ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

ANR-890

Interpreting a Forage Analysis

Beef and dairy cattle in Alabama have been genetically selected for increased growth and production over the past 25 years. The most important factor in determining if these cattle will reach their genetic potential is feed. Today, more than two-thirds of the feeds consumed by animals are not suited for human consumption. Even though these crops are undigestible by humans, from 30 to 80 percent of the cellulose found in roughage is digestible by cattle.

There are many types of silage, hay, straw, and grass consumed by cattle in Alabama. The quality of forages is highly variable. The nutrient content of these feeds depends upon variety, weather conditions, soil fertility, maturity at harvest, harvest procedures, and storage conditions. The accurate way to ensure that cattle are being properly fed is to know their nutrient requirements and to formulate diets based upon forage analyses.

In 1993, the Auburn University Forage Testing Laboratory tested more than 1,800 feed and forage samples. These included roughage, silage, and mixed feeds. For each sample submitted, Auburn University Forage Testing Laboratory sent a forage analysis report to the producer and the county Extension agent. A forage analysis determines the amount of moisture, dry matter, protein, fiber, energy, minerals, fat, nitrate nitrogen, and ash. (See Sample Forage Analysis Form.) These components are necessary to formulate a ration for cattle.

The purpose of this publication is to help producers understand the forage analysis report. By using the information in this report, producers can formulate diets which will meet nutrient requirements of cattle.

The nutrient requirements of breeding cattle vary with the stage of production and age. (See Table 1.) Younger cattle require a higher percentage of energy and protein in their diet than older animals. Lactating cows have different feed requirements from dry pregnant cows. Therefore, diets must be specifically formulated to meet the needs of cattle based on the variability of the forages and the stage of production of the cattle. Grain mixes must be formulated to provide for nutrient deficiencies in forage.

The nutrient requirements for beef cattle are contained in the Alabama Cow-Calf handbook. The requirements for dairy cattle are in Extension Circular ANR-609, "Feeding And Management Of The Dairy Calf: Birth To 6 Months"; Extension Circular ANR-632, "The Feeding And Management Of Dairy Heifers: 6 Months To Calving"; and Extension Circular ANR-289, "Management And Care Of The Dry Cow." These publications are available through each county Extension office.

Sampling Techniques for Accurate Forage Analysis

A forage analysis is no better than the sample submitted to the laboratory. The extreme variation that exists in physical form and nutritional content of forages requires careful sampling techniques.

Hay. Sample hay in lots. "Lots" are defined as hay samples taken of the same species, at the same maturity, and handled in a similar manner. Hay that has been lying on the ground for 2 weeks during rainy weather before baling would be in a different lot from hay that was cut, dried, and immediately baled. The first cutting of hay would be a different lot from hay cut in midsummer.

Use hay probes to collect hay samples. Probes are tubes on the end of a boring device, which will collect core samples. The probe should be at least ½ inch in diameter and should be long enough to extend to the center of the bale of hay. Hand or grab samples pulled from the inside of the bales of hay are very inaccurate and not representative of the average quality throughout the bale.

Collect 15 to 18 samples per lot of hay. Thoroughly blend the samples before submitting them to the forage laboratory. Sample round bales of hay from the round side, and sample square or rectangular bales from the end of the bale.

Sample Forage Analysis Form

SAMPLE #: F0483.94

NAME: Melvin Reese
ADDRESS: 200 Fairy Tale Lane
CITY: Anywhere, AL
ZIP CODE: 00001

