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Pasture Forage Quality in West Virginia

WVU Pasture Quality Program Team¹

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Cattle and sheep need to obtain most of their nutrients from forage, particularly pasture, if they are to be fed economically. With the increased interest in pasture management, there is also an increased interest in improved livestock nutrition on pasture. Livestock that lack adequate nutrients in their diet will have poor performance and health. Because of this, supplements such as salt, minerals, energy, and protein feeds are often fed. However, if supplements are fed free choice or year-round, the expense can be high. The strategic feeding of appropriate supplements at selected times in the animal production cycle can reduce production costs and maintain healthy, productive livestock. To do this, producers need to know whether a nutrient is meeting the needs of their livestock. This project was developed to determine the concentration of minerals and other nutrients in West Virginia pastures so that improved management and effective supplements can be developed.

Methods

Extension agents and farmers sampled pastures during the 1997 to 2001 growing seasons (8). This sampling represents 105 site-years of data, with samples taken monthly over the growing season for 479 total samples. [Figure 1](#) presents the intensity of samples by county. Another 128 samples were provided by USDA/NRCS and the West Virginia Conservation Agency from demonstration farms administered by the latter agency. Forage samples were sent to commercial forage testing laboratories for fiber, protein, and mineral analysis. Not all samples were analyzed for all nutrients due to changes in project protocol over the years.

Results and Discussion

The weather during the years of this study was representative of the range of weather experienced in West Virginia and included the drought of 1999, the worst statewide drought in 50 years. Monthly precipitation and average temperature, compared with the 30-year

average and standard deviation (the range that includes 66% of the observed values) are presented for Morgantown in [Figures 2 and 3](#), respectively.

The primary forage species in the pastures sampled were cool-season grasses and clovers typical to the Appalachian region. Fescue, unidentified grasses, bluegrass, orchardgrass, and clovers were the number-one species in 95% of the pastures. Clover, orchardgrass fescue and bluegrass were the number-two species on 94% of pastures. Clover bluegrass, orchardgrass, fescue, and crabgrass were the number-three species on 91% of pastures.

Of the pastures in this study, 64% were continuously grazed and 36% were rotationally grazed. This resulted in a range in sward height, fiber content, and estimated energy content of the pastures.

Pasture quality condition and nutrient content are presented in [Tables 1 and 2](#). Quality classes of “High,” “Average,” and “Low” correspond to the 75, 50, and 25 percentile rankings of the nutrient concentration in forage samples, respectively.

Grazing management (continuous vs. rotational stocking) had an effect on pasture quality by affecting plant height and maturity. Continuously grazed pastures had plants shorter than rotationally grazed pastures (5.7 vs. 9.8 inches respectively) and had lower ADF (31.5 vs. 32.8) and Ca (0.65 vs. 0.74), but they were higher in ash (10.2 vs. 8.6), resulting in higher trace mineral content for Fe (480 vs. 253), Zn (37.8 vs. 28.6), Cu (11.7 vs. 9.4), and Mn (122.8 vs. 86.7).

A study evaluating the quality of rotationally grazed pastures in New York to Maine (9) found that pasture quality was higher than that found in the continuously grazed pastures in West Virginia. For the Northeast, pastures average values for ADF, NDF, NSC, and CP were 27, 47, 17, and 22 percent respectively. Similar quality values were obtained in Jefferson County, W.Va. (27, 46, 19, 22), where all pastures were managed rotationally.

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Pasture Quality and Nutritional Components

Height – Short pasture height limits livestock's intake of pasture forage. When pasture height drops below about 4-inches, intake will decrease. Of the pastures studied, 40% had heights of 4 inches or less.

Acid Detergent Fiber (ADF) – Forage ADF is an index of the digestibility of the forage. As a plant matures, its ADF content increases and its digestibility decreases.

Neutral Detergent Fiber (NDF) – Forage NDF is an index of how much forage livestock will eat. As NDF increases, forage intake decreases. Young forages are lower in NDF than older forage, and legumes are lower in NDF than grasses. When forage availability does not limit intake, NDF may be the intake-limiting factor in pastures.

Total Digestible Nutrients (TDN) – Forage TDN, a measure of the digestibility of forage is highly related to measures of energy availability such as net energy lactation (NEL), net energy maintenance (NEM), and net energy gain (NEG). For high-producing cattle, TDN was deficient in 60% of the pastures sampled.

