

Forages for Kentucky's Horses
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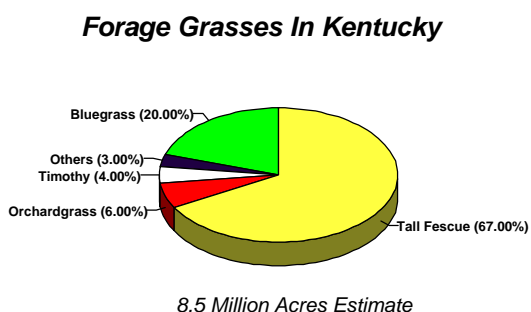
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Introduction

Kentucky has the climate and soil resource that allows the use of most forage species presently available for humid, temperate regions of the United States. While the Kentucky landscape is certainly dominated by tall fescue alone or in mixtures with red and white clover, other species add significantly to pasture and hay production (Figures 1 and 2).



However, a multitude of choices may make for difficult decisions in designing a horse pasture and hay system. In addition, after a species is chosen, what variety of that species should be

Figure 1. Forage Grasses in Kentucky

sown. Data exist to aid in selecting varieties, but an understanding of the value of better varieties is important to making an informed decision.

Selecting a Species

Species selected for use as horse pasture should be high yielding, persistent, tolerant of the anticipated level of management and adapted to the region and to the soil conditions in the field to be seeded. To generalize, nearly all species of forage crops can be utilized for pasture, especially if rotational grazing is practiced

(Table 1). However, if pastures are to be frequently and closely grazed then mixtures containing combinations of Kentucky bluegrass, orchardgrass, endophyte-free tall fescue, ryegrass (perennial and annual) and/or white clover are best. Endophyte-infected tall fescue can be used alone or in mixtures in areas that will not be grazed by mares in late gestation.

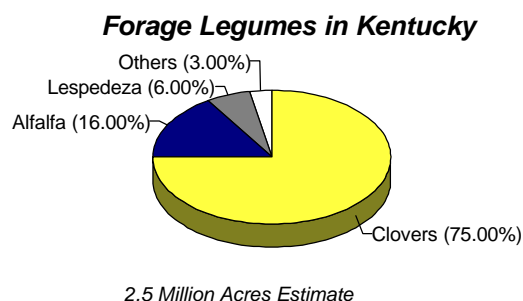


Figure 2. Forage Legumes in Kentucky

Table 1. Suitability of major forage species for grazing and hay in Kentucky.

Species	Frequent, Close Grazing	Rotational Grazing	Stored Feed
Alfalfa	□	■	■
Red Clover	□	■	■
White Clover	●	■	□
Ryegrass	●	■	■
Tall Fescue, endophyte infected	●	■	■
Tall Fescue, endophyte free	□	■	■
Bermudagrass	■	■	■
Orchardgrass	□	■	■
Bluegrass	■	■	●

□ Not Suitable ● Suitable ■ Highly Suitable

Certain species should be avoided. Tall fescue that is infected with the endophytic fungus *Neotyphodium coenophialum* should not be planted for pasture for pregnant mares. Infected tall fescue can cause abortion, prolonged gestation, agalactia, foaling difficulty and foal and/or mare mortality if grazed in the last trimester of gestation. In addition, horses should not be allowed to graze the sorghum species (sudangrass, sorghum-sudan hybrids, johnsongrass, forage sorghum) as this can cause cystitis. The hay of these species is not harmful. Finally, birdsfoot trefoil can cause photosensitization in the unpigmented skin of light colored horses.

There are many questions that must be answered to properly select the forage or forages that would make up the ideal or optimal system for horses. The producer must define the role, the forage production goal, the method of use and the ‘utilizer’, the level of management available, the soil/land limitations, and the time limitations.

Defining the role.

There must be a clear understanding as to what role a forage will play. Will it be the primary base grass in a pasture system or will it be a supplemental forage interseeded into existing forage? Will the forage be permanent (a perennial) or a temporary (an annual) addition to the system? What

will be the primary season of use? A species selected for fall or winter grazing will probably be of little value during the heat of August. Likewise, a productive summer forage will likely have a relatively short (but productive) growing season compared to a species like tall fescue.

Defining the forage production goal.

Ultimately, a forage system must provide enough dry matter to carry a given set of animals for the year and also meet the desired quality standards of the horses that will be grazing or consuming the forage. Forages must therefore produce enough dry matter yield per acre to meet these needs. Also, that yield should come at such a time as can be used efficiently. The most efficient method

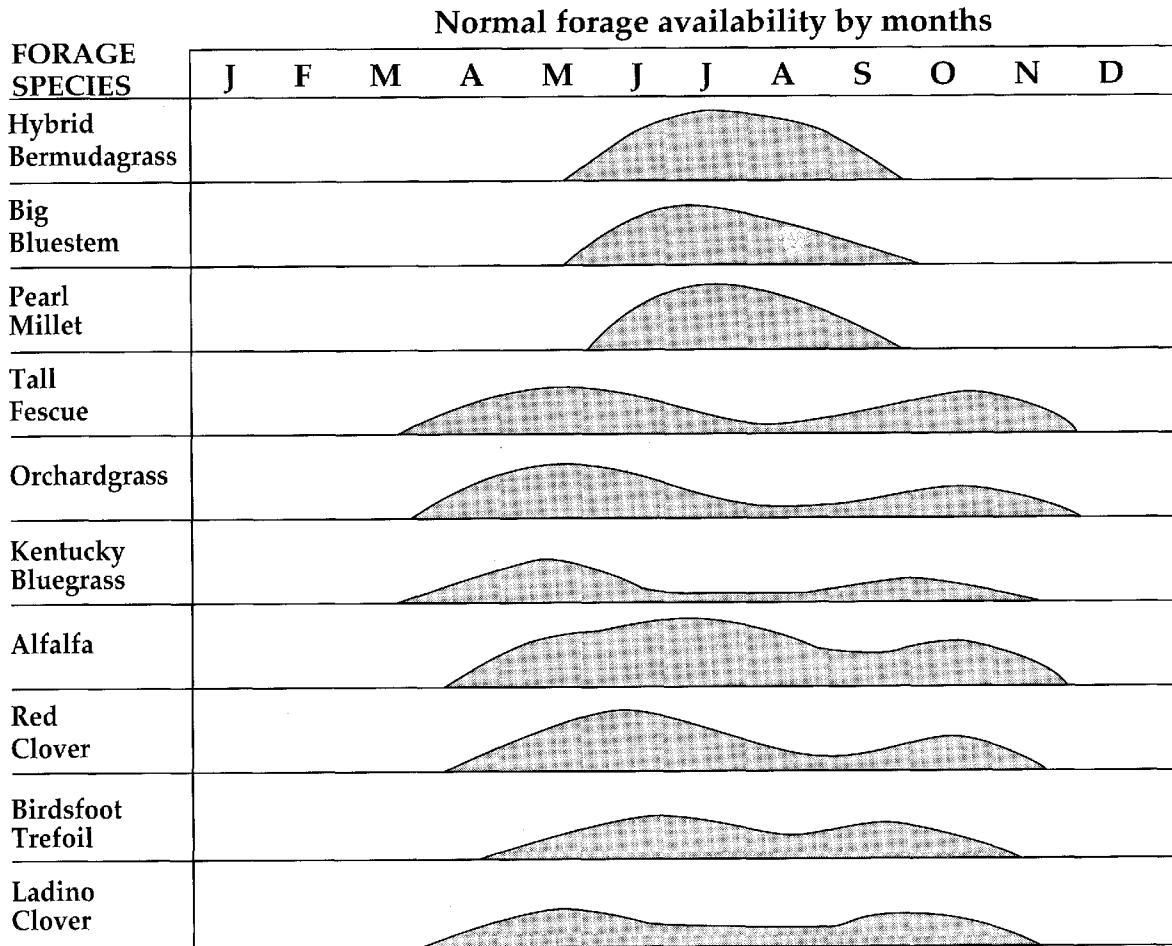


Figure 3. Monthly growth distribution of common Kentucky forages. From Southern Forages.

of forage utilization is grazing; it is estimated that nutrients supplied by grazing cost approximately half of those supplied by stored feeds such as hay and silage. Therefore, production during the time of animal need would be highly desirable.

Forage crops adapted to Kentucky can be classified as ‘cool season’ or ‘warm season’ species based on their optimum season of growth (Figure 3). Tall fescue, orchardgrass, bluegrass, timothy, red clover, alfalfa, and white clover are cool season forages, while bermudagrass, pearl millet, and big bluestem are examples of warm season species. Even though species like alfalfa and red clover are known to be more productive during mid-summer than fescue or bluegrass, these are still cool season species whose growth slows greatly during hot, summer months.

Most horse pastures need to be dual purpose and supply good nutrition but also provide good hoof support and ground cover. Often nutrition is secondary because of supplemental feeding. A common goal of most horse producers is to manage existing pastures for thick uniform grass growth that will withstand periods of heavy grazing and traffic.

Defining the method of use.

A significant constraint to forage selection is the intended method of utilization. Systems that allow for a rotation of pastures and periods of rest/recovery from grazing offer many more forage selection options. On the other hand, systems that involve continuous grazing or that will suffer excessive traffic during dormant or wet seasons have fewer options. In extreme cases (such as winter feeding pastures) there may not even be a good, permanent solution. Often, the question of ‘Am I willing to rotate pastures?’ must be answered very early in the forage selection process. Not being realistic in this area can lead to unrealized expectations, disappointment, and often significant financial losses. For example, alfalfa is a species that must be rotationally grazed for maximum stand persistence and maximum economic animal performance. As good as it is, alfalfa cannot and will not persist nor give proper animal performance when grazed continuously.

Defining the ‘utilizer.’