COUNTY: HENRY
SAMPLE DATE: 05/11/94
REPORT FEE: $ 20.00

CLIENT'S PERSONAL ID: OATS MILK STAGE
FEED: OAT HAY
WILL BE FED TO: BEEF CATTLE

==========LABORATORY RESULTS==========

STANDARD ANALYSES

	CALCULATED AS-SAMPLED BASIS	DETERMINED DRY-MATTER BASIS
MOISTURE		8.58 %
DRY MATTER		91.42 %
CRUDE PROTEIN	7.76 %	8.49 %
DIGESTIBLE PROTEIN*	4.03 %	4.41 %
FIBER - NDF	62.17 %	68.00 %
- ADF	35.65 %	39.00 %
- ADFN	---- %	---- %
CRUDE FIBER*	28.27 %	30.92 %
TOTAL DIGESTIBLE NUTRIENTS*	48.15 %	52.66 %
NET ENERGY-L*	1.07 Mc/kg	1.17 Mc/kg
NET ENERGY-M*	1.13 Mc/kg	1.24 Mc/kg
NET ENERGY-G*	0.47 Mc/kg	0.52 Mc/kg
METABOLIZABLE ENERGY*	1.73 Mc/kg	1.90 Mc/kg

* Values calculated from current research formulae

MINERAL ANALYSES

	CALCULATED AS-SAMPLED BASIS	DETERMINED DRY-MATTER BASIS
Ca	0.15 %	0.16 %
K	1.58 %	1.73 %
Mg	0.11 %	0.12 %
P	0.22 %	0.24 %
Cu	0 ppm	0 ppm
Fe	99 ppm	108 ppm
Mn	43 ppm	47 ppm
Zn	9 ppm	10 ppm
S	---- %	---- %
Ca/P	0.67	0.67

OTHER ANALYSES

	CALCULATED AS-SAMPLED BASIS	DETERMINED DRY-MATTER BASIS
FAT	---- %	---- %
NO3-N	455 ppm	500 ppm
ASH	---- %	---- %
pH	-----	

For additional information, contact your Henry County Extension agent at 585-6416.

Approved By _____

Table 1. Nutrient Requirements Of Breeding Cattle.

