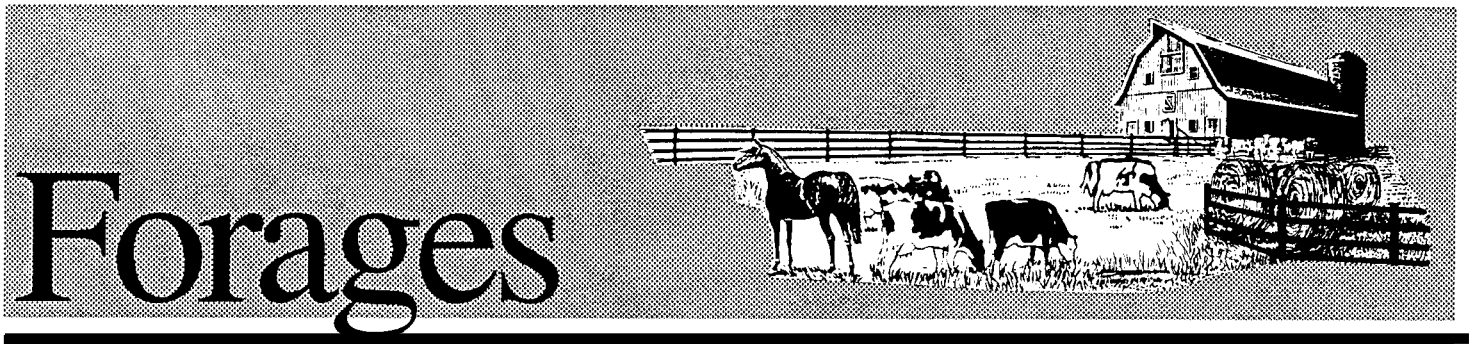

INTERPRETATION OF FEED AND FORAGE LABORATORY REPORTS

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The best and only direct measure of forage quality is through animal performance: milk production, weight gain, reproductive performance, or whatever measure is applicable. While less accurate, chemical analyses can also provide an estimate of forage quality. It can suggest the best use of the forage and lead to a more precise and economical formula for a concentrate mixture to supplement the forage.

Clemson provides a chemical analysis of forage and feedstuff through the Agricultural Service Laboratory. County Extension agents can provide a standard form to request analysis of samples. It is important that the type of animals being fed and the type of feed to be analyzed be reported on the "Feed and Forage Analysis" request form since different calculations are used to determine energy values for different categories of feed and livestock.

All samples are analyzed for dry matter, nitrogen, acid detergent fiber, and minerals (phosphorus, potassium, calcium, magnesium, zinc, copper, and manganese). In addition, pH is measured for all silage samples. Neutral detergent fiber, unavailable protein, sulfur, iron, sodium, fat, nitrate, and ash are determined upon request.

Other nutritional information reported by the laboratory is calculated from the above analysis. These factors include: digestible protein, crude fiber, total digestible nutrients, net energy/lactation, net energy/maintenance, net energy/gain, and metabolizable energy.

A report from the Agricultural Service Laboratory is shown in Figure 1. Results are presented in two ways: 1) calculated as-sampled basis, and 2) determined dry-matter basis. All analyses are conducted on a sample that has been oven dried (except for silage pH), and these values are the ones reported as dry-matter basis. The very first determination made by the lab is moisture content, which is determined by weighing a sample before and after oven drying. This is reported in the lower right-hand portion of the report sheet, along with the dry matter (dry matter + moisture = 100%). The as-sampled values, sometimes called as-fed, are then back calculated, hence the column heading--calculated as-sampled basis--and will always be a lower value than the dry-matter basis because they are "diluted" with water. **Comparisons among samples should be made only on a dry-matter basis to eliminate variability due to differences in water content.**

Many labs perform these type of analyses, and although the report form may have a different format or style, the interpretation of the reported values will be the same.

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Crude Protein is calculated by multiplying the total nitrogen content determined in the laboratory by 6.25. Crude protein includes protein and non-protein nitrogen, which are comparable for ruminants in most situations. Crude protein and one of the energy estimates (ADF discussed below) are usually considered most important when determining the quality of a feedstuff. Table 1 lists normal crude protein ranges for several hays and silages.

Available Crude Protein is calculated from crude protein and is an estimate of that portion of the protein which can be digested by an animal. Current calculations do not adequately reflect variation of protein digestibility among feedstuffs, and the value is of little use in formulating rations.

Bound Protein is an estimate of the protein not available to a ruminant. Unavailable protein, also called the browning reaction (because the hay or silage turns brown) or Maillard products, usually results from a heating reaction during faulty curing (i.e., hay put up too wet or silage put in the silo too dry). Animals like this forage better, but the nutritional quality is reduced to the extent that a portion of the protein is made unavailable. If the unavailable protein is 4 percent, for example, and the crude protein is 13 percent, then 13 less 4 or 9 percent should be used as the crude protein content of the feedstuff for balancing rations.

