HAY SAMPLING PRINCIPLES AND PRACTICES

Mike Collins, Dan Putnam, Vance Owens, and Mike Wolf[1]

ABSTRACT

Accurate forage analysis that is representative of a lot of hay is needed by nutritionists for ration balancing and by buyers and sellers of hay in determining a price for the crop. A lot of hay is generally considered to be hay from the same cutting, field, species, variety, maturity stage and curing conditions that has been stored under similar conditions. Probes should fairly represent the leaf/stem ratio of the bales and sample deeply enough to represent variation within bales. Probes of 3/8 to 5/8" inside diameter and lengths of about 16" appear to meet these criteria well.

INTRODUCTION

Hay quality information is used in pricing hay for cash sale and in balancing rations for livestock feeding, therefore, obtaining accurate data is important to hay producers and consumers alike. Collection of a representative hay sample is absolutely critical to obtaining accurate analytical information. This paper discusses research and recommendations on procedures for collecting and handling hay samples to ensure the most accurate forage quality analysis possible.

HAY SAMPLING

A Lot of Hay

Because hay is such a variable product in terms of forage quality, one must be certain that the hay being sampled is sufficiently alike to be comparable. A quantity of similarly grown and treated hay is referred to as a lot of hay. A lot of hay is generally considered to be hay from the same cutting, field, species, variety, maturity stage and curing conditions that has been stored under similar conditions. Marble and Templeton (1985) recommended that, to be considered part of the same lot, hay should also be harvested within a 48 hr period. They also suggested that any factor that could contribute to quality differences, such as rain damage or weed infestation, should cause separation into different lots.

A Representative Sample

There is a considerable amount of variation in hay composition even among bales that come from the same field and were produced under the same conditions. We conducted one such study with a crop of mixed alfalfa/grass hay in small square bales and found that NDF varied most among the variables measured (Table 1). In this study, laboratory analyses were conducted on a near infrared reflectance calibration set selected from the larger study population. This variation is due both to variation among bales within the lot of hay and to laboratory variation. Based upon the range and assuming a similar level of laboratory variation, if only a single sample were collected to represent this lot of hay, any value for total nitrogen between 1.85 and 2.77% could have been obtained just due to variation among bales within the lot of hay. The fact

[1]M. Collins, Dep. of Agronomy, Univ. of Kentucky, Lexington, KY 40546-0091. D. Putnam, Dep. of Agronomy and Range Science, Univ. of California, Davis, CA 95616. V. Owens, Plant Science Dep., South Dakota State Univ., Brookings, SD 57007. M. Wolf, JL Analytical, Modesto CA 95357.

that this hay was a grass mix probably increased variation between bales within the lot. Other variables such as NDF and ADF also varied considerably.

Whitesides and Chandler (1998) reported quality analysis results from alfalfa hay samples collected by different individuals and analyzed by different laboratories. Each sample was a composite of 20 or more cores, which were split for analysis by three laboratories. Acid detergent fiber concentration varied by an average of 2.1 percentage units among the 5 individuals collecting samples. Analytical laboratory values differed by an average of 2.7 percentage units from the high to the low value among the three laboratories.

Round bales stored outside where they are exposed to weathering can have very large intra-bale variation between the outer and inner portions of the same package. Microbial activity and leaching that occur during weathering preferentially remove cellular contents, leaving elevated concentrations of fiber in weathered hay. If a core sample is drawn from the outside surface to the center of the bale, the lower-quality outer portion of the bale will be under-represented in the final sample.

Table 1. Variation in composition of alfalfa/grass mix hay from the same lot after 3 months of storage (Collins, unpublished).

Variable	n	Mean	SD	Minimum	Maximum
		----------%----------			
IVDMD†	20	60.16	1.054	58.0	62.1
NDF	20	61.20	1.893	58.4	64.9
NIT	20	2.40	0.234	1.85	2.77
ADF	20	36.50	1.039	34.1	38.2
ADL	20	6.81	0.499	5.9	7.5

† IVDMD=in vitro dry matter disappearance;
NDF=neutral detergent fiber;
ADF=acid detergent fiber;
NIT=total nitrogen;
ADL=acid detergent lignin.

Number of Core Samples

Because of variation like that discussed above, most state extension organizations recommend that core samples be taken from about 20 bales and composited to adequately represent a lot of hay (Marble and Templeton, 1985). Compositing samples from 20 bales may result in a substantial amount of sample, however, no reduction should be done before the sample is sent to the laboratory for analysis. Segregation of particles makes accurate splitting of core samples difficult.

We sampled a lot of alfalfa hay to determine the level of variation in several quality constituents (Collins et al., 2000). Figure 1 illustrates the large amount of variation seen in ADF concentration. The hay was good quality, first cut alfalfa in mid-size rectangular bales, produced in South Dakota. The average of the 20 values for ADF was 30.5% but the range was from less than 28% to more than 33% in the same lot. .

