clover | PD | High | Medium to low | Low | Low | Low | Spreading |
| Birdsfoot trefoil | SPD | High | Medium | Medium | Medium | Low | Bunch |
| Red clover | SPD | Medium | Medium | Medium | Low | High | Bunch |
| White clover | PD | Medium | Medium | Low | High | Low | Spreading |
| **Cool-Season Grasses and Forbs** | | | | | | | |
| Festulolium | SPD | Medium | Medium to high | Low | Low | Very high | Bunch |
| Kentucky bluegrass | SPD | Medium | Medium | Low | High | Low | Dense Sod |
| Meadow fescue | PD | Medium | Low to medium | Medium | High | Medium | Bunch |
| Orchardgrass | SPD | Medium | Medium | Medium | Medium | High | Bunch |
| Perennial ryegrass | SPD | Medium | Medium to high | Low | Low | Very high | Bunch |
| Reed canarygrass | VPD | High | Medium to high | High | High | Low | Open sod |
| Smooth bromegrass | MWD | Medium | High | High | High | Medium | Open sod |
| Tall fescue | SPD | High | Medium | Medium | High | High | Variable[2] |
| Timothy | SPD | Medium | Medium | Low | High | Low | Bunch |
| Chicory | MWD | Medium | Medium to high | High | Medium | High | Bunch |
| **Warm-Season Grasses** | | | | | | | |
| Switchgrass | SPD | High | Low to medium | Excellent | High | Very low | Bunch |
| Big bluestem | MWD | High | Low to medium | Excellent | High | Very low | Bunch |
| Indiangrass | MWD | High | Low to medium | Excellent | High | Very low | Bunch |
| Eastern gamagrass | PD | High | Medium to high | Good | High | Very low | Bunch |

[1] Minimum drainage required for acceptable growth; WD = well drained; MWD = moderately well drained; SPD = somewhat poorly drained; PD = poorly drained; VPD = very poorly drained.

[2] Under lax cutting, tall fescue has bunchy growth; under frequent cutting or grazing it forms a sod.

*Table 7-2: Suitability of Perennial Forage Species to Different Types of Management and Growth Characteristics.*

| Species | Frequent, Close Grazing | Rotational Grazing | Stored Feed | Periods of Primary Production | Relative Maturity[1] |
|---|---|---|---|---|---|
| **Legumes** | | | | | |
| Alfalfa | X[2] | ● | ■ | Spring, summer, early fall | Early-medium |
| Alsike clover | X | ● | ● | Spring, early summer, fall | Late |
| Birdsfoot trefoil | X | ■ | ■ | Spring, summer, early fall | Medium-late |
| Red clover | X | ● | ■[3] | Spring, summer, early fall | Medium-late |
| White Dutch clover | ■ | ■ | X | Spring and fall | Early-medium |
| White clover, ladino | X | ■ | ● | Spring, early summer, fall | Early-medium |
| **Cool-Season Grasses and Forbs** | | | | | |
| Festulolium | X[4] | ■ | ■[3] | Spring, early summer, fall | Medium |
| Kentucky blue-grass | ■ | ■ | ● | Early spring and late fall | Early |
| Meadow fescue | X | ■ | ■ | Spring, early summer, fall | Medium |
| Orchardgrass | X[4] | ■ | ■ | Spring, summer, fall | Early-medium |
| Perennial ryegrass | X[4] | ■ | ■[3] | Spring and fall | Medium |
| Reed canarygrass | X | ■ | ■ | Spring, summer, fall | Medium-late |
| Smooth bromegrass | X | ● | ■ | Spring, summer, fall | Medium-late |
| Tall fescue | X | ■ | ■ | Spring, summer, fall | Medium-late |
| Timothy | X | ● | ■ | Late spring and fall | Late |
| Chicory | X | ■ | X | Spring, summer | Early |
| **Warm-Season Grasses** | | | | | |
| Switchgrass | X | ■ | ■ | Summer | Very late |
| Big bluestem | X | ■ | ■ | Summer | Very late |
| Indiangrass | X | ■ | ■ | Summer | Very late |
| Eastern gamagrass | X | ■ | ● | Summer | Very late |

[1] Relative time of flower or seedhead appearance in the spring. Depends on species and variety. Warm-season grasses mature in midsummer; exact time varies by species.

[2] ■ = Highly suitable
● = Suitable
X = Not recommended

[3] Silage preferred, difficult to cure for dry hay.

[4] Can tolerate frequent grazing if a 3- to 4-inch stubble is maintained.

*Table 7-3: Suitability of Perennial Forage Species to Different Soil Fertility Classes and Methods of Utilization.*

| |
|---|
| **Medium to high fertility soils, for hay & silage** |
| Alfalfa, birdsfoot trefoil, red clover |
| Festulolium, meadow fescue, orchardgrass, perennial ryegrass, reed canarygrass, smooth brome, tall fescue, timothy |
| Switchgrass, big bluestem, indiangrass |
| **Medium to high fertility soil, pasture production** |
| Alfalfa, alsike clover, birdsfoot trefoil, red clover, white clover, chicory |
| Festulolium, Kentucky bluegrass, meadow fescue, orchardgrass, perennial ryegrass, reed canarygrass, smooth bromegrass, tall fescue, timothy |
| Switchgrass, big bluestem, indiangrass, eastern gamagrass |
| **Low to medium fertility soils, for hay & silage** |
| Red clover, alsike clover, birdsfoot trefoil |
| Meadow fescue, orchardgrass, tall fescue, timothy |
| Switchgrass, big bluestem, indiangrass |
| **Low to medium fertility soil, pasture production** |
| Alsike clover, birdsfoot trefoil, white clover |
| Kentucky bluegrass, meadow fescue, orchardgrass, tall fescue |
| Switchgrass, big bluestem, indiangrass |

### *Mixtures for Hay and Silage*

Keep mixtures relatively simple for hay or silage use, two to four species are usually sufficient. Hay and silage cutting schedules are easier to manage with simple mixtures. Consider the following criteria:

- **Adaptation.** All species in the mixture should be adapted to the prevailing soil conditions (drainage, soil moisture holding capacity, soil pH, fertility, etc.).
- **Rate of Establishment.** Combine species with fairly similar seedling aggressiveness. Persistent plant species are often the least competitive in the seedling stage. Excessive seedling competition in a shotgun mixture can prevent persistent and desirable species from becoming established. An exception to this rule is the use of companion crops, or fast-establishing short-lived perennial or annual species used to achieve quick ground cover. Small grains and annual or perennial ryegrass are often used for this purpose. Keep seeding rates of these temporary companions low to avoid excessive competition with the slower establishing perennial species.
- **Time of Maturity.** Species and varieties in a mixture should mature at about the same time and match your intended harvest schedule. There is considerable variation in maturity among grass species and varieties. Such information is often collected in variety testing trials and is also available from seed suppliers.
- **Management Compatibility.** Select species that are well adapted to the intended management. For example, orchardgrass is compatible with alfalfa on a four-cut schedule because it regrows quickly, while timothy and bromegrass are compatible with alfalfa on a more lenient three-cut schedule.
- **Summer Production.** Alfalfa produces very well during the summer months while birdsfoot trefoil and red clover generally produce less summer yield. Of the grasses, orchardgrass, tall fescue and reed canarygrass produce the best summer growth. Smooth bromegrass produces moderate to light summer aftermath, and timothy, meadow fescue and perennial ryegrass are usually lower yielding in the summer months. Moisture and temperature conditions affect aftermath production of cool-season grasses more than alfalfa.
- **Variety Performance.** Use variety testing data to select species and varieties that have stable yield performance over multiple locations and years. Stable yield performance across many environments demonstrates good adaptation to a wide range of conditions. Performance over years demonstrates yield persistence with advancing stand age and is especially important for long rotations. For Ohio variety test data and links to data in other states, see **u.osu.edu/perf**.
- **Disease and Pest Resistance.** Select species and varieties with resistance to important insects and diseases for your soils. For example, *Phytophthora* root rot and *Fusarium* wilt resistance in alfalfa are very important on soils with suboptimal drainage, while potato leafhopper resistant alfalfa is useful across all of Ohio. Resistance to foliar diseases can be important in grasses.
- **Forage Quality.** Varieties with improved forage quality are available in some species. If high forage quality is very important, then select varieties based on this trait.

### *Mixtures for Pastures*

While simple mixtures are desirable for hay and silage management, studies in Ohio and the northeastern U.S. demonstrated that complex mixtures of six or more spe-

cies provide greater stability of forage production under grazing. Soil and environmental variability in pastures makes it difficult to predict which species will perform best. Species dominance and spatial distribution in a pasture will be affected by variability in fertility, soil drainage, slope aspect (north versus south facing), and animal traffic and grazing patterns, among other factors that influence the microenvironment. In addition, species vary in productivity during different seasons, i.e., between spring and summer grazing periods. Therefore, it is best to use mixtures with a range of grasses and legumes that fit the general soil conditions and management characteristics and that are not drastically different in palatability.

### *Seeding Rates*

Table 7-4 gives recommended seeding rates for individual species in pure stands and for mixtures. Seeding rate recommendations are related to seed size, germination, seedling and established plant vigor, spreading characteristics, and mature plant size. For example, more seeds per square foot are recommended for species with low seedling vigor and smaller mature plant size (e.g., Kentucky bluegrass) in order to improve establishment success and competitiveness of that species in a mixture or against weed encroachment. Increasing seeding rates above the recommended levels does not compensate for poor seedbed preparation or improper seeding methods.

There is no reliable way to predict that a specific proportion sown will result in a similar proportion of established plants in a mixed species seeding. The seeding rates shown for mixtures are simply varying percentages of the pure stand seeding rate recommendation. Use your best judgment to adjust the seeding rate for each species based on the relative proportion desired of that species in the mixture (see sidebar). Complex mixtures will often result in a higher overall seeding rate (in seeds per square foot) than simpler mixtures. This is simply a function of having more component species, each one seeded above a minimum level to provide an opportunity for it to establish and compete in the microenvironments where it is best adapted.

## Examples of Seeding Rates for Mixtures

**Simple Hay Mixture:** For an orchardgrass base with a small percentage of red clover, sow orchardgrass at the three-quarter rate (7 pounds per acre) and red clover at the one-quarter rate (3 pounds per acre) shown in Table 7-4.

**Complex Pasture Mixture:** If orchardgrass is desired to be slightly more dominant than several other species in a complex mixture, sow orchardgrass at the one-third rate and the other species at the one-eighth rate: orchardgrass (3 pounds per acre), festulolium (3 pounds per acre), smooth bromegrass (4 pounds per acre), red clover (2 pounds per acre), ladino clover (1 pound per acre), and chicory (1.5 pounds per acre).

## Characteristics of Perennial Cool-Season Forages

### *Alfalfa (Medicago sativa L.)*

Alfalfa is grown on about one-third of the total hay and haylage acres in Ohio. Where adapted, it is unmatched by any other forage as high quality feed for livestock and as a cash crop. Alfalfa requires deep, well-drained soils with near-neutral pH (6.5-7.0) and high fertility. It should not be grown on soils with moderate to poor drainage. Alfalfa is best adapted to hay or silage harvest management. While it can be used in rotationally grazed pastures, it normally lacks persistence in permanent pastures compared with other legumes. Like most legumes, it can cause bloat. Alfalfa has good seedling vigor, excellent drought tolerance, and produces very well through the summer. Important insect pests on alfalfa include the alfalfa weevil and potato leafhopper.

Select newer high-yielding alfalfa varieties with adequate winter hardiness and resistance to important diseases to capitalize on alfalfa's potential. Most new varieties of alfalfa include selection for multiple disease resistance. Varieties are also available with higher forage nutritive value, high levels of resistance to potato leafhopper, traffic and grazing tolerance, and some tolerance to lodging. Roundup Ready varieties are now available as a tool for weed management. Varieties with reduced lignin content and higher fiber digestibility have recently been developed. Studies in Ohio have demonstrated that new varieties with multiple pest resistance provide higher yields and greater stand persistence with less weed invasion than older varieties. Always evaluate performance data across multiple locations when selecting varieties. For more information on varieties, see the *Ohio Forage Performance Trials* and forage trials in other states, available at Extension offices and online at **u.osu.edu/perf**.

### *Alsike Clover (Trifolium hybridum L.)*

Alsike clover is a short-lived perennial legume that is tolerant of wet, acidic soils. Alsike tolerates soils with a pH as low as 5.0, which is too acidic for red clover and alfalfa. Alsike also grows better than red clover on alkaline (high pH) soils. Alsike tolerates flooding better than other legumes, making it well suited for low-lying fields with poor drainage. It can withstand spring flooding for several weeks. A cool and moist environment is ideal for alsike clover growth; it has poor heat and drought tolerance, thus usually produces only one crop of hay per year. It is susceptible to the same diseases that attack red and white clovers. Its growth habit is intermediate between red and white clover. Alsike clover must be allowed to reseed to maintain its presence in pastures, otherwise it will last only about two years. Alsike clover has good palatability, but can cause bloat and photosensitization in grazing animals.