Crude Protein (CP) – Forage CP is high in most pastures and is deficient relative to livestock requirement in only about 5%-10% of the pastures sampled.

Calcium (Ca) – Forage Ca content was deficient for high-producing lactating cattle in about 5% of pastures.

Phosphorus (P) – Forage P was deficient for high-producing lactating cattle in about 10% to 15% of the pastures sampled.

Livestock requirements for TDN, CP, Ca, and P are highly dependent on animal age, growth rate, or level of milk production. High-quality pasture is needed to supply the needs of young or rapidly growing animals or cows producing high levels of milk. If adequate pasture quality is not provided for these classes of animals, production will be below the animals' genetic potential. Supplementation with the proper nutrients, at an increased cost, will be required to achieve high levels of production.

Magnesium (Mg) - Forage Mg content was at or below the recommended 0.20% of dry matter in 25% of the pastures sampled. Pasture Mg was lower than average in May and June samples and increased into the summer and fall. The Mg content was above average when pastures had legumes listed as species one or two. For lactating cows on lush spring pasture, Mg in the diet should be raised to 0.25% to 0.30% to prevent the oc-

currence of grass tetany (NRC 1989, p. 28). Therefore, it is recommended that Mg supplements be provided during the spring grazing season since 80% of pastures were below the 0.30% Mg content recommended for safety.

Potassium (K) - Forage K content needed by livestock was adequate in more than 99% of the pastures tested. Pastures in April and May were often high in K, increasing the risk that Mg will not be absorbed and that grass tetany will occur.

Sodium (Na) - Forage Na content was deficient in 95% of pastures sampled. It can be supplemented readily by providing free-choice salt on pasture.

Sulfur (S) - The S content in pasture and that needed by livestock are related to the sulfur-containing amino acids in forage and rumen bacteria. The recommended S content for beef cattle (0.15%) was met by 95% of pastures. Pasture containing high levels of S in conjunction with water high in S can cause reduced feed intake if total S intake exceeds 0.40% of diet dry matter. Excess levels of dietary S also reduce the absorption of Cu from the animal's diet. Across the United States, 21% of tested water exceeds the sulfate content considered safe for cattle (2). It is probably advisable not to supplement S to livestock on pasture.

Iron (Fe) - Forage content of Fe was sufficient in 99% of pastures to meet cattle's nutrient requirement. Almost 10% of pastures exceeded the recommended 1000 ppm of Fe in the DM considered the maximum tolerable allowance of Fe. When Fe exceeds 400 ppm, which occurred in 30% of pastures, the availability of Cu in the diet can be reduced. It is recommended that Fe not be supplemented to cattle on pasture.

Zinc (Zn) – Pastures were deficient in Zn in 50% of pasture samples analyzed. Pastures sampled in August and September were higher in Zn than average. Supplementation with Zn was shown to reduce the risk of Zn deficiency in beef cattle (3). It is recommended that Zn be supplemented to all cattle on pasture.

Copper (Cu) - The Cu content of pasture forage was below the 10 ppm recommended for beef cattle in about 40% of pastures. Cattle breeds differ in their need for Cu, with Simmental and Charolais cattle requiring higher levels of Cu than Angus (5) and Jerseys being more efficient at Cu retention than Holsteins (4). Supplementation with Cu was shown to reduce the risk of Cu deficiency in beef cattle (1). It is recommended that Cu be supplemented to all cattle but not to sheep on pasture.

Manganese (Mn) - Pasture content of Mn was sufficient in more than 95% of pastures tested.

Molybdenum (Mo) - There is no stated requirement for Mo for grazing ruminants. Excessive Mo levels interacting with S can depress Cu absorption by livestock. Levels of Mo do not appear to be excessive in West Virginia pastures.

Iodine (I) - Pasture samples were not tested for I. Deficiency of I may occur when feeding the recommended level of I if as much as 25% of the ration is strongly goitrogenic crops such as the brassicas kale, rape, or turnips. When feeding these crops, the dietary iodine should be 0.5 ppm for growing and nonlactating cows and 1.0 ppm for late-gestation and lactating cows (NRC 1988).

Selenium (Se) - Pasture samples were not tested for Se. Supplementation of Se is recommended in West Virginia. Deficiency in Se is most likely to occur when forage is grown on acidic soils typical to West Virginia. It is legal to supplement Se to beef cattle at 0.30 mg/kg of total diet up to 3 mg/head/day (5).

