Forage Legumes vs. Fertilizer Nitrogen

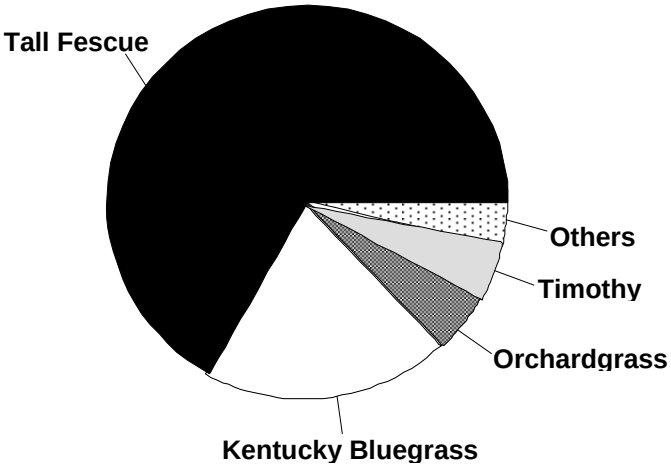
Garry D. Lacefield
Extension Forage Specialist
University of Kentucky

A few weeks after I started to work as a Forage Extension Specialist at the University of Kentucky, I heard my mentor and forage idol, Mr. Warren Thompson, speak on forage legumes. Warren, along with Dr's. Tim Taylor and W.C. Templeton had pioneered the "Pasture Renovation Program" in Kentucky. In addition, Mr. Ed Smith had joined the team and collectively they developed the "Power-til Pasture Renovator." Warren began his presentation by talking about Kentucky Forages pointing out we were so fortunate to have a good grass base and the opportunity to grow lots of legumes. He also talked about all the good things legumes could do once established into grass dominant pasture and hay fields. He stated "Pasture renovation is the most important pasture improvement practice in Kentucky". At that time, corn was under $2.00 per bushel, gas was 69 cents/gal, and nitrogen was readily available as ammonia nitrate and less than twenty cents per pound. Since that time, a lot of things have changed, especially corn, nitrogen and fuel prices; however, Warren's statement about the important of legumes is still valid. In fact, considering the merits of forage legumes and change in nitrogen and other input costs, forage legumes are more important today than ever.

Successful livestock production is dependent on forage programs which supply large quantities of adequate quality, homegrown feed. A major percentage of the feed units for beef (83%) and dairy (61%) cattle come from forages. In addition, forages supply an estimated 91%, 72%, 15% and 99% of the nutrients consumed by sheep and goats, horses, swine and ruminant wildlife, respectively.

Kentucky's forage base is composed of cool-season grasses and legumes. Four grasses occupy the vast majority of forage land with Kentucky 31 tall fescue occupying the largest number of acres (Figure 1). Clovers (red, ladino, white) (Figure 2) are, by far, the dominant legumes found. Pasture production from the cool-season species varies greatly during the growing season (Figure 3).

Figure 1. Forage Grasses



Legumes are present at a high enough level to significantly improve overall animal production on less than one-fourth of the acreage needed. Research, demonstration and farmer experience have clearly documented the positive contribution legumes can make when incorporated into grass pastures. Adding legumes to hay and pasture fields can bring at least five major benefits:

Figure 2. Forage Legumes

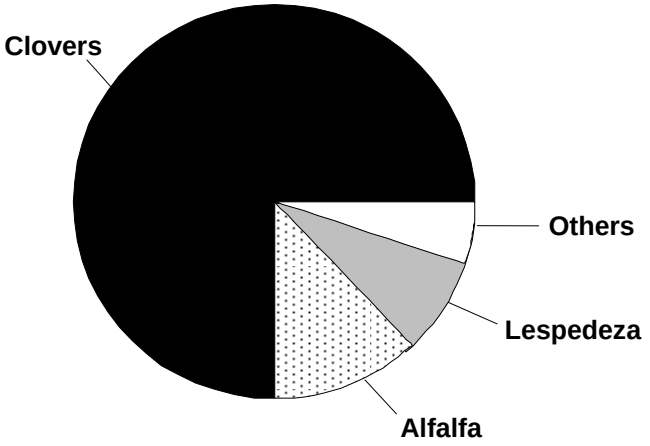
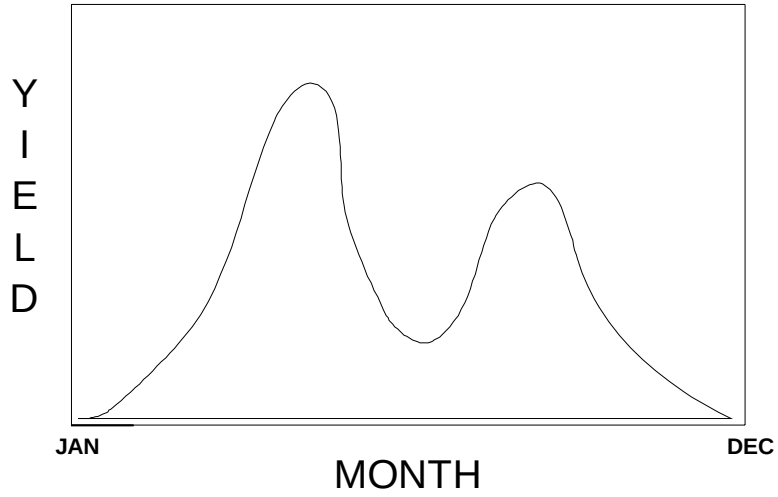


Figure 3. Seasonal Yield Distribution of KY 31 Tall Fescue.



(1) Higher Yields

The total yield of forage per acre is usually increased when forages are added. For example, a study conducted at Lexington compared renovating a fescue pasture using red clover to fertilizing the grass with nitrogen (Table 1). In this study, red clover growing with fescue produced higher yields than fescue fertilized with up to 180 lb N/ac.

Table 1. Dry Matter Yields of Fescue-Clover vs. Fescue-Nitrogen– Lexington, 1978, 2 Yr. Average.

Treatments	Yields, lb/ac
Fescue-Red Clover 6 lb Seed/ac	11,100
Fescue + Nitrogen 0 lb/ac 90 lb/ac 180 lb/ac	 3,900 6,700 9.900

Taylor, T.H., et.al. University of Kentucky.

(2) Improved Quality

Adding legumes to grass fields improves forage quality over grass alone. This added quality includes increases in palatability, intake, digestibility, and nutrient content. The result is improved animal performance. Research has shown that legumes improve animal growth rates, reproductive efficiency, and milk production. The three studies summarized in Table 2 show improved growth rates of beef cows, calves, and steers when legumes are used. The study reported in Table 3 shows increased growth rates of beef steers grazing a fescue-ladino clover pasture. It also shows higher gains per acre as a result of improved forage quality and higher yields.

Table 2. Animal Performance on Grass vs. Legume-Grass Mixtures.

Species	Length of Trial (Yrs)	Gain/Head (lb/day	Animal Class	State
Tall Fescue	3	0.12	Cows	IN
Tall Fescue + Red & Ladino Clover		0.74		
Tall Fescue	3	1.30	Calves	IN
Tall Fescue + Red & Ladino Clover		1.80		
Orchardgrass	10	1.07	Steers	VA
Orchardgrass + Ladino Clover		1.28		

Table 3. Av. Daily Gain and Gains/Acre of Steers Grazing Tall Fescue & Tall Fescue-Clover Pastures.

Pastures	Daily Gain (lb/steer)	Total Gains	
		lb/steer	lb/ac
Fescue + Ladino Clover	1.53	307	582
Fescue + 150 lb N/ac	1.06	203	374

Hoveland, C.S., et al. 1981. Bulletin 530. Auburn, AL.