*Table 7-4: Seeding Rates of Pure Live Seed (PLS) for Forages Grown in Ohio.*

| Species | Approximate Seeds/lb | Pure Stand Seeding Rate | | Proportional Seeding Rates for Mixtures[1] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/4 | 1/2 | 1/3 | 1/4 | 1/8 |
| | (x 1000) | (seeds/ft$^2$) | (lb/ac) | ---------- lb/ac ---------- | | | | |
| **Perennial Legumes** | | | | | | | | |
| Alfalfa | 227 | 80 | 15 | 12 | 8 | 5 | 4 | 2 |
| Alsike clover | 700 | 150 | 9 | 7 | 5 | 3 | 2 | 1 |
| Birdsfoot trefoil | 375 | 80 | 9 | 7 | 5 | 3 | 2 | 1 |
| Red clover | 275 | 70 | 11 | 8 | 6 | 4 | 3 | 1.5 |
| White clover | 860 | 100 | 5 | 4 | 3 | 2 | 1 | 0.5 |
| **Perennial Grasses and Forbs** | | | | | | | | |
| Festulolium | 227 | 130 | 25 | 19 | 12 | 8 | 6 | 3 |
| Kentucky bluegrass | 2200 | 500 | 10 | 7 | 5 | 3 | 2 | 1 |
| Meadow fescue | 220 | 80 | 16 | 12 | 8 | 5 | 4 | 2 |
| Orchardgrass | 590 | 130 | 10 | 7 | 5 | 3 | 2 | 1 |
| Perennial ryegrass | 237 | 130 | 24 | 18 | 12 | 8 | 6 | 3 |
| Reed canarygrass | 550 | 130 | 10 | 8 | 5 | 3 | 2.5 | 1 |
| Smooth bromegrass | 137 | 50 | 16 | 12 | 8 | 5 | 4 | 2 |
| Tall fescue | 227 | 80 | 15 | 12 | 8 | 5 | 4 | 2 |
| Timothy | 1230 | 220 | 8 | 6 | 4 | 3 | 2 | 1 |
| Big bluestem | 150 | 40 | 12 | 9 | 6 | 4 | 3 | 1 |
| Eastern gamagrass | 7.4 | 1.5 | 9 | 7 | 4 | 3 | 2 | 1 |
| Indiangrass | 175 | 50 | 12 | 9 | 6 | 4 | 3 | 1.5 |
| Switchgrass | 370 | 80 | 9 | 7 | 5 | 3 | 2 | 1 |
| Chicory | 375 | 50 | 6 | 4 | 3 | 2 | 1.5 | 1 |
| **Annuals and Biennials** | | | | | | | | |
| Italian ryegrass | 228 | 125 | 24 | 18 | 12 | 8 | 6 | 3 |
| Kale | 140 | 12 | 4 | - | - | - | - | - |
| Oats, spring | 15 | 30 | 87 | 65 | 44 | 29 | 22 | 11 |
| Pearl millet | 85 | 40 | 20 | - | - | - | - | - |
| Rape | 145 | 12 | 4 | - | - | - | - | - |
| Rye, winter | 18 | 45 | 109 | - | - | - | - | - |
| Sorghum, forage | 28 | 8 | 12 | - | - | - | - | - |
| Sorghum-sudangrass | 28 | 15 | 23 | - | - | - | - | - |
| Sudangrass | 55 | 30 | 24 | - | - | - | - | - |
| Swede | 200 | 8 | 2 | - | - | - | - | - |
| Teff | 1250 | 140 | 5 | - | - | - | - | - |
| Turnip | 190 | 8 | 2 | - | - | - | - | - |
| Triticale | 16 | 40 | 109 | - | - | - | - | - |
| Winter wheat | 15 | 40 | 116 | - | - | - | - | - |

[1] Seeding rates for stated proportions of the seeding rate for pure stands.

### *Birdsfoot Trefoil (Lotus corniculatus L.)*

Birdsfoot trefoil is a deep-rooted perennial legume that is best adapted to northern Ohio. Birdsfoot trefoil is tolerant of low-pH soils (as low as pH 5.0), moderate to somewhat poor soil drainage, marginal fertility, and soils with fragipans. Birdsfoot trefoil can withstand several weeks of flooding, and tolerates periods of moderate drought and heat. It has poor seedling vigor and is slow to establish. Early spring seedings are generally more successful than late summer seedings. It is best seeded with a grass companion. Birdsfoot trefoil produces excellent quality forage with fair palatability, it stockpiles well, and unlike most forage legumes, it is non-bloating. Birdsfoot trefoil should be managed to allow for reseeding to maintain its presence in forage stands. It is intolerant of close cutting or grazing, has slow recovery after hay harvest, and is susceptible to root and crown rot diseases.

Empire-type varieties have prostrate growth and fine stems, making them better suited to grazing. European-type varieties are more erect, establish faster, and regrow faster after harvest. Thus, they are better suited to hay production and rotational grazing. Most of the newer varieties are intermediate with semi-erect to erect growth habit.

### *Red Clover (Trifolium pratense L.)*

Red clover is a short-lived perennial legume grown for hay, silage, pasture and for green manure. Red clover is better adapted than alfalfa to soils that are somewhat poorly drained and slightly acidic; however, greatest production occurs on well-drained soils with high water-holding capacity and pH above 6.0. Red clover is not as productive as alfalfa in the summer. It has good seedling vigor and is one of the easiest legumes to establish using no-till interseeding or frost-seeding techniques. Under Ohio weather conditions, red clover is often difficult to dry for hay storage. Harvesting for silage or including a grass in the stand helps alleviate this problem. When grazed, red clover can cause bloat in cattle if sufficient grass is not present.

Medium red clover varieties can be harvested three to four times per year. Mammoth red clover is late to flower and is considered a single cut clover because the majority of its growth occurs in the spring. Most of the improved varieties are medium types and have good levels of disease resistance to northern and southern anthracnose and powdery mildew. Several new medium red clover varieties have demonstrated acceptable stand persistence for three or even four years in university trials. Varieties with greater grazing tolerance are also available.

### *White Clover (Trifolium repens L.)*

White clover is a low-growing, short-lived perennial legume that is well suited for pastures. It can cause bloat in cattle if sufficient grass is not present for grazing. White clover improves forage quality of grass pastures and reduces the need for nitrogen fertilizer. White clover can be frost seeded or no-till seeded into existing grass pastures. It spreads by stolons. White clover is most productive when moisture is plentiful. It has a shallow root system, so does not tolerate prolonged dry spells. Although well-drained soils improve production, white clover tolerates periods of poor drainage. It can be managed for reseeding to improve persistence in pastures.

Large white clover types, also known as Ladino clovers, are more productive and aggressive in mixtures with grasses than are the medium-leaf or the small-leaf type frequently referred to as White Dutch. The small- and medium-leaf clovers persist better under heavy, continuous grazing because they are often prolific reseeders. In contrast, the large-leaf types are better suited under hay or silage management because they can be too aggressive in grazed pastures, resulting in higher risk for animals to bloat. Purchase seed of stated quality to be certain of obtaining pure seed of the white clover variety desired.

### *Festulolium (xFestulolium Asch. & Graebn.)*

Festulolium grass species are hybrids derived from crosses among up to four possible parents: tall fescue, meadow fescue, Italian ryegrass and perennial ryegrass. They are bunchgrasses suitable for hay, silage or pasture. The parent species used in the cross and the relative proportion of genes from each parent determines the characteristics of any given festulolium variety, thus it is difficult to generalize about this species. For example, a meadow fescue parent contributes midsummer growth, winter hardiness, forage quality, and drought tolerance, while an Italian ryegrass parent contributes rapid establishment and quick regrowth. Festulolium is generally best adapted to the northern half of Ohio; however, when tall fescue is used to contribute a significant proportion of the genetic makeup of the festulolium variety, then it would likely be adapted to southern Ohio as well. Festulolium generally grows especially well in the spring and produces palatable forage with high nutritive value. Festulolium yields well under good fertility when moisture is adequate. Like perennial ryegrass, it is a vigorous establisher. Because it is generally less winter hardy than other grasses, festulolium is best seeded in combination with other grasses and legumes. It can be grown on occasionally wet soils. Compared with orchardgrass, it is lower yielding, less competitive with legumes, and later to mature. Like orchardgrass, festulolium can withstand frequent cutting or grazing. It is difficult to cut with a sickle bar mower and is slower to dry than other grasses, so is better suited to grazing, greenchopping, and silage harvesting than for dry hay.

Festulolium varieties can differ markedly in winterhardiness and recovery from winter injury based on the parent germplasm used to produce the variety. For permanent pastures, select varieties that are proven to persist well under Ohio conditions.

### *Kentucky Bluegrass (Poa pratensis L.)*

Kentucky bluegrass is a long-lived perennial grass especially well-suited to pastures because of its low growth habit. It forms a dense, tough sod under favorable conditions, providing good footing for grazing animals. It reproduces by seed and rhizomes. It tolerates close or frequent grazing and is one of the most forgiving grasses, able to tolerate and persist under a wide range of soil conditions and mismanagement. Kentucky bluegrass grows best under cool and moist conditions, usually going semi-dormant during the summer. Improved varieties are available.

### *Meadow Fescue (Schedonorus pratensis (Huds.) P. Beauv.*

Meadow fescue is a cool-season semi-bunch type grass native to northern Europe and mountainous regions in southern Europe that is regaining acceptance in the U.S. because of its many positive characteristics. It grows well under cool, moist conditions and reportedly tolerates wet and sometimes flooded conditions. It was introduced into the U.S. in the early 1800s, but was essentially forgotten by the 1950s. Recently, it has gained renewed interest among forage producers because it produces palatable forage of high nutritive value, It is suitable for frequent, managed grazing systems, but is lower yielding (20 to 30 percent less) than orchardgrass and tall fescue and is less suited to hay production. It is very winter hardy and yields more than perennial ryegrass, while being more palatable with higher fiber digestibility at equal stages of maturity than either tall fescue or orchardgrass, resulting in higher animal performance. Meadow fescue is consistently about five units higher in neutral detergent fiber digestibility (NDFD) than tall fescue or orchardgrass across the entire growing season. Meadow fescue has a fungal endophyte, which does not produce alkaloids that are harmful to animals. It is not currently known if the endophyte provides any benefit to the plant. Meadow fescue does exhibit good drought tolerance on shallow soils and populations of this grass on farms have been noted as growing in deep, consistent shade of remnant oak savannas in the North Central region. Mixtures of meadow fescue with alfalfa have been shown to provide higher energy to protein ratios compared with mixtures of alfalfa with orchardgrass, timothy, tall fescue, meadow brome or Kentucky bluegrass.

New varieties are available from several grass seed sources, many developed in Europe. Varieties are being developed in the U.S., including the variety Hidden Valley, a publicly released variety developed from selections in Wisconsin.

### *Orchardgrass (Dactylis glomerata L.)*

Orchardgrass is a versatile perennial bunch-type grass (no rhizomes) that establishes rapidly and is suitable for hay, silage or pasture. Orchardgrass along with tall fescue are usually the most productive cool-season grasses grown in Ohio, especially under good fertility management. Orchardgrass has rapid regrowth, produces well under intensive cutting or grazing, and has better summer growth than most of the other cool-season grasses. It grows best in deep, well-drained, loamy soils. Its flooding tolerance is fair in the summer but poor in the winter. Orchardgrass is especially well suited for mixtures with tall legumes, such as alfalfa and red clover. The rapid decline in palatability and quality with maturity is a limitation with this grass. Timely harvest management is essential for obtaining good quality forage.

Improved varieties of orchardgrass are available with high yield potential, resistance to leaf diseases, and some have been developed for greater grazing tolerance. Maturity is an important consideration in variety selection and a wide range in maturity is available among new varieties. When seeding orchardgrass-legume mixtures, select varieties that match the maturity of the legume. The later-maturing varieties are best suited for mixtures with alfalfa and red clover. In pastures, early maturing varieties will often produce higher yield than late maturing varieties, but grazing management must be aggressive in the spring to manage their rapid and early maturation.

### *Reed Canarygrass (Phalaris arundinacea L.)*

Reed canarygrass is a tall, leafy, coarse, high-yielding perennial grass tolerant of a wide range of soil and climatic conditions (Table 7-1 and 7-2). It can be used for hay, silage, and pasture. It has a reputation for poor palatability and low forage quality. This reputation was warranted in the past because older varieties produced forage containing alkaloid compounds (bitter, complex, nitrogen-containing compounds). However, varieties are now available that make this forage an acceptable animal feed, even for lactating dairy cows.

Reed canarygrass grows well in very poorly drained soils, but is also productive on well-drained upland soils. It is winter hardy, drought tolerant (deep-rooted), resistant to leaf diseases, persistent, responds to high fertility, and tolerates spring flooding, low pH, and frequent cutting or grazing. Reed canarygrass forms a dense sod. Limitations of this grass include slow establishment, expensive seed, and rapid decline in forage quality after heading.

Only low-alkaloid varieties (e.g., Palaton, Venture, Rival, Marathon) are recommended if the crop is to be used as an animal feed. These varieties are palatable and equal in quality to other cool-season grasses when harvested at similar stages of maturity. Common reed canarygrass seed should be considered to contain high levels of alkaloids, and is undesirable for animal feed.

### *Ryegrass (Lolium species)*

Perennial ryegrass (*Lolium perenne* L.) is a bunch grass suitable for hay, silage or pasture that is best adapted to the northern half of Ohio. Perennial ryegrass produces palatable forage with high nutritive value. It has a long growing season and yields well under good fertility when moisture is plentiful. It is a vigorous establisher and is often used in mixtures to establish quick ground cover. Because it is less winter hardy than other grasses, perennial ryegrass is best seeded in combination with other grasses and legumes. It can be grown on occasionally wet soils. Compared with orchardgrass, it is lower yielding, less competitive with legumes, and later to mature. Like orchardgrass, perennial ryegrass can withstand frequent cutting or grazing. It is difficult to cut with a sickle bar mower and is slower to dry than other grasses, so is better suited to grazing, greenchopping, and silage harvesting than for dry hay.

Perennial ryegrass varieties can differ markedly in winterhardiness and recovery from winter injury. Maturity also differs widely among ryegrass varieties. Be sure to purchase endophyte-free seed of forage-type varieties; seed of many turf-type varieties is infected with a fungal endophyte (fungus inside the seed and plant), which can be harmful to livestock and cause a neurological condition known as ryegrass staggers. Forage-type varieties are either diploid (the basic chromosome number is doubled) or tetraploid (basic chromosome number is quadrupled). Tetraploid varieties have fewer, but larger, tillers and wider leaves, resulting in more open sods than diploids. Tetraploids are usually slightly higher in forage digestibility.

Hybrid ryegrass (*Lolium xhybridum* Hausskn.) is achieved by crossing perennial and annual ryegrass. It generally has characteristics intermediate between those of perennial and annual ryegrass.

Italian ryegrass (*Lolium perenne* L. subsp. *multiflorum* (Lam.) Husnot) is generally annual or biennial in longevity, and can provide short-term high yields of high-quality forage. More details on this species are provided under the *Annual Forage Crops* section of this chapter.

