Growing and Harvesting High Quality Grasses for Dairy Cattle

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Abstract

Understanding growth and development of adapted forages that are part of the dairy cattle diet is important. Management, including fertilization, species and variety choice, weekly scouting and proper harvest timing, is critical if full benefit is to be realized. This article focuses on major differences among adapted species, with an emphasis on cool-season grasses and the agronomic principles necessary for most success to occur.

Soil Considerations

Soil types on the farm

Before getting too concerned about different grass species, it is imperative to learn more about characteristics of the soil where forages are to be grown. Drainage, topography, water holding capacity, organic matter **(OM)** content, and the presence or absence of a restrictive layer (fragipan) differ among soil types. The Natural Resources Conservation Service has a web-based tool called the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov) that should be utilized to learn about the soils on the farm. Certain soil types will be adapted to some grass species better than others

Soil testing and fertilization

Cool-season grasses need sufficient soil nutrients to grow and thrive. A near neutral pH is not necessary for growing a pure stand or mixture of cool-season grasses as it is with alfalfa.

However, if a legume is grown with the grass, the soil pH should be at the level necessary for legume growth and development.

Soil nutrient deficiencies are a leading cause of seeding failures and poor yields, so test soils in advance of seeding, and in general, every 3 or 4 years. However, soils with low buffer capacity that have sand, loamy sand, or sandy loam textures should be sampled every 1 or 2 years because pH and nutrient content can change rapidly in these soil types. To track pH and soil nutrient level trends over time, collect samples at the same time each year since levels can vary seasonally. Soils that are very high in phosphorus (P) and potassium (K) will not require additional application of these nutrients to attain high yields. Nitrogen is typically the yield-limiting nutrient when grasses are grown as a pure stand. One of the advantages of a grass-legume association is that the source of nitrogen for grass growth is provided by the legume and no commercial nitrogen fertilizer will need to be purchased.

The only way to accurately know the amount of limestone and fertilizer needed for a particular soil, located in a specific field, and that

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has been managed in different ways is to collect and submit soil samples to a testing laboratory. Recommendations like, "apply 300 lb of a blended 12-12-12 fertilizer per acre" should be ignored because nutrients will either be under or over applied. Sampling soils properly, interpreting test results carefully, and applying recommended nutrients is important to a sustainable forage system. Recommendations for lime, nitrogen (**N**), phosphorus (as $\mathbf{P_2O_5}$), and potassium (as $\mathbf{K_2O}$) based upon soil test results are in Tables 1-3.

A good soil sample from a uniformly managed area of 25 acres or less can be obtained by taking one soil core per acre in a zigzag fashion. A soils map with the use of the Web Soil Survey can help locate different soil types in established forages. In tilled land, surface color and soil texture are good indicators of different soil types. Soil cores taken within 200 ft of a gravel road or field borders, or from other areas that are distinctly different from the rest of the field, should be sampled separately.

Soil samples should be taken to a depth of 8 inches at least 6 months prior to establishing forages. After establishment, take samples to a 4-inch depth and periodically sample at the 4- to 8-inch soil depth as soil nutrients can be more abundant in the surface 4 inches.

Shipping moist samples to a soil testing laboratory is acceptable, but very wet soil samples should be air-dried or oven-dried (< 120°F) to lower moisture before shipping. The analyses requested should include pH and buffer pH, available P, exchangeable K, calcium and magnesium, and cation exchange capacity (CEC; a measure of a soil's nutrient-holding capacity and resistance to change in pH; usually increases as clay and OM content increase).

Liming to adjust soil pH

Proper soil pH is a basic requirement for optimum plant growth, since pH affects the availability of soil nutrients to plants. If soil test results indicate that the soil is acidic (low pH), adding limestone will be recommended. Preferably, limestone should be applied at least 6 months before seeding to ensure sufficient time to lower soil acidity (i.e., raise the pH). If the soil test recommends 5 or more tons of limestone per acre, apply half of the limestone before the primary tillage and the other half before a secondary tillage, to ensure more uniform mixing of the limestone into the soil.

In Table 1, the liming rates for maintaining established pastures are about half of what is recommended for pasture or hay establishment because established pastures are not tilled before limestone application.