The type of horse and its growth stage will determine its nutritional needs and also will help define the forage options available. This is especially important relative to the use of existing, old fields of tall fescue by horses. Old fields of tall fescue are probably infected with a fungal endophyte that spends its whole life cycle inside the plant. The presence of this endophyte makes the plant more drought tolerant but causes serious problems to mares in late gestation. However, there is no problem using fescue pastures for mares in early gestation or for other types of growing or mature horses. Therefore, fescue may be a great choice for yearling pastures or stallion paddocks because of its tolerance of grazing and traffic. However, it would be a very poor choice for pasture or hay for pregnant mares, especially in late gestation.

Defining the level of management available.

Requirements for good forage growth and persistence may include pasture subdivisions (to aid in good rotations), soil fertility, weed control, rotational grazing, residual height management, fall rest for winter hardiness, and insect control. Without pasture subdivisions and the ability to rotate pastures, certain forages (like alfalfa, Matua Prairie Grass) will not be viable options. Meeting fertilizer needs of a crop are necessary for production and persistence. Likewise, more intensive pest management is required for some crops, such as alfalfa. While controlling the alfalfa weevil and potato leafhopper do not always require the use of insecticides, the economic thresholds of each one as well as the proper cultural controls must be understood and be incorporated into the grazing plan.

The level of management available determines what can be achieved from a forage system. In particular, the ability to maximize forage growth rates by using a good, fast (3 to 5 days of grazing followed by 30 to 40 days of rest) rotation will allow the maximum production of high quality forage per acre and consequently, animal output should be equally high. Also, soil nutrient must be managed to supply the mineral needs of the plant.

Defining the soil resource.

What are the soil limitations of the fields in the grazing system? Is the soil fertility and pH known on pasture fields. Surveys of Kentucky's pasture fields indicate that most are low in phosphorus and also need lime to raise the pH. Acid soils and low soil-P are severe limitations to legume production. While some legumes such as annual lespedeza and birdsfoot trefoil are tolerant of acid soils and lower fertility, most are not productive or persistent under the same conditions.

Other significant soil limitations include rooting depth, drainage, and topography. Shallow soils are droughty and stress forage plants during hot, dry weather. Soils that are poorly drained place stresses on the root systems of forage crops and may be unsuitable for species like alfalfa and many of the native warm season grasses. Severely rolling topography may remove annual crops such as sudangrass or millet as options for forage systems because of their inaccessibility to planting equipment. Even applying fertilizer and lime on these fields is a challenge in some cases.

Soil fertility is an addressable limitation in forage systems, and forage systems recycle a large portion of nutrients that plants take up during the growing system. However, seldom can all fields be 'brought up to soil test' at one time. But the important point is to know what the fertility limitations are, where they are, and to have a plan for best using these fields in the forage system.

Defining the time constraints.

Making changes in a forage system take time. Making big changes in a forage system take a lot of time. Some forages by nature can have an immediate effect, but their effect is often short-lived. Sudangrass, pearl millet, german millet, wheat, and rye can have immediate effects but these are annuals. Perennials like tall fescue, orchardgrass, and bluegrass have longer periods of usefulness.

Designing a forage system must allow time for perennials to become established. Not allowing enough time for establishment is perhaps the greatest cause of stand failure and reseeding in horse pasture. If adequate time cannot be planned or provided for, plan on re-seeding that area every other year or so. A species such as perennial ryegrass can be good for this purpose, since it is a fast starter and only lives two or three years under most conditions.

Summarizing Forage Characteristics in Kentucky

A summary of many agronomic characteristics of several forage crops that can be grown in Kentucky are shown in Tables 2 and 3. Also, estimates of forage quality of several forage crops are found in Table 4. Forage quality can deviate significantly from these values; always take a forage analysis to know the nutrient value of forages. Use these values to help decide whether a given forage will meet the needs of the intended animal.

Table 2. Characteristics of Perennial Cool Season Grasses in Kentucky

(0)Grass	<i>Tolerance to:</i>							
	(0)Heat/ (0)drought	(0)Flooding	(0)Frequent cutting	(0)Frequent grazing	(0)Winter Hardiness	(0)Seedling vigor	(0)Sod Forming Capacity	(0)Adaptation to Kentucky
Tall Fescue - Infected	<i>E</i> ¹	<i>G</i>	<i>E</i>	<i>E</i>	<i>E</i>	<i>G</i>	<i>G</i>	<i>E</i>
Tall Fescue - Non-infected	<i>F</i>	<i>G</i>	<i>G</i>	<i>F</i>	<i>E</i>	<i>F</i>	<i>G</i>	<i>G</i>
Orchardgrass	<i>G</i>	<i>P</i>	<i>G</i>	<i>F</i>	<i>E</i>	<i>G</i>	<i>F</i>	<i>E</i>
Bluegrass	<i>P</i>	<i>F</i>	<i>G</i>	<i>E</i>	<i>E</i>	<i>P</i>	<i>E</i>	<i>E</i>
Timothy	<i>F</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>E</i>	<i>G</i>	<i>P</i>	<i>E</i>
Matua Prairie Grass	<i>F</i>	--	<i>P</i>	<i>P</i>	<i>G</i>	<i>G</i>	<i>F</i>	<i>F-G</i>
Smooth Brome	<i>F</i>	<i>F</i>	<i>P</i>	<i>P</i>	<i>E</i>	<i>G</i>	<i>G</i>	<i>P-F</i>
Reed Canarygrass	<i>G</i>	<i>E</i>	<i>G</i>	<i>G</i>	<i>E</i>	<i>F</i>	<i>E</i>	<i>G</i>
Perennial ryegrass	<i>P</i>	<i>P</i>	<i>E</i>	<i>E</i>	<i>F</i>	<i>E</i>	<i>P</i>	<i>F</i>

¹ E=Excellent, G=Good, F=Fair, P=Poor. Values presented are estimates. Conditions and actual performance will vary widely across Kentucky. Bluegrass for example is very well adapted to central and eastern Kentucky, but not well adapted to southern and western areas.

Table 3. Characteristics of Perennial Legumes in Kentucky

(0)Legume	Tolerance To						(0)Seedling (0)Vigor	(0)Bloat Risk
	(0)Heat/ (0)drought	(0)Wet	(0)Winter Hardiness	(0)Haying (0)	(0)Grazing	(0)Acidity		
Alfalfa	<i>E</i> ¹	<i>P</i>	<i>E</i>	<i>E</i>	<i>F</i>	<i>P</i>	<i>G</i>	<i>Yes</i>
B. Trefoil	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>F</i>	<i>G</i>	<i>P</i>	<i>No</i>
Crown -vetch	<i>G</i>	<i>P</i>	<i>F</i>	<i>P</i>	<i>F</i>	<i>G</i>	<i>P</i>	<i>No</i>
Sweet Clover	<i>E</i>	<i>P</i>	<i>E</i>	<i>P</i>	<i>F</i>	<i>P</i>	<i>G</i>	<i>Yes</i>
Red Clover	<i>F</i>	<i>F</i>	<i>F</i>	<i>E</i>	<i>G</i>	<i>F</i>	<i>E</i>	<i>Yes</i>
White Clover	<i>P</i>	<i>F</i>	<i>P</i>	<i>P</i>	<i>E</i>	<i>F</i>	<i>F</i>	<i>Yes</i>
Alsike Clover	<i>F</i>	<i>G</i>	<i>P</i>	<i>P</i>	<i>F</i>	<i>G</i>	<i>G</i>	<i>Yes</i>

¹ E=Excellent, G=Good, F=Fair, P=Poor.

Table 4. Forage Quality Values for Selected Forages.

Crop	CP,%	ADF,%	NDF,%	TDN,%	RFV
Alfalfa					
Bud	22-26	28-32	38-47	64-67	127-164
E.bloom	18-22	32-36	42-50	61-64	113-142
Mid bloom	14-18	36-40	46-55	58-61	98-123
Cool Season Grasses					
Vegetative to early boot	12-16	30-36	50-56	61-66	101-122
Boot to early head	8-12	36-42	56-62	56-61	84-101
Warm Season Perennial Bunchgrass					
<Boot	10-14	35-40	55-60	58-62	90-104
Mature/head	6-10	40-50	60-75	50-58	62-90
Warm Season Ann. Grass					
	10-14	35-40	55-60	58-62	90-104
Red clover					
Early flower	14-16	28-32	38-42	64-67	142-164
Late flower	12-14	32-38	42-50	59-64	110-142
Ann. Lespedeza	12-16	35-40	45-55	58-62	98-127

Selecting Improved Forage Varieties:

The Value of Improved Forage Varieties

A forage variety should be high yielding, persistent, adapted to Kentucky, nutritious, palatable, and free from known antiquality components. In addition, it should be tolerant of the anticipated method of utilization and level of management. The variety chosen should be 'improved,' which means that it has been bred, tested, and proven to have better traits or performance than older varieties. The variety should be certified (denoted by a blue tag on the bag) or at least a proprietary variety on which performance data is available.

A significant amount of forage seed is purchased annually in Kentucky. If 50,000 acres of alfalfa are reseeded each year, this amounts to approximately 1 million pounds of alfalfa seed. If 10% of the fescue acreage is overseeded with red clover at the rate of 10 pounds per acre, then over 5.5 million pounds of red clover seed move across agri-business counters in the state. Grass seed sales are somewhat harder to estimate, but are significant for new hayfields or as cover crops behind tobacco or wheat. In addition, orchardgrass is usually included in mixes with new alfalfa seedings. Conservatively speaking, over 600,000 acres of land in Kentucky are seeded or overseeded with some type of forage annually. Therefore, improving productivity of these acres by choosing an improved variety would have a large impact on the potential farm income from forage livestock systems. These improved varieties should represent an increase in yield, persistence, and disease/pest resistances.