Cobalt (Co) - Pasture samples were not tested for Co. Supplementation for Co is recommended.

Application

Table 3 compares the ability of pastures of differing forage qualities to meet the needs of a high- and a low-producing lactating beef cow, a weaned steer calf, and a yearling steer.

Pastures in the High category meet the intake needs of all four classes of livestock. Average height pastures are marginally adequate for the high-producing cow, calf, and yearling but adequate for the low-producing cow. The low-height pastures were not adequate for the high-producing cow, calf or yearling and only marginal for the low-producing cow.

Pasture quality evaluated in terms of NDF and TDN follows a similar trend. High-quality TDN and NDF pasture meets the needs of the high-producing cow and yearling. The high-quality NDF pasture is marginal to the needs of the weaned calf, but high-quality TDN pastures are adequate. This brings out the need for having adequate legumes in pastures for weaned calves and for providing adequate forage to allow selective grazing, which enables the calves to eat forage lower than average in NDF. Average NDF and TDN pasture is marginal for the high-producing cow and yearling. The

low-quality NDF and TDN pastures meet the needs of the low-producing cow.

Pasture CP and ADF would not limit performance of any of these example animals at any of the three pasture qualities.

Of the major minerals, only Mg and Na are insufficient. Of the micro minerals Zn and Cu are deficient for all three classes of livestock even under average conditions. Given the high levels of S and Fe and the interactions of these two minerals with Zn and Cu there may be a greater need to supplemental Zn and Cu than implied in Table 3.

Conclusions

This on-farm pasture quality study confirms that:

- Energy intake is the first limiting nutrient for animals grazing pastures.
- Managing pasture height and forage NDF content is critical for maintaining adequate dry matter intake in high-producing livestock.
- Managing to maintain adequate legume content in pastures increases pasture intake by reducing forage NDF and increases the nutrient value of pastures.
- Ca and P supplementation may be needed for heavy milking cows and fast-growing calves if energy supplements such as corn or corn silage are provided to these animals on pasture.
- Mg should be supplemented to lactating animals in the spring.
- Trace mineral supplements should supply Co, Cu, I, Se, and Zn, but trace mineral supplements that supply Fe and S probably should be avoided.
- A high quality trace mineral salt can be supplemented strategically with Ca, P, and Mg to meet the seasonal needs of all classes of grazing animals.

Most pastures in West Virginia are adequate for average-producing cattle used in a cow-calf production system, the primary pasture use in the state. Where animals of above-average production ability are desired, above-average management is needed to provide adequate forage quantity and quality over the grazing season. This management needs to include proper stocking rate, the use of a buffer in the grazing system (aftermath grazing or grazing warm-season grasses), and the use of rotational grazing with proper control of pre- and post-grazing pasture height.

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- Dr. Kenneth Turner, USDA/ARS, Appalachian Farming Systems Research Center, 1224 Airport Road, Beaver WV 25813-0400

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Figure 1. Number of pasture samples taken in West Virginia counties.

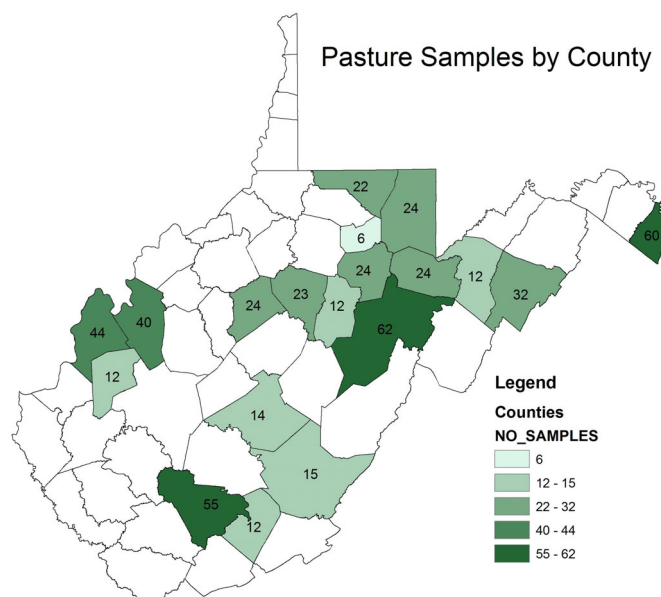


Figure 2. Monthly precipitation at Morgantown during the term of this study compared to the 30-year average. The vertical line above and below the average represents the range that includes 66% of the observed values over 30 years.