Most limestone recommendations are based on a 9-inch plowing depth. If a mineral soil (not a muck or peat soil) pH is more than 6.0 on established grass pastures or hay fields, and more than 6.6 on grass-legume pastures or hay fields, a limestone application is not needed. The Shoemaker-McLean-Pratt **(SMP)** buffer pH (or "lime index," as it is commonly called in soil test reports), measures how readily a soil's pH will change after a limestone application. Highly buffered soils (soils with a high cation exchange capacity) have lower lime index values and require more limestone than soils with a low CEC.

If soil test results recommend a limestone application and indicate that soil Mg is less than 150 lb/acre, consider applying dolomitic limestone because it contains up to 22.6% magnesium carbonate ($\mathbf{MgCO_3}$). Applying dolomitic limestone can address 2 issues at once, low soil pH and low Mg levels.

Fertilization and rate of application

The N, P (as P_2O_5), and K(as K_2O) fertilizer application recommendations shown in Tables 2 and 3 depend on yield goals. Rates of P and K are lower for established pastures than they are for establishing or reestablishing pastures or hay fields or maintaining hay fields because grazing animals return nutrients to established pastures. One of the inherent advantages of rotational stocking over continuous stocking is that animal manure is more evenly distributed on the pasture surface. This means P and K are also distributed more evenly, which helps maintain soil fertility and forage health and saves money.

The N recommendations shown in Table 2 are for established grass pastures and hay fields at various yield goals. Realistic yield goals for most midwestern pastures and hay fields are 2 tons of DM per acre for Kentucky bluegrass and 4 tons of DM per acre for tall-growing, cool-season grass species, such as orchardgrass or tall fescue.

The P and K recommendations in Table 3 for established forages show that significantly higher K rates are needed for grass-legume than grass-only pastures since grasses are much more competitive for available K than legumes.

Established fields with more than 30% legumes require no additional N. However, N can be important to pasture establishment. For instance, 15 lb/acre of N at seeding should benefit a grass-legume stand being established on light colored soils with less than 3% OM, and on coarse-textured (sandy) soils. For establishing a grass-only pasture or hay field, apply 50 lb/acre of N prior to the last tillage before seeding on mineral soils.

Timing of fertilizer application

Application timing is just as critical as rate when it comes to N fertilization of perennial grasses. The best way to fertilize cool-season grasses is to apply half of the recommended N in very early spring (mid- to late March), with a quarter applied in late spring and the final quarter applied in late August or early September. This approach should improve cool-season grass summer production when the moisture received is average or above average and should improve late summer and early fall growth.

An alternative fertilization method is to apply two-thirds of the recommended N in very early spring (mid- to late March), with the remaining third applied in late August or early September. If only one N application is made each year, it should be a broadcast application in the very early spring. For perennial warm-season grasses, apply N when the grass breaks winter dormancy, typically in the latter half of April.

Apply P and K annually according to yield goal and whether the stand is pure grass or grass-legume mixture. Do not apply K fertilizer in the late winter or early spring. Generally, K is not yield limiting until early summer and can have higher uptake by roots in the spring than is necessary for plant growth. To reduce the risk of exposing animals to fertilizer, remove livestock from the fields to be fertilized until a significant rainfall dissolves the fertilizer particles into the soil.

Sources of N, P, and K

For grasses, especially under dry soil conditions, ammonium nitrate is the preferred N source because it is less likely to volatilize to N gas. However, it is difficult to locate ammonium nitrate for purchase. Urea can be used effectively without volatilization loss if application is made when the soil is moist or just before a rain. Some urea products also are formulated to have less volatilization loss. Ammonium sulfate contains readily available N but creates more soil acidity than other N fertilizers.

Understanding fertilizer analysis

Knowing how to read a fertilizer analysis is critical to determine rate of fertilizer application. That begins by understanding what the 3 numbers in a fertilizer analysis represent. For example, for a fertilizer analysis of "18-46-0," the first number is the percentage of N, the second is the percentage of P_2O_5, and the third number is the percentage of K_20.

Phosphorus and K rate recommendations are always based on oxide formulations (P_2O_5 and K_2O); P_2O_5 (phosphate) contains 44% elemental P and K_2O (potash) has 83% elemental K. Nitrogen recommendations are always on an elemental basis. It's important to remember that the actual fertilizer application rate varies according to the fertilizer's analysis and the amount of the nutrient recommended.