### *Smooth Bromegrass (Bromis inermis Leyss.)*

Smooth bromegrass is a leafy, sod-forming perennial grass best suited for hay, silage, and early spring pasture. It spreads by underground rhizomes and through seed dispersal. Smooth bromegrass is best adapted to well-drained silt-loam or clay-loam soils. It is a good companion with cool-season legumes. Smooth bromegrass matures somewhat later than orchardgrass in the spring and makes less summer growth than orchardgrass. It is very winter hardy and, because of its deep root system, will survive periods of drought. Smooth bromegrass produces excellent quality forage, especially if harvested in the early heading stage. It is adversely affected by cutting or grazing when the stems are elongating rapidly (jointing stage), and is less tolerant of frequent cutting. It should be harvested for hay in the early heading stage for best recovery growth. Fluffy seed makes this grass difficult to drill unless mixed with a carrier (e.g., oats, rice hulls, vermiculite or small amount of phosphate fertilizer). It is susceptible to leaf diseases.

Improved high-yielding and persistent varieties are available. Some varieties are more resistant to brown leaf spot, which may occur on smooth bromegrass. These improved varieties start growing earlier in the spring and stay green longer than common bromegrass, which has uncertain genetic makeup.

Several other brome species are now available from forage seed suppliers including Alaska brome, meadow brome, prairie brome, and mountain brome. Always ask for information on species characteristics and evaluate performance data in your region before purchasing any newer grass species or variety. Plant small areas when your experience with a particular species is limited.

### *Tall Fescue (Schedonorus arundinaceus (Schreb.) Dumort., nom. cons.)*

Tall fescue is a deep-rooted, long-lived, sod-forming grass that spreads by short rhizomes. It is suitable for hay, silage or pasture for beef cattle and sheep. Tall fescue is the best cool-season grass for stockpiled pasture or field-stored hay for winter feeding. It is widely adapted, and persists on acidic, wet soils of shale origin. Tall fescue is drought resistant and survives under low fertility conditions and abusive management. It is ideal for waterways, ditch and pond banks, farm lots, and lanes. It is the best grass for areas of heavy livestock and machinery traffic.

Most of the tall fescue in older permanent pastures in Ohio contains a fungus (endophyte) growing inside the plant. The fungal endophyte produces alkaloid compounds that reduce palatability in the summer and result in poor animal performance. Several health problems may develop in animals grazing endophyte-infected tall fescue, especially breeding animals. Deep-rooted legumes should be included with tall fescue if it is to be used in the summer. Legumes improve animal performance, increase forage production during the summer, and dilute the toxic effect of the endophyte when it is present. For more information on this problem and solutions, refer to fact sheets available through county Extension offices.

Newer endophyte-free varieties or varieties with very low endophyte levels (less than 5 percent) are recommended if stands are to be used for animal feed. In addition, varieties are also available with novel endophytes that are not toxic to livestock. Kentucky-31 is the most widely grown variety, but most seed sources of this variety are highly infected with the toxic endophyte fungus, and should not be planted. When buying seed, make sure the tag states that the seed is endophyte-free or has a very low percentage of infected seed, or contains novel endophyte only. Because endophyte-free varieties are less stress tolerant than endophyte-infected varieties, they should be managed more carefully.

### *Timothy (Phleum pratense L.)*

Timothy is a hardy perennial bunchgrass that grows best in cool climates. It generally grows better in northern Ohio than southern Ohio. Its shallow root system makes it unsuitable for droughty soils. It produces most of its annual yield in the first crop. Summer regrowth is often limited because of timothy's intolerance to hot and dry conditions. Timothy is used primarily for hay and is especially popular for horses. It requires fairly well-drained soils. Timothy is less competitive with legumes than most other cool-season grasses. It is adversely affected by cutting or grazing when the stems are elongating rapidly (jointing stage), and is less tolerant of frequent cutting. It should be harvested for hay in the early heading stage for best recovery growth.

## Forage Species Identification

There are several excellent printed and online resources for identifying forage species. Below is a partial list of what is available:

### *Printed publications:*

*Identifying Pasture Grasses*, University of Wisconsin Bulletin A3637

*Identifying Pasture Legumes*, University of Wisconsin Bulletin A3787

*Forage Identification and Use Guide*, University of Kentucky Cooperative Extension Service Bulletin AGR-175

*Forage Legumes*, 2nd Ed., University of Minnesota Station Bulletin 608-2003

*Forage Field Guide*, Purdue University Extension Guide ID-317

### *Online resources:*

*Purdue Forage Identification pages*, **agry.purdue.edu/ext/forages/ForageID/forageid.htm**

*Forage Information System Forage Identification*, **forages.oregonstate.edu/nfgc/eo/onlineforagecurriculum/instructormaterials/availabletopics/plantid/identifyforages**

*University of Wyoming Forage Identification*, **uwyo.edu/plantsciences/uwplant/forages/**

## Pre-Establishment Fertilization and Liming

### *Soil pH*

Proper soil pH and fertility are essential for optimum economic forage production. Take a soil test to determine soil pH and nutrient status at least six months before seeding. This allows time to correct deficiencies in the topsoil zone. The topsoil in fields with acidic subsoils (most common in eastern Ohio) should be maintained at higher pH than fields with neutral or alkaline subsoils.

### *Topsoil pH Levels for Forages:*

pH 6.8 for alfalfa on mineral soils with subsoil pH less than 6.0.

pH 6.5 for other forage legumes and grasses on mineral soils with subsoil pH less than 6.0.

pH 6.5 for alfalfa on mineral soils with subsoil pH greater than 6.0.

pH 6.0 for other forage legumes and grasses on mineral soils with subsoil pH greater than 6.0.

Soil pH should be corrected by application of lime when topsoil pH falls 0.2 to 0.3 pH units below the recommended levels. With conventional tillage plantings, soil samples should be taken to an 8-inch depth and lime should be incorporated and mixed well in the soil at least six months before seeding. If more than 4 tons per acre are required, half the amount should be incorporated deeply and the other half incorporated lightly into the top 2 inches. If low rates of lime are recommended or if a split application is not possible, the lime should be worked into the surface rather than plowed down. This assures a proper pH in the surface soil where seedling roots develop and where nodulation begins in legumes.

### *Phosphorus and Potassium*

Corrective applications of phosphorus and potassium should be applied prior to seeding regardless of the seeding method used; however, fertilizer applications incorporated ahead of seeding are more efficient than similar rates not incorporated. This is especially true for phosphorus and for no-till seedings. Phosphorus and potassium fertilizer recommendations for forages are provided in Tables 7-5 to 7-7.

*Table 7-5: Annual Phosphate ($P_2O_5$) Recommendations for Pure Grass Forage Stands. Includes Maintenance Plus Four-Year Buildup to the Critical Level Where Needed.*

| Soil P Test Level | Yield Potential (ton/ac) | | |
|---|---|---|---|
| | 4 | 6 | 8 |
| ppm (lb/ac) | -----lb $P_2O_5$ per ac----- | | |
| 5 (10)[1] | 100 | 135 | 140 |
| 10 (20) | 75 | 110 | 115 |
| 15-30 (30-60)[2] | 50 | 85 | 90 |
| 35 (70) | 25 | 45 | 45 |
| 40 (80) | 0 | 0 | 0 |

[1] Values in parentheses are pounds per acre.

[2] Maintenance recommendations are given for this soil test range.

*Table 7-6: Annual Phosphate ($P_2O_5$) Recommendations for Forage Legume or Legume-Grass Mixtures. Includes Maintenance Plus Four-Year Buildup to the Critical Level Where Needed.*

| Soil P Test Level | Yield Potential (ton/ac) | | |
|---|---|---|---|
| | 4 | 6 | 8 |
| ppm (lb/ac) | -----lb $P_2O_5$ per ac----- | | |
| 10 (20)[1] | 130 | 160 | 190 |
| 15 (30) | 100 | 135 | 160 |
| 20 (40) | 75 | 110 | 135 |
| 25-40 (50-80)[2] | 50 | 85 | 110 |
| 45 (90) | 25 | 45 | 50 |
| 50 (100) | 0 | 0 | 0 |

[1] Values in parentheses are pounds per acre.

[2] Maintenance recommendations are given for this soil test range.

*Table 7-7: Annual Potassium ($K_2O$) Recommendations for Forage Grass Only, Legume Only and Legume-Grass Mixtures. Includes Maintenance and Four-Year Buildup to the Critical Level Where Needed.*

| Soil Test K Level | | Yield Potential (ton/ac) | | |
|---|---|---|---|---|
| | | 4 | 6 | 8 |
| ppm (lb/ac) | | -----lb $K_2O$ per ac----- | | |
| | CEC | -----10 meq/100 g----- | | |
| 75 (150)[1] | | 260[2] | 300 | 300 |
| 100-130 (200-260)[3] | | 220 | 300 | 300 |
| 140 (280) | | 40 | 60 | 80 |
| 150 (300) | | 0 | 0 | 0 |
| | CEC | -----20 meq/100 g----- | | |
| 100 (200) | | 270 | 300 | 300 |
| 125-155 (250-310)[3] | | 220 | 300 | 300 |
| 165 (330) | | 40 | 60 | 80 |
| 175 (350) | | 0 | 0 | 0 |
| | CEC | -----30 meq/100 g----- | | |
| 125 (250) | | 280 | 300 | 300 |
| 150-180 (300-360)[3] | | 220 | 300 | 300 |
| 190 (380) | | 40 | 60 | 80 |
| 200 (400) | | 0 | 0 | 0 |

[1] Values in parentheses are pounds per acre.

[2] Maximum potassium rate recommended is 300 pounds $K_2O$ per acre.

[3] Maintenance recommendations are given for this soil test range.

### *Sulfur*

Sulfur is an essential secondary plant nutrient and is a component of plant proteins and vitamins. In the past, the supply of sulfur in Ohio soils was more than adequate for good forage growth; however, with the implementation of the Clean Air Act, there has been a 30 to 40 percent reduction in sulfur deposition to Ohio soils since 1985. Sulfur deficiencies on alfalfa have been documented in some Ohio soils. If soils have exhibited sulfur deficiency in the past, consider applying 70 pounds per acre of elemental sulfur ahead of seeding to alfalfa. Elemental sulfur requires at least two months to be converted in the soil to the sulfate form which is available for plant uptake. If more rapid uptake of sulfur is desired in the seeding year, add 30 pounds per acre of a sulfate form of sulfur at seeding along with the elemental sulfur for subsequent years. A sulfur deficiency is unlikely on soils where manure or gypsum have been applied, since both are good sources of sulfur. Refer to the *Tri-State Fertilizer Recommendations* (Bulletin E-2567) for additional information.

## Pre-Establishment Fertilization for No-till

For no-till seedings, take soil samples to a 4-inch depth to determine pH and lime needs, and to a normal 8-inch depth to determine phosphorus and potassium needs. If possible, make corrective applications of lime, phosphorus, and potassium earlier in the crop rotation when tillage can be used to incorporate and thoroughly mix these nutrients throughout the soil. When this is not feasible, be sure to make lime, phosphorus, and potassium applications at least eight months or more ahead of seeding to obtain the desired soil-test levels in the upper rooting zone. Use the finest grade of lime available at a reasonable price when surface applications are made. Lime and phosphorus move slowly through the soil profile. Once soil pH, phosphorus, and potassium are at optimum levels, surface applications of lime and fertilizers maintain those levels. Attempts to establish productive forages often fail where pH, phosphorus or potassium soil-test values are below recommended levels, even when corrective applications of those nutrients are surface applied or partially incorporated just before seeding.

### *Starter Nitrogen*

Seedling vigor of cool-season forage grasses is enhanced on many Ohio soils by nitrogen applied at seeding time. Apply nitrogen at 10 to 20 pounds per acre when seeding grass-legume mixtures, and 30 pounds per acre when seeding pure grass stands. Starter nitrogen applications of 10 pounds per acre may be beneficial with pure legume seedings, especially under cool conditions and on soils low in nitrogen. Manure applications incorporated ahead of seeding can also be beneficial to seedling establishment of forages, including alfalfa. Obtain a manure nutrient analysis and base application rates on soil-test results. For more information on manure application to soils refer to the *Ohio Livestock Manure And Wastewater Management Guide* (Bulletin 604).

## Stand Establishment

Establishing a good stand is critical for profitable forage production and requires attention to details for success.

As discussed above, begin by selecting species adapted to soils where they will be grown. Plan well ahead of time so corrective lime applications have time to neutralize soil acidity, and soil fertility deficiencies can be corrected. Make sure fields are free of any herbicide carryover that can harm forage seedlings. Refer to the current *Weed Control Guide* (Bulletin 789) and current labels for more information on herbicides with crop rotation restrictions.

An established stand having about six grass and/or legume plants per square foot is generally adequate for good yields. About 20 to 25 seedling plants per square foot in the seeding year usually results in good stands the following year. The following guidelines greatly improve the likelihood of successful establishment of productive forage stands.

### *Crop Rotation and Autotoxicity*

Crop rotation is an important management tool for improving forage productivity, especially when seeding forage legumes. Crop rotation reduces disease and insect problems. Seeding alfalfa after alfalfa is especially risky because old stands of alfalfa release a toxin that reduces germination and growth of new alfalfa seedlings (called autotoxicity). This is especially true on heavy-textured soils. Disease pathogens accumulate and can cause stand establishment failures when seeding into a field that was not rotated out of alfalfa. Rotating to another crop for at least one year before re-establishing a new alfalfa stand is the best practice. If that is not possible, chemically kill the old alfalfa in the fall and seed the next spring, or spring kill and seed in late summer.

### *Seed Quality*

High quality seed of adapted species and varieties should be used. Seed lots should be free of weed seed and other crop seed, and contain only minimal amounts of inert matter. Certified seed is the best assurance of securing high-quality seed of the variety of choice. Purchased seed accounts for just 20 percent or less of the total cost of stand establishment. Buying cheap seed and seed of older varieties is a false and short-lived economy. Always compare seed price on the basis of cost per pound of pure live seed, calculated as follows:

percent purity = 100 percent - (percent inert matter + percent other crop seed + percent weed seed)

percent pure live seed (PLS) = percent germination x percent purity

pounds of PLS = pounds of bulk seed x percent PLS

### *Seed Inoculation*

Legume seed must be inoculated with the proper nitrogen-fixing bacteria prior to seeding to assure good nodulation. Inoculation is especially important when seeding legumes in soils where they have not been grown for several years. Because not all legume species are colonized by the same strains of nitrogen-fixing bacteria, be sure to purchase the proper type of inoculum for the forage legume to be planted. Verify the inoculant expiration date and make sure it was stored in a cool, dry place. Because many seed suppliers distribute pre-inoculated seed, check the expiration date and reinoculate if necessary. If in doubt, reinoculate the seed before planting. The seed should be slightly damp and sticky before adding the inoculant. This can be accomplished with a syrup/water mixture or a commercial sticker solution. Soft drinks are also effective as sticking agents. Protect inoculants and inoculated seed from sun and heat as much as possible and plant soon after inoculation.