Weight[a] (lb.)	Gain[b] (lb.)	Daily DM[c] (lb.)	TDN (lb.)	TDN (%)	Protein In Diet Daily (lb.)	Protein In Diet DM (%)	Calcium In Diet Daily (g)	Calcium In Diet DM (%)	Phos. In Diet Daily (g)	Phos. In Diet DM (%)
Pregnant yearling heifers - Last third of pregnancy										
700	0.9	15.3	8.5	55.4	1.3	8.4	19	0.27	14	0.20
700	1.4	15.8	9.6	60.3	1.4	9.0	24	0.33	15	0.21
750	0.9	16.1	8.9	55.1	1.3	8.3	20	0.27	14	0.19
750	1.4	16.6	10.0	59.9	1.5	8.9	24	0.32	16	0.21
800	0.9	16.8	9.2	54.8	1.4	8.2	21	0.28	15	0.20
800	1.4	17.4	10.4	59.6	1.5	8.8	25	0.33	16	0.21
850	0.9	17.6	9.6	54.5	1.4	8.2	21	0.26	16	0.20
850	1.4	18.2	10.8	59.3	1.6	8.6	25	0.30	17	0.21
900	0.9	18.3	9.9	54.3	1.5	8.1	22	0.26	17	0.20
900	1.4	19.0	11.3	59.1	1.6	8.5	26	0.30	18	0.21
950	0.9	19.0	10.3	54.1	1.5	8.0	23	0.27	17	0.20
950	1.4	19.8	11.7	58.9	1.7	8.4	26	0.29	19	0.21
Dry pregnant mature cows -Middle third of pregnancy										
800	0.0	15.3	7.5	48.8	1.1	7.1	12	0.17	12	0.17
900	0.0	16.7	8.2	48.8	1.2	7.0	14	0.18	14	0.18
1,000	0.0	18.1	8.8	48.8	1.3	7.0	15	0.18	15	0.18
1,100	0.0	19.5	9.5	48.8	1.4	7.0	17	0.19	17	0.19
1,200	0.0	20.8	10.1	48.8	1.4	6.9	18	0.19	18	0.19
1,300	0.0	22.0	10.8	48.8	1.5	6.9	20	0.20	20	0.20
1,400	0.0	23.3	11.4	48.8	1.6	6.9	21	0.20	21	0.20
Dry pregnant mature cows - Last third of pregnancy										
800	0.9	16.8	9.2	54.5	1.4	8.2	20	0.26	15	0.20
900	0.9	18.2	9.8	54.0	1.5	8.0	22	0.27	17	0.21
1,000	0.9	19.6	10.5	53.6	1.6	7.9	23	0.26	18	0.20
1,100	0.9	21.0	11.2	53.2	1.6	7.8	25	0.26	20	0.21
1,200	0.9	22.3	11.8	52.9	1.7	7.8	26	0.26	21	0.21
1,300	0.9	23.6	12.5	52.7	1.8	7.7	28	0.26	23	0.21
1,400	0.9	24.9	13.1	52.5	1.9	7.6	29	0.26	24	0.21
Two-year-old heifers nursing calves - First 3-4 months postpartum - 10 lb. milk/day										
700	0.5	15.9	10.3	65.1	1.8[d]	11.3	26	0.36	17	0.24
750	0.5	16.7	10.8	64.4	1.8[d]	11.0	26	0.34	18	0.24
800	0.5	17.6	11.2	63.8	1.9[d]	10.8	27	0.34	19	0.24
850	0.5	18.4	11.6	63.2	1.9[d]	10.6	27	0.33	19	0.23
900	0.5	19.2	12.0	62.7	2.0[d]	10.4	28	0.32	20	0.23
950	0.5	20.0	12.5	62.3	2.0[d]	10.2	28	0.31	21	0.23
1,000	0.5	20.8	12.9	61.9	2.1[d]	10.0	29	0.31	22	0.23
Cows nursing calves - Average milking ability - First 3-4 months postpartum - 10 lb. milk/day										
800	0.0	17.3	10.1	58.2	1.8[d]	10.2	23	0.30	17	0.22
900	0.0	18.8	10.8	57.3	1.9[d]	9.9	24	0.28	19	0.22
1,000	0.0	20.2	11.5	56.6	2.0[d]	9.6	25	0.28	20	0.22
1,100	0.0	21.6	12.1	56.0	2.0[d]	9.4	27	0.27	22	0.22
1,200	0.0	23.0	12.8	55.5	2.1[d]	9.3	28	0.27	23	0.22
1,300	0.0	24.3	13.4	55.1	2.2[d]	9.1	30	0.27	25	0.22
1,400	0.0	25.6	14.0	54.7	2.3[d]	9.0	31	0.27	26	0.22
Cows nursing calves - Superior milking ability - First 3-4 months postpartum - 20 lb. milk/day										
800	0.0	15.7	12.1	77.3	2.2[d]	14.2	34	0.48	22	0.31
900	0.0	18.7	13.1	69.8	2.4[d]	12.9	35	0.41	24	0.28
1,000	0.0	20.6	13.8	67.0	2.5[d]	12.3	36	0.39	25	0.27
1,100	0.0	22.3	14.5	65.2	2.6[d]	11.9	38	0.38	27	0.27
1,200	0.0	23.8	15.2	63.7	2.7[d]	11.5	39	0.36	28	0.26
1,300	0.0	25.3	15.9	62.6	2.8[d]	11.2	41	0.36	30	0.26
1,400	0.0	26.7	16.5	61.7	2.9[d]	11.0	42	0.35	31	0.26

Source: Nutrient Requirements Of Beef Cattle, Sixth Edition, 1984.

[a]Average weight for feeding period.

[b]Approximately 0.9 pound of weight gain per day during the last third of pregnancy is accounted for products of conception.

[c]Dry matter consumption will vary, depending on the energy concentration of the diet and environmental conditions.

[d]Includes 0.03 lb. protein/lb. of milk produced.

Silage. Take silage samples at harvest time, but be sure to identify different crops. To collect silage samples, pull grab samples from several locations and mix carefully. Avoid excessive mixing which will cause the grain to fall to the bottom and not give an accurate representation of the silage. Fill a 1-quart freezer bag, release any trapped air, and ship the sample. If you need to delay shipping, freeze the sample, and ship when convenient. Be sure the bag has an airtight seal so the moisture analysis will be accurate.