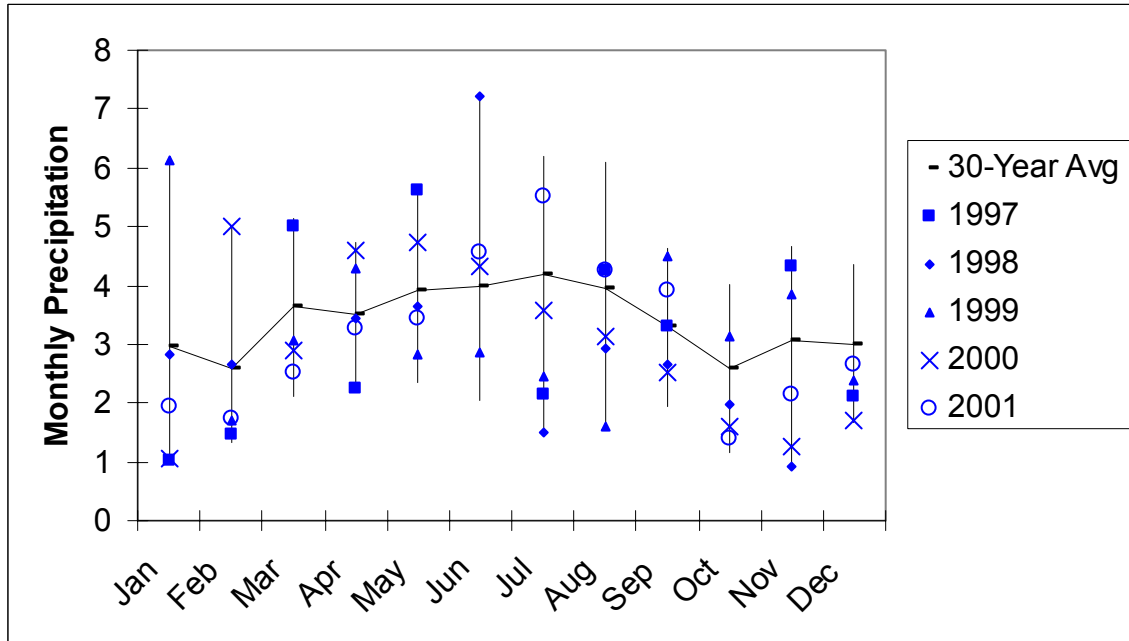


Figure 3. Monthly mean temperature at Morgantown during the term of this study compared to the 30-year average. The vertical line above and below the average represents the range that includes 66% of the observed values over 30 years.