### *Seed Treatments*

Fungicide-treated seed is highly recommended for alfalfa and may be useful for red clover. Metalaxyl and mefenoxam are systemic fungicides for controlling seedling damping-off diseases caused by *Pythium* and *Phytophthora* during the first four weeks after seeding. These pathogens kill legume seedlings and cause establishment problems in wet soils. Many companies are marketing alfalfa seed treated with either of these fungicides. Various other seed treatments and coatings are sometimes added to forage seed. It is very important to calibrate seeders appropriately, especially when the seed has been coated. For example, lime coatings can account for up to one-third of the weight of the seed, so the actual number of seeds planted can be drastically affected on a weight basis. In addition, some seed coatings affect the flowability of seed, which can dramatically affect the seeding rate output of a planter. The manufacturers' seeding calibrations for the planter are not likely to hold true for coated seed.

### *Spring Seedings*

Plant as soon as the seedbed can be prepared after March 15 in southern Ohio and April 1 in northern Ohio (Table 7-8). Spring seeding should be completed by early May in northern Ohio and by late April in southern Ohio. With early seeding, the plants become well established before the warm and dry summer months. Weed pressure increases with delayed seeding. Annual grassy weeds can be especially troublesome with delayed spring seedings. Herbicides are usually essential when seeding late in the spring. Refer to the most current *Weed Control Guide* published by OSU Extension (Bulletin 789) for guidelines on weed management and for specific herbicide options.

**DIRECT SEEDINGS** without a companion crop in the spring allows growers to harvest two or three crops of high-quality forage in the seeding year, particularly when seeding alfalfa and red clover. Select fields with little erosion potential when direct seeding into a tilled seedbed. Weed control is important during early establishment when direct seeding pure legume stands. Several and post-emerge herbicide options are available for pure legume seedings (refer to the *Weed Control Guide*, Bulletin 789).

**SMALL GRAIN COMPANION CROP SEEDINGS** are successful when managed properly. Companion crops reduce erosion in conventional seedings and help minimize weed competition. Companion crops usually increase total forage tonnage in the seeding year, but forage quality will be lower than direct seeded legumes. When seeding with a small grain companion crop, take precautions to reduce excessive competition, which may lead to establishment failures:

- Spring oats and triticale are the least competitive, while winter cereals are often too competitive.
- Use early-maturing, short and stiff-strawed small grain varieties.
- Sow companion small grains at 1.5 to 2.0 bushels per acre.
- Remove small grain companions as early pasture or silage.
- Do not apply additional nitrogen for the companion crop.

Where the need for erosion control suggests use of a companion crop, but high-quality legume forage is desired the first year, seed oat as a companion and kill it at 4 to 8 inches with a post-emerge grass herbicide. The oats will suppress early weed growth, provide erosion protection, and protect seedlings from wind damage. After oats are killed, the legume forage will perform about the same as in a direct seeding.

*Table 7-8: Suggested Seeding Dates for Forages Grown in Ohio.*

| Forage species | Northern Ohio | Southern Ohio |
|---|---|---|
| **Legumes** | | |
| Alfalfa | 4/1 - 5/1 or 8/1 - 8/15 | 3/20 - 4/25 or 8/1 - 8/30 |
| Alsike clover[1] | 2/1 - 5/1 or 7/20 - 8/10 | 2/1 - 4/25 or 8/1 - 8/20 |
| Annual lespedeza | NR[2] | 2/15 - 4/15 |
| Birdsfoot trefoil | 4/1 - 5/1 | 3/20 - 4/25 |
| Red clover[1] | 2/1 - 5/1 or 7/20 - 8/10 | 2/1 - 4/25 or 8/1 - 8/20 |
| White clover[1] | 2/1 - 5/1 or 7/20 - 8/10 | 2/1 - 4/15 or 8/1 - 8/20 |
| **Perennial Grasses and Forbs** | | |
| Festulolium | 3/20 - 5/1 or 8/1 - 8/20 | 3/5 - 4/20 or 8/1 - 8/30 |
| Kentucky bluegrass | 3/20 - 5/1 or 8/1 - 8/30 | 3/5 - 4/15 or 8/10 - 9/15 |
| Meadow fescue | 3/20 - 5/1 or 8/1 - 8/20 | 3/5 - 4/20 or 8/1 - 8/30 |
| Orchardgrass | 3/20 - 5/1 or 8/1 - 8/20 | 3/5 - 4/20 or 8/1 - 8/30 |
| Perennial ryegrass | 3/20 - 5/1 or 8/1 - 8/20 | NR[2] |
| Reed canarygrass | 3/20 - 5/1 or 8/1 - 8/15 | 3/5 - 4/20 or 8/1 - 8/25 |
| Smooth bromegrass | 3/20 - 5/1 or 8/1 - 8/20 | 3/5 - 4/20 or 8/1 - 8/30 |
| Tall fescue | 3/20 - 5/1 or 8/1 - 8/20 | 3/5 - 4/20 or 8/1 - 8/30 |
| Timothy | 3/20 - 5/1 or 8/1 - 10/5 | 3/1 - 4/20 or 8/1 - 10/15 |
| Big bluestem | 4/20 - 5/15 | 4/15 - 5/15 |
| Eastern gamagrass | 4/20 - 5/15 | 4/15 - 5/15 |
| Indiangrass | 4/20 - 5/15 | 4/15 - 5/15 |
| Switchgrass | 4/20 - 5/15 | 4/15 - 5/15 |
| Chicory | 4/1 - 5/1 or 8/1 - 8/20 | 3/15 - 4/20 or 8/1 - 8/30 |
| **Annual Crops** | | |
| Annual/Italian ryegrass | 4/1 - 5/1 or 7/20 to 8/30 | 3/15 - 4/20 or 8/1 to 9/15 |
| Pearl Millet | 5/15 - 7/10 | 5/1 - 7/20 |
| Sudangrass | 5/15 - 7/10 | 5/1 - 7/20 |
| Sorghum-sudangrass | 5/15 - 7/10 | 5/1 - 7/20 |
| Sorghum, forage | 5/15 - 7/10 | 5/1 - 7/20 |
| Teff | 5/25 - 6/25 | 5/15 - 7/1 |

[1] February to early March is the recommended frost seeding period for clovers; some cool-season grasses may also be frost seeded, but this is less common.

[2] NR = Not recommended.

### *Late Summer Seedings*

Late summer is an excellent time to establish many forage species, provided sufficient soil moisture is available. August is the preferred time for late summer seeding because it allows enough time for plant establishment before winter. Do not use companion crops with August seedings because they compete for soil moisture and can slow forage seedling growth to the point where the stand will not become established well enough to survive the winter. Refer to the *Weed Control Guide* (Bulletin 789) for weed control guidelines for late summer forage seedings.

*Sclerotinia* crown and stem rot is a serious disease threat when seeding alfalfa and clovers in late summer. The risk of infection is greatest in fields where forage legumes have been grown recently and minimum tillage is used. *Sclerotinia* infects seedlings in the fall, but injury is not visible until plants begin to die in late winter and early spring. Crop rotation, conventional tillage plantings, and seeding by early August reduce the risk of severe damage from this disease. A limited number of alfalfa varieties have some resistance to this disease.

### *Conventional Tillage Seeding*

**THE IDEAL SEEDBED** for conventional seedings is smooth, firm, and weed-free. Don't overwork the soil. Too much tillage depletes moisture and increases the risk of surface crusting. Firm the seedbed before seeding to ensure good seed-soil contact and reduce the rate of drying in the seed zone. Cultipackers and cultimulchers are excellent implements for firming the soil. The lack of a firm seedbed is a major cause of establishment failures. The soil should be firm enough at planting so that a footprint is no deeper than ½ to ¾ inch.

**SEEDING DEPTH** for most cool-season forages is ¼ to ½ inch on clay and loam soils. On sandy soils, seed can be placed ½- to ¾-inch deep. Seeding too deep is one of the most common reasons for seeding failures.

**SEEDING EQUIPMENT** Forage stands can be established with many different types of drills and seeders, provided they are adjusted to plant seed at an accurate depth and in firm contact with the soil. When seeding into a tilled seedbed, drills with press wheels are an excellent choice. If the seeder is not equipped with press wheels, cultipack before and after seeding in the same direction as the seeder was driven. This assures that seed is covered and in firm contact with the soil. Cultipacker seeders, such as the Brillion seeder, provide accurate and consistent seed placement in tilled seedbeds.

**FLUID SEEDING** is a new technique being used to seed forage legumes. Seed is distributed in a carrier of water or in a fertilizer solution. Custom application is recommended because it requires special equipment for good seed suspension and distribution. Prepare a firm seedbed and cultipack after the seed is sprayed on. For fluid seeding, seed should be mixed into solution at the field and applied immediately. Some producers are also having success with seeding legumes through dry fertilizer air spreaders, with cultipacking before and after the seed is broadcast.

### *No-Till and Minimum-Till Seeding*

Many producers are successfully adopting minimum and no-till practices for establishing forage crops. Advantages include soil conservation, reduced moisture losses, lower fuel and labor requirements, and seeding on a firm seedbed. Most forage species can be seeded no-till with proper management. Species such as red clover that have good seedling vigor are the easiest to establish. No-till forage seedings are most successful on silt loam soils with good drainage. Consistent results are more difficult on clay soils or poorly drained soils. Weed control and sod suppression is essential for successful no-till establishment, because most forage crops are not competitive in the seedling stage.

**SEED PLACEMENT** is critical with reduced tillage. It is very easy to plant seeds too deep with no-till drills. A relatively level seedbed improves seed placement. A light disking may be necessary before attempting to seed. Plant seed shallow (¼ to ½ inch, in most cases) in firm contact with the soil. Crop residue must be managed to obtain good seed-soil contact. Chisel plowing or disking usually chops residue finely enough for conventional drills to be effective. When residue levels are greater than 35 percent, no-till drills are recommended.

**FOR NO-TILL PLANTING FOLLOWING CORN**, plant as soon as the soil surface is dry enough for good soil flow around the drill openers and good closure of the furrow. Perennial weeds should be controlled in the previous corn crop. If perennial weeds are still present, apply glyphosate before seeding. If any grassy weeds or winter annual broadleaf weeds are present in the field, use paraquat or glyphosate before seeding. Most drills can handle corn grain residue, but removal of some of the residue (e.g., for bedding) often increases the uniformity of stand establishment. Most drills do not perform as well when corn stalks are chopped and left on the soil surface. Be sure to avoid problems with carryover of triazine residue from the previous corn crop.

**FOLLOWING SMALL GRAINS**, no-till seeding of forages in late summer conserves valuable moisture. Weeds should effectively be controlled in the small grain crop. Ideally, wait to plant the forage crop until at least ½ inch of rain has fallen postharvest to stimulate germination of volunteer small-grain seeds and weeds; however, do not delay planting beyond the recommended seeding date for your area. Burn down any weeds and volunteer small grain seedlings before seeding the forage crop. Glyphosate can be used if thistles, Johnsongrass or other perennial or biennial weeds are present in the small grain stubble. Remove straw after small grain harvest. It is not necessary to clip and remove stubble; however, it may be removed if additional straw is desired. Do not clip stubble and leave it

in the field, as it may interfere with good seed-soil contact when seeding forages. If volunteer small grains become a problem after seeding, apply a selective grass herbicide to pure legume seedings to remove excessive competition.

**INSECT CONTROL** can be a serious problem in no-till seedings, especially those seeded into old sods. Slugs can be especially troublesome where excessive residue is present from heavy rates of manure applied in previous years. Chemical control measures for slugs are limited to baits containing methaldehyde (Deadline products) and iron phosphate (e.g., Sluggo). Lorsban insecticide products are registered for use during alfalfa establishment for suppression of various soil insects.

## Seeding-Year Harvest Management

Harvest management of cool-season forages during the seeding year depends on time and method of seeding, species, fertility, weather conditions and other factors. Forages seeded in August or early September should not be harvested or clipped until the following year. For spring seedings, it is best to harvest the first growth mechanically. This is especially true for tall-growing legumes. If stands are grazed, stock fields with enough livestock to consume the available forage in less than seven days. Grazing for a longer period increases the risk of stand loss. Soils should be firm to avoid trampling damage. The following are general harvest management guidelines for spring seedings, according to species.

**ALFALFA** Generally two harvests are possible in the seeding year when alfalfa is seeded without a companion crop; three harvests are possible with early planting and good growing conditions. The first cutting can be made 60 to 70 days after emergence. Subsequent cuttings should be made in early bloom stage (approximately 30- to 35-day intervals), with the last harvest taken by the first week of September. Fall cutting is not advisable; even a late dormant cutting is not recommended because it increases the risk of winter heaving. When seeding with a small grain companion crop, the first harvest should be taken during the late boot or early-heading stage of the companion crop.

**BIRDSFOOT TREFOIL** Seedling growth of trefoil is much slower than alfalfa or red clover. Seeding year harvests should be delayed until the trefoil is in full bloom. Do not harvest after September 1. When seeded with a companion crop, an additional harvest after removal of the small grain is generally not advisable.

**RED CLOVER** When seeded without a companion crop, red clover can usually be harvested twice in the year of establishment. Under good conditions, up to three harvests are possible. Harvest red clover before full bloom in the seeding year. If allowed to reach full bloom in the year of seeding, red clover often has reduced stands and yields the following year. Complete the last harvest by the first week of September.

**COOL-SEASON GRASSES.** Harvest management depends greatly on stand vigor and weather conditions. Most grasses establish slowly compared with alfalfa. Clipping may be necessary to prevent annual weeds from going to seed.