Dry Matter and Moisture

In a forage sample, the first item to examine is moisture or dry matter (DM). The amount of moisture in a sample will help determine how much to pay for the forage, how to store the forage, and how much to feed per animal unit per day. The amount of any forage that cattle consume is influenced by its DM content.

Stocker cattle will consume an average of 3 percent of their body weight per day on DM basis. This means that a 700-pound steer will consume about 21 pounds of dry forage per day (700 pounds $\times$ 0.03 = 21 pounds). Maximizing DM intake for dairy cattle is extremely important with 45 to 55 pounds DM intake per day considered normal.

Bermudagrass hay should be about 89 to 91 percent DM for proper storage. Wet hays will heat and mold, rendering them inedible or undesirable to the cattle. A 700-pound steer will consume about 23.33 pounds of a 90 percent DM bermuda grass hay as sampled or as fed (21 pounds $\div$ 0.90 = 23.33 pounds). "As fed" or "air dry" refers to a sample as it would be fed rather than the amount of DM it contains. A 10-pound sample of forage containing 50 percent DM actually contains 5 pounds of DM and 5 pounds of water. Good corn silage should be between 30 and 40 percent DM.

Forage samples are oven dried to determine the amount of water and DM in a sample. The left column of the lab report will represent the forage sample on an as fed basis and the right column on a DM basis. When viewing a forage sample, always calculate nutrients based on the DM column.

Protein

Protein is an important nutrient supplied by forages. Protein is necessary for growth, milk production, and muscle development.

Protein is extremely variable in forages. Forages contain higher levels of protein when they are young and growing. Generally, all nutrients in plants decrease as they age. The protein in bermudagrass hay may be as low as 3 percent in mature hay or as high as 17 percent in the early growth stage. Legumes such as clovers and alfalfa are higher in protein than grass hays but have considerable variation, depending upon the stage of maturity and weather conditions.

Crude protein (CP) is the percent of total nitrogen in a forage sample multiplied by a 6.25 correction factor. The CP value on a forage sample includes true protein and nonprotein nitrogen compounds.

Digestible protein is a calculated value based on the kind of forage analyzed. The digestible protein in green growing forages is about 70 percent of the CP. It is an estimate of the protein digestibility only. It has little value in formulating rations for beef cattle or dairy. CP values should be used in feed formulation.

Available crude protein (ACP) can be calculated based on acid detergent fiber nitrogen (ADFN). ADFN, or bound nitrogen, determines the amount of bound protein and indicates the percentage of protein unavailable because of heating. Nitrogen (used to calculate protein) becomes bound when forages go through a heat. Forages heat when excessive moisture and oxygen are present. Forages start to heat when the moisture exceeds about 14 percent. The average amount of bound nitrogen in a forage sample is about 12 percent. Bound nitrogen figures greater than 12 percent result in decreased protein digestibility.

Using ADFN To Calculate Available Crude Protein. ACP can be calculated from ADFN, or bound nitrogen.

First convert ADFN percent to amount bound protein:

If ADFN equals 0.84 percent, then

$$\begin{aligned}\text{Amount bound protein} &= \text{ADFN} \times 6.25\\ &= 0.84 \times 6.25\\ &= 5.25\%\end{aligned}$$

Next, determine what percent of CP is bound: If CP equals 24.45 percent, then

$$\begin{aligned}\text{Percent bound protein} &= \frac{\text{Amount bound protein}}{\text{CP}} \times 100\\ &= \frac{5.25}{24.45} \times 100\\ &= 21.47\%\end{aligned}$$

Finally, calculate ACP using the following equation:

$$\begin{aligned}\text{ACP} &= \frac{\text{CP} \times [100 - (\%\text{ bound protein} - 12\%)]}{100}\\ &= \frac{24.45 \times [100 - (21.47 - 12)]}{100}\\ &= 22.13\%\end{aligned}$$

Table 2. Percent Of Body Weight Intake Of Feed Based On Percent Of NDF.