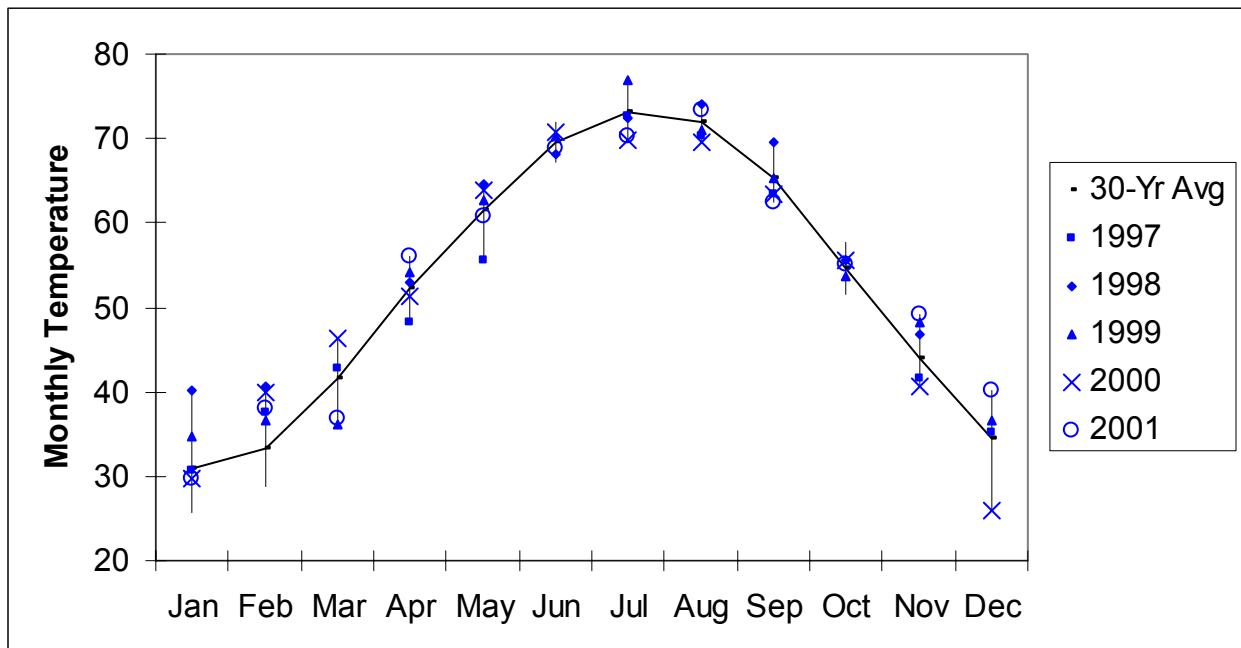


Table 1. Ranking of pastures based on pasture ruler height, acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), crude protein (CP), net energy lactation (NEL), net energy maintenance (NEM), net energy gain (NEG), and relative feed value (RFV) of pastures.

¹ Low values are “good” nutritionally

Pasture Nutrient Quality	Pasture Attribute or Nutrient								
	Height	ADF ¹	NDF ¹	TDN	CP	NEL	NEM	NEG	RFV
	Inches	% Dry Matter							
High	7.5	27.3	47.5	67.0	21.9	0.68	0.71	0.43	132
Average	5.0	30.9	52.1	64.1	18.6	0.62	0.65	0.38	115
Low	3.0	33.8	56.9	60.5	15.3	0.58	0.58	0.32	102

Table 2. Ranking of pastures based on mineral content for calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), sodium (Na), sulfur (S), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), and molybdenum (Mo).

Pasture Nutrient Quality	Pasture Attribute or Nutrient					
	Major Minerals					
	Ca	P	Mg	K	S	Na
	% Dry Matter					
High	0.78	0.41	0.28	2.94	0.29	0.024
Average	0.64	0.33	0.24	2.53	0.26	0.013
Low	0.53	0.27	0.20	2.14	0.22	0.010
	Micro Minerals					
	Fe	Zn	Cu	Mn	Mo	
	Parts per Million					
High	506	38	13.2	147	1.60	
Average	281	31	10.9	98	1.11	
Low	174	24	8.9	69	0.64	

Table 3. Ability of different quality pastures in West Virginia to meet the needs of different classes of beef cattle.

Pasture Nutrient Quality	Pasture Attribute or Animal Nutrient														
	Height	ADF	NDF	TDN	CP	Ca	P	Mg	K	Na	S	Fe	Zn	Cu	Mn
	Meets Critical Nutrient Requirement, 1200 LB Beef Cow 30 lbs Milk Production														
High	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Average	Y?	Y	Y?	Y?	Y	Y	Y	Y	Y	N	Y	Y	Y?	Y?	Y
Low	N	Y	N	N	Y	Y	Y	Y?	Y	N	Y	Y	N	N	Y
	Meets Critical Nutrient Requirement, 1200 LB Beef Cow 10 lbs Milk Production														
High	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Average	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y?	Y?	Y
Low	Y?	Y	Y	Y	Y	Y	Y	Y?	Y	N	Y	Y	N	N	Y
	Meets Critical Nutrient Requirement, 550 lb Steer Gaining 2.23 lbs ADG														
High	Y	Y	Y?	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Average	Y?	Y	N	Y?	Y	Y	Y	Y	Y	N	Y	Y	Y?	Y?	Y
Low	N	Y	N	N	Y	Y	Y	Y?	Y	N	Y	Y	N	N	Y
	Meets Critical Nutrient Requirement, 780 lb Steer Gaining 2.0 lbs ADG														
High	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Average	Y?	Y	Y?	Y	Y	Y	Y	Y	Y	N	Y	Y	Y?	Y?	Y
Low	N	Y	N	N	Y	Y	Y	Y?	Y	N	Y	Y	N	N	Y

Y—Yes
 Y? - Yes but Marginally
 N—No