## Fertilizing Established Stands

A current soil test is the best guide for a sound fertilization program. Make sure to request the current *Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa* (Ohio-Michigan-Indiana) from your soil testing lab. Forages are very responsive to good fertility. Adequate levels of phosphorus and potassium are important for high productivity and persistence of legumes, especially alfalfa. Forage fertilization should be based on soil-test levels and realistic yield goals. Under hayland management, forages should be topdressed annually to maintain soil nutrient levels. Each ton of tall grass or legume forage removes approximately 13 pounds of $P_2O_5$ and 50 pounds of $K_2O$. These nutrients need to be replaced, preferably in the ratio of one part phosphate to four parts potassium. Phosphorus and potassium recommendations for forages are given in Tables 7-5 to 7-7. Exceeding the recommended levels for potassium fertilization is especially of concern. Luxury consumption of potassium by the plant will result in high forage potassium concentrations, which can lead to serious animal health problems.

### *Timing Topdress Phosphorus and Potassium Applications*

The timing of phosphorus and potassium applications is not critical when soil-test levels are optimum. Avoid applications with heavy equipment when the soil is not firm. Soil conditions are frequently most conducive to fertilizer applications immediately following the first cutting or in late summer to early fall. Split applications may result in more efficient use of fertilizer nutrients when high rates of fertilizer are recommended. For example, apply one-half of the recommended fertilizer after the first cutting and one-half in late summer to early fall. If soil-test levels are marginal to low, fall fertilization is especially important to provide nutrients such as potassium that improve winter survival.

### *Nitrogen Fertilization*

Nitrogen fertilization is extremely important for good production where grasses are the sole or predominant forage. Economic returns are usually obtained with 150 to 175 pounds of nitrogen per acre per year, split three times during the year–70 to 80 pounds per acre in early spring when grasses first green up and 50 pounds per acre after each cutting. Legumes fix atmospheric nitrogen. Where the forage stand is more than 35 percent legumes, nitrogen should not be applied (Table 7-9). In pastures, nitrogen application can be used to strategically increase forage production when it will be most needed. This is discussed in more detail in “Chapter 9, Grazing and Pasture Management.”

When applying nitrogen in the summer, keep in mind that many forms are subject to surface volatilization resulting in loss of available nitrogen. Ammonium nitrate is the best source choice because surface volatilization losses are minimized; however, this formulation is virtually unavailable now. For more information on nitrogen forms and volatilization losses, refer to the *Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa* (Bulletin E-2567).

*Table 7-9: Examples of Nitrogen Rates Recommended for Perennial Cool-Season Grass Forages.*

| | Yield Potential, ton/ac | | |
|---|---|---|---|
| Crop, Percent Legume | 4 | 6 | 8 |
| | Annual Application (lb N/ac[1]) | | |
| Tall grass, less than 20% legume | 100 | 140 | 180 |
| Mixed tall grass-legume, 20 to 35% legume | 50 | 90 | 130 |
| Mixed tall grass-legume, greater than 35% legume | 0 | 0 | 0 |

[1] Make split applications of nitrogen in the early spring and after first harvest. Liquid nitrogen should be applied in early spring or immediately following foliage removal.

### *Sulfur Fertilization*

Although sulfur deficiency in forages grown in Ohio is still quite rare, we have begun to see cases of deficiency in alfalfa on some Ohio soils. Sulfur may be needed when alfalfa and clover are grown on low organic-matter soils and course soils when yield levels are high. Sulfur deficient plants exhibit a general pale green or yellowing color, with weaker growth along with lower crude protein content. The symptoms resemble a mild nitrogen deficiency and are more apparent in new growth than in old growth. We are beginning to see sulfur deficiencies in alfalfa on some soils in Ohio. For a positive diagnosis, a tissue test should be taken, as the soil test for sulfur is not reliable since sulfate is water soluble and leaches through the soil profile in a similar manner to nitrogen. The upper third of the alfalfa plants should be collected and sent to a commercial soil and tissue testing lab to analyze the sulfur content in the plant. If the sulfur content is below 0.25 percent in the upper third of the plant, then it is likely sulfur deficient and should respond to additional sulfur. Use a sulfate form of sulfur if the application is made in the spring (for rapid uptake by the plant), and an elemental form of sulfur for fall applications (elemental sulfur requires at least two months to become available to the plant in the soil solution).

### *Micronutrients*

Micronutrient deficiencies are rare in most Ohio mineral soils. Micronutrient fertilization should be based on demonstrated need through soil testing and/or tissue testing. Boron may be needed when alfalfa and clover are grown on sandy soils and highly weathered soils low in organic matter. If the soil test is one part per million (ppm) or less of boron (B), or a plant tissue test shows 30 ppm or less boron, then apply a fertilizer containing two pounds of boron per acre. Refer to OSU Extension Bulletin E-2567 for more details on micronutrient fertilization.

### *Grass Tetany*

Grass tetany occurs in animals when their demands for magnesium exceed the supply. It most often occurs in the spring when high-producing animals are consuming primarily grass forage. High soil potassium tends to reduce uptake of magnesium by plants. The risk of grass tetany is reduced by not applying potash in early spring to grasses, because grasses take up more potassium than needed for growth (luxury consumption). After the first harvest, apply needed fertilizer to maintain a balanced soil-fertility program. It may also be helpful to feed livestock a high-magnesium supplement during spring.

## Established Stand Harvest Management

Harvest management is an important tool in achieving high-quality forage, high yields and stand persistence. Harvest management can also be used to reduce the impact of weeds, insects and disease pests. Harvest timing is a compromise between forage yield, quality and persistence. While forage quality decreases with maturity, dry matter yield usually increases up to full-flower stage in legumes and full-heading stage in grasses. Cutting more frequently at earlier stages of maturity results in forage with higher nutritive value but lower yield compared with cutting less frequently at more mature stages of growth.

A good compromise between forage yield, quality and stand persistence is to harvest legumes in late-bud to early-bloom stage, and grasses in late-boot to early-heading stage. Harvesting at that stage will result in the highest yields of digestible dry matter per acre. Cutting management of grass-legume mixtures should be based on the best harvest schedule for the legume.

### *First Harvest Timing*

Make a timely first harvest to achieve the best quality possible in what is usually the largest crop of the year. Forage quality declines more rapidly with advancing maturity in the spring than it does later in the summer. Timing of the first harvest should be based on the calendar rather than on stage of maturity. Bud development and flowering are not reliable guides for proper timing of first cutting in Ohio. In some seasons, little or no bloom is present; in others, bloom is abundant. Table 7-10 gives recommended harvest dates for the first cutting of legume-grass hay meadows. Harvesting during these periods maximizes yields of digestible dry matter per acre. By using various grasses and legumes that differ in maturity development (Table 7-2), producers can spread the optimum first cutting date over one week to 10 days.

*Table 7-10: Recommended Harvest Dates–First Cutting, Legume-Grass Mixtures.*

| Forage Mixture | Cutting Schedule A[1] | | | Cutting Schedule B[2] | | |
|---|---|---|---|---|---|---|
| | Southern Ohio | Central Ohio | Northern Ohio | Southern Ohio | Central Ohio | Northern Ohio |
| Alfalfa-Orchardgrass | 5/10 - 5/20 | 5/15 - 5/23 | 5/23 - 5/28 | 5/15 - 5/20 | 5/20 - 5/25 | 6/1 - 6/5 |
| Alfalfa-Tall fescue or Alfalfa-Meadow fescue | 5/15 - 5/23 | 5/20 - 5/26 | 5/26 - 6/2 | 5/20 - 5/25 | 5/25 - 6/1 | 6/5 - 6/10 |
| Alfalfa-Timothy | 5/20 - 5/25 | 5/23 - 5/28 | 5/28 - 6/5 | 5/28 - 6/5 | 6/1 - 6/10 | 6/5 - 6/15 |
| Red clover-Timothy | 5/24 - 6/5 | 6/1 - 6/10 | 6/1 - 6/15 | 5/25 - 6/5 | 6/1 - 6/10 | 6/5 - 6/15 |
| Birdsfoot trefoil-Timothy | 5/20 - 6/1 | 5/25 - 6/15 | 6/1 - 6/20 | 6/1 - 6/10 | 6/5 - 6/15 | 6/10 - 6/20 |

[1] Cutting Schedule A—Forage cut during these periods is of high quality. Dry matter yields are lower than would be received from later harvests; however, yields of digestible dry matter per acre equal or exceed those from later harvests. Current alfalfa varieties are adapted to earlier harvest.

[2] Cutting Schedule B—Harvesting at these dates produces medium quality forage. Digestibility is lower than from earlier harvests. These dates may be followed in these situations: For long-lay sods where it is important to keep legume stands for several years; where soil pH and fertility levels are less than optimum; where a late fall cutting may have been taken; winter injured fields; north facing slopes.

Most grasses should be harvested in the boot stage for best forage quality; however, timothy and smooth bromegrass should not be cut until the grass is in the early heading stage. Earlier harvesting of those species may reduce regrowth and result in stand loss, because the basal buds for regrowth are not fully developed until early heading.

### *Summer Harvest Timing*

Stage of growth is usually a reliable guide for timing summer harvests of legumes. Generally, summer cuttings are permitted to reach early bloom for alfalfa (approximately 35 days between cuttings) and half bloom for birdsfoot trefoil and red clover. High yields of good quality forage can be harvested if four cuttings are made on a 35-day schedule. Four cuttings of alfalfa can be made on soils with good fertility without any detrimental effects on the stand. Harvest schedules for legume-grass mixtures should follow closely to what favors the legume component. Smooth bromegrass and timothy are more compatible with less intensively managed stands (three-cut schedule), while orchardgrass, perennial ryegrass, tall fescue and reed canarygrass are adaptable to more frequent harvesting.

### *Intensive Cutting for High Quality*

More intensive frequent cutting schedules are desirable where high forage quality is important. Shorter harvest intervals will usually shorten stand life, especially of legumes. Allowing legume stands to reach early flower stage once during the season improves stand persistence. This can usually be achieved in late summer without great reductions in forage quality (forage fiber levels increase at a slower rate in late summer than earlier in the year). Cutting intervals that are consistently shorter than 30 days stress legume stands because the plants do not fully replenish depleted energy reserves in the taproots and crowns. Fiber levels may be undesirably low when legumes are cut extremely early (pre-bud to very early bud stage). Some grass species can be harvested very intensively to achieve dairy-quality forage. Pure stands of orchardgrass and perennial ryegrass (where adapted) can be maintained on harvest intervals of 24 days under good fertility management.

### *Fall Harvesting*

Producers often want to harvest the fall growth from forage stands, but fall harvesting usually increases the risk of legume heaving and winter kill, and interferes with accumulation of root reserves required for winter survival and growth the following spring. The need for the forage or its value should be weighed against the increased risk of stand damage.

### *Minimizing Fall Harvesting Hazard to Tall Legumes*

- Complete the last regular harvest by the following dates: September 7 in northern Ohio, September 12 in central Ohio and September 15 in southern Ohio.
- Do not harvest during late September and October. Forages are actively storing reserve carbohydrates in the crowns and roots during this period.
- If a late fall harvest is made, it should be delayed until after a killing frost (25 degrees Fahrenheit for several hours) or at least near to the time of killing frost. A word of caution: removing topgrowth at this time can dramatically increase the risk of legume frost heaving on heavy soils. Mulching with up to 4 tons per acre of straw-manure or 2 tons per acre of old hay or straw should reduce frost-heaving potential after a late harvest. Late fall harvesting should only be attempted on healthy, established stands grown on well-drained soils with optimum pH and high fertility (high soil potassium levels are especially important).

- Avoid fall harvesting of new seedings.
- If a mid-fall harvest is made, select fields that are well drained, have optimum pH and fertility, are planted to improved varieties having multiple pest resistance, and where at least 45 days of regrowth was allowed prior to the fall harvest.

## Weed Management in Forages

Specific chemical weed control recommendations can be found in the *Weed Control Guide*, Extension Bulletin 789, available at all County Extension offices and online at: **estore.osu-extension.org/**. The best weed control practice is to establish and maintain a healthy and vigorous forage stand by following the forage management guidelines outlined in this chapter.

## Insect Pest Management

Management of forage insect pests is important to achieve high yields of high-quality forage. The primary insect problems in Ohio are the alfalfa weevil and the potato leafhopper in alfalfa. The alfalfa weevil is primarily active in the spring. The potato leafhopper is active during the summer months and can cause severe yield and quality losses in alfalfa. New alfalfa seedings are especially vulnerable to potato leafhopper damage.

When pest populations reach or exceed action thresholds, it is economically justifiable to either harvest the crop, provided it is near the harvestable stage; or treat the stand with an insecticide to control the pest in question. Producers should scout fields and determine if the action threshold has been exceeded.

A general threshold for potato leafhoppers in alfalfa is as follows: if alfalfa is more than seven days from a harvest for plants under normal stress, treat when the average number of leafhoppers in a single sample (10 sweeps) equals or is greater than the height of the alfalfa. For example, if the alfalfa is 8 inches tall and the average number of leafhoppers per sample is eight or higher, treatment is warranted. If the average is seven or lower, the grower should come back within a few days to see if the population is higher or lower. Vigorous alfalfa can tolerate higher numbers, and stressed alfalfa can tolerate fewer. The threshold should be lowered when the alfalfa is under stress, especially for new seedings. Potato leafhopper-resistant alfalfa varieties offer an excellent tool for managing this insect pest in Ohio. The action threshold for leafhopper resistant varieties is about three times the normal threshold for susceptible alfalfa.

The alfalfa weevil is a small, brown, snout-nosed beetle approximately 3/16 inch in length with a wide dark stripe down its back. The larva is green with a black head and a white stripe down its back. Both the adult and larvae feed on alfalfa foliage. Foliar feeding injury by the adult is not significant. Foliar injury by young larvae is primarily confined to the growing tips. Older larvae may extensively defoliate alfalfa when abundant. In general, foliar injury by alfalfa weevil occurs on the first cutting of alfalfa. During periods of heavy weevil activity, early growth of the second cutting may be impacted.

Over the past few decades, populations of alfalfa weevil have seldom reached economic levels of abundance due to biological control by a complex of three parasitic wasps and a fungal pathogen. Occasionally, however, a rescue treatment of insecticide is warranted. Application of an insecticide to prevent excessive defoliation is justified when one or more late instar larvae are found feeding per stem and the stand cannot be harvested early. Because alfalfa weevil is usually controlled by beneficial wasps, which are susceptible to chemical treatments, it is important that treatments not be applied unless necessary. The yield impact of weevil feeding declines as alfalfa stand height increases, and decisions to treat alfalfa for weevil should be focused on an alfalfa stand when larvae can be readily found on alfalfa that is 12 inches or less in height. Once alfalfa is 16 inches or more in height, early cutting is a preferred option for reduction of weevil impact.