High quality feed is important in getting beef cows rebred after calving. Research conducted in Illinois and Indiana (Table 4) compared conception rates of cows

Table 4. Conception Rates on Grass vs. Grass-Legume Pastures		
Species	Conception Rate %	State
Tall Fescue	75	IL
Tall Fescue + Legume	89	
Tall Fescue	72	IN
Tall Fescue + Clover	92	

grazing tall fescue pastures with and without legumes. In both tests, the cows grazing legume-grass pastures had much higher conception rates.

(3) Nitrogen Fixation

Legumes get their nitrogen needs from symbiotic bacteria that live in "knots" (nodules) on their roots. These bacteria are added when legume seed is inoculated. This "fixed" nitrogen provides the nitrogen needed by the legumes and also by grasses growing with them. Different legumes are able to "fix" different amounts of nitrogen (Table 5). Alfalfa usually fixes the most, while annual legumes fix the least. The value of the nitrogen fixed by legumes depends on the cost of nitrogen fertilizer.

Table 5. Value and Amount of Nitrogen Fixed by Various Legumes.					
Crop	N fixed, Lb/A/year	N value, $, @			
		55¢/lb	65¢/lb	75¢/lb	$1.00/lb
Alfalfa	150-250	83-138	98-163	113-188	150-250
Red clover	75-200	41-110	49-130	56-150	75-200
White clover	75-150	41-83	49-98	56-113	75-200
Vetch, lespedeza, and other annual forage legumes	50-150	28-83	33-98	38-113	50-150
SOURCE: Adapted from Southern Forages 2007					

(4) More Summer Growth

Most of the growth of cool-season grasses occurs during the spring and fall. Legumes (alfalfa, lespedeza, red clover) make more growth during the summer months than cool-season grasses. Growing grasses and legumes together improves the seasonal distribution of forages and provides more growth during summer.

(5) **Legumes in Rotations**:

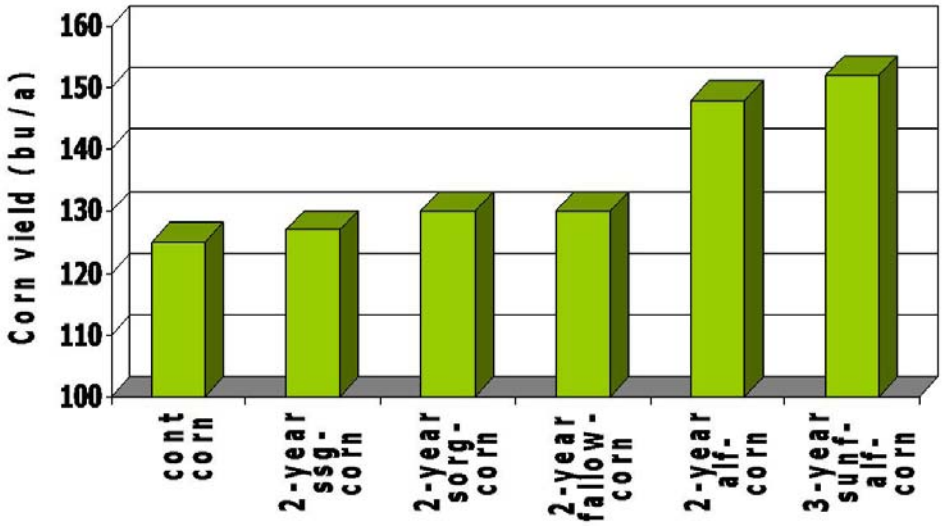
Legumes can play an important role in crop rotations. In general, any non-legume crop following legumes will show some improved production. Legumes can provide nitrogen for the following crop (Table 6, Figure 4), help break disease and insect cycles, improve soil conditions, reduce erosion (Table 7) and potentially improve profit.

Table 6. Alfalfa Legume Credits.

Stand Density	Medium/Fine Soils		Sandy Soils	
	----- Regrowth after last cutting -----			
	> 8 inches	< 8 inches	> 8 inches	< 8 inches
	---------- lb nitrogen/acre ----------			
Good, > 4 plt/ft^2	190	150	140	100
Fair, 1.5 to 4 plt/ft^2	160	120	110	60
Poor, < 1.5 plt/ft^2	130	90	80	40

SOURCE: Dan Undersander, Agronomy, University of Wisconsin Extension, AITS March 2008.