Why aren't improved varieties used more often? The answer to this question has several parts. First, it is the indirect nature of the marketing of forages that can make farmers resistant to adoption of newer varieties. Also, because the yield of most forage crops are spread over multiple harvests and over multiple years in the case of perennials, differences in yield are particularly hard to see. Finally, because of the costs of development and promotion, newer varieties are almost always more expensive than older brands of seed. As a result, there is a strong tendency for farmers, when buying seed, to choose older brands, even uncertified varieties. In doing so, their actions have just stated very strongly that they feel there is no difference between the older, unimproved seed and new varieties.

Benefits from using improved forage varieties.

Seed quality.

The seed quality standards of companies marketing newer certified varieties of forage crops often exceed that required for certification. For example, the minimum requirement for germination of certified red clover seed is 85%. However, companies may specify that total germination be 90%, depending on their standards. Certified seed will be very free of other crop seed, inert material, and weed seed.

Consistent Performance.

Certified seed is your assurance that the performance on your farm will match the name on the bag. The major forage crops in Kentucky are primarily cross-pollinated. However, unlike hybrid seed corn, forage varieties may have 20 or more parents. These 'parent plants' are seeded from foundation or breeders seed in an area that can be excluded from pollination by 'wild' or other

plants of the same species. The seed harvested from this field is classified as 'certified.' The process of seed certification involves a process where this isolation is checked. In the case of uncertified or common seed, there is no verification of isolation or any other standards.

Finally, what is in a name?

There is quite a bit of confusion about whether buying uncertified Kenland is actually buying an 'improved' variety. The perception of producers is that buying a 'name' variety is in fact buying an improved variety. As the 'Porgy and Bess' song goes, 'It ain't necessarily so.' But, you say, haven't we been stressing the importance of buying newer named varieties and to avoid common seed. Yes, but seed can be sold under the names of varieties that were developed by public institutions or even companies as long as that variety was not plant variety protected (called PVP). However, farmer expectations from buying a 'named' variety are high, even if it is not certified. The best example of this in Kentucky is 'Kenland' red clover. There is very little certified 'Kenland' but a great deal of uncertified 'Kenland' available. University of Kentucky research has shown that the performance of uncertified lots of 'Kenland' vary greatly and in general are much poorer than that of certified varieties (Table 5). Sigafus and Taylor found that, out of 10 uncertified lots of 'Kenland' seed from a variety of sources, only 2 had any measurable yield in the third year after seeding into wheat compared to 3.4 tons per acre for 'Kenstar'. Six of these produced less than half the yield of Kenstar in the second, or primary year of red clover growth.

How to avoid the 'name' trap.

Generally, all newer varieties released by universities or companies protect the name of the variety by a process known as 'Plant Variety Protection.' That is, you will never be able to find uncertified 'Renegade', 'Redland III,' or 'Cinnamon' red clover if they are PVP'ed. If seed is taken from these fields that does not meet the company standards or certification standards, then it cannot be sold under the brand name. However, with older varieties like 'Kentucky 31' tall fescue, and 'Kenland' red clover, seed can be sold under the name without certification. The best way to be sure that you are going to get the performance to match the name is to look for the blue certified seed tag.

Availability.

Proprietary varieties will be consistently available at agri-business outlets. Their supply will show less fluctuation than the stocks of common or uncertified seed.

Improved Performance.

Table 5

Yields in 1978-79 of Certified Kenstar, Uncertified Kenland, and Several Lots of Common Red Clover (Sown at Lexington, March 25, 1977).*

Seed Origin	Lot number	Identification	1979 Yields					2 Yr.Total
			1978	May 29	July 3	Aug 13	Total	
----- tons dry weight per acre -----								
Ky.	59-L38-1554	Kenstar	4.00 a	2.06 a	0.98 a	0.36 a	3.40 a	7.40
Ore.	FSA-4778	Kenland	3.67 ab	1.76 b	0.76 b	0.16 b	2.71 b	5.46
Ky.	0-1384	Variety Unknown	3.25 bc	1.72 b	0.77 c	0.15 b	2.53 bc	5.78
Ill.	0.340	Red clover	2.95 cd	1.42 d	0.44 e	0.10 c	1.96 e	4.91
Mo.	0-964	Variety Unknown	2.91 cd					2.91
Ore.	0-402	Kenland	2.65 de	1.67 c	0.65 d	0.13 c	2.45 d	5.10
Ore.	0-473	Kenland (Aff.)	2.26 ef					2.26
Ore.	0-104	Kenland	2.17 ef					2.17
Ida.	0-533	Red Clover	2.17 ef					2.17
Ohio	0-125	Variety Unknown	2.06 e-g					2.08
Ore.	0-243	Kenland	1.93 fg					1.93
Mich.	0-229	Medium red	1.90 fg					1.90
Ore.	FSAM-4772	Kenland	1.68 f-h					1.68
Ore.	0-787	Kenland	1.51 gh					1.51
Ore.	0-282	Kenland	1.12 hi					1.12
Ore.	0-371	Kenland	0.67 ij					0.67
Minn.	0-111	Red clover	0-58 ij					0.58
Ore.	0-370	Medium red	0-51 j					0.51
Ore.	0-115	Red clover	0-41 j					0.41
Ore.	0-730	Kenland	0.24 j					0.24

Ultimately, there must be some measurable benefit in terms of yield, persistence, quality, or disease resistance to justify the increased cost of newer, improved varieties of forage crops. The University of Kentucky is currently conducting yield trials of several forage crops, including alfalfa, red clover, tall fescue, orchardgrass, bluegrass, and timothy. Alfalfa is tested in a cooperative program with Dr. Linda Brown at Western Kentucky University in Bowling Green.

Variety Differences/ Yield

A primary determinant in variety selection must always be yield. Yield more than an estimate of productivity; it is an indirect measure of the persistence and disease resistance of a variety. For example, alfalfa varieties that perform well at the Bowling Green site of the Kentucky Forage Variety Trials, a site that is infected with both phytophthora and aphanomyces have proven that they can tolerate these soil diseases and yield well and persist at the same time.

Orchardgrass Variety Differences

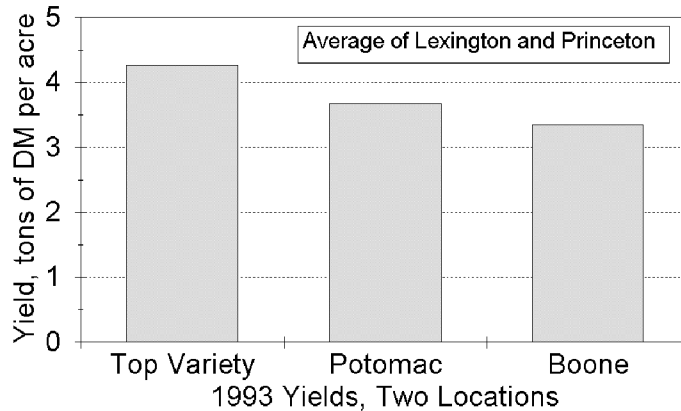


Figure 4

Present Yield Data in Kentucky.

Each year, data is collected on dry matter yields of alfalfa, red clover, tall fescue, orchardgrass across Kentucky. These are regularly published as Progress Reports of the Agricultural Experiment Station of the College of Agriculture at the University of Kentucky. These are available at no cost from each county extension office. In addition, occasional reports on timothy and bluegrass variety performance are available.

Orchardgrass.

The differences in the yields of orchardgrass varieties are not as large as with alfalfa or red clover, but are significant also.

Boone orchardgrass yielded significantly less than the top variety for yields taken in 1993 at Lexington and Princeton (Figure 4). Potomac yields were intermediate and were consistently numerically lower than the top varieties.

Tall Fescue.

Yield differences were present among tall fescue varieties seeded in the fall of 1992 and harvested in 1993 at Lexington and Princeton (Figure 5). The highest yielding

Tall Fescue Variety Differences

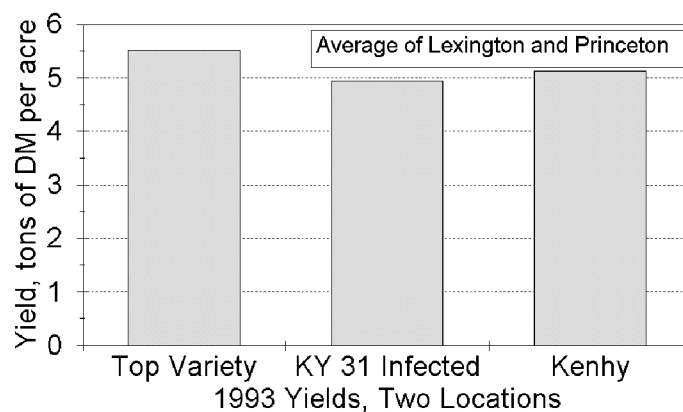


Figure 5

varieties at each location were consistently numerically greater than that of Kentucky 31 (infected) and Kenhy.

Alfalfa.

As the highest yielding, highest quality forage crop raised in Kentucky, alfalfa has the most variety options available. The difference in seeding better varieties of alfalfa can be seen in the disease resistance levels of older varieties compared. Varieties such as Buffalo, Saranac AR, Liberty, and Arc are susceptible to Phytophthora Root Rot, where almost all other varieties of alfalfa marketed in Kentucky have at least an 'MR' or moderately resistant rating to this disease.

However, yields differ as well. Choosing any one of the top five varieties from Lexington, Bowling Green, or Princeton location data would generate an average of 1440 pounds of dry matter per acre *each year* compared to the check varieties of Arc, Buffalo, Liberty, and Saranac AR. (Table 6).