Understanding a fertilizer's analysis and soil test recommendations will result in proper fertilizer rate application. Misunderstandings can result in costly misapplications. For example, a soil test indicates the need for 200 lb/acre of potash (K_2O); but if the applicator were to apply 200 lb of muriate of potash, which is 0-0-60 or 60% K_2O, only 120 lb/acre of K_2O would be applied, not the 200 lb/acre of K_2O recommended.

Forage Considerations

Many forage choices

Many forage crops are adapted to a geographical region. When selecting which forages to grow, consider soil characteristics, nutritional needs of the cattle class being fed, and whether the crop is to be used long term, or as a supplemental or doublecrop forage.

Forages are classified as grasses, legumes, or forbs. In the upper midwest, the majority of a dairy cattle producer's machine-harvested forage acreage should be a legume, such as alfalfa or red clover grown alone or with an adapted perennial cool-season grass. Excess K level, especially in legume forage, is not uncommon and should be monitored. Examples of cool-season grasses include tall fescue, orchardgrass, perennial ryegrass, smooth bromegrass, and timothy.

Perennial warm-season grasses do not warrant use by lactating dairy cattle as the nutrient profile does not meet the demands of this class of cattle. Paddocks of vegetative, perennial warm-season grasses like big bluestem and indiangrass can complement acreage of cool-season grass/legume paddocks when replacement heifers are being pastured.

Winter small grains (such as wheat, rye, and triticale) and annual ryegrass are commonly used as winter cover crops. They can be harvested in the spring prior to planting corn or soybean. Spring oat is another small grain that can be used as forage when sown alone or as a companion crop when seeding perennial forages. Date of seeding spring oat in the upper midwest is very early spring or in August. Unlike winter small grains, spring oat will not survive cold temperatures in the fall.

Annual warm-season grasses might be considered where there is an opportunity to doublecrop following wheat grain harvest or after a first cutting of hay where the stand is determined to be less than desirable. Typical warm-season annual grasses include sudangrass, sorghum-sudangrass, pearl millet, and teff. Sudangrass and sorghum-sudangrass with the brown midrib trait would be preferred over non-brown midrib options as energy value and intake should be enhanced with the trait.

The most common forb (neither a grass nor a legume) utilized in ruminant livestock agriculture in the midwest is turnip. Inclusion of the small grain spring oat with turnip makes a good combination since the turnip alone can exceed the energy requirement needed for grazing cattle and has less effective fiber than the turnip-oat mixture. Caution is advised to select turnip varieties that have been documented to have lower risk of imparting off flavor to milk.

Specifically, perennial cool-season grasses

Within adapted cool-season grasses, there are traits worthy of consideration before one selects the most right choice. Traits to consider include soil drainage, drought tolerance, fertility needs, pest resistance, forage quality, longevity of stand, length of growing season, date of pollen shed, and invasiveness. Table 4 provides detail about common cool-season grasses adapted to the midwest.

Within a specific cool-season grass, it is important to evaluate varieties carefully. Not only will there be potential differences in DM yield, but date of heading and resistance to disease organisms could be different. Date of heading is important as it is best to match flowering date of the selected grass variety with the flowering date of the selected legume. If the grass is earlier to mature than the legume, the quality of the resulting forage will be reduced if date of harvest is determined by legume morphology stage.

Nutrient Composition of Hay and Silage

The wellbeing of the cattle is highly correlated to a proper nutrition program. It is imperative that producers routinely sample and analyze stored forage feedstuffs so that a balanced ration can be prepared. Use of generalized feed composition tables for forages should not be used to balance a ration because forage quality is highly variable.

Updated information about hay probes, sampling procedure, where certified laboratories are located, and analytical procedures can be found at www.foragetesting.org.

Generalizations about cool-season grass forage quality as compared to legumes at a similar maturity stage is that they are lower in crude protein, similar in acid detergent fiber and digestibility, and higher in neutral detergent fiber, and thus, have lower intake level. Cool-season grasses are lower in lignin than legumes and have a higher final extent of digestion, but digestion rate is slower. Calcium and magnesium levels are lower in grasses than legumes.

