UNIVERSITY OF MINNESOTA
Extension
SERVICE

FORAGE SAMPLING AND INTERPRETATION

Lesson 4

Introduction

Many different factors affect forage quality. Some of these variables include: plant species that are in the particular hay lot (including different legumes, grasses, and weeds), stage of maturity during harvest, environmental conditions during growth and harvest, damage due to insects and plant diseases, soil fertility, and losses during harvest and storage. Knowing the nutritional value of forages, and using that information in combination with feed inventory and ration information can help cut feed costs - the biggest expense in a cow/calf operation.

Forage Sampling

Forage tests are based on a small sample that is selected to represent a larger quantity, or ”lot,” of hay. Sampling requires identification of forages by lot, or group of fairly uniform hay type. Ideally, a lot of hay should be all hay made from the same field in the same day. This may not always be possible, but the closer one comes, the better the results.

Hay lots should be determined during harvest based on the types of hay being made. In storage, forages should be grouped by lots based on factors such as cutting, whether or not it got rained on, maturity, and types of plants in it (alfalfa, clover, grass, weeds, mixes). Storing these hay lots together allows for successful inventory management and testing which can provide information valuable to an overall feed management plan.

Taking Samples

Sampling itself is where some of the biggest errors can occur in attempts to analyze the quality of forage resources. An inaccurate test can be as useless as no test at all. A publication included with this lesson entitled "Sampling Hay and Silage for Analysis" details approaches recommended to keep sampling error low. One of the first suggestions is to purchase a hay probe. A hay probe is a tool that helps to sample hay lots with much greater accuracy than the "hand grab" sampling technique. It makes sense to obtain a sample that accurately represents the hay lot. A variety of hay probes are available. The fact sheet, "Forage Sampling and Sampling Equipment" which is included with this lesson contains a partial list of sources for purchasing a hay probe. Many University of Minnesota Extension Service offices have hay probes that can be borrowed for a short period of time.

The best time to take hay samples is at the time of storage. This way producers know the quality in each lot long before uncovering lots for feeding.

Sampling Methods

The proper approaches to sampling square bales, round bales, and silage are outlined in "Sampling Hay and Silage for Analysis." Each of these different forage storage methods has a different recommended sampling procedure. Samples should be representative of the entire lot. That is, the sample sent to the testing lab must include hay from each part of the lot, with proportionate numbers of samples from each area within the lot. When sampling each lot, don't skimp on the number of sub-samples. The recommendation is at least 15 to 20 core samples.

Package the entire sample (a combination of all 15 to 20 core samples) in a clean bag, label with a lot number, and send it to the lab. Record which lot is which, so that when the test results come back, the proper lot can be identified. This exercise should include developing a map of where each lot begins and ends, and perhaps marking the actual lots with stakes or non-toxic paints. For distinguishing between different silage lots in upright silos, colored egg cartons or plastic can be blown into the silo after completing each lot, or at least each cutting.

Suggested sampling methods are:

- **small square bales** -- Take core samples through the center of one end of the bale, 12 to 15" deep.
- **large square bales** -- Take core samples at waist height on the rounded side of the bale, 12 to 15" deep.
- **silages** -- All spoiled material should be removed prior to sampling. These procedures are covered in detail in the "Sampling Hay and Silage for Analysis" publication.
- **stacks and piles** -- Remove spoiled material and sample 18” deep.

Sending Samples to the Laboratory

Samples should be organized and prepared for the laboratory, then double-checked for proper labeling. The estimated forage composition of the lot sampled must be on both the bag and the lab's sample submission sheet. Because the vast majority of labs now use NIRS (Near Infrared Reflectance Spectroscopy) rather than the slower and more expensive wet chemistry, the labs need to have a clear description of forage species composition so that they can use the correct calibration equation for analysis. For example, if a hay lot is an alfalfa-grass mix, that should be noted, rather than submitting it as pure alfalfa. Estimate the percentages of each species (i.e. 40% alfalfa, 50% grass, 10% weeds).

To ensure accuracy of results, select a laboratory that has been certified by the National Forage Testing Association certification program. A listing of certified labs called "Laboratories Certified to Test Forages in 1997" is included with this lesson. The lab charge for NIRS analysis is usually between $10 to $15 per sample. Test results should be back within a day or two after the lab receives a sample, or faster if fax or e-mail service is available.

Forage Inventory

A major concern of cattle producers as winter approaches is the amount of forage on hand, and, whether the forage supply is sufficient for their animals to the following spring. The combination of forage quality information, mentioned earlier, and the measurement of forage quantity through an inventory, will provide the tools needed to make effective feed and nutrition management decisions.

Measuring and Calculating

To estimate the amount of forage closely, a couple of measurements are needed. Obviously a count (or careful estimate) of the number of bales in each lot is needed. Secondly, an average bale weight must be estimated or measured. For small square bales, this isn't difficult to do, but for large round and large square bales, it can be challenging. It may be tempting to simply estimate the weight of the bigger bales, but often estimates can be off 100 pounds or more, leading to a significant error in estimating the entire inventory.

It makes sense to at least weigh a few big bales from each cutting. Hydraulic weight gauges that fit in-line on the boom's hydraulic system can be purchased. Or, weigh a load of bales on a public truck scale, weighing the wagon full and empty, and divide the difference by the number of bales to calculate an average bale weight. For silos and bunkers, forage amounts will have to be calculated. Silo capacity charts permit estimation of the number of tons of dry matter in vertical silos. For bunkers, a measurement of silage density and volume is necessary to predict the number of tons available. Charts for various sizes and styles of silos are available from silo manufacturers, feed dealers, and county extension offices. A sample chart is included with this lesson.