The difference in seed cost between the checks and the best varieties is about \$2.00 per pound. At a 20 pound per acre seeding rate, the extra cost of seeding the best alfalfa compared to the checks would be \$40 per acre, which is certainly a significant figure. However, 1440 pounds of dry matter amounts to 1700 pound of 15% moisture content hay. At \$85 per ton, this equals \$72 extra revenue per acre per year from better varieties of alfalfa. Over 5 years, this extra yield totals 4.25 tons of hay per acre on average, and at \$85 per ton, an extra \$361.25 per acre over the life of the stand.

Table 6. Average annual dry matter yields of top 5 alfalfa varieties and of check varieties (Arc, Buffalo, Liberty, Saranac AR) for five yield trials across Kentucky. (Lex = Lexington, BG = Bowling Green, Prn = Princeton).

Test Site- Seeding Year	Lex-1990	Lex-1991	BG-1990	BG-1992	Prn-1990	Average
----- Yield, lb of dry matter per acre -----						
Top 5	9,200	10,200	11,400	10,200	9,800	10,160
Checks	8,000	9,000	10,000	8,200	8,400	8,720
Difference	1,200	1,200	1,400	2,000	1,400	1,440
-----Hay equivalent 15% moisture content hay, lb per acre-----						
	1,410	1,410	1,650	2,350	1,650	1,690
Value @ \$85/ton	\$60	\$60	\$70	\$100	\$70	\$72

Red Clover.

Using improved, certified varieties of red clover has been a consistent recommendation of UK for Kentucky's producers. However, the difference in cost between uncertified, common red clover and improved certified red clover seed can exceed \$1 per pound.

Research was begun at the University of Kentucky in the spring of 1991 to compare the yields of improved, certified red clover to that of four unidentified common medium red clovers obtained from local distributors. In the first year, the difference between the average

Red Clover Variety Effect

Certified Vs. Common Seed

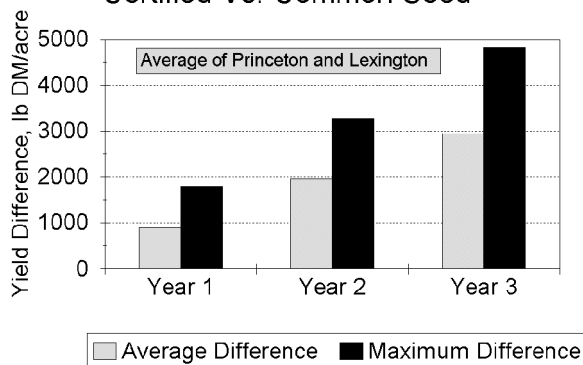


Figure 6

performance of the certified varieties in the test and the average of the four commons was over 1000 pounds of dry matter per acre (Figure 6). In the second and third years, the average effect of seeding an improved, certified variety of red clover was worth almost 2000 lb/A and 3000 lb/A, respectively.

However, if a farmer is going to plant a better variety, he or she is not going to select the "average" variety, they are going to go after the best. Also, since buying a common variety of red clover is, by definition, getting an unknown product, it is valid to compare the difference between the best and the worst red clovers in the trial (Figure 6). We found that differences in stand height were visible in the plots within 18 months of seeding. In addition, there was visible thinning of the common stands by fall of the first full production year. Comparing the stand and yield of the best/worst red clovers indicates that the advantage of using the "best" variety according to these yield tests was worth 5.3 tons of dry matter or over 6.2 tons of 15% moisture hay. Most of this difference in yield occurred at the end of the stand life when the commons failed to persist. The bottom line is that seeding an improved variety of certified red clover seed pays in terms of yield and stand, period.

Putting an economic value on the forage generated from the investment in better seed is equally impressive. Seeding 10 pounds of seed of red clover in tall fescue would cost approximately \$10 more per acre compared to common seed. If you value the 6.2 tons of hay at \$80 per ton, then the net improvement in income per acre over a three period would be \$496 minus \$10 or \$486. Seeding better red clover truly pays.

Variety Differences/ Grazing

Current Research on Grazing Tolerance

The University of Kentucky has just concluded the first experiments to determine the survival of selected varieties of orchardgrass and tall fescue and alfalfa under abusive continuous grazing management. Stands were established in the fall of 1994 and then closely and continuously grazed in 1995 and 1996. An initial hay harvest was made each year and forage was allowed to grow to about 6 to 8 inches before initiating grazing. Duplicate plots were maintained that were only harvested for hay. The data from these initial experiments are summarized below.

Orchardgrass

Orchardgrass was much less tolerant of grazing than tall fescue (Table 7). In general, the winter of 1996-97 was very damaging to orchardgrass stands in general. Plots managed for hay were

thinned to 1/3 to 1/2 of a full stand. Table 7. Effect of 2 years of use of orchardgrass thinned the stands of all varieties to unacceptable levels.

Table 7. Effect of 2 years of use of orchardgrass thinned the stands of all varieties to unacceptable levels observed July 17, 1997 at Lexington, Kentucky

	Grazing	Hay
Orchardgrass Variety	Percent Stand	
Shiloh	18.8*	41.5*
Benchmark	15*	50*
Dawn	11.3*	43.8*
Takena	11.3*	45*
Condor	7.5	32.5*
Potomac	7.5	38.8*
Hallmark	7.5	42.5*
Warrior	6.3	32.5*
Pizza	3.8	33.8*
LSD, %	8.2	18.6
CV, %	60	32.1
R-square	0.47	0.67
<p>LSD is the least significant difference. CV is a measure of the variation within the study, and R-square is the amount of the variation that is due to variety.</p> <p>*: Values followed by an "*" are not significantly different from the highest value in the column.</p>		

Tall Fescue

Tall fescue was more tolerant of abusive grazing and the winter conditions (Table 8). The presence of the endophyte was not necessary for survival of tall fescue. Cattle Club and Richmond, both endophyte free, were statistically equal to endophyte infected Kentucky 31. Infected Kentucky 31 is generally considered to be the most grazing tolerant variety of tall fescue.

Table 8. Effect of 2 years of close grazing or hay management on percent stands of tall fescue varieties observed July 17, 1997 at Lexington, Kentucky

	Grazing	Hay
Tall Fescue Variety	Percent Stand	
Cattle Club	83.8*	83.8*
Kentucky 31 - Infected	72.5*	86.3*
Richmond	72.5*	88.8*
Johnstone	56.3	76.3*
Kentucky 31 - Uninfected	56.3	88.8*
GaJesup - Uninfected	47.5	77.5*
Stargrazer	35	75*
LSD	21.6	17.8
CV,%	31.8	18.7
R-square	0.72	1.81

LSD is the least significant difference. CV is a measure of the variation within the study, and R-square is the amount of the variation that is due to variety.

: Values followed by an "" are not significantly different from the highest value in the column.

Alfalfa

Currently, there is a great expansion of alfalfa varieties being marketed as ‘grazing’ types. The first of these was “AlfaGraze”, a product of the forage breeding program at the University of Georgia. Several others have been released and marketed subsequently, such as Pasture Plus, Pro-Grazer, Haygrazer, Spredor 3, and Graze King. Many more are expected. Independent data on the true grazing tolerance of these varieties is limited. However, there are mature stands of AlfaGraze in Kentucky that have been grazed moderately (a mixture of long rotation and continuous grazing) for over 5 years. These stands have shown a ‘normal’ decline in plant density as would be seen in any alfalfa field. However, compared to “Apollo”, AlfaGraze did have denser and more vigorous stands at the end of 5 seasons of use (Table 9).

Table 9

The effect of moderate grazing pressure on stand density and vigor* of two alfalfa varieties after 5 seasons of use** on a Lincoln County, Kentucky beef cattle pasture.		
Variety	Plants per Square Foot	Percent Ground Cover
AlfaGraze***	1.9	23.5
Apollo	0.6	5.5

* Seeded March, 1990. Interseeded with orchardgrass two years after seeding.
** Data are averages of ten random locations within the field, taken 9/30/94
*** The variety effect is highly significant (P = 0.01)

In general, the varieties selected for grazing tolerance held up well after two seasons of grazing (Table 10). Grazing tolerant types such as AlfaGraze and ABT 205 were much more tolerant of abusive grazing than traditional hay types (considered grazing intolerant) such as Apollo and Pioneer 5373.

Table 10. Effect of 2 years of close grazing management on percent stands of alfalfa varieties on June 7, 1997 at Lexington, Kentucky.

Alfalfa Variety	Percent Stand
AlfaGraze	62.6*
Wintergreen	60*
ABT 205	57.5*
Quantum	45*
Spredor III	45*
ABT 405	45*
Cut-N-Graze	42.5*
Pasture Plus	37.5
Magnagraze	35
Apollo	30
Fortress	25
Legacy	20
Rushmore	20
Pioneer Brand 5373	12.5
LSD	21
CV, %	35.8
R-square	0.71
<p>LSD is the least significant difference. CV is a measure of the variation within the study, and R-square is the amount of the variation that is due to variety.</p> <p>*: Values followed by an "*" are not significantly different from the highest</p>	

Summary

Select a species based on its ability to yield, to persist, to supply the quality needed, and to meet the seasonal needs of the livestock to be fed. A species should be tolerant of the type of utilization and management that it will receive. Good varieties will be resistant to economically significant diseases, will be high yielding over many years and in many different locations, and will show good adaptation and persistence. Use objective sources of variety information such as university yield trials plus local experience to aid in the variety decision.

