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Understanding Your Forage Test Results

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Balanced nutrition is important for efficient livestock production. Daily nutrient requirements vary depending on the phase of production. Knowing the nutrient composition of feeds and matching feeds to animal requirements at a given stage of production will ensure that nutritional needs are met. Forage analysis is a management tool that provides information needed for proper livestock nutrition.

Using the results

Once you have your forage test results, carefully go through each item and consider how the results will influence the way you use the feed in your livestock nutrition program. You can use the information to formulate a balanced ration for your livestock or for general feeding decisions.

You need to understand the nutrient requirements for different livestock in order to match forage resources with animal needs. These requirements can be found in publications such as *Nutrient Requirements of Domestic Animals* and the *Cow–Calf Management Guide and Cattle Producer's Library* (see "References," page 3).

This publication describes common terms found in laboratory forage analyses. A sample test result sheet is included on page 4. The following information pertains to ruminants, including beef and dairy cattle and sheep.

Moisture is the percent water in a sample.

As-fed is the actual feed, including moisture content, as it is offered to the animal. Also referred to as as-sampled or as-received, if not altered between sampling, testing, and feeding time.

Dry matter (DM) is the feed without the moisture (DM = 100% – Moisture). It represents everything in the sample other than water, including protein, fiber, fat, minerals, etc.

On an as-fed basis, animals must consume more of a wet feed to receive the same amount of dry matter as they would from a drier feed. For example, if an animal consumes 25 lb of 90 percent DM hay, it consumes about 23 lb of dry matter (25 x 0.9). If haylage at 40 percent dry matter is substituted for the above hay, the animal must consume about 58 lb of haylage as-fed (23 ÷ 0.4) to receive the same amount of dry matter. Thus, it is very important to know the dry matter content of a feed to establish feeding rates and to ensure that livestock receive the proper amount of feed to meet their daily needs.

Dry matter basis means nutrient results for the sample with the water removed. Feeds vary in their moisture content, as discussed above. Nutrient content of feeds can be compared directly by removing the water (DM basis).

For example, suppose you want to compare the protein content of hay (90 percent DM) and haylage (40 percent DM). On an as-sampled basis, the hay tested 10 percent protein and the haylage 7 percent protein. The hay seems to have a higher protein level. However, on a DM basis (without the water), the hay is 11 percent protein (10 ÷ 0.9), and the haylage is about 18 percent protein (7 ÷ 0.4). Thus, the haylage is higher in protein per pound of dry matter. Animals will consume more protein per pound of dry matter from the haylage than they will from the hay.

Make sure the animal nutrient requirements and lab results are expressed on the same basis, either DM or as-fed. Always use the DM matter basis when comparing feeds.

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Protein

Proteins are made up of amino acids, known as the building blocks of the body. Protein is essential for tissue growth and repair, maintenance, lactation, growth, and reproduction.

Crude protein (CP) is an estimate of the protein content of the feed. The normal range is 6 to 20 percent on a DM basis. Laboratories measure the nitrogen (N) content of forage and then calculate crude protein using the formula CP = %N x 6.25. The factor of 6.25 is used because protein is approximately 16 percent nitrogen (100 ÷ 16 = 6.25).

Crude protein includes both true protein and nonprotein nitrogen. True proteins are organic compounds made up of amino acids. They are a major component of vital organs, tissue, muscle, hair, skin, milk, and enzymes. Nonprotein nitrogen is urea and ammonia, which can be used by rumen microbes to make protein for the animal. Nonprotein nitrogen is not used as efficiently as true protein when animals consume low-quality forages.

Adjusted crude protein is the crude protein with adjustments for availability to the animal. Some protein might be tied up with the fiber and unavailable to the animal.

Carbohydrates

Carbohydrates make up the structure of plants (stems, cell walls) and the cell contents that provide energy.

Neutral detergent fiber (NDF) is a measure of hemicellulose, cellulose, and lignin, which represent the fibrous bulk of forage. These components are called cell wall or structural carbohydrates. They give the plant rigidity, enabling it to support itself as it grows. Cellulose and hemicellulose can be partially broken down by microbes in the rumen to provide energy to the animal.

NDF is negatively correlated with intake; a high percent NDF reduces forage intake. A normal range is 30 to 60 percent on a DM basis.

