

FORAGE LEGUMES: THEIR IMPORTANCE AND MANAGEMENT IN PROFITABLE LIVESTOCK SYSTEMS

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The landscape of most Kentucky operations is heavily dominated by the utilization of cool-season grasses as the primary source of forage for livestock. However, legumes species, such as alfalfa and red or white clovers are an essential component to a complete forage-livestock system. Relative to grasses alone, incorporating legumes into a mixture has the benefits of improving the nutritive value of the available forage in the field, extending the grazing season by increasing the yield of forage during the early summer months, and providing a more economical source of N compared to commercial fertilizers. This paper will briefly describe each of these potential benefits and explain any trade-off, as well as any additional management required, that a producer may face with maintaining grass-legume mixtures in their operations.

Improving Nutritive Value of Available Forage

In terms of meeting the nutrient requirement of most class of livestock, all forage types will likely be limiting energy and protein content during some point of the forage plants life cycle. The maturity (or stage of growth) of the forage is typically the largest determinate of the crop's nutritive value. As the plant enters the reproductive stages of growth, it develops a higher proportion of fibrous stem material which lowers the overall concentration of digestible energy and protein the animal will receive from the plant. In general, legumes tend to have higher concentrations of protein and digestible energy than grasses when compared at a similar stage of growth, though there may be considerable overlap between these forage types (Table 1). When planning their forage system, producers may want to consider not only the level of nutrients provided by legumes and grasses, but also how the quantity of nutrients provided may change across the season relative to what is need by their livestock. An example of this type of interaction may be seen in the figures below.

Table 1. Range of possible Crude Protein (CP) and Total Digestible Nutrients (TDN) concentrations provided by multiple types of forages.

<i>Forage Type</i>	<i>CP</i>	<i>TDN</i>
	----- %DM -----	
Legumes	14-22	57-62
Cool-season Grasses	8-16	50-62
Warm-season Grasses	8-14	50-60

Source: Southern Forage (2004)

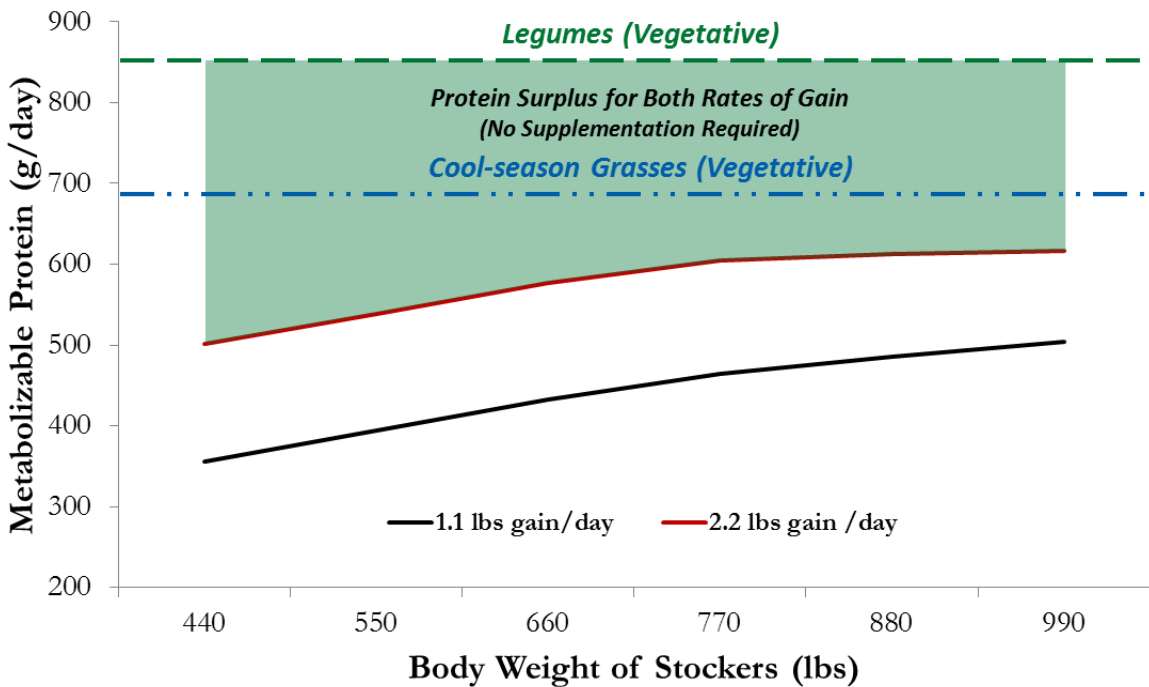


Figure 1. National Research Council (NRC) protein requirements (g of metabolizable protein/day) for stockers. Lines refer to the minimum amount of protein provided by the vegetative growth of legume and grass forages assuming a daily consumption rate of 2.5% BW.