Newer varieties of tall fescue will be available that are free of the fungal endophyte and will be equal or superior to older varieties in yield. Likewise, the best varieties of orchardgrass outyield Potomac and Boone. Improved alfalfa varieties will continue to have superior pest resistance profiles plus will average 1700 more pounds of hay per acre compared to Arc, Buffalo, Saranac AR, and Liberty. Finally, seeding a top variety of red clover will persist longer and yield up to 6.2 tons more hay per acre than common red clover (over 3 years). The extra value gained by seeding improved alfalfa or red clovers can total \$361.25 and \$496 per acre, respectively, over the life of the stand (depending on the value placed on hay). Truly, seeding improved forage varieties pays, period.

Finally, the grazing tolerance of varieties of orchardgrass, tall fescue, and alfalfa vary significantly. Trials at UK have demonstrated that fescue is more tolerant of overgrazing than orchardgrass. Endophyte-free tall fescues have been found to be as tolerant of overgrazing as endophyte-infected Kentucky 31. These grazing tolerant varieties of endophyte-free tall fescue could prove to be very useful to horse owners to replace acres now in endophyte-free tall fescue.

Fescue, the Endophyte, and Horses

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Tall fescue (*Festuca arundinacea* Schreb.) is the most important cool season grass grown in the United States. It is one of the most widely adapted grass grown in the U.S., having been identified in every state. At present, it occupies approximately 35 million acres in the U.S. with approximately 5.5 million acres in Kentucky. Tall fescue is a versatile plant used for livestock feed, lawns many turf purposes, and for erosion control. Most of the tall fescue acreage in the U.S. was established during the 1940's and 1950's following the release of "Alta" and "Kentucky 31". It's rapid acceptance was a result of its many agronomic characteristics including: ease of establishment, wide range of adaptability, long growing season, pest resistance, tolerance of environmental stress and persistence.

HISTORY

Tall fescue was introduced into North and South America from Europe. In 1771 the German botanist Schreber recognized and described tall fescue as being more robust than meadow fescue.

The exact time of introduction of tall fescue into the U.S. is unknown. It was reported as a specimen in the U.S. National Herbarium collection in 1879. Early performance data was collected during the late 1800's at the Utah and Kentucky agricultural experiment stations and by USDA personnel in Washington, D.C. In these studies, tall fescue was reported to be taller, more drought and cold tolerant, to form denser stands, to be more competitive with weeds, and to thrive on a wider range of soils than other species tested. Although testing continued, tall fescue did not attain prominence until the release during the 1940's of the "Alta" and "Kentucky 31" varieties by the Oregon and Kentucky agricultural experiment stations, respectively.

"Alta" tall fescue is an ecotype selected over a number of years beginning around 1916. The history of Alta can be traced back to a tall fescue nursery on the farm of Max Heinrichs in Pullman, Washington. In 1916, H.A. Schoth, ARS, USDA, Corvallis, Oregon, collected seed from this nursery. Seeds were planted in 1918 on the Oregon experiment station in Corvallis. From this nursery Alta tall fescue was developed and released jointly by Oregon agricultural experiment station and the Forage and Range section of the USDA.

In 1931, Dr. E.N. Fergus, of the University of Kentucky, discovered an ecotype of tall fescue growing on the W.M. Suiter farm in Menifee County, Kentucky. Seed collected on the Suiter farm by Dr. Fergus was planted on the Kentucky experiment station in 1932. Seed for the

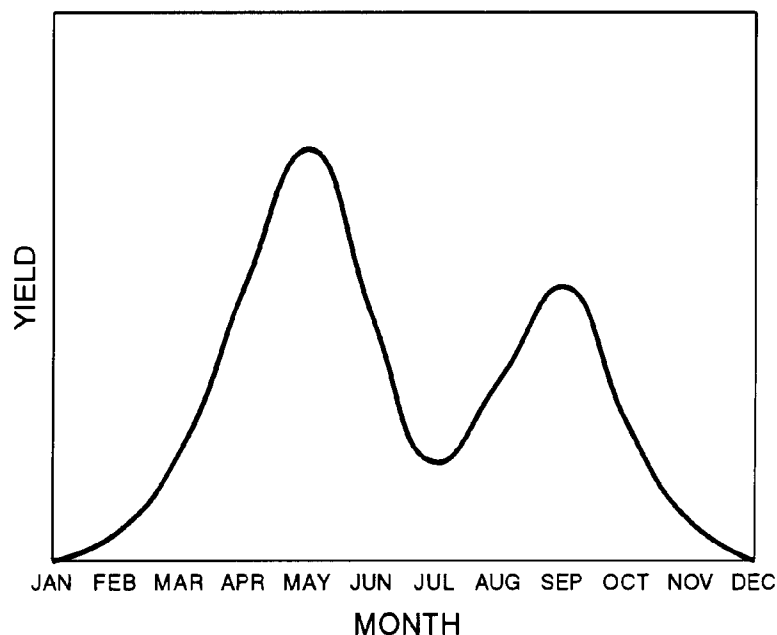


Figure 1. Seasonal Yield Distribution of KY 31 Tall Fescue at Lexington, KY.

original planting on the Suiter farm is believed to have come from a seedsman in Virginia. A patch of the grass was growing on the farm when Mr. Suiter purchased the farm in 1887.

Early seedings throughout the state showed the grass to be well adapted, persistent, and dependable. From 1932 through 1939, seedings were made in outlying experiment fields, and in 1939 seed was distributed by W.C. Johnstone for trials by interested farmers. After testing, this grass was released in 1943 as the variety "Kentucky 31". This variety was rapidly accepted and widely planted during the 1940's and 1950's. Many varieties have been released since Alta and Kentucky 31; however, these two remain the standard against which others are compared. Although many varieties are presently available, Kentucky 31 continues to occupy the bulk of the acreage in the U.S.

GROWTH AND DEVELOPMENT

Tall fescue is a deep-rooted, long-lived, bunch grass with short underground stems. The roots are tough and coarse, permitting the formation of a good sod which can support livestock in wet conditions.

Like other cool-season grasses, tall fescue produces the majority of its total growth during the first third of the growing season (Figure 1). Growth is slow during July and August, followed by increased production during autumn. Although the major share of tall fescue total production under low fertility occurs during spring, with proper fertility and split applications of nitrogen aftermath growth may account for more than half of the total production.

Total seasonal production of tall fescue is affected by variety, weather, fertility (especially nitrogen), and management. Yields of 2-5 tons of hay equivalents per acre are common, with the higher yields associated with proper fertility application and harvest management.

High yields of tall fescue are partially attributed to its wide temperature adaptation, producing more dry matter during autumn than most other grasses. Although growth is slow during late October and November, even with adequate N fertilization, net dry matter accumulation continues and total nonstructural carbohydrates increases. Also, much of the foliage remains green during late autumn and early winter and deterioration of herbage is much slower than for other cool-season species such as bluegrass, bromegrass, orchardgrass and timothy.

QUALITY

Chemical analyses for forage quality indicate that tall fescue compares favorably to other cool-season grasses. Tall fescue quality is characterized by seasonal changes. Palatability, digestibility, protein content and sugars are highest in fall, lowest in summer and intermediate to high in spring.

Even though laboratory analyses show tall fescue to be of high quality, animal performance has historically been erratic and oftentimes disappointingly low. In addition, cattle grazing tall fescue occasionally developed lameness and sometimes lost portions of their feet or tail during fall and winter. The term "fescue foot" was used to refer to this serious, although relatively infrequent, problem. Another problem noted was termed "fat necrosis" and involves deposits of hard fat in the abdominal cavity of cattle. This problem has been associated with heavy applications of broiler litter to fescue pastures.

In addition, cattle grazing tall fescue often developed a chronic unthrifty condition, especially apparent during the hot summer months. This condition has been referred to as "summer slump", "summer syndrome", "fescue toxicosis", or "fescue toxicity". Furthermore, mares grazing tall fescue pastures often aborted, produced stillborn foals and exhibited poor milk production. For many years, these and other animal performance problems remained a mystery, despite vigorous research efforts.

ENDOPHYTE

In an on-farm situation, USDA scientists in Georgia found high infection levels by an endophytic fungus in tall fescue being grazed by cattle exhibiting fescue toxicity symptoms, but not in another herd on separate fescue pastures on the same farm.

The mystery surrounding the inconsistent animal performance of cattle grazing tall fescue began to unravel in the mid-1970's. The association of the endophyte with poor animal performance was confirmed soon thereafter in grazing studies in Alabama.

The term "fescue fungus", "endophyte", "fungal endophyte" and "fescue endophyte" have all been used to denote the organism in question. "Endo" (within) plus "phyte" (plant) means a plant that lives within another plant. In this case, the plant (endophyte) is a fungus (*Acremonium coenophialum*) which lives within the tall fescue plant.

Studies with animals consuming endophyte-infected fescue have shown the following responses in comparison to animals grazing non-infected fescue: (1) lower feed intake, (2) lower weight gains, (3) lower milk production, (4) higher respiration rates, (5) higher body temperatures, (6) rough hair coats, (7) more time spent in shade, (8) less time spent grazing, (9) excessive salivation, and (10) reduced reproductive performance. Some or all of these responses have been observed in numerous studies in dairy cattle, beef cattle, sheep, and horses consuming endophyte-infected pasture, green chop, hay and/or seed (Table 1).

