Matching Forage Quality to Beef Cattle Requirements

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Beef cattle have basic nutritive requirements for maintenance or survival, growth, and reproduction which includes lactation. The essential nutrients for these animal functions include water, energy, protein, minerals, and vitamins. Under grazing conditions, energy is usually the nutrient which most limits animal performance. Energy deficits in forages occur because of the relatively variable, and often low, digestibility of structural carbohydrates such as cellulose, hemicelluloses, and lignin. Collectively, these structural carbohydrates are referred to as fiber and may comprise from 40 to 85% of the forage dry matter. Ruminants have the ability to utilize these carbohydrates and store the resultant energy as fat. This fat deposition may then be expended during prolonged periods of energy-deficient diets. In contrast to energy storage, ruminants have limited stores of protein which are available during dietary deficits. Thus, protein deficiencies in the diet (forage) should be amended if possible. Deficiencies in dietary protein or in the quality of protein have negative effects on intake and efficiency of digestion. These overriding effects on intake and digestion result in reduced animal performance.

Availability of minerals, both macro- and micro- (trace), in forages are influenced by inherent soil fertility status and fertilizer applications. Calcium and phosphorus have traditionally received the most attention in the literature; however, trace minerals such as copper, cobalt, zinc, manganese, iodine, and magnesium are receiving renewed attention in meeting beef cattle requirements for specific functions. Because mineral content of warm-season perennial grasses is usually low, general recommendations have included offering minerals free-choice throughout the year. Except for vitamins A, D, and E, ruminants can synthesize adequate amounts of all other required vitamins provided the forage has adequate energy, protein, and cobalt. Since vitamin E is relatively abundant in forages, only vitamin A has the potential to become deficient. And, vitamin A is only a concern under certain conditions.

The nutritive requirements for beef cattle vary according to size, age, sex, reproduction, lactation, rate of growth, etc. The amount of energy, protein, etc. required to prevent weight loss or weight gain is called the maintenance requirement of the animal. Thus, once sufficient nutrients have been ingested to maintain physiological activities, then additional nutrients consumed may be used for other activities such as growth, etc. Nutrient requirements have been quantified or projected for numerous classes, weights, sex, and activities of beef cattle by the National Research Council (3). These requirements are generally expressed as the concentration of protein, energy, etc. required in the diet (forage). Thus, if forage intake can be predicted or estimated, and if the nutritive value of the forage is known, then animal performance may be predicted.

Forage nutritive value has been generally classified into components of chemical composition (energy, protein, etc.), digestibility, and nature of the digesta (2). Forage intake by the animal is influenced by the availability or biomass of forage, ease of prehension, acceptability and palatability, and rate of passage. Forage quality, therefore, has long been considered to be a product of factors which comprise nutritive value and forage intake. Thus, forage quality and the potential of the animal to perform are the primary factors which influence output per animal (2).

Beef cattle requirements can be relatively easily matched under feedlot or supplementation conditions. However, the freely grazing beef cattle are under the direct influence of the nutritive value of adapted forage species of a particular environment. Thus, management skills are necessary to match the peak forage quality attributes with beef cattle activities that require the highest levels of energy and protein. Quality varies greatly among forage species with legumes being higher in quality than grasses. Within either legume or grass cultivars, quality varies with season, climatic conditions,

soil fertility, age, etc. In general, forages may be ranked from highest to lowest quality as follows: legumes, cool-season annual grasses, warm-season annual grasses, cool-season perennial grasses, and warm-season perennial grasses. Most of the pasture systems in the lower southeastern U.S. are based on warm-season perennial grasses such as bermudagrass, stargrass, bahiagrass, dallisgrass, and limpograss. In the upper parts of the southeastern U.S., cool-season perennial grasses such as tall fescue, orchardgrass, and Kentucky bluegrass dominate the pastures.