Acid Detergent Fiber (ADF) is determined in the laboratory as an estimate of the fiber fraction (the portion with low digestibility in non-ruminants). ADF is not totally digestible by ruminants, and the portion that can be is digested more slowly than the non-fiber fraction. Thus, within a forage type, higher ADF generally means reduced intake and digestibility. At the same time, a certain amount of fiber is necessary in animal diets to maintain animal health and butterfat in milk. Normal ranges of ADF in common forages are listed in Table 2.

Neutral Detergent Fiber (NDF) is another estimate of fiber content determined in the laboratory. It includes the fiber measured by ADF and one additional fraction (hemicellulose); thus, NDF values are always higher than ADF values. As with ADF, higher values within a forage type generally mean reduced intake and digestibility.

Crude Fiber is an older estimate of the fiber content developed in the 1890's. It can be determined directly in the laboratory but at Clemson is calculated from ADF. Crude fiber is gradually being replaced by ADF to estimate fiber for animal nutritional purposes.

Total Digestible Nutrients (TDN) is used to describe the digestibility of a feedstuff and approximates the percentage of the feed that the animal will be able to utilize. TDN and crude protein are frequently used to determine relative quality of feeds for sale. TDN is no longer directly determined, but is predicted from the ADF value. Normal ranges of TDN are presented in Table 3.

Partitioning digestible energy into various components (net energy/lactation, net energy/maintenance, net energy/gain, and metabolizable energy) is a more accurate method of predicting animal performance. However, it is important to remember that the energy values presented are only estimates of the energy in the feedstuff calculated from Total Digestible Metabolizable energy (in kilocalories/lb). It represents the amount of energy in the feedstuff that is available for metabolism. Net energy for maintenance (in megacalories/lb) is the portion of the metabolizable energy needed for the basal metabolism, that is, to keep the animal alive but not to grow, produce milk, etc. Net energy for maintenance must be met before any growth or other type of production can take place. Net energy/growth and net energy/lactation define the energy value of the feed to promote gain and lactation, respectively, when fed above maintenance. These values are lower than net energy/maintenance because utilization of energy is more efficient for maintenance than production.

The forage can be analyzed for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), and sodium (Na). These minerals are essential to animals and if not in the diet at adequate levels must be supplied in an additional supplement. The Ca/P ratio is also calculated if mineral analysis is requested. The value is primarily of concern in lactating cattle where the Ca/P ratio for the entire ration should be 1.75. Any significant deviation from it will result in decreased milk production and, possibly, animal health problems.

Several other analyses can be run by the laboratory on request, and the results are reported in the lower right corner of the report. **Fat** can be important in balancing high concentrate ration. **Nitrate** (NO_3-N) is a component that may accumulate to toxic levels

in hay or silage, particularly where fields have been fertilized and then subjected to stress. Feedstuffs with levels above 1,000 ppm on a dry-matter basis should be fed with caution. **Ash** is a measure of the total minerals in the forage and includes soil which may be contained in the sample. The **pH** (silage) is a measure of the acids formed during the fermentation process after forages are ensiled. The pH should drop to 3.8 to indicate normal fermentation has occurred and that the silage can be stored indefinitely. A pH of 4 or higher for corn or sorghum or 4.2 or higher for grass silage indicates that normal fermentation did not occur. The final results reported are moisture and dry matter.

Moisture is the percentage of water in the sample, and dry matter is the percentage of material in the sample that is not water. The two figures should total 100 percent.

The results presented in the Feed and Forage Laboratory Report can be used to determine which factors are lacking in the feedstuff and must be included in a supplement for desired animal performance. Examples of animal requirements are presented in Table 4. Rations can be formulated to determine the most economical, balanced ration to meet animal requirements. If additional help is needed, contact your county Extension office.

Table 1. Typical Ranges of Crude Protein Content for Several Hays and Silages

Feedstuff	5	10	15	20	25
Bermudagrass hay	*_____*_____*				
Tall fescue hay		*_____*_____*			
Alfalfa hay			*_____*_____*		
Sorghum, millet, sorghum-sudangrass hay	*_____*_____*				
Clover hay			*_____*_____*		
Corn silage	*__*__*				
Grain sorghum silage	*__*__*				
Forage sorghum silage	*__*__*				

Lower values than the left asterisk would be considered poor for the type, higher values than the right asterisk would be considered excellent for the type, and values near the middle of the range would be considered good.

Table 2. Typical Ranges of Acid Detergent Fiber (ADF) Content of Several Hays and Silages

Feedstuff	20	30	40	50	60
Bermudagrass hay		*_____*_____*			
Tall fescue hay			*____*____*		
Alfalfa hay		*____*____*			
Sorghum, millet, sorghum-sudangrass hay			*____*____*		
Small grain hay			*____*____*		
Clover hay			*____*____*		
Corn silage	*__*__*				
Grain sorghum silage		*__*__*			
Forage sorghum silage			*____*__*		

Lower values than the left asterisk would be considered poor for the type, higher values than the right asterisk would be considered excellent for the type, and values near the middle of the range would be considered good.