Table 1. Animal performance as affected by endophyte level of tall fescue.				
	Endophyte level		Animal	Forage or feedstuffs
Research	High	Low		
Average daily gain, lb				
Read and Camp(1986)	0.99	2.14	Steers	Pasture
Pedersen et al. (1986)	1.41	2.18	Steers	Pasture
Stuedemann et al. (1986)	1.02	1.31	Steers	Pasture
Hoveland et al (1983)	1.00	1.83	Steers	Pasture
Schmidt et al. (1982)	0.44	2.12	Steers	Seed
Schmidt et al. (1982)	0.62	1.46	Steers	Hay
Gain per acre, lb				
Pedersen et al. (1986)	371	462	Steers	Pasture
Stuedemann et al. (1986)	454	509	Steers	Pasture

Hoveland et al. (1983)	342	528	Steers	Pasture
Milk production, lb/day				
Siegel et al. (1985)	37.9	45.6	Dairy cows	Green chop
Schmidt et al. (1984)	6.7	11.7	Beef cows	Pasture
Intake, lb/day				
Jackson et al. (1984)	2.40	3.31	Steers	Seed
Schmidt et al. (1982)	9.13	14.13	Steers	Seed
Schmidt et al. (1982)	9.70	10.56	Steers	Hay
Spears et al. (1984)	0.61	1.12	Lambs	Hay
SOURCE: Stuedeman, J. A. and C. S. Hoveland. 1988. J. Prod. Agric. 1:39-44.				

ENDOPHYTE EFFECTS ON HORSES

Several studies have provided evidence that the fungus is associated with horse reproductive problems. Clemson University scientists found that mares grazing EF pastures produced more live foals, and had less agalactia, retained placentas, and greater conception rates than mares on EI fescue. In Kentucky, 40% of the mares grazing EI fescue had reproductive abnormalities. In Georgia, prolactin levels in the blood (associated with milk production) were depressed when mares grazed EI, but not EF fescue.

In a classic study at Auburn University, pregnant mares of various breeds were placed on adjacent EI and EF pastures, where they remained until foaling. The dramatic increase in foaling problems, foal deaths, gestation lengths, and foal weights, and the reduction in numbers of mares lactating, foals surviving, and mares surviving (Tables 2 and 3) provide convincing evidence of the dangers associated with grazing pregnant mares on EI fescue.

Table 2. Effects of the fungal endophyte on pregnant mares and foals grazing tall fescue

	Endophyte free	Endophyte infected
Foals carried to term	11	11
Mares lactating	11	1
Foals alive at birth	11	3
Foaling problems	0	10
Foals surviving	11	1
Mares surviving	11	8

Source: Ball et al. *In Forages for Horses*. Oregon Tall Fescue Commission Special Publication

Table 3. Effects of the fungal endophyte on pregnant mares and foals grazing tall fescue

	Endophyte free	Endophyte infected
Gestation length (days)		
Range	332-350	334-371
Average	336	356
Foal weight (lb)		
Range	73-129	91-131
Average	101	110

Table 3. Effects of the fungal endophyte on pregnant mares and foals grazing tall fescue

Source: Ball et al. *In Forages for Horses*. Oregon Tall Fescue Commission Special Publication.

A striking difference between horses and cattle is the lack of carryover effects when mares are removed from EI pastures. Test results show that horses respond rapidly to EF fescue and have a rapid turnover of toxicants, allowing them to quickly overcome the negative effects. Conversely, lactating mares moved onto EI fescue will cease lactating within a few days.

Mares removed from EI fescue within a month of foaling can often recover from fescue toxicosis and have normal foals. The prevalent recommendation to producers is that mares be removed from EI fescue 60 to 90 days before anticipated foaling.

KENTUCKY EXPERIENCE WITH THE ENDOPHYTE

The data from Auburn and South Carolina would make it seem that any pregnant mare exposed to infected tall fescue in late gestation would in all probability lose the foal and maybe die herself. However, in actual practice, the damage due to infected tall fescue is much more variable. Certainly there are documented cases every year of prolonged gestation, agalactia, and foaling difficulty that can be attributed to grazing infected tall fescue.

Date of foaling seems to play a role in the variability of toxicity of tall fescue. In most years, the endophyte in tall fescue starts growing sometime after the plant itself starts growing. Therefore, in early spring, toxicity symptoms would be minimal for mares that foal during this period (probably up into early April). However, as the weather warms, the endophyte is more active and the plant produces the toxic alkaloids. Later foaling mares would be more at risk.

However, this scenario is not consistent. In some years the endophyte seems to active much earlier, leading to toxic levels of alkaloids much earlier than expected. In addition, there is some evidence that the level of toxic alkaloid in fescue may be determined during the fall and winter. Therefore, even brown, non-growing clumps of fescue can be detrimental to mares if there is no other pasture available.

COPING WITH THE ENDOPHYTE

There is little doubt that the endophyte is associated with the quality problems being observed in tall fescue, even though a cause-effect relationship between the endophyte and a toxin has not been shown conclusively. Research and farmer experience suggest at least four areas of consideration to minimize or eliminate the endophyte effect.

Management strategies include managing fescue and animals to minimize the effects, diluting the endophyte and/or its toxin in the animals diet, and avoiding the endophyte infected fescue totally or during critical times of the year (summer) or with most susceptible animals (high producing or reproductive animals). In addition, replacing the endophyte infected fescue with endophyte-free fescue, other cool or warm season grasses or grass-legume mixtures is also an option.

Even though absence of the endophyte improves animal performance, elimination of the endophyte from tall fescue has been associated with decreased seedling vigor and stress resistance of certain types, especially drought. Even so, some new endophyte free varieties have seedling vigor equal to or greater than endophyte-infected Kentucky 31. Decreased drought tolerance, and less resistance to certain diseases and insects have also been associated with endophyte-free varieties in laboratory tests.

Endophyte free varieties have the potential to produce significantly more animal product per acre, but, require more intense management. Endophyte-infected tall fescue pastures have historically withstood overgrazing and continued grazing. Research and farmer experience has shown that endophyte free varieties will not tolerate continued close grazing, especially under stressful conditions, without risk of stand damage.

Making Your Pastures and Hay Grow

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Princeton and Quicksand, Kentucky, Respectively

How much forage can your land produce? How many animals can you feed? These are questions livestock owners need to have answers to. There are many factors that affect the answers. Some such as precipitation, sunshine, and temperature depend mostly on geography. Their effects can be determined, but there may not be much we can do about them. An obvious exception is the use of irrigation to supplement rainfall.

Other factors, such as soils and soil fertility and crop management are more variable. Knowledge of these and other factors can help landowners get the most from their pasture and hay fields.

I. Know your soils potential:

The potential of an acre of land to grow forage depends on the soils' slope, depth, drainage and texture. Slope of the land determines what equipment and types of tillage that can be used. It may be unsafe or impossible to use tractors on steep land. Even on land where tractors and tillage equipment can be used, the risk of severe erosion may limit the tillage that can be done. Slope also influences the kinds of forage plants and management that should be used. More sloping areas need a sod forming plant such as tall fescue to help hold soil in place and prevent erosion. Also, these areas should be managed to keep more cover on the land. Forages do a good job of protecting the soil, but only when plenty of top growth is left to intercept raindrops and slow runoff.

This leads to another influence of slope - less water available to plants. This is partly due to the fact that more water runs off steeper land. But water also drains out of sloping land faster. Keeping good cover on the land helps, but in general, steeper land will be less productive.

Soil depth is just as important as slope and is difficult to determine. The best source of information is a soils map which can be obtained through the USDA offices of the Farm Services Administration and/or Natural Resources Conservation Service. Soil depth determines the ability of a soil to store and supply to growing plants water and nutrients. Shallow soils are less productive than deep soils and are not suitable for some forages. For example, alfalfa should not be planted on shallow soils.

Shallow soils are more likely to be affected by dry conditions. As a result, the number of animals that can be carried through the summer months will be less on shallow soils than on deep soils.

Soil drainage affects the kinds of forages that can be grown and the management needed. Soils that are not well or moderately well drained are very limited in the forage plants that can be grown. In most situations, tall fescue and ladino clover will work. Red clover, Timothy, orchardgrass and bluegrass do well on moderate-to-well drained soils. Alfalfa needs deep, well drained soils to be productive.

It may be difficult to graze or work poorly drained soils during winter or spring. In some cases hay harvesting is delayed or curing is slowed on wet soils. Managing these soils for summer production is one way to avoid some of the problems and take advantage of the moisture at a time when other soils are likely to be dry.

Soil texture affects the ability of a soil to hold water and nutrients, how fast water moves into the soil, how easy it is to till and other effects on plant roots. Information on soil texture is also given on the soils maps. Most soils in Kentucky have a silt loam surface texture which is very good. Heavier soils (soils with more clay) tend to dry slowly and are difficult to till. Sandy soils dry out quickly and do not hold plant nutrients well.

II. Know your soils fertility needs.

Scientists agree that there are 16 elements essential for plant growth. They are:

Carbon (C) Hydrogen (H) Oxygen (O) Nitrogen (N)

Phosphorus (P) Potassium (K) Calcium (Ca) Magnesium (Mg)

Iron (Fe) Manganese (Mn) Boron (B) Chloride (Cl)

Copper (Cu) Molybdenum (Mo) Sulfur (S) Zinc (Zn)

These essential elements can be divided into two major groups, non-mineral and mineral nutrients. The non-mineral nutrients are carbon (C), hydrogen (H) and oxygen (O). These nutrients are found in the air and water so their availability for plant growth is generally constant. However, the remaining 13 nutrients are derived from soil and divided into three major groups:

* **Primary Nutrients:** nitrogen (N), phosphorus (P), and potassium (K). These nutrients are required by plants in the greatest amounts and subsequently become deficient in soils more rapidly.

* **Secondary Nutrients:** calcium (Ca), magnesium (Mg), and sulfur (S). Usually deficient less often and smaller amounts are required for plant growth.

* **Micronutrients:** boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). These nutrients are just as important as the primary and secondary nutrients, but they're required in very small amounts for plant growth.