Acid detergent fiber (ADF) is a measure of cellulose and lignin. ADF is negatively correlated with overall digestibility; high ADF feed is less digestible. A normal range is 25 to 45 percent on a DM basis.

Relative feed value (RFV) ranks feed based on digestibility (ADF) and intake (NDF) potential. An RFV of 100 is considered the average score and represents an alfalfa hay containing 41 percent ADF and 53 percent NDF on a dry matter basis. The higher the RFV, the better the forage quality.

Use a range of RFV values when classifying a forage. A good guideline is to accept anything within at least +/-5 points of the target value. For example, if an RFV of 150 is the target, any forage testing 145 to 155 should be considered to have an equivalent value.

RFV is used in feed marketing and comparisons, not in balancing a ration for animals.

Nonstructural carbohydrates (NSC) are starches and sugars inside the cell that serve as energy sources for the animal. NSC is calculated as follows: 100% – (CP% + NDF% + Fat% + Ash%).

Fat

Crude fat contains fat and other compounds soluble in ether. Fat contains 2.25 times the energy found in carbohydrates and proteins. It is added to rations to boost energy concentration when intake may be limiting.

Energy

Energy is used in all biological processes and is essential for life. For livestock, energy requirements are determined for maintenance, growth or gain, lactation, reproduction, and activity level. Failure to supply adequate energy results in poor performance. Energy values usually are not measured directly from feed but are predicted using equations and relationships with various nutrients.

Total digestible nutrients (TDN) is the sum of the digestible protein, digestible NSC, digestible NDF, and 2.25 times the digestible fat.

Net energy for maintenance (NE_m) is an estimate of the energy value of a feed to maintain animal tissue without gain or loss of weight. NE_m is used in formulating beef and sheep rations for maintenance plus energy for pregnancy and lactation.

Net energy for lactation (NE_l) is used in formulating rations for dairy cattle. It estimates the energy available from the feed to support an animal's requirements for maintenance plus milk production during lactation and for maintenance plus the final 2 months of gestation for dry, pregnant cows.

Net energy for gain (NE_g) is an estimate of the energy value of a feed used for body weight gain above that required for maintenance. It is used in ration balancing for beef and sheep when gain is desired.

Minerals

Minerals make up 3 to 5 percent of an animal's body dry weight. They have multiple functions within the animal. They are classified into two groups: macrominerals (major minerals), which normally are present at greater levels in the animal body or needed in relatively larger amounts in the diet, and microminerals (trace minerals), which are present at lower levels or needed in very small amounts. Minerals cannot be synthesized; they must come from the diet (feed plus mineral supplement).

Macrominerals and their functions

Calcium (Ca)—bone and teeth formation, blood clotting, muscle contractions, milk component, transmission of nerve impulses, cardiac regulation, and enzyme function

Phosphorus (P)—bone and teeth formation, key component of energy metabolism, milk component, body fluid buffer systems

Sodium (Na)—acid–base balance, muscle contraction, nerve transmission, osmotic pressure regulation and water balance, glucose uptake, and amino acid transport

Chloride (Cl)—acid–base balance, osmotic pressure regulation and water balance, component of gastric secretions

Magnesium (Mg)—enzyme activator, found in skeletal tissue and bone, neuromuscular transmissions

Potassium (K)—osmotic pressure regulation and water balance, electrolyte balance, acid–base balance, enzyme activator, muscle contraction, nerve impulse conductor

Sulfur (S)—used for microbial protein synthesis, especially when nonprotein nitrogen is fed

Microminerals and their functions

Cobalt (Co)—required for vitamin B_{12} synthesis

Copper (Cu)—required for hemoglobin synthesis, coenzyme functions

Fluoride (F)—prevents tooth decay

Iodine (I)—required for proper thyroid function and to guard against goiter, still births, and woolless lambs

Iron (Fe)—hemoglobin and oxygen transport, enzyme systems

Manganese (Mn)—growth, bone formation, enzyme activation, fertility

Molybdenum (Mo)—component of enzymes, may enhance rumen microbial activity

Selenium (Se)—antioxidant properties, prevention of white muscle disease and retained placenta

Zinc (Zn)—enzyme activation, wound healing, skin health, some impact on udder health (reduced somatic cell counts)

Other items

pH measures the degree of acidity. Good corn silage typically has a pH of 3.5 to 4.5 and haycrop silages 3.8 to 5.3.