Percent NDF	Dry Matter Intake As Percent Body Intake
38	3.16
40	3.00
42	2.68
44	2.73
46	2.61
48	2.50
50	2.40
52	2.31
54	2.22

Source: Pioneer Forage Manual, A Nutritional Guide, 1990.

Fiber

Cattle require fiber in their diet to stimulate the microorganisms of the rumen and to assist in nutrient use by breaking down fiber. Diets deficient in fiber can cause permanent damage to the rumen wall.

The level of fiber in the diet does not always indicate that the diet is adequate in fiber. The fiber may not be effective if it is chopped or ground too short or fine. The length of fiber should be a minimum of ¼ to ½ inch to adequately meet the rumen needs. A finely ground diet with 30 percent fiber will not meet the fiber requirements of cattle because it will pass through the digestive system too rapidly.

A forage analysis does not define the quality of fiber in the diet when using the crude fiber (CF) value. Young weaned cattle normally require at least 22 percent CF. Finishing cattle can consume diets with only 8 to 10 percent CF. CF, neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent fiber nitrogen (ADFN) are the four components of fiber that are measured or calculated in a forage sample.

NDF is negatively correlated with dry matter intake (DMI). As NDF increases in a forage, DMI decreases. ADF is negatively correlated with digestibility of forage. As the ADF increases, forages become less digestible. NDF and ADF both increase as forages mature. See Table 2 to determine percent of body weight intake of a forage based on percent NDF.

CF is a function of NDF. The method of calculating CF by the forage laboratory depends upon what forage is being measured. One formula is used for all nonlegume hays and silages and another for legume hays, legume silages, mixed feed, and grain.

ADFN indicates the percentage of bound protein. Nitrogen (used to calculate protein) becomes bound when forage moisture exceeds about 14 percent and forages start to heat.

Table 3. Average NDF, ADF, And CF Contents Of Forages.

	Percent, Dry Matter Basis		
Forage	NDF	ADF	CF
Alfalfa			
late vegetation	40	29	22
early bloom	42	31	23
mid-bloom	46	35	26
full-bloom	50	37	29
Coastal bermudagrass (30 days growth)	76	38	33
Sorghum-sudangrass (sun cured, full-bloom)	68	42	36
Corn silage			
stover	68	55	31
well eared	51	28	24
few ears	53	30	32

Source: Pioneer Forage Manual, A Nutritional Guide, 1990.

Using NDF To Calculate Dry Matter Intake. Research has shown that as NDF increases in forages, animals eat less. The prediction for DMI is a function of NDF and is expressed as a percentage of body weight. The equation for predicting DMI in cattle is:

$$DMI = \frac{120}{\%NDF}$$

Using ADF To Calculate Digestible Dry Matter. The amount of dry matter digested is a function of the level of ADF in the forage and is expressed as a percentage. Digestible dry matter (DDM) can be estimated based on the amount of ADF in a forage as follows:

$$\%DDM = 88.9 - (0.779 \times \%ADF)$$

The average NDF, ADF, and CF contents of forages at different stages of maturity are illustrated in Table 3.

Calculating Relative Feed Value. When DDM and DMI have been calculated based on the NDF and ADF in a forage sample, relative feed value (RFV) can be calculated. The purpose of RFV is to allow a producer to compare two or more forage samples for energy.

Forage samples greater than 100 are satisfactory for beef cattle but may be inadequate for dairy cattle. If the calculated RFV of bermudagrass forage A is 100 and the RFV of bermudagrass forage B is 110, then forage B is worth 10 percent more than forage A. RFV will aid producers in comparing the monetary and feed value of two or more forages, but it is not used in actual calculation of the ration.

$$RFV = \frac{\%DDM \times \%DMI}{1.29}$$

Energy

Energy in all feeds is a source of fuel similar to fuels for cars, tractors, trucks, and rockets. Just as these fuels vary in the amount of energy per unit volume, so does the energy within forages. The energy in gasoline is expressed in octane ratings like 87, 89, or 92 octane. As the octane number increases, so does the energy per gallon.