It is important to understand that a similar cool-season grass grown in a warm or cool environment would have lower forage quality in the warm environment as lignin and fiber concentrations are higher. Caution is advised when evaluating response of livestock when fed forage without knowledge of where and when the crop being fed was harvested because of this environmental influence upon forage quality. Cool-season grass harvest should be timed before late boot stage, if high quality forage is the goal.

Evaluate Weekly

Potential concerns and forage growth should be evaluated weekly. Just like cattle, the well-being of the forage should be monitored often. Grazing to a height less than 4 inches should be avoided as the meristem tissue of highly productive forage plants can be damaged and result in less productive forages and weed encroachment. The only time overgrazing should be allowed is in the late fall when a pasture will have legumes reintroduced in late winter. There has been expressed concern regarding mowing height of orchardgrass, as many stands have been depleted more quickly than what would be expected. Orchardgrass stores nutrient reserves in lower stem bases, and if cut too low, less than 3 to 4 inches, length of stand could be reduced.

Weeds, insects, and disease concerns should be monitored as fields are scouted. Get a positive identification of pests so proper control measures can be considered and accomplished. Some weeds can be harmful to livestock if consumed.

If herbicides are used to control weeds, be aware of the harvest restrictions and crop rotation interval associated with the products that are candidates for use. Most herbicides used to control broadleaf weeds unfortunately will be harmful to legumes growing in association with a grass. Carefully consider whether the negative impact of the weeds present is more concern than the positive value of legumes in the forage stand.

Monitor the population of various insect pests and determine if their numbers warrant control. Harvest timing, genetic resistance, reducing other stress levels to the plants, and insecticide applications are approaches that can be used to minimize insect damage. Beneficial insects and infection of the detrimental insect with certain microorganisms can keep damage below the economic threshold.

Fungicide use on established forage crops is typically not a best management practice. The best approach to reducing plant disease is to select varieties that have resistance to diseases that are common to the crops selected and the soil where sown.

Conclusions

Managing forages properly is important to the well-being of livestock and the sustainability of the dairy enterprise. Value of the crop is affected by management provided. Utilizing best management practices is essential.

Resources

Much of the information was used with permission and adapted from: Cow-Calf Production in the U.S. Corn Belt. MWPS-66. Currently in production. 2011.© MWPS (Midwest Plan Service), Iowa State University, Ames, IA., www.mwps.org.

Forages – An introduction to grassland agriculture. 2003. 6th ed. Vol. I. Iowa State University Press. Ames, IA.

Management-Intensive Grazing in Indiana. 2007. AY-328. Purdue Cooperative Extension Service. 59 pp.

Purdue Forage Field Guide. 2010. ID-317. Purdue Cooperative Extension Service. 320 pp.

Table 1. Recommended agricultural limestone application rates for grass and grass-legume pastures.[1]

	Mineral Soils (less than 20% organic matter)	
	Soil pH < 6.0 Grass Only	Soil pH < 6.6 Grass-Legume
Buffer pH (lime index)	For Renovation/Maintenance Tons of Limestone/Acre Needed	
>70	0	1
68 to 70	1	1
67	1	2
66	2	2
< 66	3	4
	For Establishment/Reestablishment Tons of Limestone/Acre Needed	
> 70	1	2
69 to 70	2	2
68	2	3
67	3	4
66	4	5
65	6	8
< 65	7	8

[1]These recommendations are based on certain assumptions about previous limestone applications, tillage depth, and limestone quality. Adjust rates for the following:

a. If limestone was applied within the last year, subtract the amount applied in the previous application from the amount recommended here.
b. The establishment/reestablishment rates are based on a 9-inch tillage depth. Adjust rates by 10% for every inch of difference in tillage depth (decrease rate by 10% for an 8-inch depth, increase by 10% for a 10-inch depth). Do not adjust rates by more than 30% (3 inches).
c. Rates are based on 25 to 30% of the limestone passing through a 60-mesh sieve. If your liming product's fineness differs, check with your Extension Educator, crop consultant, or fertilizer representative for the appropriate adjusted rate at that level of fineness.
d. If you need to apply more than 5 tons/acre, a split application is recommended. Broadcast the first half and plow it down. Broadcast the second half and incorporate with a secondary tillage.
e. You may substitute 2 cubic yards of marl containing at least 70% calcium carbonate equivalent for 1 ton of standard agricultural ground limestone.

