Forage Species Adapted to the Northeast

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Profitable livestock production is based on good marketing, cost control, and forage management. Part of forage management is deciding whether to use native or improved forages and how to optimize grazing management to minimize the need for hay.

Most of our so-called native grasses and legumes are cool-season species that were brought from Europe. Native pastures and hayfields usually provide economical yield and quality simply through good liming, fertilization, and grazing and haying management. But, often the manager wishes to plant an improved species or variety. This may be as part of a crop rotation where annual crops were grown and a new perennial grass-legume stand is needed; or because previous management allowed the development of a non-desirable species mix, such as the invasion of endophyte-infected tall fescue.

When choosing forage species for a new stand, evaluate the species based on their:

1. Ecological niche adaptation
2. Growth habit and management adaptation
3. Growth distribution
4. Stand longevity

Ecological niches of forage species differ and are related to climate, soil fertility, soil drainage, grazing management, and pest tolerance (Table 1). Plants growing in an established pasture are usually the ones best adapted to the current combination of site and management. If you want a different plant community you will have to change the management, soil fertility, or soil drainage. Some species will not grow well on some soils. The manager needs to select the forage species that will work best on the soil existing in the field and implement the management needed by that species for optimum production and quality.

In a field having variable drainage, it is beneficial to mix two or more species that complement each other relative to drainage. For example, birdsfoot trefoil or ladino clover mix well with alfalfa in grass-legume stands in fields with variable drainage. The trefoil or ladino clover will predominate in poorly drained areas of the field and the alfalfa will thrive in the well-drained areas of the field.

Growth habit determines the forage species' response to grazing or hay harvest. Orchardgrass, tall fescue, and bluegrass head-out in the spring then tiller in later growths with their growing points near the ground. Because the growing point is near the ground they tolerate close, frequent defoliation. However, timothy, smooth bromegrass, and reed canarygrass joint in the aftermath with the growing point moving up above the soil surface in every growth cycle and can be injured if grazed or hayed at the wrong time.

Alfalfa, red clover, and upright birdsfoot trefoil are good legumes to use in hayfields and rotationally grazed pastures with orchardgrass, tall fescue, timothy, smooth bromegrass, or reed canarygrass. White clovers (Ladino and common), red clover, alsike clover, and prostrate-type birdsfoot trefoil are good legumes to use with orchardgrass, tall fescue, bluegrass, and redtop in pastures. Due to the competition between legumes and grasses, legumes do best under proper rotational grazing.

Growth distribution of forage species is a response to weather and day length. Some forages grow better in cool weather; others grow better in warm weather. Tall fescue is more tolerant of hot and dry weather than orchardgrass; timothy is least tolerant of these conditions. Tall fescue is most tolerant of freezing weather in the fall and is the best for fall and winter grazing. The flush of spring growth in grasses differs among species. Orchardgrass heads out earlier than does timothy, with redtop being the latest cool-season grass to head. There are differences between varieties within a species. Hallmark orchardgrass goes to head sooner than Pennlate and has more vigorous fall growth.

Stand longevity is the result of species tolerance to harvest management, soil fertility and drainage, disease and insects, and the species' ability to move into openings in the stand. Some forage species increase plant size by tillering (Kentucky bluegrass, orchardgrass, tall fescue, timothy) or by growing larger crowns (alfalfa, red clover, birdsfoot trefoil). Other species invade open areas by moving growing points underground (Kentucky bluegrass, tall fescue, smooth bromegrass, reed canarygrass) while others have growing points that move above ground (white clover). Species that move to fill openings can repair damage to the sod that occurs from hoof action and winterkill. Also, species and varieties that have good spring and fall growth (early heading Orchardgrass and tall fescue) are competitive with winter annual and biennial weeds, resulting in fewer of these weeds in the stand.

The longest-lived grasses in West Virginia, Virginia, and Pennsylvania are orchardgrass, Kentucky bluegrass, endophyte enhanced tall fescue, timothy, bromegrass, and reed canarygrass. The best legumes for general use are red clover, ladino clover, alfalfa, and birdsfoot trefoil.

Seeding only a single forage species will result in other plants invading more quickly. These may be "weeds" or native forages. Proper mixes will reduce weed encroachment as long as the stand is managed properly. For example, a little ladino white clover (1 lb/a) in an alfalfa grass mix will fill in openings as the alfalfa thins to reduce weed invasion. A small amount of Kentucky bluegrass serves the same purpose in an orchardgrass clover seeding. When mixing forage species, use ones that are compatible in growth habit and palatability and complement each other in growth distribution and ecological niche.