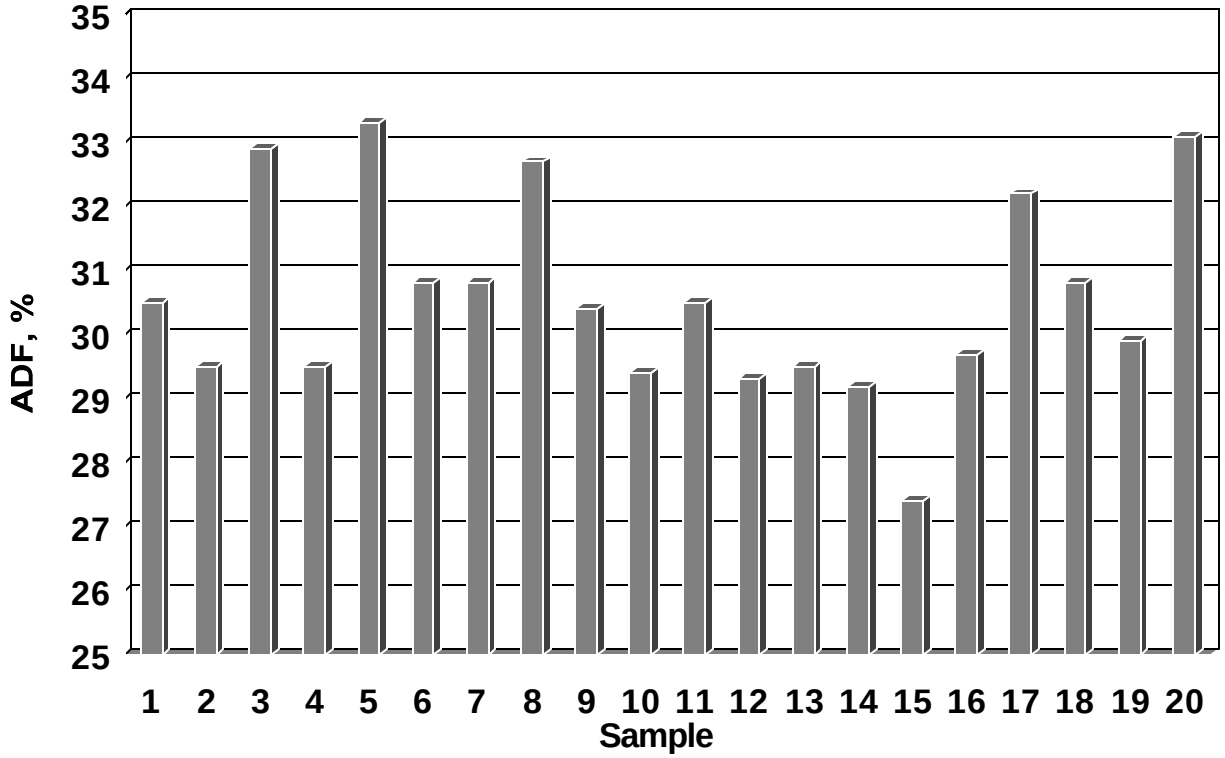

Figure 1. Variation in ADF concentration within a lot of alfalfa hay. Samples came from different bales and from different locations in the same bale (Collins et al., 2000).

Sampling Location

When sampling alfalfa in small square bales, it has been recommended that a core sample be taken down the center of the bale from the butt end (Martin et al., 1988). Leaf separated by plunger action during baling moves downward and away from the knife side of the bale so this central location is likely to give a more representative value than would samples collected from either corner (Figure 2).

Sampling Equipment

The purpose of good technique is to develop a sample of about 1/2 lb with at least 20 probed cores. Core samplers are recommended to be sure a representative sample is obtained (Martin et al., 1988). Grab samples from flakes of hay are not acceptable because they do not represent a cross-section of the bale and considerable segregation of coarse and fine particles can occur during their collection. Probes should satisfy a number of criteria: they must fairly represent the leaf/stem ratio of the bales, they should sample deeply enough to represent the variation within bales, the tips should be kept sharp, and tips are recommended to be at 90^{o} to the shaft (not cut at an angle). No part of the sample (eg leaves or stems) should be lost when the probe is withdrawn from the bale (as it is with open augers). Diameter should be between 3/8" an 5/8". An extremely small diameter coring device may not cut or represent the leaf-stem ratio properly, and a very large diameter probe may obtain a sample which is too large and therefore difficult for labs to grind properly. Length should probe to 14-24" in the butt-ends of the bale. On large bales, some studies have shown that it is not necessary to sample to a greater depth, though further studies are being conducted.