Table 2. Nitrogen (N) recommendations for established grass-only pasture and grass-only hay production[1]

Crop Use	Recommendation When Per-Acre Yield (Dry Matter Basis) Is: 2 tons	4 tons	6 tons
	lb N/Acre		
Grass Pasture	55	100	150
Grass Hay	75	140	210

[1]These recommendations are adjusted to credit the value of livestock manure based on 10 pounds of N is recycled per ton of forage dry matter produced.

Table 3. Phosphorus (P_2O_5) and potassium (K_2O) recommendations (lb/acre)[2] for grass-only and grass-legume pasture renovation/maintenance and establishment/reestablishment.[1]

			Grass-Only Pasture Recommendation When Per Acre Yield (Dry Matter Basis) Is:						Grass-Legume Pasture Recommendation When Per Acre Yield (Dry Matter Basis) Is:					
Bray	Exchange	Soil Test	2 tons		4 tons		6 tons		4 tons		6 tons		8 tons	
P_1	-able K	Level	P_20_5	K_2O	P_20_5	K_2O	P_20_5	K_2O	P_20_5	K_2O	P_20_5	K_2O	P_20_5	K_2O
			Renovation/Maintenance Levels											
0-10	0-80	Very low	80	60	100	120	120	180	100	240	120	360	140	480
11-20	81-150	Low	40	10	40	20	40	30	40	120	40	180	40	260
21-30	151-210	Medium	10	0	10	0	10	0	10	70	10	120	10	200
31-50	211-300	High	0	0	0	0	0	0	0	0	0	60	0	140
51+	301+	Very high	0	0	0	0	0	0	0	0	0	0	0	80
			Establishment/Reestablishment Levels[3]											
0-10	0-80	Very low	80	60	100	120	120	180	100	240	120	360	140	480
11-20	81-150	Low	60	50	80	100	100	150	80	200	100	300	120	420
21-30	151-210	Medium	30	40	50	80	70	120	50	150	70	240	90	360
31-50	211-300	High	20	30	40	50	60	90	30	80	50	180	70	300
51+	301+	Very high	0	0	20	0	20	0	20	0	40	120	50	240

[1]The renovation/maintenance recommendations are adjusted to credit the value of livestock waste based on 85% of the P and 50% of the K is recycled in the forage dry matter. No adjustments are made when the soil test is very low.
[2]2 lb/acre =1 part per million.
[3]Establishment/re-establishment values should be used when harvesting as hay or silage.

Table 4. Soil and Other Considerations for Selected Cool-season Grass Forages.[1]

Species	Soil pH (Minimum Adequate Level)	Soil Drainage[2] (Minimum Adequate Level)	Comments
Kentucky Bluegrass	5.8 to 6.5	SPD	Excellent quality, low yield, drought intolerant. Sod forming.
Orchardgrass	5.5 to 8.2	SPD	Use late-maturing varieties when legumes are a component of a mixture. Select varieties with disease resistance. Bunchgrass.
Reed Canarygrass	5.8 to 8.2	VPD	**Do not seed near natural wetlands.** Use low-alkaloid varieties. Harvest immature stages for best animal performance and to stop seed escape to natural wetlands. Many consider it an invasive species. Sod forming.
Ryegrass	5.6 to 6.2	SPD	Excellent quality, drought intolerant, quick establishment. There are canopy growth differences among varieties (compact or tall). Annual ryegrass is actually a weak perennial. Bunchgrass.
Smooth Bromegrass	5.8 to 6.5	SPD	Do not harvest regrowth too quickly between harvests (less than 6 weeks) or the stand can be depleted. Less productive at mid-season compared to tall fescue or orchardgrass. Sod forming.
Tall Fescue	5.0 to 8.5	SPD	Use low-endophyte or friendly endophyte varieties only. Drought tolerant, stockpiles well. Sod forming bunchgrass.
Timothy	5.4 to 6.2	SPD	Compared to other cool-season grasses, timothy is late to mature, and there is less production after first harvest. Winter hardy but not long-lived. Bunchgrass.

[1]From Purdue Extension publications AY-328 and ID-317.
[2]SPD = Somewhat poorly drained; VPD = Very poorly drained.