Energy is expressed several ways in a forage sample. Total digestible nutrients (TDN) and net energy for lactation (Net Energy-L), maintenance (Net Energy-M), and gain (Net Energy-G) are the most common ways of expressing energy for ruminants. Energy is expressed in megacalories per kilogram or per pound. The Auburn University Forage Laboratory expresses energy in megacalories per kilogram (Mc/kg) derived from calculations using NDF values.

Energy in a forage variety such as bermudagrass hay will vary with growing conditions and maturity. As forages mature, the amount of energy available to cattle decreases. This is not true for forages which produce a seed or grain such as corn silage. NDF and or ADF values are used to calculate TDN or net energy values of forages. Producers should compare energy values in their available forages to the nutrient requirements of the cattle to determine if the forages meet nutrient requirements. If additional energy is required, grain or concentrates should be used to supplement the forage.

Energy in a forage sample is expressed in several ways as shown below. Each of these expressions of energy is calculated based on the TDN level in the forage.

Net Energy-L = (TDN × 0.0245) – 0.12

Net Energy-M = (TDN × 0.029) – 0.29

Net Energy-G = (TDN × 0.029) – 1.01

Metabolizable Energy = (TDN × 1.01 × 0.04409) – 0.45

Minerals

Minerals play an important role in the development and growth of cattle. Mineral levels needed in the diet vary, depending on the animals' age and stage of development. Different levels of dietary minerals create variations in growth performance, soundness, reproduction, and longevity of animals in the herd. Not only are the levels of minerals in the diet important, but the ratios of certain minerals to each other are also important.

A forage laboratory lab report will give values of calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn). Sulfur (S) is not routinely included but is available upon request.

Table 4. Mineral Interrelationships In Animals.

Mineral	Minerals Affected
Ca	Mn, Mg, Zn, F, S, P
P	Fe, Ca, Be, Al, Cu, Mn, Mo, Mg, Zn
S	Se, Ca, Cu, Mo, Zn
Na	K
Cl	—
Zn	S, P, Fe, Ca, Cd, Cu
Mg	P, Ca, Mn, K
I	As, F, Co
Mo	S, P, Cu
K	Mg, Na
Mn	Mg, P, Fe, Ca
Fe	Zn, P, Co, Mn, Cu
Se	As, S
Cu	Cd, Fe, Ag, Fe, P, S, Zn, Mo

Source: Nutrient Requirements Of Beef Cattle, Sixth Edition, 1984.

Mineral Levels. Mineral levels in a forage sample are expressed as a percent of the total sample or in parts per million (ppm). Having the correct level of minerals in the diet is important.

Minerals needed in relatively large amounts are macrominerals, and minerals needed in relatively small amounts are microminerals or trace minerals. *Macro* or *micro* do not denote importance but rather the amount of the mineral required by livestock. The levels of calcium and phosphorus necessary for maximum growth rate and mineralization of the bones are not always adequate in forages.

Mineral Ratios. Having the correct ratios of minerals in the diet is also important. The interaction of minerals as they affect one another is listed in Table 4.

A forage analysis provides calcium-phosphorus ratios. A high calcium-phosphorus ratio lowers phosphorus absorption resulting in reduced growth and bone mineralization in cattle. A good calcium-phosphorus ratio is between 1.3:1 and 1.5:1. The ratio is less important if the diet contains amounts of phosphorus in excess of the animal's requirements. High levels of macrominerals, such as calcium or phosphorus, can be responsible for making certain microminerals, such as zinc, less available.

Dietary Mineral Requirements. Cattle minerals can be supplied in the complete diet or provided free choice. A forage analysis will determine how much additional mineral must be added to an animal's ration. Phosphorus is the most expensive mineral fed to cattle because of the cost and amount fed. If phosphorus is included in the diet, the inclusion rate should be about 0.35 percent of

Table 5. Mineral Requirements Of Beef Cattle.