Forage yield from pasture or hay is largely determined by:

- Soil type (deep soils are more productive than shallow soils)
- Soil fertility (high-fertility soils are more productive than low-fertility soils)
- Forage species (deep-rooted species are more productive than shallow-rooted species)
- Nitrogen availability (legume in mixture or applied N)
- Grazing and haying management

A farm's soil and management affects what forage species are most adapted to the farm. Soil type and its capability can be determined from the county soil survey and should be used when choosing forage species. Soil fertility can be determined by soil testing and applying the needed fertilizers and lime.

The productivity of grass species is compared in Table 2. Local ecological site conditions will improve a species' performance compared to average. In hot, dry areas smooth bromegrass may be one of the best grasses for hay production. In cool, high-elevation environments timothy is highly productive. On poorly drained sites reed canarygrass is most adapted.

The most productive legume on deep, well-drained soils is alfalfa (Table 3). On shallow soils having a yield potential of 2.5 tons or less of grass legume hay, red clover will usually be as or more productive than alfalfa (Fig. 1).

For good growth, grasses require nitrogen (N) from soil organic matter, manure, or commercial nitrogen. Legumes in mixture with grass can provide nitrogen to the grass through biological nitrogen fixation and N-cycling through soil organic matter. A good grass legume mixture, containing 25-30% or more legume, will be about as productive as the grass alone fertilized with 150 pounds per acre of commercial nitrogen. If commercial nitrogen is to be used it should be applied at 50 to 60 lbs N per acre at spring green up and after each harvest to a maximum of 180-250 lbs N/a/year to prevent nitrate from going into the ground water. Likewise, if manure is used as the nitrogen source, plant-available nitrogen should be limited to what the grass is able to use.

Grazing and haying management affects the total forage yield, forage yield in the first cut, and the proportion of forage available in aftermath growth (Table 3). Grasses harvested at early head stage in the first cut will have only 84% of the total yield and 59% of the first cut yield compared to cutting at post bloom. On the other hand, when harvested at early head, 60% of the total yield will be available as aftermath while a post-bloom first cut leaves only 39% of the total yield for aftermath. When aftermath grazing is used to manage the summer pasture slump, this can make a big difference. Legumes respond to harvest management in a manner similar to grasses.

Forage Quality is little affected by forage species. Forage quality is determined by:

- Plant growth stage at harvest (as plants mature the quality goes down)
- Legume content (at a given growth stage legumes are higher quality than grasses)
- Grazing intensity or hay harvest damage
- Plant species (some forage species have anti-quality components)

The single most important factor determining quality is the stage of plant maturity at harvest. As a plant matures the forage increases in fiber, reducing the crude protein and digestible dry matter content (Table 5). At our latitude, first-cut hay digestibility decreases 0.33 to 0.50 percentage points each day harvest is delayed. Delaying harvest also reduces the amount of aftermath growth, critical in a grazing system to reduce the summer slump in pasture availability.

The second-most important factor in determining forage quality is legume content of the forage. Legumes are of higher quality than grasses when harvested at the same growth stage. Legumes are lower in cell wall fiber (neutral detergent fiber or NDF), which allows animals to eat more. Animals that eat more forage gain weight faster or produce more milk. However, when they eat more it takes more forage to feed the same number of animals. Legumes are also higher in nonstructural carbohydrates (sugars and starches that are nearly 100% digestible) and protein.

If pasture or hay on the farm does not supply the nutrients the livestock require and the animals are not performing adequately, or if the cost of supplemental feed is too high, then there may be the need to introduce and manage for legumes in the stand or graze or harvest hay at an earlier growth stage.

Differences in plant species do occur. One that is most talked about is date of heading in grasses. This is a management concern but only after identifying the species most adapted to the soil and management. One characteristic of late-heading species and varieties is that they are less competitive with weeds. There are negative quality components in some grasses, such as endophyte-infected tall fescue and native reed canarygrass. These problems can be avoided by using endophyte-free or endophyte-enhanced tall fescue and new varieties of palatable reed canarygrass.

Conclusion

A profitable forage-livestock system needs to be low-cost. One of the best ways to do this is to produce low-cost, high-quality forages. Pasture and hay quality and quantity need to be optimized for the livestock enterprise. Knowing the livestock's nutritional requirements and the quality of the forage produced tells if the quality is adequate. If quality is not adequate the introduction of legumes and grazing or haying at an earlier growth stage will increase digestibility and protein content.

When mixing forage species, use ones that are compatible in growth habit and palatability and complement each other in growth distribution and ecological niche.

Table 1. Forage species characteristics and management and ecological adaptation.