The dilemma of matching forage quality with desirable, economically productive animal performance may be illustrated in Figure 1 by Lippke (1). In this simplistic, yet vivid example, forages are ranked according to digestibility (energy) with the requirements of selected classes of cattle superimposed on the quality ranges. Thus, it becomes readily apparent that the most abundant forages in southern pastures, warm-season perennial grasses, are quite satisfactory for meeting the nutritive requirements of mature beef cows. The economic performance desired for first calf heifers and stocker cattle, however, may be marginally met or excluded from the warm-season perennial grass pastures.

Among the various management alternatives available, the two primary considerations for enhancing forage quality to meet beef cattle requirements for accelerated performance are to either include other forages via overseeding, etc. and/or to offer supplemental energy-protein. With respect to energy deficits, the most cost-effective alternative may include the planting of annual forages together with making and storing high quality hay during appropriate times. For example, the overseeding of annual ryegrass and/or clovers into a bermudagrass, bahiagrass, etc. pasture serves to dramatically increase the quality of the diet and to lengthen the grazing period. Grazing research from the Texas Agricultural Experiment Station at Overton (5, 6) has consistently shown that non-supplemented fall-born calves will gain in excess of 3 lbs/day and wean in excess of 800 lbs when grazing ryegrass or clover overseeded on bermudagrass pastures. Since these types of practices require increased management and financial inputs, the proper utilization of the sod-seeded pastures becomes paramount to positive, economic returns.

The availability of forage protein and beef cattle requirements for protein follow similar patterns to those illustrated in Figure 1. In addition, Table 1 presents selected examples of protein and energy requirements for various classes of cattle and projected performance. As mentioned before, dietary deficits may be met via alternative forages and/or supplemental feed. Proteins have been fractionated into rapidly degraded, slowly degraded, and undegraded (4). In the case of dietary or intake protein, forage protein can be generally classified as readily degradable in the rumen with only a small proportion being slowly degraded or "bypassing" the rumen into the omasum. Various oil meals and by-product feedstuffs contain proteins in which more than 50% may be slowly or undegraded in the rumen. Numerous, recent research reports have documented the positive, economic benefits associated with providing slowly degradable (by-pass) protein supplements to forage systems. Positive animal responses have been reported in forages with wide ranges of crude protein values from less than 10% to greater than 25%.

Properly matching forage quality with beef cattle requirements is mandatory for economic survival in the cattle business. Some of the prerequisites for interfacing forages and livestock are as follows:

1. Be aware of quality attributes of specific forages in pasture system.
2. Know levels of energy, protein, mineral, etc. required by specific classes of livestock for anticipated performance levels.
3. Practice proven animal husbandry guidelines for culling, animal health, replacements, etc.
4. Understand the influence of season and maturity (age) of forage on quality fluctuations.
5. Have reasonable expectation of climatic variabilities which may occur in a particular region.
6. Spend time in planning processes to estimate and project forage quantity and quality excesses and deficits so that alternative nutrient sources (supplementation) may be considered.
7. Select animal activities (calving, etc.) to coincide with positive attributes of forage and environment.

8. Maintain proper (economic) stocking rates to prevent risks associated with overgrazing, destruction of the grassland resource, and subsequent herd dispersal.
9. Plan for maximum flexibility in considering pasture utilization and merchandizing of livestock which may include vertical integration from cow-calf to feedlot operations.

The above-mentioned suggestions are by no means all-inclusive and do not ensure an economically profitable enterprise. Profitability may be achieved from a biological perspective, but the economic perspective remains to be closely related to efficiency of production, efficiency of utilization, and the livestock pricing structure.

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TABLE 1. Nutrient requirements for selected classes and weights of cattle.