More information about potato leafhopper and weevil management in alfalfa can be found at:

*Potato Leafhopper*: **ohioline.osu.edu/factsheet/ENT-33**

*Alfalfa Weevil*: **ohioline.osu.edu/factsheet/ENT-32**

## Disease Management in Forages

Diseases can negatively affect stand establishment, limit yields and hasten stand decline in established forage crops. Effects of disease on individual plants vary widely. Some diseases are lethal while others cause only stunting or leaf loss, reducing yields and forage nutritive value. Sound crop production practices will lower the chances for serious losses to forage productivity due to disease because they help maintain a vigorous stand. Any practice that improves plant vigor is likely to reduce the chance of plants becoming diseased. More importantly, good growing conditions will allow surrounding uninfected plants to achieve their maximum potential and compensate for the loss in stand or productivity due to diseased plants.

Important considerations for managing diseases include matching forage species to soils where they are adapted, practicing crop rotation (especially important for forage legumes), maintaining adequate soil pH and fertility, using proper harvest schedules that don't unduly stress plants, and selecting disease resistant varieties.

It is very important to avoid compaction damage in forages as much as possible. Traffic damage allows disease organisms to invade the plants, resulting in stand and yield losses. Forage varieties with some tolerance to traffic have been developed in recent years, but every effort should be made to control and reduce compaction damage as much as possible. Especially important is avoiding traffic on wet soils. In addition, minimize traffic on the field, designate traffic lanes to reduce the field area subjected to compaction, and use lighter equipment whenever feasible.

Disease organisms are often spread from infested to healthy fields by transport of harvesting equipment, hay or manure on the farm. Care should be taken to harvest fields that are obviously diseased after harvesting healthy fields, and to clean equipment thoroughly prior to entering healthy fields.

Few fungicide options are available for most forage species, but more options are becoming available especially for alfalfa. Fungicides can reduce disease infestations, and increase yield and forage quality under conditions that are conducive to disease development–such as humid or wet conditions in spring and early summer. Check with Extension plant pathologists and forage specialists for available fungicide options that might be of benefit.

## Preserving Forage as Hay and Silage

Good management practices are required for successfully storing forage as either dry hay or as silage or balage (individually wrapped bales, in plastic tubes or chopped into silo bags). In general, putting up silage or haylage will result in less forage yield loss and higher nutritive value than when stored as dry hay. Curing forage for hay requires more drying time, resulting in greater chances for rain damage, and more losses occur when the forage is handled in a drier condition. Since silage and haylage is preserved at a higher moisture content, it is faster to get to a proper dry matter content for safe preservation than it is to make dry hay. Proper dry matter content for chopping haylage can often be achieved within 24 hours as compared with three to five days for dry hay, depending on the conditions. The following practices will improve the success of preserving forage in a good condition:

**MAXIMIZE EXPOSURE TO SUNLIGHT** because it is the single most important weather factor that speeds drying. Make the windrows as wide as possible for maximum forage surface area exposure to the sunlight. The swath width should be at least 70 percent of the actual cut width. Another way to spread out and aerate the crop for faster drying is with a tedder. Tedders are especially effective with grass crops, but they can cause excessive leaf loss in legumes if done when the leaves are dry. Grasses in particular should be spread in wide swaths, otherwise the forage will settle together and be hard to loosen up to increase the drying rate. Tedders can be a good option when the ground is damp, because the crop can first be mowed into narrow windrows to allow more ground exposure to sunlight, and then–once the soil has dried a bit–the crop can be spread out. Spreading the forage out to dry results in lower neutral detergent fiber (NDF) and higher energy content in the stored forage compared with drying in narrow swaths.

**MECHANICALLY CONDITION THE FORAGE** to increase the drying rate of cut forage. Make sure the mower-conditioner is adjusted to cause 90 percent of the stems to be crimped/cracked (roller conditioners) or abraded (impeller conditioners).

**CHEMICAL DESICCANTS** are an option to increase drying rate, but only under good drying conditions. They are not effective when conditions are humid, damp and cloudy. They are applied at the time of mowing the crop, so consider the forecasted weather conditions and only apply them if good drying conditions are expected. The most effective desiccants contain potassium carbonate or sodium carbonate. They are more effective on legumes than grasses and most useful for making hay rather than silage or balage. Desiccants work best when applied to the crop stems with uniform coverage under good drying conditions.

**RAKE THE FORAGE** after a period of initial drying. For haylage under good drying conditions, you can usually rake multiple swaths into a windrow about five to seven hours after cutting and right before chopping. For dry hay under good drying conditions, rake multiple swaths into a windrow the next morning after mowing when the forage is 40 to 60 percent moisture to avoid excessive leaf loss later when the crop will likely be too dry. Raking should create a swath narrow enough to meet the width of the harvester or baler pickup. Raking also helps create a windrow density to match the harvester or baler capacity. Raking is useful to turn the crop over so the bottom forage can be exposed for faster final drying and to move the swath from wet to dry ground.

**STORE AT PROPER DRY MATTER CONTENT.** Proper dry matter content for silage ranges from 30 to 50 percent (50 to 70 percent moisture) depending on the structure used, while wrapped balage should be dried to 45 to 55 percent dry matter (45 to 55 percent moisture). Dry hay should be baled at 80 to 87 percent dry matter (13 to 20 percent moisture), depending on the size of the bale package. The larger and more dense the package, the dryer it has to be to avoid spoilage; small rectangular bales can be baled safely at 20 percent moisture or less, large round bales at 15 to 18 percent moisture, and large rectangular bales at 13 to 15 percent moisture content. If the forage is wetter than these ranges for hay, use hay preservatives (see below).

**PACK AND SEAL UP SILAGE AND HAYLAGE** quickly to minimize exposure to oxygen and hasten the fermentation process. For silage, ensure sufficient packing to eliminate oxygen from the pile. For wet wrapped bales, ensure tight bales and wrap them with a minimum of four layers of 1.5 mil thickness of plastic (two turns at 50 percent overlap) as quickly as possible after baling. More layers are needed when moisture is below the recommended range, in more mature crops, and when baling crops with sharp stems that can puncture the plastic.

**HAY PRESERVATIVES** can be applied at baling when the hay is a little wetter than ideal for safe preservation of dry hay. The most common and effective preservatives are based on proprionic acid. This acid can be caustic to equipment, but many buffered proprionic preservative products are available on the market that reduce this cor-

rosion problem. The preservatives inhibit mold growth and allow safe baling at moisture contents a little higher than the normal range for dry hay. Preservatives have been most effective on rectangular bales and have questionable effectiveness in large-round bales. Carefully follow the manufacturer's directions and application rates when using preservatives. Keep in mind that the preservative effect is temporary, so the hay must be dried down to a safe moisture content for long-term storage or used within several months to avoid spoilage.

**SILAGE INOCULANTS** are often very useful for legume haylage when the wilting phase is short and conditions are cool. For example, lactic acid bacteria inoculants improve fermentation and often provide a good return on investment when putting up alfalfa haylage. In contrast, the return on investment for silage inoculants on corn silage is less likely if good management practices are followed.

Some excellent guidelines for putting quality hay and silage, including management guidelines and information on equipment adjustments, can be found at the University of Wisconsin Extension website: **uwex.edu/ces/crops/uwforage/storage.htm**.

## Perennial Warm-Season Grasses

The native, perennial, warm-season grasses have the potential to produce good hay and pasture growth during the warm and dry mid-summer months. These grasses initiate growth in late April or early May, and produce 65 to 75 percent of their growth from mid-June to mid-August in Ohio. Warm-season grasses complement cool-season grasses by providing forage when the cool-season grasses are less productive. Warm-season grasses produce well on soils with low moisture holding capacity, low pH and low phosphorous levels. However, they do best on deep, fertile, well-drained soils with good water-holding capacity. They generally require much lower levels of nitrogen fertilization than cool-season grasses.

The following species are winter hardy and grow in all areas of Ohio. They can be seeded alone or as a mixture, but seeding a single warm-season grass species is easier to manage. Legumes or cool-season grasses generally are not suited for planting with warm-season grasses because they compete too much during stand establishment. Even in established mixed stands, cool-season species may compete too much because they begin spring growth much earlier and suppress growth of the warm-season species.

**SWITCHGRASS** (*Panicum virgatum* L.) is a tall, rhizomatous perennial that grows 3 to 5 feet tall. It appears bunch like, but the short rhizomes may produce a coarse sod under grazing. Later in the season, leafy regrowth develops from basal tillers and shoots emerging along the lower stems at leaf nodes. Switchgrass tolerates poorly drained soils, occasional flooding and perched water tables better than other warm-season grasses. Leaves and stems of switchgrass have good forage value and are readily grazed by livestock in the immature stage; however, it is considered to be of lower forage quality than big bluestem or indiangrass. Palatability and nutrient content of switchgrass stems decline rapidly after heading. Switchgrass is often the first choice among farmers trying a warm-season grass for the first time. The seed is clean, free flowing and can be seeded with standard forage seeding equipment.

**BIG BLUESTEM** (*Andropogon geradii* Vitman) is an erect, robust, perennial bunchgrass that grows 3 to 6 feet tall and is often reddish-purple at maturity. It produces foliage in late spring from buds at basal nodes and from short, scaly rhizomes. Growing points stay close to the ground until late summer when heads appear. It is considered more palatable than switchgrass or indiangrass, especially after maturity. Big bluestem is more drought tolerant than other warm-season grasses and better adapted to excessively drained soils with low water-holding capacity. The seed is light, chaffy and difficult to seed without a special grassland drill.

**INDIANGRASS** (*Sorghastrum nutans* L. Nash) is an erect, robust perennial growing 3 to 6 feet tall. It has short, knobby rhizomes and spreads slowly. Indiangrass starts growth somewhat later than switchgrass or big bluestem and provides good quality forage during much of the summer. It is moderately palatable after heading. Indiangrass can be planted on moderately well-drained soils and can withstand occasional flooding. The seed is light, chaffy and difficult to seed without a special grassland drill.

**EASTERN GAMAGRASS** (*Tripsacum dactyloides* (L.) L.) is a robust, upright, leafy bunchgrass that grows 6 to 12 feet tall. It is adapted to deep soils with good water-holding capacity. In natural habitats, it grows in fertile bottomland, swamps and along streambanks. Eastern gamagrass is one of the earliest warm-season grasses to begin growth in the spring. It has high-yield potential and maintains its quality better when mature that the other species. One drawback to eastern gamagrass is its need for a long, late summer rest period beginning by mid-August.

### *Establishment*

Soil pH should be at least 6.0, and phosphorus and potassium should be applied based on soil-test recommendations. Do not apply nitrogen fertilizer at seeding, which will only stimulate excessive weed competition. About 30 pounds per acre of nitrogen can be applied on low fertility sites in July after the grasses have started growing provided the stand is very good and weed competition is not high.

The perennial warm-season grasses are slow to establish and are weak competitors with weeds until established. Attempts to establish warm-season grasses under heavy weed infestations may fail completely or will at best require two to three years before acceptable growth is achieved. Fields previously in row crops where weeds were controlled are ideal sites. Two years is generally

required for successful establishment of warm-season grasses. Plateau herbicide (ammonium salt of imazapic) can be used to control weeds during establishment of big bluestem and indiangrass, as well as established stands of those species. Consult the herbicide label for further details.

Spring seedings should be made from mid-April to mid-May, the earlier dates being especially better for southern Ohio. Use the seeding rates listed in Table 7-4. Switchgrass and eastern gamagrass can be planted with standard drills equipped to handle cool-season grasses, but big bluestem and indiangrass require special grassland drills unless the seed is debearded. These grasses can be seeded in conventionally tilled seedbeds or no-tilled where existing competition is eliminated. Seed should be planted ¼- to ½-inch deep, except eastern gamagrass which has a larger seed and should be planted ½- to 1-inch deep. Seed stratification requirements of eastern gamagrass need to be followed closely to assist in germination of this species.

A seeding year stand of warm-season grass should not be harvested unless growth is unusually vigorous and the stand is strong. Weed competition in the seeding year can be reduced by clipping weeds above the warm-season grass seedlings. Adjust the clipping height upward as the season progresses to prevent clipping off the warm-season grass seedlings, as that would reduce their vigor. Do not clip or graze new seedlings after August 1. It is usually best not to graze warm-season grasses during the seeding year.

### *Managing Established Stands*

Perennial warm-season grasses are more tolerant of low pH and fertility than the cool-season species, but they will respond to higher levels of fertility. Soil testing at least every three years is the best guide for maintenance rates of phosphorus and potassium. The timing of phosphorus and potassium application is not critical, and rates are similar as those for cool-season grasses. Lower nitrogen rates are suggested for warm-season grasses than for cool-season grasses. If a single application is made, 60 to 80 pounds of nitrogen per acre can be applied in mid-to-late May. For higher rates, split the application with half in mid-May and half in early July. Higher rates should only be used on highly managed excellent stands.

Harvest or graze these grasses when they are 16 to 20 inches or more in height (boot stage). Once seedheads emerge, the quality decreases rapidly. Heading will occur in late June to early July depending on location, year and species. Leave at least a 5-inch stubble for rapid regrowth. Mowing or grazing closer than 5 inches will remove important plant carbohydrate storage organs and areas of new bud development. Rotational grazing is advised for good persistence. Enough time should be allowed for at least 12 inches of fall regrowth before frost on all species, so do not graze or harvest after mid-September. Plants can be harvested after a killing frost without damage to the stand and the forage is safe for livestock. Removal of dead stubble in December will increase grass yields during the following growing season. This can be done with grazing animals but these animals will need protein supplement to balance protein needs. Leave at least an 8-inch stubble cover for the winter.

## Annual Forage Crops

Annual forage crops can be used effectively in forage production systems. These crops can be used to provide supplemental feed when perennial forages are less productive; emergency feed when perennial crops fail; serve as interim crops between grazing periods of perennial forages when long rest periods are needed: and extend the grazing season in the fall and early spring. Most annual forage crops are best used for pasture or silage rather than for hay. Double-cropping combinations are feasible with these annual forage crops (for example, small grains followed by summer annual grasses or brassicas).