Major Or Macro Minerals	Recommended Level (%)	Maximum Tolerable Level (%)
Sodium (Na)	0.08	10.0
Chlorine (Cl)	—	—
Calcium (Ca)	0.40	2.0
Phosphorus (P)	0.30	1.0
Magnesium (Mg)	0.10	0.4
Potassium (K)	0.65	3.0
Sulfur (S)	0.10	0.4
Trace Or Micro Minerals	**Recommended Level (ppm)**	**Maximum Tolerable Level (ppm)**
Silicon (Si)	—	—
Chromium (Cr)	—	—
Cobalt (Co)	0.1	5
Copper (Cu)	8.0	115
Fluorine (F)	—	20-100
Iodine (I)	0.5	50
Iron (Fe)	50.0	1,000
Manganese (Mn)	40.0	1,000
Selenium (Se)	0.2	2
Molybdenum (Mo)	—	6

Source: Nutrient Requirements Of Beef Cattle, Sixth Edition, 1984.

Table 7. Maximum Tolerable Levels Of Certain Toxic Elements In Beef Cattle[a].

Element	Maximum Tolerable Level (ppm)
Aluminum	1,000
Arsenic	50
Bromine	200
Cadmium	0.5
Fluorine	20 -100
Lead	30
Mercury	2
Strontium	2,000

Source: Nutrient Requirements Of Beef Cattle, Sixth Edition, 1984.

[a]Dairy toxicities are identical. Exceptions are the additions of molybdenum, 10 ppm; nickel, 50 ppm; vanadium, 50 ppm; and the exclusion of strontium.

the diet and calcium about 0.4 to 0.45 percent of the diet. This level of calcium and phosphorus will provide adequate levels of both minerals at the correct ratio (1.3 to 1.5:1). Calcium-phosphorus ratios may be as high as 2 to 1 in diets with some forages. This is acceptable, and no additional phosphorus is needed in the ration.

Mineral requirements for beef cattle are listed in Table 5. Mineral requirements for dairy cattle

Table 6. Recommended Nutrient Content Of Diets For Dairy Cattle.

Cow Wt. (lb.)	Fat (%)	Wt. Gain (lb./day)	Lactating Cow Diets — Milk Yield (lb./day)							
900	5.0	0.50	14	29	43	58	74			
1,100	4.5	0.60	18	36	55	73	91			
1,300	4.0	0.72	23	47	70	93	117	Early Lactation (wks. 0-3)	Dry Pregnant Cows	Maximum Tolerance Level
1,500	3.5	0.82	26	52	78	104	130			
1,700	3.5	0.94	29	57	86	114	143			
Minerals										
Calcium, %			0.43	0.53	0.60	0.65	0.66	0.77	0.39[a]	2.0
Phosphorus, %			0.28	0.34	0.38	0.42	0.41	0.49	0.24	1.0
Magnesium[b], %			0.20	0.20	0.20	0.25	0.25	0.25	0.16	0.5
Potassium[c], %			0.90	0.90	0.90	1.00	1.00	1.00	0.65	3.0
Sodium, %			0.18	0.18	0.18	0.18	0.18	0.18	0.10	-
Chlorine, %			0.25	0.25	0.25	0.25	0.25	0.25	0.20	-
Sulfur, %			0.20	0.20	0.20	0.20	0.20	0.25	0.16	0.4
Iron, ppm			50.00	50.00	50.00	50.00	50.00	50.00	50.00	1,000.0
Cobalt, ppm			0.10	0.10	0.10	0.10	0.10	0.10	0.10	10.0
Copper[d], ppm			10.00	10.00	10.00	10.00	10.00	10.00	10.00	100.0
Manganese, ppm			40.00	40.00	40.00	40.00	40.00	40.00	40.00	1,000.0
Zinc, ppm			40.00	40.00	40.00	40.00	40.00	40.00	40.00	500.0
Iodine[e], ppm			0.60	0.60	0.60	0.60	0.60	0.60	0.25	50.0[f]
Selenium, ppm			0.30	0.30	0.30	0.30	0.30	0.30	0.30	2.0
Vitamins										
A, IU/lb.			1,450	1,450	1,450	1,450	1,450	1,800	1,800	30,000
D, IU/lb.			450	450	450	450	450	450	540	4,500
E, IU/lb.			7	7	7	7	7	7	7	900

Source: Nutrient Requirements Of Dairy Cattle, Sixth Edition, 1989.