Figures 1 & 2 show the National Research Council (NRC) estimates of the daily protein requirements of stockers growing at two rates of gain (1.1 and 2.2 lbs/day). Also in these figures, are the minimum amount of protein that may be provided by legume and grasses (average across species) assuming an average daily intake of 2.5% BW for each steer. When the forages are vegetative (Fig. 1), the level of protein provided by both of the respective diets exceeds the requirements for both rates of gain. This may be interpreted in one of two potential ways. First, even though both forages

provided sufficient protein, legumes provided a higher concentration of dietary protein, which will translate into higher animal gains if there are no additional factors that may restrict animal development. Alternatively, for many producers 2.2 lbs of gain/day is a suitable goal for their operation and in these situations interseeding a legume species may not be needed. This may simplify the management input required compared to mixtures (see below), but the producer will still have to commit to the regular applications of N fertilizer and additional management required to maintain a vegetative stand (either through more regular mowing or more intensive grazing management) to ensure that these gains are achieved. It should also be noted that this example does not account for any anti-quality factors associated with the grasses, such as ergot alkaloids, that may limit animal growth regardless of the forage's nutritive value.

More advantages for utilizing legumes in forage systems may be seen as both forage types enter the reproductive stages of growth, which may occur even with the most attentive management. Maturity had a much larger effect on the quantity of protein provided by the grass diets and was inadequate to meet the steer requirements even at the lowest rate of gain (Fig. 2). In these situations, a supplemental source of protein would need to be provided for the animals. Yet the legume diet was still able to meet the protein required by the steers at both rates of gain, although the amount of protein provided in these diets were beginning to become limiting for steers with larger body weights (~700 lbs) growing at the high rates of gain (2.2 lbs/day) (Fig. 2).

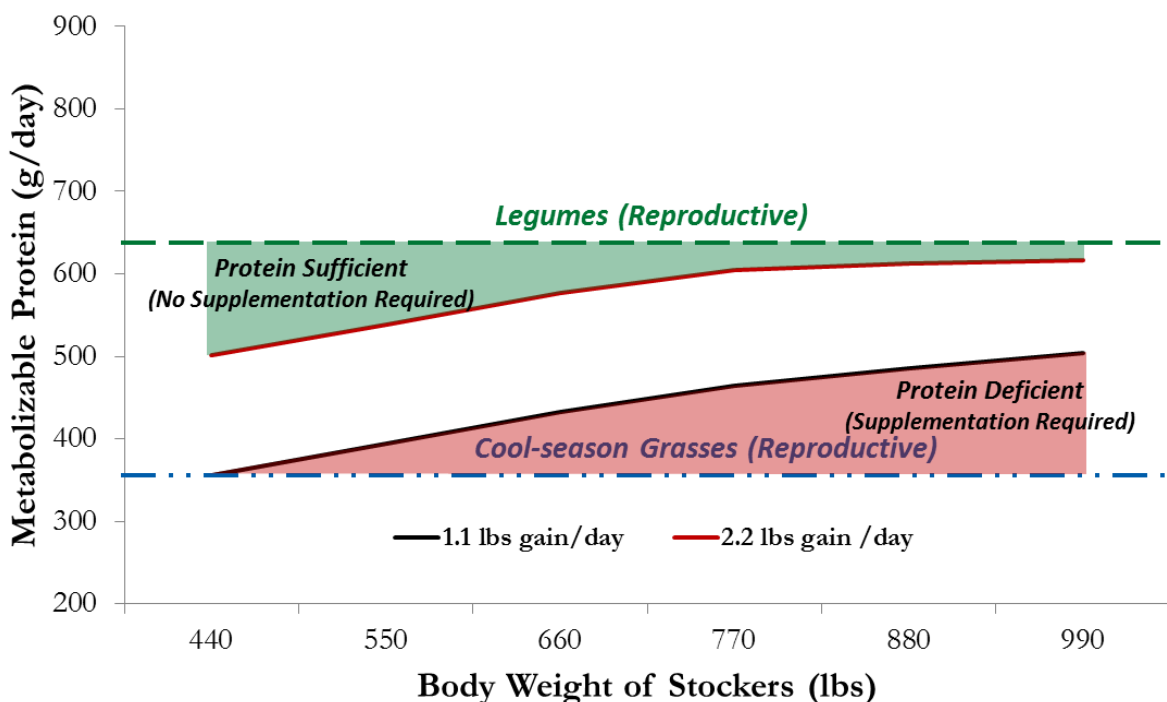


Figure 2. National Research Council (NRC) protein requirements (g of metabolizable protein/day) for stockers. Lines refer to the minimum amount of protein provided by the reproductive growth of legume and grass forages assuming a daily consumption rate of 2.5% BW