As a general rule of thumb, forages contain approximately 1.5 to 4% N (dry wt basis). Nitrogen content will be the lowest in infertile grass and highest in alfalfa, clover and grass mixtures well supplied with N. Percent N content can be calculated from a forage analysis report by dividing % crude protein by 6.25. Forages also contain 0.2 to 0.4% P and 1 to 4% K. Therefore, each ton of mixed grass-legume hay will typically contain 40-50 lbs of N, 5-10 lbs of P and 40-50 lbs of K and varying amounts of other essential plant nutrients. Continually harvesting hay without replacing the P and K removed by the forage crop will deplete the soil of these plant nutrients over time resulting in a loss in productivity, species persistence, and livestock nutritive quality. In contrast, grazing results in the recycling of N-P-K contained in livestock manure and urine. However, the efficiency of nutrient recycling in pastures will be a function of forage species ingested, nutrient intake (forage nutrient content), animal age, size, and grazing habit and/or system.

Because so many factors affect nutrient availability for plant growth, the most accurate means of determining the fertility status of a pasture or hay field followed by a fertilization recommendation is to soil test. Soil testing involves collecting a soil sample that represents a given area and submitting it to a soil test laboratory for chemical analysis. A key point to keep in mind when collecting a soil sample is that only a few ounces of soil will be used to determine lime and fertilizer needs for what may be several million pounds of soil in the field. It is absolutely necessary that care be taken to assure that the soil sample sent to the laboratory accurately reflects the area sampled.

Timing

Soil samples can be collected through much of the year, though fall (September to December) or spring (February to April) are the best times. Fall sampling will often result in a faster return of results and recommendations. A soil test record system for each pasture or hay field is a great way of monitoring fertility trends and explaining possible production swings. In an effective sampling program, each field should be tested every 2-4 years and at the same time of year. Some changes in soil test results may occur due to seasonal changes in soil temperature and moisture conditions. Annual sampling is preferable for high production hay fields such as alfalfa.

Tools Needed

A soil probe, auger, garden trowel or just a spade are all the tools needed to take the individual cores that will make up the field sample. A clean, dry bucket will be needed for collecting and mixing the sample cores. Avoid using buckets or container that have been in contact with fertilizers. The slightest contamination will cause significant errors in the analysis.

Taking the Sample

The most representative sample can be obtained from a large field by dividing the area into smaller units on the basis of soil type, cropping history, erosion or past management practices. More accurate results are obtained when problem areas are sampled separately. Designate each sample area with letters or numbers on a field or area map for record-keeping purposes. A sample should represent no more than 20 acres except when soils, past management, and cropping history are quite uniform.

Random sampling is important and can best be accomplished by following a zig-zag pattern across the field. Sample depth is also important. For fields that have been tilled, soil cores should be

taken to the depth of the tillage operation 6-8". For established fields, soil cores should be taken to a depth of 2-3" where fertilizer and lime will be placed on the soil surface and not incorporated.

Sample Preparation

After all cores are collected and placed in the bucket, crush the soil material and mix the sample thoroughly. Allow the sample to air dry in an open space free from contamination. Do not dry the sample in an oven or at an abnormally high temperature. When dry, the sample is ready to be submitted to your county extension office and sent to the soil test laboratory of analysis.

III. Feed your forages.

Without soil test results, knowing what to feed your forages is nothing short of guess work that can prove to be costly in terms of dollars spent on too little or too much fertilizer. The University of Kentucky's lime and fertilizer recommendations are based on laboratory and field research designed to calibrate laboratory results with the probability of obtaining a yield response with a fertilizer application of a given plant nutrient.

Fertilizer rates recommended for a given nutrient soil test level are somewhat specific to the forage species to be produced. Cool season grasses such as bluegrass, timothy, orchardgrass and tall fescue grow best from early spring into early summer and again in the fall. Nutrient demand will be the highest during these periods, therefore, P and K fertilizer application should be made prior to this peak demand period for highest fertilizer use-efficiency and yield.

Neither soil organic matter nor nitrate nitrogen have proven to be reliable indicators of plant available nitrogen for forage crops during the growing season for the soil and climatic conditions in Kentucky. For this reason, present N recommendations for forage crops are based on yield response field studies and past management practices. The use of nitrogen should depend on what is expected from the grass. Nitrogen fertilization can help increase total production and protein content. However, one of the critical factors in establishing legumes in an established grass sods is grass competition with young seedlings. Use of N at renovation time will stimulate grass growth and increase the likelihood of failure in getting a stand of the legume.

Soil pH is routinely determined to assess the level of acidity present and potentially present for optimum plant growth. A soil pH of 6.2-6.8 is considered ideal for most forage species. To correct soil pH, lime is typically applied at rates that correspond to the amount of acidity measure in the soil. The adjustment of soil pH by lime is affected by 1) amount of mixing with the soil, 2) time of application, 3) quality of lime, and 4) the use of acid forming nitrogen fertilizer that may lower the effective soil pH obtained. In general, as soil pH decreases, the yield of grasses is less affected than that of legumes. Low soil pH ($5.8 <$) does not provide a suitable environment for the rhizobia in the soil, that are responsible for nodulation and atmospheric N fixation, to survive. Therefore, it is critical that lime be applied as early as possible to allow for the time necessary for neutralization to occur and adjust the pH in a range that maximizes legume production and persistence.

Soil testing should be an important part of every livestock producers forage management plan. Taking the guess work out predicting plant nutrient availability by soil testing can improve the odds of maximizing production, maintaining a high quality livestock forage, and ensuring that dollars invested in fertilizers contain the nutrients needed for optimum plant growth.

IV. Manage forages for good production.

To make pasture and hay crops grow requires many management factors. The following are some that relate to the soil and its' potential:

1. Match forage species to the soils you have. What does well on a neighbor's farm or in another state may not do well for you.
2. Supply the nutrients needed in your soils. Most pasture fields in Kentucky are low in one or more major plant nutrient.
3. Match the number of animals with the production potential of your soils. It is unrealistic to expect an acre of pasture to support five animal units for a year. Some fields may be capable of supporting one animal unit per acre. In others, it may take five acres or more to support an animal unit.
4. Use a grazing system that will maximize production and protect the soil. For example, some forage species must be rotationally grazed for good production while others can be grazed continuously with good management.

Knowing and using these management factors should help get the most from your soils.

Pasture and Hay as Nutrient Sources for Horses

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By maximizing pasture, horse owners can enhance the well being and efficient management of their horses. Pasture is an extremely nutritious feed source for many horses and can provide an excellent physical and social environment as well. In most of Kentucky, the grazing season begins in March and extends into November. During this period, some horses, particularly horses at maintenance (such as barren mares and riding horses receiving little or no regular work), can meet most of their nutrient requirements with pasture alone. Lactating mares, growing horses and horses in moderate to heavy work have higher nutrient requirements and will need grain in their diets. All pastured horses should have access to a salt block, even if they are receiving grain or other supplements.

The amount and type of supplements needed by horses on pasture vary with the quality of the pasture. Pastures with a dense population of rapidly growing desirable plants are very high quality nutrient sources, but pastures that are sparsely populated with desirable pasture plants are relatively poor nutrient sources. Table 1 provides some estimates of the amount of supplementation needed by mature horses grazing pastures of different "qualities." The quality of a pasture should be evaluated regularly as the amount of plant material available will vary during a grazing season as weather conditions and grazing pressure (number of horses/acre) change.

Table 1: Approximate Supplementation Rates for 1100 lb Mature Horses on Pasture^a

Pasture Rating	% Total Required Nutrients Provided By Pasture	Supplementation Rate/Comments
dry lot	0	20 to 25 lb of good ^b quality hay or 15 to 20 lb low ^c quality hay and 6 to 8 lb of grain
fair	25 to 35%	15 to 20 lb good quality hay or 10 to 15 lb of low quality hay and 6 to 8 lb of grain
good	70 to 100%	0 to 4 lb grain
very good	100 to 120%	no supplementation necessary; horses will probably gain weight
lush	100 to 150%	graze with caution; horses may overeat and encounter digestive problems

^aAll pastured horses should have free access to clean fresh water and a salt block. Lactating mares, performance horses and growing horses will require different levels of supplementation

^bExamples of good quality hays are early maturity grasses (orchard grass or timothy), mixed grass/legume hays or alfalfa hay.

^cExamples of low quality hays are late maturity grass hays (fescue, blue grass, orchard grass or timothy)

For example, an extended period of hot dry weather will slow pasture plant growth and may result in a change in pasture quality from "good" to "fair." Changing the number of horses in a pasture can also affect pasture quality within a few weeks. The type of plant in the pasture will affect the nutrient value of the pasture, but will be less important than the amount of plant material available to the horses.

The information in Table 1 applies primarily to horses at maintenance (such as barren mares) but will also apply to mares in early and mid-gestation and many horses that are ridden once or twice a week. Horses that perform moderate or hard work, lactating mares and growing horses will require higher levels of hay, grain or other supplements. For example, most lactating mares on "good" pastures will

need about 6 to 10 lb of concentrate per day, compared to the 0 to 4 lb required by a horse at maintenance.

When horses do not have access to pasture, they must be fed hay. Hay is also necessary in the winter when pastures are not actively growing. Table 2 provides some estimates of hay consumption by horses of different classes. The exact amount of hay a horse will eat on a daily or yearly basis will depend on the size of the horse, the class of the horse (pregnant, working, etc) and the type of hay being fed. Hay intake is generally related to body size,

Table 2: Approximate Daily Hay Consumption of Horses ^a

Type of Horse	Daily Hay Intake	Comments
Mature-little or no work, mares in early or mid-gestation	18 to 25 lb	More hay may be needed in cold temperatures; if low quality hay is fed, some grain may be necessary
Late gestation mares	18 to 22 lb	Most horses will require some grain in addition to the hay
Lactating mares	20 to 28 lb	Most lactating mares will require some grain; amount will vary (6 to 12 lb/d) depending upon hay quality ^b
Yearlings	15 to 25 lb	Amount of hay and grain will vary depending on hay quality and age/situation of horse (sale preparation, breaking, etc)
Weanlings	8 to 15 lb	Amount of hay and grain will vary with hay quality; most horses will receive 5 to 9 lb of grain/d
Performance horses	15 to 25 lb	Amount of hay and grain will depend on level of work and quality of hay; most will receive 6 to 12 lb/d. ^b

^a Assumes horses have no access to pasture. When pasture is available, the amount of hay needed will be reduced. Voluntary hay intake will be affected by hay quality. This table applies to horses with a mature weight of 1000 to 1100 lb.

