

How Fiber Concentration Impacts Dry Matter and Nutrient Intake in Beef Cattle

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Testing forage quality prior to feeding hay is a highly recommended practice for livestock producers. Forage reports comprise precisely calculated values describing concentrations of nutrients available in the forage. Although all nutrient values play an important role in determining a quality feeding regimen, solely focusing on the total digestible nutrients (TDN) and crude protein (CP) has become a favored practice of reading a forage report. When protein and energy values meet recommended requirements at first glance, fiber content is often overlooked. However, if fiber is not within a specific range, intake and digestibility of the forage may become limited, reducing the total protein and energy available to the herd and potentially not meeting cattle nutrient requirements.

What Is Fiber?

Fiber comprises mainly three substances—hemicellulose, cellulose and lignin. These three components are made up of different chemical monomers, simple molecules that can combine to form larger molecules, that introduce unique characteristics necessary for plant productivity and cell wall protection, with higher concentrations particularly in the stems. Through rumination and microbial activity, cattle digest hemicellulose more easily than cellulose and lignin. These two components only partially degrade in the digestive tract, limiting their nutrient contributions. Together, these three fibrous components ensure structure, flexibility and reduced water loss within the plant tissues (Hongzhang, 2014).

As plants mature, fibrous material will increase due to a higher stem-to-leaf ratio. Similarly, the digestibility and the nutrient quality of this plant will decrease as can be seen in Figure 1.

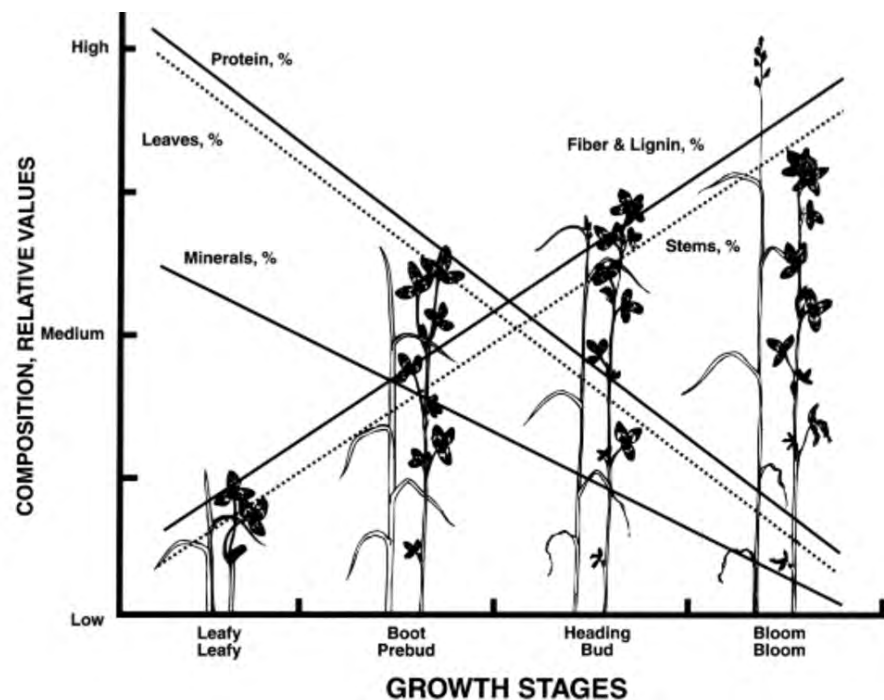


Figure 1: An illustration of the forage growth stages and associated composition of nutrients. Source: Harlan E. White, 1996

How to Evaluate Fiber on a Forage Report

Fiber is most commonly represented on a forage report with **acid detergent fiber (ADF)** and **neutral detergent fiber (NDF)** values. NDF is described as the partially digestible content composed of all cell wall materials—hemicellulose, cellulose and lignin. As NDF increases, dry matter intake decreases due to the bulky and more slowly digested forage impacting rumen fill. Dry matter intake is calculated as a percent of body weight by dividing NDF into a standardized value of 120. For example, if a forage contains 50 percent NDF on a dry matter basis, the dry matter intake of this feed is estimated to be about 2.4 percent of the animal's body weight (120/50). ADF contains only cellulose and lignin, the less digestible material. As ADF increases, digestibility decreases. This number will always be lower than NDF, and the difference between the two values is the concentration of the more digestible component in fiber, the hemicellulose.

Grass hays typically contain 50-75 percent NDF while legume hays contain 40-65 percent NDF (Hoffman et al., 2001). Concern arises when NDF levels surpass 60 percent, as this can lead to reduced dry matter intake. Hay ADF can range from 30-55 percent, and digestibility is reduced when feeding hay with values greater than 40 percent (Montgomery, 2023).