### Corn Silage

Production of corn for silage is a primary component of most confinement dairy operations, but it should also be considered for any operation in need of supplemental forage during the summer months. Corn produces high yields of energy dense forage. Even if planted late and harvested before grain formation, the feeding value of corn is at least equal to that of the other summer annual grasses such as sorghum-sudangrass and forage sorghum, and yields are likely to be higher for corn silage. Hybrids are available that combine both high forage yield and high nutritive value, which is often determined by neutral detergent fiber digestibility. Production of corn for silage is covered in "Chapter 4, Corn Production."

### Small Grains for Forage

**SPRING OAT** (*Avena sativa* L.) is commonly used as a companion crop for seeding forage legumes. It can be used for silage or spring and early summer pasture when sown early. Oats grazed or chopped early regrow and provide a second period of grazing or greenchop. Highest yields are achieved with a single harvest in early heading to milk stage. Oats can be used for hay; however, as with the winter cereals, oats are coarse, slow to dry and often produce dusty hay. Ohio producers have also successfully used oat for late fall grazing, by seeding it in August (after winter wheat) or following an early corn silage harvest. Oat has also been aerially seeded into standing corn in mid-August to provide high-protein forage as a supplement to the lower quality corn stover when grazed in late fall after corn grain harvest.

**WINTER BARLEY** (*Hordeum vulgare* L.) is not as winter hardy as other winter cereal grains and is more sensitive to poorly drained soils. It can tolerate moderate droughts, but does not produce well under moist, hot conditions.

Barley provides good quality forage for grazing in the fall if seeded early, but it should not be grazed as close or as late in fall as wheat or rye. Barley makes good quality silage, but is less desirable for hay after heading because it has awns.

**WINTER WHEAT** (*Triticum aestivum* L.) provides highly digestible fall and spring pasture. Winter wheat can be sown later in the fall than barley because it is more winter hardy and able to withstand wetter soils than barley. Wheat produces more tonnage than barley and is of higher quality than rye. With careful fall or early-spring grazing, it can be subsequently harvested for grain, silage or hay. Varieties of winter wheat used for grain may also be used for forage.

**WINTER RYE** (*Secale cereale* L.) is the most winter hardy of the small grains. Quick growth in both fall and spring make it the most productive of the small grains for pasture. Forage-type varieties are available that have greater fall growth and extend the grazing season in late fall. Although best production is on fertile, well-drained soils of medium or heavier texture, it is more productive than other small grains on soils with lower pH and fertility, higher clay or sand content, or poorer drainage. Winter rye matures the earliest of the small grains, making it the most difficult of the small grains to manage for high quality in the spring. Palatability and quality of rye are unacceptable if allowed to mature past the boot stage.

**TRITICALE** (*Triticum* x Secale) is a hybrid of wheat and rye. Varieties are available for fall or spring seeding. Fall-seeded winter triticale varieties can be used for late fall and early-spring pasture, as well as for silage or hay. Under good management, triticale produces good forage yields; high animal performance is possible when it is harvested at the right stage. Winter triticale should be managed similarly to wheat, but matures about five to 10 days after wheat.

**MIXTURES** of small grains or small grains with annual legumes (e.g., field peas, soybean) can be used to achieve specific production objectives. For example, oat can be mixed with the winter grains to increase fall growth for grazing without sacrificing yield of the winter cereals the following spring. Small grain-annual legume mixtures are especially useful when harvested as silage. The seed cost of annual legumes is usually higher, and should be weighed against the value of the harvested forage. Adding annual legumes, such as peas, improves forage quality and expands the harvest window for achieving good quality forage. These mixtures do not yield as much as corn silage, but their production in the spring may fill an important niche in a forage system. Harvest timing should be based on the proper time for the small grain species in the mixture.

### *Establishment and Fertilization*

Seed small grains for forage in the same way as for grain (see Chapter 6). When seeding small grains for fall pasture, either plant in mid- to late August or follow normal seeding date guidelines. If small grains are planted only for pasture use, use the seeding rates given in Table 7-4 and apply nitrogen at a rate of 50 to 70 pounds per acre at planting time.

### *Harvest Management*

For the best compromise between yield and quality, harvest oats, barley and wheat in the early heading stage. Although harvesting later (up to early milk stage) increases tonnage, quality declines rapidly. Triticale should be harvested in the late boot to early heading stage. Rye should be harvested in the boot stage to avoid palatability problems and large reductions in forage quality. Always use a mower conditioner to increase drying rate of small grains.

### *Grazing Management*

Fall and spring grazing of small grains should begin when sufficient growth is available to support livestock. Delayed planting dates and wet fields during the prime grazing season often make grazing of small grains difficult in Ohio. In the fall, graze only early-seeded small grains. Begin grazing when 6 inches of growth is available, and leave 3 inches of stubble after grazing. Heavy fall grazing can increase the risk of winterkill. Do not graze when the small grain is dormant or when the ground is frozen if subsequent spring growth and/or grain production is desired. In the spring, graze only when fields are firm. Heavy or late-spring grazing greatly reduces grain yields. Remove livestock from small grain fields to be harvested for grain as soon as the plants begin stem elongation (jointing stage).

### *Animal Health Concerns with Small Grains*

Animal health hazards are not as common with the small grains as they are with the sorghum species grasses; however, the following precautions should be taken:

- Supplement lush spring pastures with high-magnesium mineral blocks or mineral-salt mixes to reduce the risk of grass tetany.
- When using seed treated with fungicides, observe harvest and grazing restrictions on the label.
- Remove lactating dairy animals from small grain pastures two hours before milking to reduce the problem of off-flavored milk.
- Split nitrogen applications to avoid nitrate poisoning.

## Italian Ryegrass

Italian ryegrass (*Lolium perenne* L. subsp. *multiflorum* (Lam.) Husnot) is generally annual or biennial in longevity, and can provide short-term high yields of high-quality forage. The Westerwold types do not have a vernalization (cold temperature) requirement for flowering, so they will head out throughout the seeding year and usually complete their life cycle by late summer when planted in the spring. The types known in the industry as true Italian

ryegrass varieties have a vernalization requirement for flowering, so they will not head out until the second year. They usually grow through the second year and sometimes into the third year.

Italian ryegrass can be planted in April or in August through mid-September. The late summer to early autumn seedings can be made after wheat or corn silage and may produce enough forage for grazing by November if rainfall is sufficient during the fall. Late summer to autumn plantings survive the Ohio winters (except for the occasional severe winter) and produce forage the next spring and into mid-summer. The Italian ryegrass varieties can differ greatly in winter hardiness, so consult the *Ohio Forage Performance Trials* (**u.osu.edu/perf**) for evaluations of yield and winter survival in Ohio.

Establishment and management of Italian ryegrass is similar to the perennial cool-season grasses, including fertilization and harvest and grazing management. This species can be planted no-till and has vigorous seedling growth. This species can be difficult to cut with a sickle bar mower, but disk mowers handle it very well. For optimal yield and nutritive value, harvest or graze it in the boot stage before heading.

When establishing Italian ryegrass after corn silage in early autumn, be aware of the potential for nitrogen carryover in the Italian ryegrass in the autumn growth, especially following a dry summer. Nitrates can accumulate to toxic levels to animals in the autumn growth of Italian ryegrass. If there is potential of high nitrogen carryover, it would be prudent to test the forage for nitrate content before harvesting or grazing it.

## Summer-Annual Grasses

These grasses grow rapidly in late spring and summer and when managed properly provide high-quality forage. They are well suited as supplemental forages during hot, dry periods when perennial cool-season forages are less productive. Because the need for extra forage usually becomes apparent after row crops have been planted in early spring, summer-annual grasses are a good double-crop option when planted after a small grain harvest. They have the potential to produce forage yields of 3 tons of dry matter per acre within 45 to 50 days. With the exception of pearl millet, the summer-annual grasses are members of the sorghum family and have the potential for prussic acid poisoning (see *Animal Health Concerns* below).

**SUDANGRASS** [*Sorghum bicolor* (L.) Moench.] is fine-stemmed, leafy and grows between 3- to 8-feet tall. Sudangrass regrows following each harvest, until cool temperatures or lack of moisture inhibit growth. It is the preferred summer-annual grass for pasture, and can be used for hay. Solid stands grow shorter than when seeded in rows. Sudangrass usually contains lower levels of prussic acid and is usually lower yielding than the other sorghum family grasses.

Sudangrass hybrids are generally slightly higher yielding and have slightly higher prussic acid potential than sudangrass at comparable stages of growth. New varieties with higher digestibility are available, known as brown midrib varieties. Those varieties have a characteristic brown discoloration on the main vein (midrib) of the leaves, which is a marker for the mutation for lower lignin content. The brown midrib varieties have greater animal preference and animal performance (intake and gains) compared with the normal varieties.

**SORGHUM-SUDANGRASS HYBRIDS** are crosses of sorghum with sudangrass. They resemble sudangrass in growth habit, but are generally taller, have larger stems and leaves, and are higher yielding. This grass can become coarse and unpalatable if not properly utilized. It is not as well suited for hay production as sudangrass. Sorghum-sudangrass hybrids regrow following each harvest, barring restrictive environmental conditions. Brown midrib varieties with higher digestibility are available, as described above for sudangrass.

**FORAGE SORGHUM** [*Sorghum bicolor* (L.) Moench.] grows 6- to 15-feet tall and has potential for high yields. It is utilized as a one-cut silage or greenchop crop. Forage sorghum produces silage containing more digestible energy than legume and cool-season grass silage. Making high-quality silage from forage sorghum is generally easier than from forage legumes because of the high levels of nonstructural carbohydrates, which enhance fermentation. The high-energy, low-protein characteristics of forage sorghum silage make it a good supplement for high-protein forage legumes. Because the feeding value of forage sorghum silage is considered to be about 85 percent that of corn silage, corn silage is usually the preferred high-energy silage grown in Ohio. Forage sorghum has the potential, however, to grow better than corn on light-textured, shallow soils that tend to be droughty. Brown midrib varieties with higher digestibility are available, as described above for sudangrass.

**PEARL MILLET** (*Pennisetum glaucum* L.) is not in the sorghum family, and prussic acid is not produced in the plant. It tends to have smaller stems and is leafier than the sorghum grasses. Pearl millet regrows after each harvest, but not as rapidly as sudangrass or sorghum-sudangrass hybrids. It may also be more sensitive to cutting height for regrowth than sudangrass. Other types of millets include: German, Foxtail and Japanese millet. German and Foxtail millet do not regrow after harvest. Japanese millet grows best in wet soils.

**TEFF** (*Eragrostis tef* (Zuccagni) Trotter) is an annual grass native to Ethiopia that can be used for hay and silage. Its use for grazing is questionable because grazing animals can pull plants out of the ground. Teff produces several cuttings and can tolerate both drought-stressed and waterlogged soils. It is fairly easy to establish, provided the very small seed is placed ⅛- to ¼-inch deep. It should

be seeded in late May to early June once soils are warm. It emerges quickly and produces harvestable forage within 40 to 50 days (early heading stage), with subsequent harvests expected every 30 to 35 days in Ohio. When harvested in the early boot stage, it produces relatively high-quality forage. In Ohio, teff can be harvested three times with total forage yields reaching a total of 3 to 4 tons of dry matter per acre. A 4-inch cutting height will promote vigorous regrowth. Teff is very sensitive to frost, so growth ceases with the first frost. More details on managing this forage can be found in a fact sheet from Cornell University (**nmsp.cals.cornell.edu/publications/factsheets/factsheet24.pdf**).

**SUMMER-ANNUAL GRASS-LEGUME MIXTURES** are marketed by some seed dealers. The legumes (e.g., field pea, soybean) generally improve protein content compared with summer-annual grasses grown alone. The annual legumes included in these mixtures would be present in the first growth only; regrowth would occur only from the grasses. The additional cost of the legume seed should be weighed against the improved forage quality potential.

### *Establishment*

Summer-annual grasses require well-drained to moderately well-drained soils. They grow best in warm weather and should be planted from about two weeks after corn planting until the end of June in northern Ohio and mid-July in southern Ohio. Soil temperatures should be at least 60 to 65 degrees Fahrenheit. Late plantings (after mid-July) shorten the growing season and may result in low yields because of poor establishment in dry soils in the summer followed by cool fall temperatures. Making two seedings about three weeks apart staggers the maturities and makes rotational grazing or harvest timing easier to manage.

Seeds should be planted on a well-prepared, firm, and moist seedbed at a depth of ½- to 1-inch, except teff which should be planted ⅛- to ¼-inch deep. The seed can be broadcast and harrowed, lightly disked (except teff), or seeded with a grain drill. Forage sorghums should be planted in rows with row-crop planters to facilitate harvest and minimize lodging. These summer-annual grasses may also be established in grass sods or stubble with no-till equipment (except teff which does not establish well into existing sods), but this is less desirable than conventional seedbed preparation. Refer to Table 7-4 for suggested seeding rates.

### *Fertilization*

Determine lime and fertilizer needs by soil test. Fertilization is similar to that used to grow 100 to 150 bushels per acre corn. Incorporate fertilizer in the soil prior to seeding, or apply at least six months before for no-till seedings. The soil pH should be maintained between 6.0 and 6.5 for best results. Nitrogen fertilization is critical to achieve high yields, and varies by previous crop (Table 7-11). Nitrogen rates for teff are generally lower, about 50 to 60 pounds of nitrogen per acre at planting. For the other species, split applications of nitrogen should be made; half applied prior to seeding, and the remainder divided equally and applied after each cutting or grazing to achieve the most efficient use. Keep in mind possible volatilization losses of some forms of nitrogen when applied in the summer. Refer to Bulletin E-2567, *Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa*, for more information on nitrogen volatilization losses.

*Table 7-11: Nitrogen Recommendations for Summer-Annual Grasses.*

| | Yield Goal (tons dry matter/ac) | | |
|---|---|---|---|
| Previous Crop | 3-4 | 5-6 | 6+ |
| | lb N/ac | | |
| Good legume stand (5 plants/sq ft) | 0 | 0 | 40 |
| Average legume stand (3 plants/sq ft) | 0 | 40 | 80 |
| Grass sod | 60 | 100 | 140 |
| Soybeans | 70 | 110 | 150 |
| Other | 100 | 140 | 180 |

### *Harvest Management*

Table 7-12 summarizes the guidelines for harvest management of the summer-annual grasses.