[a]The value for calcium assumes that the cow is in calcium balance at the beginning of the dry period. If the cow is not in balance, then the dietary calcium requirement should be increased by 25 to 33 percent.

[b]Under conditions conducive to grass tetany, magnesium should be increased to 0.25 or 0.30 percent.

[c]Under conditions of heat stress, potassium should be increased to 1.2 percent.

[d]The cow's copper requirement is influenced by molybdenum and sulfur in the diet.

[e]If the diet contains as much as 25 percent strongly goitrogenic feed on a dry basis, the iodine provided should be increased two times or more.

[f]Although cattle can tolerate this level of iodine, lower levels may be desirable to reduce the iodine content in milk.

are listed in Table 6. Some minerals such as aluminum and fluorine are toxic to cattle. Others are required but are toxic above certain levels in the diet. Mineral toxicities are listed in Table 7.

Fat

The term *fat* includes both fats and oils or a mixture of the two. Fat contains approximately 2.25 times more energy or calories per pound than carbohydrates or starches. Starches or carbohydrates are the major energy source in most grains. The maximum level of fat in cattle diets should not exceed 8 percent, including the fat found naturally in the forage or feedstuff.

Corn contains between 3 and 4 percent fat. Cottonseed contains an average of 24.3 percent fat. If an ingredient such as whole cottonseed or whole soybeans is added to a cattle diet, the amount added should not bring the total fat level to more than 8 percent of the diet.

Higher levels of dietary fat result in drastically reduced feed consumption. A high level of fat in the ration (above 8 percent) has a strong laxative effect in cattle and will decrease the digestibility of the diet. Excess fat in the diet binds with some minerals, forming insoluble soaps and making the minerals unavailable. When fats are added to beef cattle diets, calcium and phosphorus levels should be 0.55 and 0.35 percent, respectively. Dairy producers use rumen-protected fats to increase energy without decreasing consumption.

NO_3-N or Nitrate Nitrogen

Nitrates are reported on forage samples when requested. Nitrates are potentially deadly for cattle, sheep, goats, and horses. The vegetative portion of most forages and hays can contain high levels of nitrates or nitrate nitrogen. Nitrate is potentially lethal at 9,000 ppm (0.9 percent), nitrate nitrogen at 2,100 ppm (0.21 percent). Oats, wheat, barley, rye, corn, and sorghum are grain hays which may contain nitrates. Sudangrass, bermudagrass, fescue, and weeds are grasses that may contain high levels of nitrates.

Nitrates are high in forages which are stressed because of drought, insufficient sunlight, early killing frost, or herbicide treatment. Nitrates may also be formed in forages following heavy nitrogen fertilization of the soil.

Nitrates can vary within pastures and even within bales of hay. Ask your county Extension agent for assistance with properly sampling your hay or forage for nitrates. For further information, see Extension Circular ANR-112, "Nitrate Poisoning Of Cattle In Alabama."

Ash

Ash content of a forage sample is the amount of mineral which remains after a forage is completely burned. The minerals are contained in the ash of a forage sample. Ash determination is important in certain specific samples such as broiler litter because the ash content also contains the soil collected along with the sample. Broiler litter that contains more than 20 percent ash contains a great deal of soil. The ash content of broiler litter should be between 20 to 25 percent.

Norwood J. Van Dyke, *Extension Animal Scientist,* Associate Professor, Animal and Dairy Science, Auburn University, and Paula M. Anderson, former *Extension Associate*

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

ALABAMA COOPERATIVE Extension SYSTEM

ANR-890

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UPS, 3M16, **Reprinted Dec 1998,** ANR-890