Putting it in Writing

The amount of forage in each lot should be documented as it is harvested so that inventory analysis and planning can be conducted with confidence after the harvest. At the end of this lesson is a copy of Nebraska's "Forage Inventory and Allocation Worksheet" table. A worksheet like this one can be used for documenting quantity and quality of forage in each lot. Writing in pencil allows changes to be made on individual lots as they are fed. Additionally, this table can be handy in conducting regular forage inventory audits, which allow tracking forage use against the feeding plan. Each year a new sheet is started, which includes bringing the inventory left from last year onto the new sheet after the cattle are on pasture and before making first-cut hay. Updating the inventory throughout the forage harvest allows for an on-going comparison between the forage needs of each animal feeding group and the respective forage lots which best meet those needs.

An area that needs to be considered in determining forage inventory is the impact that storage and feeding systems have on both the amount of hay that is delivered to the animal and the amount that the animal actually eats. Because cellular respiration continues within the plant cells of hay and silage sources, there is a storage loss that can be anticipated each year. These amounts vary depending on the type of storage, harvest moisture, plant maturity, etc. A good rule of thumb, however, is to anticipate a storage loss of 10 to 15% per year. Research on hay storage losses was conducted at the University of Minnesota West Central Experiment Station in Morris in 1996 and 1997. Those research results are reported in the 1998 Minnesota Beef Cow/Calf Report (C-147). The report is available from extension offices in Minnesota, or from the University of Minnesota Animal Science Department.

In silage situations where moisture levels are high, seepage can reduce both quality and dry matter amounts of the ensiled forage. Large storage losses due to spoilage are common in some silage systems.

Feeding losses vary based on the type of feeders used, physical form of the feed when delivered to the cows, weather, and other factors. These feeding losses can significantly affect animal performance and profits. Feeding losses are calculated in addition to the storage losses discussed above.

Interpreting Test Results

How can lab test results be used to help manage forage resources? First, differences in dry matter level, crude protein, total digestible nutrients and relative feed value should be noted. These are the primary measurements that will affect decisions made regarding a herd's feeding program. Terms used in most NIRS lab test reports are:

<u>Dry Matter (DM)</u>
Dry matter is the percentage of forage that is not water (DM% = 100 - % moisture). Knowing DM content is important for:

1. *Ration formulation*. Nutrient requirements of animals are expressed on a DM basis. Animal intake is regulated more by DM intake than volume of feed consumed.
2. *Comparison of forages*. Nutrients are contained in the DM portion of forages.
3. *Predictor of indicator of storage problems.* Forages ensiled when too dry, or hay baled when too wet, can heat, reducing protein availability and/or becoming moldy. Ensiling forages too high in moisture can result in excessive losses through seepage and undesirable fermentation.

Crude Protein (CP)

Crude protein is both true protein and nonprotein nitrogen. It is determined by measuring total nitrogen and multiplying this number by 6.25. Crude protein content indicates the capacity of the feed to meet an animal's protein needs. Forages which are moderate to high in CP (14 to 20%) reduce the need for supplemental purchased protein. Crude protein levels will be affected by the timing of forage harvest. As forage plants mature, the CP level in the plant declines. However, total CP per acre may increase as forage quantity increases with maturity. With timing and management, forage quality and quantity can be optimized to meet the specific nutrient needs of your herd.

Available Crude Protein (ACP)

Available crude protein (ACP) is the amount of CP available to an animal for utilization after correcting for unavailable protein. In unheated forages, 12% or less of the CP is in the ADF fraction. For example, alfalfa containing 20% CP may have 2.4% CP or less in the ADF fraction. When the percentage of CP in the ADF fraction increases above 12%, it indicates harvesting and storage conditions were not ideal and some reduction in CP availability has occurred. The higher the percentage CP in the ADF fraction, the more extensive is the reduction. Use ACP values in formulating livestock rations.

Acid Detergent Fiber (ADF)

Acid detergent fiber (ADF) is the percentage of highly indigestible and slowly digestible material in a feed or forage. This fraction includes cellulose, lignin and pectin. Lower ADF indicates a more digestible forage and is more desirable.

Neutral Detergent Fiber (NDF)

Neutral detergent fiber is the percentage of cell walls or fiber in a feed. It includes acid detergent fiber (except pectin) and hemicellulose. The NDF value is inversely related to animal intake potential - lower NDF percentages indicate greater animal consumption. Thus, a low percentage is desirable as long as a certain minimum fiber level in the ration is met.

Total Digestible Nutrients (TDN)

Total digestible nutrients is a term commonly used to express the energy value of feeds. The TDN values shown on forage analysis reports are calculated primarily from crude fiber or ADF fractions.

Net Energy (NE)

Net energy is a more comprehensive measure of energy than TDN. Three measures of NE are used: NEl(lactation), NEm (maintenance), and NEg (gain). All are expressed as megacalories (Mcal) per 100 pounds of feed DM. The NEm and NEg are used primarily in formulation of beef rations, whereas NEl is used in formulation of dairy cow rations. Feed energy is used equally well for maintenance and milk production but less efficiently for body weight gain.

Relative Feed Value (RFV)

Relative feed value is an index that combines important nutritional factors (potential intake and digestibility) into a single number for a quick, easy and effective method of evaluating feeding value or quality. The formula for calculating RFV uses the estimated digestibility and potential intake of a forage calculated from ADF and NDF fractions, respectively.

Minerals

All forages should be tested for calcium and phosphorus. Many standard forage test options also include other minerals based on common mineral deficiencies in a specific locality. Minerals identified in the forage sample will reduce the need for some costly purchased mineral supplements.

For more detailed information and interpretation of results refer to "Forage Quality Tests and Interpretation" (AG-FO-2637) included with lesson one.

Additional Resources and Reading

- 1998 Minnesota Beef Cow/Calf Report, Department of Animal Science, University of Minnesota

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