Table 3. Typical Ranges of Total Digestible Nutrients (TDN) for Several Hays and Silages

Feedstuff	40	50	60	70	80
Bermudagrass hay		*_____*_____*			
Tall fescue hay			*____*____*		
Alfalfa hay				*_____*_____*	
Sorghum, millet, sorghum-sudangrass hay			*_____*_____*		
Small grain hay			*_____*_____*		
Clover hay				*_____*_____*	
Corn silage			*____*____*		
Grain sorghum silage			*____*____*		
Forage sorghum silage			*____*____*		

Lower values than the left asterisk would be considered poor for the type, higher values than the right asterisk would be considered excellent for thetype, and values near the middle of the range would be considered good.

Table 4. Typical Animal Requirements

	Daily Dry Matter Intake	TDN	Crude Protein
	lb	%	%
BEEF CATTLE			
Dry pregnant mature cow			
middle third of pregnancy			
900 lb	16.7	48.8	7.0
Cows nursing calves			
10 lb milk per day			
first 3-4 months postpartum			
900 lb	18.8	57.3	9.9
Pregnant yearling heifers			
last third of pregnancy			
gaining 1.4 lb day	15.8	60.3	9.0
Bulls			
maintenance, 1600 lb	26.5	48.4	6.9
Steers			
gaining 1.5 lb/day			
500 lb	13.4	59.5	10.4
HORSES			
Mature mare			
maintenance, 1100 lb	16.4	50.0	8.5
Yearling horse			
12 months, 715 lb			
gaining 1.2 lb/day	13.2	63.6	12.9
Lactating mare			
1100 lb, 22 lb milk/day			
3 months to weanling	20.6	59.2	8.3
SHEEP			
Ewes			
non-lactating, 132 lb			
gaining .3 lb/day	3.5	57.1	11.4
Ewes			
first 6-8 weeks lactation			
132 lb, suckling twins	5.5	69.1	13.1

	TDN	Net [1] Energy-L	Crude Protein	ADF
	%	Mcal/lb	%	%
DAIRY CATTLE				
Lactating cow				
1300 lb, 55 lb milk	71	.73	15	21
Dry cows				
1300 lb	60	.61	11	21
Growing heifers				
	60	—	12	19

[1] Net energy for lactation.

Figure 1. Report Form of the Clemson University Cooperative Extension Service Agricultural Service Laboratory

FEED & FORAGE ANALYSIS REPORT

Lab No. 40547

Clemson University
Cooperative Extension Service
Agricultural Service Laboratory
Clemson, SC 29634-0391

Name _____ County: Georgetown
Address _____ Date: 04-29-1991
City _____
Zip Code _____
Sample No. _____ Feed: Hay Bermuda Fed to: Beef Cattle

LABORATORY RESULTS

	Calculated As-sampled Basis	Determined Dry-Matter Basis
CRUDE PROTEIN	8.3%	9.0%
AVAILABLE CRUDE PROTEIN*	8.2%	9.0%
BOUND PROTEIN	1.0%	1.1%
FIBER - ADF	36.4%	39.7%
- NDF	67.7%	73.8%
CRUDE FIBER*	30.6%	33.3%
TOT. DIG. NUTRNTS*	49.5%	54.0%
NET ENERGY-L*	0.501 Mc/lb	0.546 Mc/lb
NET ENERGY-M*	0.531 Mc/lb	0.579 Mc/lb
NET ENERGY-G*	0.231 Mc/lb	0.252 Mc/lb
METAB. ENERGY*	934 Kc/lb	1019 Kc/lb
RELATIVE FEED VALUE*	---	73

* VALUES CALCULATED FROM CURRENT RESEARCH FORMULAS

MINERAL ANALYSIS

	Calculated As-Sampled Basis	Determined Dry-Matter Basis
P	0.18%	0.20%
K	1.50%	1.64%
Ca	0.35%	0.38%
Mg	0.17%	0.18%
S	0.28%	0.30%
Zn	24 ppm	26 ppm
Cu	6 ppm	6 ppm
Mn	44 ppm	48 ppm
Fe	40 ppm	44 ppm
Na	445 ppm	485 ppm
Ca/P	1.90	1.90

OTHER ANALYSES

	Calculated As-Sampled Basis	Determined Dry-Matter Basis
Fat	1.8%	2.0%
NO_3-N	1122 ppm	1223 ppm
ASH	4.9%	5.3%
pH (SILAGE)_____		
MOISTURE_____	8.3%	
DRY MATTER_____	91.7%	

For additional information please contact your county Extension agent.

APPROVED BY _____