Forage species	Growing point	Aftermath reproductive growth	Establishment vigor	Plant type	Management adaptation			Optimum soil pH	Tolerance to poor drainage	Tolerance to flooding	Tolerance to drought
					Hay	Grazing					
						Rotational	Continuous				
Legumes											
Alfalfa	Elevated	Yes	Medium	Bunch	E	E	P	6.5-7.0	P	P	E
Alsike clover	Elevated	Yes	Medium	Bunch	P	G	P	5.8-6.5	E	P	P
Birdsfoot trefoil	Elevated	Yes	Low	Bunch	E	G	G	6.0-6.5	E	P	G
Lespedeza, Korean	Elevated	Yes	Medium	Bunch	G	G	G	5.8-6.5	G	P	G
Lespedeza, Sericea	Elevated	Yes	Low	Bunch	P	G	G	5.8-6.5	G	P	G
Red clover	Elevated	Yes	High	Bunch	G	G	P	5.8-6.5	G	P	G
White clover	Ground	Yes	Low	Bunch	P	E	G	5.8-6.5	E	P	P
Grasses											
Bermudagrass	Elevated	Yes	Medium	Sod	G	G	G	5.8-6.5	P	P	G
Bluegrass, Kentucky	Ground	No	Low	Sod	P	E	E	5.8-6.5	G	G	P
Bromegrass, Smooth	Elevated	Joints	Medium	Sod	E	G	P	5.8-6.5	G	P	E
Orchardgrass	Ground	No	Medium	Bunch	E	E	G	5.8-6.5	G	P	G
Ryegrass, Perennial	Ground	Yes	High	Bunch	G	G	P	5.8-6.5	P	P	P
Ryegrass, Annual	Ground	Yes	High	Bunch	P	G	P	5.8-6.5	P	P	P
Reed canarygrass	Elevated	Joints	Low	Sod	E	G	P	5.8-6.5	E	E	E
Tall Fescue, E+	Ground	No	Medium	Bunch	G	G	G	5.6-6.5	E	E	E
Tall Fescue, E-	Ground	No	Medium	Bunch	E	E	P	5.8-6.5	E	E	G
Timothy	Elevated	Joints	Medium	Bunch	E	G	P	5.8-6.5	G	P	P

E+ = endophyte infected E- = endophyte free E - excellent G - good P- poor

Table 2. Average yield of grass species grown in the Northeast ranked from high to low.

Grass Species	Site Years	Yield	SD	Min	Max
Tall Fescue	55	5.05	± 1.38	2.41	7.85
Orchardgrass	68	4.80	± 1.22	1.80	8.24
Reed Canarygrass	36	4.78	± 1.46	1.25	6.67
Smooth Bromegrass	35	4.39	± 1.08	1.26	6.18
Timothy	54	4.25	± 1.24	1.31	7.16
Perennial Ryegrass	25	3.58	± 1.39	1.36	5.93
Harding Grass	2	3.46	± 0.20	3.32	3.60
Kentucky bluegrass	2	2.65	± 1.07	1.89	3.41
Festulolium	2	2.62	± 1.47	1.59	3.66

Table 3. Yield of alfalfa and red clover grown at sites across the Northeast.

Legume Species	Site Years	Yield	SD	Min	Max
Alfalfa	122	6.23	± 1.18	2.56	8.68
Red clover	46	4.35	± 1.47	1.18	7.03

Table 4. The effect of grass growth stage at first harvest on the relative total yield, relative first cut yield, and the fraction of the total yield obtained in the aftermath (mean ± standard deviation).

Growth stage	Total yield	First cut yield	Aftermath fraction
Pre-joint	0.79 ± 0.08	0.55 ± 0.16	0.57 ± 0.16
Early head	0.84 ± 0.06	0.59 ± 0.18	0.60 ± 0.13
Early bloom	0.98 ± 0.06	0.88 ± 0.12	0.47 ± 0.09
Post bloom	1.00 ± 0.00	0.99 ± 0.02	0.39 ± 0.10

Table 5. The effect of grass growth stage at first harvest on hay's crude protein (CP) and digestible dry matter (DM) content under normal management after harvest and storage losses (mean ± standard deviation).

Growth stage	Crude protein	Digestible DM
Pre-joint	0.24 ± 0.04	0.73 ± 0.06
Early head	0.16 ± 0.04	0.63 ± 0.06
Early bloom	0.11 ± 0.02	0.58 ± 0.05
Post bloom	0.09 ± 0.02	0.50 ± 0.05

Figure 1. When grown on deep soils under the same environmental conditions, alfalfa is more productive than red clover. When the yield potential approaches 2.5 tons per acre these two species are about equal.