^b When horses are being fed rations with large amounts of grain, they should still be fed at least 1 lb of hay for every 100 lb of body weight.

so a 1000 lb horse will consume about twice as much hay as a 500 lb pony. However, this relationship does not hold true for lactating mares and growing horses, as these horses may have greater appetites than would be expected from their body weight. The quality of the hay will also affect intake. Horses will tend to consume less and waste more low quality hay than high quality hay. Hay quality can be evaluated in several ways. Cleanliness of the hay is the first characteristic that should be evaluated. All horse hay should be free from mold, dust, weeds and debris. In particular, moldy or dusty hay should be avoided. Mold and dust irritate the lungs. Repeated exposure to mold and dust may predispose horses to heaves, a chronic lung disease that permanently affects the ability of the horse to breathe normally. Horses that develop heaves have difficulty exercising and have limited usefulness as riding horses. Increased levels of mold and dust are associated more with baling conditions than type of hay. All other quality criteria should be considered after the hay has been accepted or rejected based on cleanliness and freedom from dust and mold.

Stage of maturity at time of harvest is an important determinant of nutritional value of hay. In general, the older the plant is at the time of harvest the lower the nutrient content, digestibility and palatability. Plants harvested in late maturity will have more stem than plants harvested in early maturity, and the stems will usually be thick and woody. Very early maturity hay often has a soft texture, a high nutrient density and high palatability. Horse owners/managers often select early maturity hay and discriminate against more mature hay even though both types of hay can be effectively used in horse feeding programs.

Horse owners and farm managers often disagree about the best hay for horses. For example, some owners/managers will indicate alfalfa is the "best" hay for horses and others will indicate alfalfa is "too rich" for horses. Although these two statements seem completely contradictory, they both have elements of truth. Alfalfa is typically more palatable than orchard grass or timothy hay. Alfalfa is also higher in protein and calcium than most grass hays. In some, but not all cases, alfalfa hay may also be higher in energy and total digestible nutrients than grass hay. In general, if alfalfa hay is selected and used appropriately, it is a very effective nutrient source in horse rations. Similarly, grass hays such as timothy and orchard grass, can be effectively used in horse feeding programs. To make the best use of any type of hay, horse owners and managers must match hay "quality" to the nutrient requirements of the particular horse (or horses) being fed.

Ideally, horse feeding programs should combine nutritional adequacy with economic efficiency; that is, they should meet a horse's needs at an economical cost. Many nutrients can be provided more economically with hay or pasture than with grain, and thus it is cost effective to maximize forage use in most horse rations. Maximizing forage use may also provide some non-nutritional benefits in that horses on high forage rations may have more natural eating patterns. To select the most economical hay for a given situation, the price of the hay must be considered relative to nutrient value. Early maturity alfalfa hay can be very economical in feeding programs for horses with high nutrient requirements because it is very palatable and it provides more nutrients per pound. However, early maturity alfalfa is not the most economical hay choice for all horses. Many horses have relatively low nutrient requirements and do not require feeds with high nutrient density. In fact, if early maturity alfalfa hay is fed to horses with low nutrient requirements, intake must be strictly controlled to avoid excessive nutrient consumption. For horses that have lower nutrient needs, feeds with lower nutrient density are appropriate. Horses with lower nutrient requirements can be fed mid-to-late maturity alfalfa hay or mid maturity timothy or orchard grass hay, which will be much less expensive than early maturity alfalfa hay.

Table 3 gives some guidelines for the type of hay that can be fed to horses of different classes. Because alfalfa hay is quite high in protein and calcium, a feeding program based on alfalfa hay may provide levels of calcium and protein in excess of a horse's requirement. This situation will be most common when large amounts of alfalfa are fed to mature horses at maintenance or light work. Currently, there is no evidence to suggest that a moderate dietary excess of calcium or protein is detrimental to a mature horse.

Table 3: Matching Nutritional Value of Hay to Nutritional Need

Hay Type	Stage of Maturity	Description ^a	Types of Horses
Alfalfa ^b	Pre-bloom	very leafy and fine; very high nutrient value and palatability	weanlings, some yearlings, some performance horses, poor eaters
Alfalfa ^b	Early bloom	leafy, moderately fine stems, high nutrient value and palatability	weanlings, yearlings, lactating mares, some performance horses
Alfalfa ^b	Mid-bloom	more stem than leaf, stems are not fine, moderate nutrient density and palatability	some weanlings, yearlings, lactating and gestating mares, some performance horses and some horses at maintenance
Alfalfa ^b	Late bloom	very stemmy, stems are thick, palatability will be lower and waste higher	horses at maintenance and light work, mares in early and mid-gestation
Timothy or Orchard grass	Pre-head	very soft, fine blades, no seed heads, high nutrient value and palatability	weanlings, yearlings, lactating mares, performance horses, poor eaters
Timothy or Orchard Grass	Early head	small seed heads, texture is somewhat coarse, moderate nutrient value and palatability	gestating mares, performance horses, horses at maintenance or light work
Timothy or Orchard Grass	Late head (seed)	large seed heads, coarse texture, low nutrient value, palatability will be low and waste high	horses at maintenance, confined horses receiving most nutrients from other sources

^a All hays for horses should be free of weeds, dust and mold.

^b When alfalfa hay is fed, the calcium and protein requirements of many horses will be exceeded.

All of the guidelines given here must be adjusted for individual horses. The body condition of all horses should be monitored regularly and the diet adjusted accordingly. Body condition can be rated

on a scale of 1 to 9, where 1 is an extremely thin horse and 9 is an extremely fat horse. A horse in moderate body condition ("5") has enough fat cover over the ribs that the ribs are not visible, but is lean enough that the ribs are easily felt. A body condition of 5 is acceptable for most types of horses, including broodmares, breeding stallions and performance horses. Somewhat fatter body conditions are not detrimental to broodmares and horses in light to moderate work. In fact, extra fat cover in the winter may assist horses kept outdoors in adjusting to cold temperatures. Body condition must be evaluated by actually feeling the horses ribs, rather than by visual appraisal. A heavy hair coat in the winter often disguises a thin body condition.

How To Buy Hay for Horses

Tom Keene

As we get into discussing the purchasing of hay for horses, we will cover quite a few ideas. However, I would like to start with two points that I would hope everyone would remember when buying hay.

“Green is good, brown is bad.”

“Always weigh 8 to 10 bales with hand scale”

When buying hay for horses, most people purchase the hay on visual and sensory perceptions rather than on nutritive value. Some of these perceptions are:

1. Color
2. Smell or odor
3. Any evidence of dust or mold
4. Weed Content
5. Composition (legume vs. grass)
6. Texture
7. Preservatives
8. Weight

One of the questions we have to ask ourselves is, “Are we buying the hay because it looks good and smells good to us or are we buying it for the nutritive value of the horse?” Most purchased horse hays far exceed the nutritive composition needed by the horse.

Now that we have discussed some of the visual characteristics of the hay that we are going to buy, now let’s talk about PRICE!

What are some of the factors determining price?

1. Type of product purchased
2. Shipping Cost

3. Type package
4. Size of load contracted
5. Supply and demand

Is the price I am paying really bargain? What about weight? What about the hay that goes out in the muck? Can the horse utilize the type hay I am feeding him?

If you pay \$5.00 per bale, what is the hay actually costing you?

\$5.00 per bale & 40 pound bale (2000 lbs/40lb. bale = 50 bales per ton)

$\$5.00 / \text{bale} * 50 \text{ bales per ton} = \250.00 per ton

$\$5.00 / \text{bale} * 45 \text{ bales per ton} = \225.00 per ton

$\$5.00 / \text{bale} * 40 \text{ bales per ton} = \200.00 per ton

If you pay \$2.50 per bale, what is the straw actually costing you?

\$2.50 per bale & 35 pound bale (2000 lbs/ 35lb. Bale = 57 bales per ton)

$\$2.50 / \text{bale} * 57 \text{ bales per ton} = \142.50 per ton

Even if you are buying by the ton right now, be sure and put you next load in a separate location, count the bales and then weigh six to ten bales ton find the average weight per bale and so the multiplication.

20 Ton of Hay @ \$195.00 per ton = \$3900.00

20 Ton of Hay @ \$180.00 per ton = \$3600.00

Except the fact that he only has on 18 ton of hay.

$\$3600 / 18 \text{ ton of hay} = \200.00 per ton

What about the hay that goes out in the muck?

45 lb./ bale @ \$5.00 = \$225.00 per ton

If you feed a half a bale per day (22 lbs.) And half of that goes out in the muck you just doubled the cost of your hay.

How accessible is your farm for receiving purchased hay?

1. Is entrance wide enough for tractor-trailer loads?
2. Are farm roads wide enough and weather tough?
3. Is there adequate space for trucks to turn around?
4. Is storage space easily accessible?
5. Are there low hanging limbs or power line that could cause injury or loss of life?

Taxes

Always obtain a Kentucky State sales tax number from the individual you are buying your hay from. Once you have that number, call the Kentucky Department of Revenue to make sure that he is sending the taxes collected to the state. If your farm is audited and those revenues have not sent to the state, you can be held liable for the back taxes.