Nitrates can be accumulated by forage plants under stressed conditions such as drought, freezing, or heavy fertilization. Corn, sorghum, sudangrass, and oat hay are nitrogen accumulators even without added stress to the plants.

Forage with nitrate nitrogen levels of less than 1,000 ppm are safe to feed. Those with nitrate nitrogen levels of greater than 4,000 ppm may be toxic; **do not feed**. Use forages with levels between 1,000 and 4,000 ppm with extreme caution, and restrict which animals receive them. Immature ruminants are more susceptible than more mature animals. However, pregnant ruminants may not be as tolerant of higher levels as nonpregnant animals. This could be because signs of subacute nitrate toxicity are abortion and other reproductive problems.

Acid detergent insoluble nitrogen (ADIN or ADF-N) is a measure of the protein bound to fiber due to overheating of stored forage. This protein, which is indigestible, is called "heat damaged."

References

Nutrient Requirements of Domestic Animals (National Research Council, National Academy Press, Washington, DC). http://www.nap.edu

Cow–Calf Management Guide and Cattle Producer's Library (University of Idaho Cooperative Extension System, Moscow, ID).

OSU Extension publications

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Acknowledgments

This publication was modeled after a publication by Dairy One, DHIA, Ithaca, NY, *Understanding and Significance of Forage Analysis Results,* by Paul Sirois.

SAMPLE ANALYZED BY: 27

FORAGE TESTING LABORATORY

SAMPLE DESCRIPTION	FARM	CODE	LAB SAMPLE
MMG HAY (NNE)		104	724587

.907

DATE SAMPLED	LAB RECEIVED	DATE PRINTED	STATE	CO.	FARM
11/01/00	11/15/00	11/18/00	92	00	0000

* HOLIDAY LAB CLOSINGS *
THANKSGIVING 11/28/96 AND 11/29/96
CHRISTMAS 12/25/96 NEW YEAR'S 1/1/97

COMMENTS:

1. TDN DETERMINED BY OSU EQUATION. NET ENERGIES DETERMINED USING 1988 NRC DAIRY EQUATIONS.
2. HORSE ENERGIES CONFORM TO THE 1989 NRC NUTRIENT REQUIREMENTS OF HORSES.

EXAMPLE

FOR NORTHEAST DHIA SUPERVISOR

KIND	DESCRIPTION	% DM	NEI	% PROTEIN
1	DRY ROUGHAGE	91	60	11

SEE REVERSE SIDE FOR EXPLANATIONS

ANALYSIS RESULTS

COMPONENTS	AS SAMPLED BASIS	DRY MATTER BASIS
% MOISTURE	9.3	
% DRY MATTER	90.7	
% CRUDE PROTEIN	10.3	11.3
% AVAILABLE PROTEIN		
% UNAVAILABLE PROTEIN		
% ADJUSTED CRUDE PROTEIN	10.3	11.3
% SOLUBLE PROTEIN	-	22
% ACID DETERGENT FIBER	30.7	33.8
% NEUTRAL DETERGENT FIBER	52.4	57.8
% CRUDE FAT		
% NSC	19.0	20.9
% T D N	53	58
NET ENERGY (LACTATION) -Mcal/lb.	.54	.60
NET ENERGY (MAINTENANCE)-Mcal/lb.	.53	.58
NET ENERGY (GAIN) -Mcal/lb.	.29	.32
% CALCIUM	.20	.22
% PHOSPHORUS	.19	.21
% MAGNESIUM	.38	.42
% POTASSIUM	1.31	1.45
% SODIUM	.208	.230
PPM IRON	482	531
PPM ZINC	19	21
PPM COPPER	6	6
PPM MANGANESE	280	308
PPM MOLYBDENUM	1.5	1.6
% SULFUR	.21	.23
% PROTEIN EQUIV. FROM UREA		
% PROTEIN EQUIV. FROM AMMONIA		
% NITRATE ION		
% CHLORIDE ION		
pH		
REL. FEED VALUE		101.0
HORSE TDN, %	44	49
HORSE DE, MCAL/LB.	.88	.97

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