**DIRECT-CUT SILAGE** Forage sorghum and sorghum-sudangrass hybrids are well suited as silage crops. Harvesting forage sorghum in the dough stage and sorghum-sudangrass in the heading stage should provide sufficient dry matter content for ensiling without wilting.

**GREENCHOP OR WILTED SILAGE** Sudangrass should be cut at 18 to 40 inches of growth. Sorghum-sudangrass hybrids should be cut when at least 30-inches tall, teff in pre-boot to early boot stage, and pearl millet in late-boot to early bloom stage.

**HAY** Sudangrass, sorghum-sudangrass hybrids, pearl millet and teff can be cut for hay. Harvest when the grasses are vegetative (boot stage, before heading) or the plant reaches a height of 3 to 4 feet. Always use a hay conditioner to mow and crush the stems to improve drying. Even with a hay conditioner, it is difficult to field cure most of these grasses adequately for safe storage as hay. Teff can be made into hay.

**GRAZING** All of the summer-annuals, except forage sorghum, are suitable for grazing. Sufficient height must be achieved before grazing to reduce animal health problems and to optimize production. Grazing plants that are less than 18-inches tall will weaken them, resulting in delayed regrowth. The chance of prussic acid poisoning is higher when grazing the sorghums before a full 18 inches of growth is present. Grasses in the vegetative stage are more palatable and nutritious. Trampling and wastage

*Table 7-12: Harvest Information for Summer-Annual Grasses and Brassica Crops.*

| | | ------- Fall Pasture ------- | | ---------- Summer Pasture ---------- | | |
|---|---|---|---|---|---|---|
| Crop | Silage | When to Graze | When to Terminate Grazing | When to Graze | Height After Grazing | Between Grazings |
| Sudangrass | Late boot to early bloom | 18-24 in. tall | At frost, may resume 5-7 days after killing frost. | 18-24 in. tall | 6-8 in. tall | 2-3 weeks |
| Sorghum x Sudangrass | Late boot to early bloom | 30+ in. tall | At frost, may resume 5-7 days after killing frost. | 30+ in. tall | 6-8 in. tall | 2-3 weeks |
| Pearl millet | Late boot to early bloom | 18-24 in. tall | When utilized. | 18-24 in. tall | 6-8 in. tall | 3-4 weeks |
| Forage sorghum | Soft dough to medium dough | ---------- Not recommended for pasture ---------- | | | | |
| Teff | Pre-boot to early boot | 16-24 in. tall | When utilized. | 16-24 in. tall | 4 in. tall | 3-4 weeks |
| Rape | Not recommended | 80-90 days after summer seeding | When herbage utilized. | 80-90 days after spring seeding | 6-10 in. tall | 4 weeks |
| Turnip | Not recommended | 80-90 days after summer seeding | When herbage & roots utilized. | 80-90 days after spring seeding | 6-10 in. tall | 4 weeks |
| Kale[a] | Not recommended | 150-180 days after summer seeding | When herbage utilized. | Growth insufficient for summer grazing, not recommended. | | |
| Swede | Not recommended | 150-180 days after summer seeding | When herbage & roots utilized. | Growth insufficient for summer grazing, not recommended. | | |

[a] Stemless kale varieties exist that are ready for harvest 80 to 90 days after seeding (e.g., Premier forage kale) and will regrow after harvest if not grazed below 3 to 4 inches; therefore, Premier stemless kale provides summer grazing when spring seeded.

increases when grazing is delayed past the boot stage. Plants reach the grazing height of 18 to 30 inches about six to eight weeks after planting. Rotational grazing or strip grazing management should be practiced. A sufficient number of animals should be placed on the pasture to graze the grass down in less than 10 days. After grazing, clip the residue to about 8 inches if old stems remain. This improves forage quality for the next grazing period.

## *Animal Health Concerns*

**PRUSSIC ACID POISONING** can occur when feeding sudangrass, sorghum-sudangrass hybrids, forage sorghum or grain sorghum. These species contain varying concentrations of cyanogenic glucosides, which are converted to prussic acid, also known as hydrogen cyanide (HCN). As ruminants consume forage containing high levels of cyanide-producing compounds, prussic acid is released in the rumen and absorbed into the bloodstream, where it binds hemoglobin and interferes with oxygen transfer. The animal soon dies of asphyxiation. Prussic acid acts rapidly, frequently killing animals in minutes. Symptoms include excess salivation, difficult breathing, staggering, convulsions and collapse. Ruminants are more susceptible than horses or swine because cud chewing and rumen bacteria help release the cyanide.

Species and varieties differ in prussic acid poisoning potential–sudangrass varieties are low to intermediate in cyanide potential; sudangrass hybrids are intermediate; sorghum-sudangrass hybrids and forage sorghums are intermediate to high; and grain sorghum is high to very high. Piper sudangrass has low prussic acid poisoning potential. Pearl millet is virtually free of cyanogenic glucosides and no cases of prussic acid poisoning have been reported for teff.

Any stress condition that retards plant growth may increase prussic acid levels in plants. Hydrogen cyanide is released when leaf cells are damaged by frost, drought, bruising, cutting, trampling, crushing or wilting. Plants growing under high nitrogen levels or in soils deficient in soil phosphorus or potassium tend to have high levels of cyanogenic glucosides. Fresh forage is generally higher in cyanide than in silage or hay because cyanide is volatile and dissipates as the forage dries.

### *Reducing the Risk of Prussic Acid Poisoning in Sorghum Species*

When grazing or greenchopping:

- Graze or greenchop only when grass exceeds 18 inches in height.
- Do not graze wilted plants or plants with young tillers.
- Do not graze plants during or shortly after a drought when growth has been reduced.
- Do not graze on nights when frost is likely. High levels of the toxic compounds are produced within hours after a frost occurs.
- Do not graze after a killing frost until the plants are dry. Wait five to seven days to allow the released cyanide to dissipate.
- After a non-killing frost, do not allow grazing because the plants usually contain high concentrations of toxic compounds. Once the first frost has occurred, grazing should not begin until five to seven days after a killing frost.
- Don't allow hungry or stressed animals to graze young sorghum grass growth. To reduce the risk, feed ground cereal grains to animals before turning them out to graze.
- Use heavy stocking rates (four to six head of cattle per acre) and rotational grazing to reduce the risk of animals selectively grazing leaves that can contain high levels of prussic acid.
- Feeding greenchopped, frost-damaged plants has lower risk than grazing because animals have less ability to selectively graze damaged tissue; however, the forage can still be toxic, so feed with great caution.
- Always feed greenchopped forage of these species within a few hours (even in absence of frost), and do not leave greenchopped forage in wagons or feedbunks overnight before feeding.
- Split applications of nitrogen decrease the risk of prussic acid toxicity, as do proper levels of phosphorus and potassium in the soil.

When making hay or silage:

- Frost-damaged annual sorghum grasses can be made into hay with little or no risk of toxicity. When plants are wilted enough to make dry hay, most of the volatile cyanide gas will have dissipated.
- Normal silage making allows most of the cyanide to dissipate from frost damaged annual sorghum grasses. Delay feeding of silage for six to eight weeks after ensiling.
- Silage that likely contained high cyanide levels at harvest should be analyzed for HCN content before feeding.

**NITRATE POISONING** can occur under conditions of high nitrogen fertilization, heavy manure applications, drought, overcast weather, freezing or other stress conditions that retard plant growth. Under these stressful conditions, high nitrate levels accumulate in the crop. Once forage is fed, nitrate is converted to nitrite in the animal. When nitrite levels are high, the animal cannot metabolize it quickly enough, and nitrite inhibits oxygen transport in the blood. Symptoms include rapid breathing, fast and weak heartbeat, muscle tremors, staggering and death if corrective steps are not taken.

The same management precautions for prussic acid poisoning help prevent nitrate poisoning. Pearl millet does accumulate high nitrate levels leading to nitrate poisoning. As mentioned above, pearl millet does not accumulate prussic acid. High nitrate levels persist when forages are cut for hay, but ensiling the crop reduces nitrates by one-half. If you suspect that forage contains high nitrate levels, have it tested before feeding.

**POISONING OF HORSES** fed sudangrass, sorghum-sudangrass hybrids and forage sorghum has been reported. The exact cause of poisoning is not known. Do not feed horses any of these summer annual grasses.

## Brassica Crops

Forage brassicas are fast-growing annual crops that are highly productive and digestible. Crude protein levels range from 15 to 25 percent in the herbage and 8 to 15 percent in the roots, depending on nitrogen fertilization rate and weather conditions. The most commonly used forage brassica crops are rape, turnip, kale and swede. They can be grazed from 80 to 150 days after seeding depending on species (Table 7-12). These crops offer great potential and flexibility for improving livestock carrying capacity from August through December. Spring-seeded brassicas boost forage supply in late summer. Summer-seeded brassicas extend the grazing season in late fall and early winter.

**RAPE** (*Brassica napus* L.) is a short-season, leafy crop whose stems and leaves are eaten by the grazing animal; rape can also be greenchopped. It has fibrous roots, and each plant produces many stems. Rape regrows after harvest and is the easiest brassica species to manage for multiple grazings. Mature rape is excellent for fattening lambs and flushing ewes. Yields are generally maximized with two 90-day growth periods, but some varieties yield better with one 180-day growth period while rape hybrids yield best with 60 days of growth for the first harvest followed by 30 days for the second harvest.

**TURNIP** (*Brassica rapa* L.) is a fast-growing crop that reaches near maximum production 80 to 90 days after seeding. Roots, stems and leaves are grazed. The relative proportion of tops and roots varies markedly with variety, crop age, and planting date. The crude protein concentration of roots (8 to 10 percent CP) is approximately one-half of that in turnip top growth; however, stockpiled tops are more vulnerable to weather and pest damage than roots.

**KALE** (*Brassica oleracea* L.) is a long-season, leafy brassica that produces some of the highest yields of the brassica family when it is spring-seeded. Some varieties are very cold tolerant, which allows grazing of leaves and stems into December and January most years. Stemless varieties reach about 25 inches in height, whereas narrow stem kale grows to 5 feet with primary stems 2 inches in diameter. Stemless kale (e.g., Premier) establishes quickly and reaches maturity in about 90 days. Narrow stem kale is slower to establish and requires 150 to 180 days to reach maximum production.

**SWEDE** (*Brassica napus* L.) is a long-season brassica that produces a large edible root like turnip. Swede produces higher yields than turnip, but it grows more slowly and requires 150 to 180 days to reach maximum production. Swede produces a short stem when not shaded. If plants are shaded, it produces stems 30-inches tall. Swede does not regrow after harvest.

**HYBRIDS OF CHINESE CABBAGE** with rape, turnip or swede can also be used for forage. Research information on the production and management of these hybrids is limited.

### *Establishment*

Brassica crops germinate quickly, and can be planted to provide either summer or late fall/winter grazing:

- Plant rape, turnip and stemless kale in the spring (mid-April through May) to provide pasture in August and September.
- Plant rape and turnips in July and August to provide grazing in November and December.
- Plant swede and kale in the spring for grazing in November and December.

Brassica crops require well-drained soils with a pH between 5.3 and 6.8 for good production. Seeding rates for rape and kale are 3.5 to 4.0 pounds per acre while turnip and swede are 1.5 to 2.0 pounds per acre. In the spring, use the higher side of the suggested seeding rates. Plant seeds in 6- to 8-inch row spacings at ¼- to ½-inch deep in a firm seedbed. Apply 50 to 75 pounds of nitrogen per acre at seeding to stimulate establishment and seedling growth. Weed competition should be controlled during brassica establishment, otherwise stand establishment failures are very likely.

On conventionally prepared seedbeds, brassica seed can be broadcast and incorporated with cultipacking. No-till seeding into grain stubble or grass sod is recommended, but weeds and sod must be suppressed for two to three weeks to allow the brassicas to establish. Apply either paraquat or glyphosate for sod suppression. Another alternative is to apply a manure slurry or liquid nitrogen solution to burn the sod back, then no-till plant the brassica seeds. Brassicas can also be seeded with rye to provide forage growth and protect the soil after brassicas are consumed.

### *Fertilization*

Determine lime and fertilizer needs by a soil test. Adequate phosphorus and potassium are important for optimum growth. In addition to the nitrogen applied at planting (50 to 75 pounds per acre), another 70 pounds per acre should be applied when multiple grazings are planned with rape and turnips. This second application should be made from 60 to 80 days after seeding. Nitrogen application in a chemically-suppressed grass sward tends to increase the efficacy of the suppressing herbicide. This reduces the proportion of grass in the brassica-grass sward, which is not always advantageous. Avoid excessive nitrogen and potassium fertilization to prevent animal health problems (see *Animal Health Conserns with Brassicas*).

### *Harvesting*

Although brassicas can be harvested for greenchop, they are most often grazed. Rotational grazing or strip grazing helps reduce trampling and waste by livestock. Graze small areas of brassicas at a time to obtain efficient utilization. Rape is most easily managed for multiple grazings. Leave 6 to 10 inches of stubble to promote rapid regrowth of rape. When turnips are to be grazed twice, allow only the tops to be grazed during the first grazing. Turnip regrowth is initiated at the top of the root. Both rape and turnips should have sufficient regrowth for grazing within four weeks of the first grazing.

Stockpiling these crops for grazing after maturity should only be attempted when plants are healthy and free of foliar diseases. Some varieties are more suited for stockpiling because they possess better disease resistance. Do not grow brassica crops on the same site for more than two consecutive years to prevent the buildup of pathogens that limit stand productivity. Insect problems are not a consistent problem in Ohio.

### *Animal Health Concerns with Brassicas*

Brassica crops are high in crude protein and energy, but low in fiber. The low fiber content results in rumen action similar to when concentrates are fed. Sufficient roughage must be supplemented when feeding brassicas to livestock. If grazing animals are not managed properly, health disorders–such as bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism and polioencephalomalacia–may occur.

These disorders can be avoided by following two guidelines:

- Introduce animals to brassica pastures slowly and avoid abrupt changes from dry summer pasture to lush brassica pasture. Do not turn hungry animals into brassica pasture, especially if they are not adapted to brassicas.
- Only two-thirds of the animal's diet should be comprised of brassica forage. Supplement with dry hay or allow grazing animals access to grass pastures while grazing brassicas. No-tilling brassicas into existing grass pastures helps reduce the risk of these disorders, if sufficient grass growth is available for grazing.