Figure 4. Rotational benefit of alfalfa on corn



Source: Dan Undersander, Agronomy, University of Wisconsin Extension, AITS March 2008.

Table 7. Relative Erosion of Cropping Systems	
System	Relative Erosion
Fallow	244
C-Sb*	120
C-C-Sb	112
Continuous corn	100
C-C-C-O-A	46
C-C-O-A	32
C-C-O-A-A	27
C-C-O-A-A-A	22
C-O-A-A-A	9
Continuous Cover	0
*C=Corn, Sb=Soybeans, O=Oats, A=Alfalfa	

SOURCE: Dan Undersander, Agronomy, University of Wisconsin Extension, AITS March 2008.

Summary

Legumes have played an important role in Kentucky pasture and hay fields in the **PAST**. They are playing an important role at **PRESENT**; however, they must play a more important role in the **FUTURE** as we exploit these unique plants to improve our overall forage-livestock programs.

References

Ball, D.M., and J.R. Crews. 1993. Comparison of selected Alabama forage crops as pasture for stocker steers. Alabama Cooperative Extension Circular ANR-764. Auburn University.

Ball, D.M., C.S. Hoveland, and G.D. Lacefield. 2002. Southern Forages. Potash and Phosphate Institute and Foundation for Agronomic Research, Norcross, Georgia.

Ball, D.M., J.F. Pedersen, and G.D. Lacefield. 1993a. The tall-fescue endophyte. American Scientist 81:370-379.

Ball, D.M., G.D. Lacefield, C.S. Hoveland, and W.C. Young. 1993b. Tall fescue-endophyte-animal relationships. Oregon Tall Fescue Commission, Salem, Oregon.

Hoveland, C.S. 1989. Legume persistence under grazing in stressful environments of the United States. *In* Marten, G.C., A.G. Matches, R.F. Barnes, R.W. Brougham, R.J. Clements, and G.W. Sheath, eds., Persistence of Forage Legumes, pp. 375-385. ASA, CSSA, SSSA, Madison, Wisconsin, USA.

Lacefield, G.D. 2007. Legumes' Role in Managed Grazing. Proceedings of the 6th Heart of America Grazing Conference. Mt. Vernon, Illinois.

Lacefield, G.D. 2008. Legume-Nitrogen Fertilizer Alternative. Proceedings 7th Heart of America Grazing Conference. Columbia, Missouri.

Lacefield, G.D. 1995. Grazing alfalfa-an overview. Proceedings of the National Alfalfa Grazing Conference. Nashville, Tennessee.

Lacefield, G.D., D.M. Ball and C.S. Hoveland. 1993b. It is advantageous for producers to include legumes in cow-calf production systems in the southern region. Proceedings Southern Pasture and Forage Crop Improvement Conference. Longboat Key, Florida.

Lacefield, G.D., D.M. Miksch, and C. Absher. 1980. Forage-related cattle disorders. University of Kentucky Cooperative Extension Service.

Lacefield, G.D., M. Rasnake, and H. Rice. 1989. Renovating hay and pasture fields. University of Kentucky Cooperative Extension Service AGR-26.

Marten, G.C., A.G. Matches, R.F. Barnes, R.W. Brougham, R.J. Clements, and G.W. Sheath. 1989. Persistence of Forage Legumes. ASA, CSSA, SSSA, Madison, Wisconsin, USA.

Petritz, D.C., V.L. Lechtenberg, and W.H. Smith. 1980. Performance and economics returns of beef cows and calves grazing grass-legume herbage. Agronomy Journal 72:581-584.

Undersander, D.J. 2008. Alfalfa Intensive Training Seminar. Boise, Idaho.

Undersander, D.J. 1993. Pastures for profit. University of Wisconsin Extension Service and University of Minnesota Extension Service Special Publication A-3529. Madison, Wisconsin.