Class of Livestock	Weight	Daily Gain	Minimum D.M. Intake	Protein %	Protein Intake	Digestibility
	(lbs)	(lbs)	(lbs)		(lbs)	(%)
Medium frame	400	1.0	10.4	10.3	1.06	58.5
Steer	400	2.0	11.0	12.7	1.41	67.5
	600	1.0	14.1	9.0	1.26	58.5
	600	2.0	15.0	10.5	1.57	67.5
Two-yr-old,	750	.5	16.7	11.0	1.8	64.4
Lactating Heifer	900	.5	19.2	10.4	2.0	62.7
Mature Cow,	900	0	18.8	9.9	1.9	57.3
Lactating	1100	0	21.6	9.4	2.0	56.0
Mature Cow,	900	.9	18.2	8.0	1.5	54.0
Dry	1100	.9	21.0	7.8	1.6	53.2

Values adapted from NRC 1984.

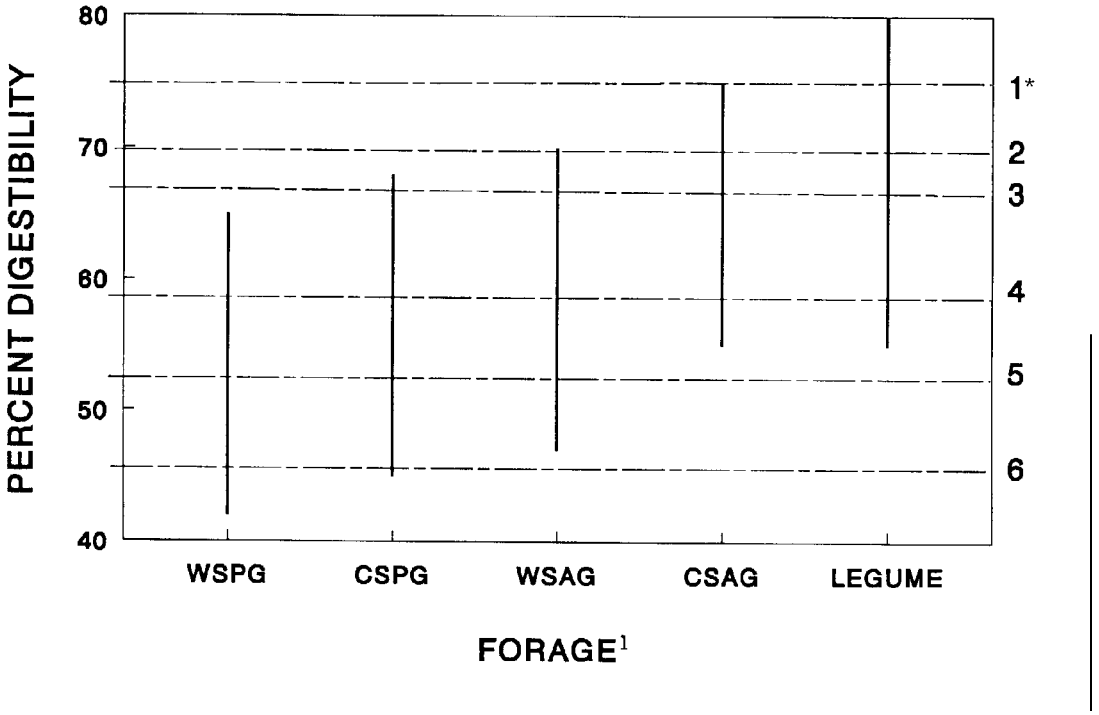

FIGURE 1. Percent digestibility ranges for categories of forages and nutritive requirements for various classes of livestock.

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[1] WSPG = warm-season perennial grass; CSPG = cool-season perennial grass; WSAG = warm-season annual grass; CSAG = cool-season annual grass.

*Classes of Livestock:

1 = Dairy cow producing 48 lbs milk per day
2 = 450-lb stocker steer gaining 1.8 lbs per day
3 = Lactating, first-calf heifer
4 = Beef cow and calf to wean at 500 lbs
5 = Dry, pregnant cow gaining weight
6 = Mature cow at maintenance of body functions