Extending the Grazing Season

Interseeding legumes in a cool-season grass pasture may also offer producers an opportunity to extend the number of days a field (i.e. the grazing season) later into the growing season. Alfalfa and clovers have similar physiologies as cool-season grasses. This means that they also experience the “summer slump” in production that many grasses, such as Kentucky bluegrass, are known for. However, most legume species are less prone to the hot, dry conditions that restrict growth of other species due to their large tap root systems that allows the plant to access soil moisture deeper in the soil profile. In addition, legumes also have an indeterminate growth habit (i.e. multiple “flushes” flowering shoots) whereas most cool-season grasses exhibit a determinate growth habit (i.e. a single “flush” of flowering shoots). This results in legumes producing a greater proportion of their growth during the summer months. Based on a 5 Yr average (2008-2012) of the University of Kentucky Forage Variety Trial, cool-season grasses produced 85% and 15% of their growth during the spring (May & June) and summer (July & August) months, respectively. Over the same period, 78 and 68% of the growth from clover and alfalfa occurred during the spring months and 22% and 32% during the summer. If the yields from these estimates are extrapolated to a mixed species pasture containing 30% of each legume species, incorporating legumes extended the grazing season by 4.33 and 11.86 cow/calf days/acre for clovers and alfalfa, respectively (assuming 1,200 lbs cow with a forage intake of 3% BW/day). In other terms, these approximations indicate that a 10 acre pasture containing 30% clover (or alfalfa) may maintain a cow/calf pair an additional 43 days (or 118 days for alfalfa) under optimal conditions relative to a grass pasture alone.

Legumes vs. N Fertilizers

The concentration of N provided by the soil is low and insufficient to support regular plant growth. As previously mentioned, cool-season grasses require high rates of N fertilizer (150-200 lbs N/acre) in order to achieve a level of forage production and nutritive value that is suitable for livestock production. Legumes, on the other hand, are capable of providing their own source of N through a symbiosis with *Rhizobia*. These bacteria infect the legume host's root system and produces an enzyme (i.e. nitrogenase) that converts (or “fixes”) inert, atmospheric N into active, plant available forms. Conservative estimates place the amount of N provided by this symbiosis annually at approximately 100-200 lbs N/acre. As portions of the legume plant decompose or are redistributed as manure following the consumption by livestock, the fixed N slowly becomes available for use by other species in the pasture. The use of N fertilizer is not recommended when a pasture contains greater than 25-30% legumes species and only low rates (30-50 lbs N/acre) are recommended when the pasture consist of 15-25% legumes. In these scenarios, any additional sources of N has a tendency to stimulate more growth of any grass or weed species present in the pasture and lower the persistence of the legume.

When deciding to rely on legumes as the primary source of N for the pasture, many producers may find it difficult to limit the use of N fertilizer on grass-legume pastures. At least initially, interseeded pasture may seem to be less productive compared to when N fertilizers were previously used. This is because commercial fertilizers are near instantaneously available to the plant, whereas legume N should be seen as an investment. Table 2 summarizes a comparison of the profitability of interseeding white clover into a tall fescue pasture vs. fertilizing the pasture with 200 lbs N/acre. When the price of N was low or the length of time the clover was maintained in the pasture short, it may be more profitable for the producer to use N fertilizers (i.e. negative values indicate a greater cost advantage for the fertilizer). However as the cost of the fertilizer and persistence of the white clover increased, interseeding a legume may provide a better option for producers. Based on the average price of urea during the past spring (April 2014: \$0.29/lb N), a producer may begin receiving a return on their “legume investment” by the second growing season. If the costs of urea increases to the levels seen in previous years (April 2012: \$0.49/lb N), an advantage for interseeding legumes into a pasture may be seen within a single growing season

Table 2. Cost advantage (\$/acre) of interseeding white clover into tall fescue pastures vs. 200 lbs N/acre. Negative values indicate more advantage for N fertilizer & positive values indicate more advantage for interseeding legumes.

<i>N Costs (\$/lb)</i>	<i>Legume Stand Life (Yrs)</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
<i>0.10</i>	-65.12	-51.02	-38.05	-25.64	-13.97
<i>0.20</i>	-47.27	-16.45	12.47	39.93	65.77
<i>0.30</i>	-29.43	18.13	62.99	105.51	145.51
<i>0.40</i>	-11.59	52.70	113.51	171.08	225.25
<i>0.50</i>	6.26	87.27	164.03	236.66	304.99
<i>0.60</i>	24.10	121.84	214.55	302.23	384.73

Updated from Burns & Staundaert (1984)