Effect of Fiber on Energy and Protein

It is easy to assume a certain level of dry matter intake when calculating rations. However, this one value can quickly alter calculated available energy and protein. Protein and energy are only valuable if they reach the rumen of the animal. If the NDF and ADF concentrations are too high, then the animal is not capable of eating the expected amount due to the slow digestion in the rumen, and as a result, dry matter intake as a percent of body weight decreases significantly. Despite adequate CP and TDN values, if the animal is not able to consume enough forage, then nutrient requirements are not met.

Example

A 1,400-pound mature cow is in the first month of lactation. It is late January in Tennessee, and fescue hay is utilized to feed the herd. Nutrient requirements and forage report values are listed below.

Fescue Hay Analysis Results (dry matter basis)	Nutrient Requirements (pounds of dry matter per head per day)
Dry Matter: 90%	Total Digestible Nutrients: 16.54
Total Digestible Nutrients: 50%	
Crude Protein: 11%	Crude Protein: 2.84
Neutral Detergent Fiber 70%	

A common practice is to simply use the TDN and CP values to calculate available nutrients based on an assumed dry matter intake (DMI), as follows:

Assume the dry matter intake is 2.5 percent of cow's body weight.

1400 lb cow $\times$ 0.025 = 35 lb of dry matter intake possible

35 lb dry matter $\times$ 0.11 lb crude protein = 3.85 lb crude protein

35 lb dry matter $\times$ 0.50 lb total digestible nutrients = 17.5 lb total digestible nutrients

These available CP and TDN values exceed our needed requirements and would imply this ration is plenty to support this lactating cow and her calf. If the NDF is rightfully considered, the following calculations are made:

120 $\div$ 70 percent neutral detergent fiber = expected dry matter intake is 1.71 percent of body weight

1400 lb cow $\times$ 0.0171 = 23.94 lb of dry matter intake possible

23.94 lb dry matter $\times$ 0.11 lb crude protein = 2.63 lb crude protein

23.94 lb dry matter $\times$ 0.50 lb total digestible nutrients = 11.97 lb total digestible nutrients

These calculated values reflect available nutrients based on the pounds of DM the cow can ingest daily due to limited digestibility of the hay. This ration no longer meets CP or TDN requirements.

When Is This Important?

Fiber should always be considered when formulating appropriate rations that meet nutrient requirements, especially in higher maturity or harvested forages that tend to accumulate more fiber. In Tennessee, winter and summer months often provide less fresh forage for cattle compared to spring and fall. Producers often feed hay or stockpiled forages during these periods of low cool-season forage production. Taking into consideration hay fiber concentration in addition to CP and TDN is imperative to ensure proper intake, especially when cattle are likely gestating or lactating, and to maintain higher daily nutrient requirements.

Cows in peak lactation or the last third of gestation need to meet all requirements to easily calve, nurse and maintain body weight to cycle and rebreed, maintaining a desirable calving interval. These goals cannot be met if cattle are unable to meet required dry matter intake due to high fiber concentrations in the diet. Additionally, gestating cattle maintain a limited gut capacity due to a growing fetus applying pressure on the abdomen in the last third of gestation. Dry matter intake is already limited by this factor during this stage; therefore, it is of even greater importance to ensure these cattle receive adequate nutrient levels to meet the requirements for a healthy calving.

Alternative Feeding Options and Forage Management

If forages contain high fiber contents that reduce the ability of cattle to meet their nutrient requirements, additional options and supplements can be considered. If less mature/fibrous forage or hay is available, feed this to groups with the highest nutrient requirements. Save the high NDF (> 60%) forages for open cattle who can likely maintain body weight on this feed. Additionally, low-cost grains or concentrate feeds can be supplemented just enough to meet requirements as needed.

To mitigate high fiber concentrations in harvested forage, try to harvest hay at shorter intervals or at an earlier stage of maturity (for example, boot stage). Despite a greater yield, a more mature forage also contains higher fiber contents and lower nutrient concentrations. Baling forages as baleage, or wet hay, rather than dry hay may present an opportunity to conserve high-quality forage, especially when weather conditions do not favor hay-making, resulting in harvesting at mature stages. This fermentation process could increase fiber breakdown and forage digestibility for cattle. Incorporating an inoculant additive bacterium before baling also can encourage prolonged quality and digestibility of forages.

Submitting a forage sample is only the first step to making an informed decision. Refer to the UT Soil, Plant and Pest Center website or contact your local Extension agent to learn more about collecting and submitting a forage sample for nutrient analysis. It is essential to fully understand all components of a forage report and how they work in tandem to develop the most cost-efficient nutritional management strategy.

Online Resource

UT Soil, Plant and Pest Center website: soillab.tennessee.edu

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