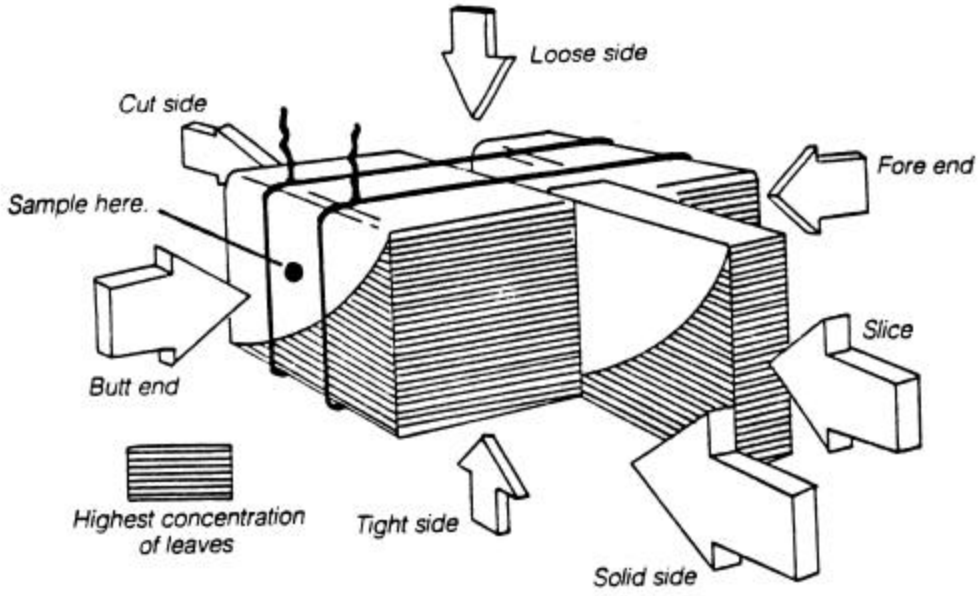

Figure 2. Recommended sampling procedure for alfalfa small square bales (From Martin et al., 1988).

The National Forage Testing Association (NFTA) is a joint effort of the American Forage and Grassland Council, National Hay Association and forage testing laboratories with the goal of improving the accuracy of forage testing among laboratories. Since its formation, reproducibility of lab results among laboratories has dramatically improved. Various lab methods have been reviewed and improved. Over 150 laboratories annually participate in the certification process. NFTA (Putnam et al., 1999) has a listing of hay probes at:

http://agronomy.ucdavis.edu/alfalfa.wg/SUBPAGES/ForageQuality/ListofHayProbes.htm

This listing of hay probes is not intended to be exhaustive, and is not an endorsement of these probes or a disparagement of other probes by omission. If readers have knowledge of other probes that are available, please contact us so that we can improve the completeness of this listing.

HAY PROBE LISTING

Colorado Hay Probe. Contact: UDY Corp., Phone: (970) 482-2060. www.udycorp.com.
Description: "PUSH TYPE" aluminum alloy barrel, 5/8” diameter X 18” long, with stainless steel angled tip (>45 degrees, resharpenable). Collection chamber holds 10-15 cores.

Forageurs Hay Probe. Contact: Forageurs Corp. PO Box 564 Lakeville, MN 55044. Phone (612) 469-2596.
Description: "DRILL TYPE" Stainless steel probe barrel, either 14” or 24” long, ¾” outside diameter. Hardened steel cutting tip, 0.6” cutting diameter. Steel canister ring

with hexagonal steel shaft, fits hand brace or drill. Canister: 100 cu. inches, holds 20-30 cores, 4” PVC body with clear plexiglass top.

Frontier Mills 'Yankton' Hay Probe. Contact: Frontier Mills, Inc., 2002 South Dakota Highway 314, Yankton, SD 57078. Phone (605) 665-2441.

Description: "DRILL TYPE" 30” long X 1” inside diameter conduit pipe shaft with round 7” long X 4” diameter canister. External auger pulls the long probe into the bale. Different ends allow use as hand brace or with drill. Comes with replaceable tip and wooden dowel for cleaning.

Hay Chec Hay Sampler. Contact: A.m. Hodge Products, Inc. PO Box 202005, San Diego, CA 92120. Phone (619) 444-3147.

Description: "PUSH TYPE" This is a 12" long hand probe with an internal diameter of 7/16 “ with a well-built stainless steel body and a clear plastic catch sample collection jar, and two foam-padded handles. Probe has a sample clearing stick. The body is weighted for helping to push into bales.

HMC Hay Probe. Contact: Hart Machine Co., 1216 SW Hart St., Madras, OR. 97741. Phone: (541) 475-3107.

Description: "DRILL TYPE" Stainless steel barrels 12”, 18”, 24”, or 30” long X ¾” outside diameter and 5/8” inside diameter. Hardened, smooth re-sharpenable tip, ½” diameter. Aluminum and steel collection canister holds 25-30 12” cores. Hub for brace or drill.

Penn State Probe. Contact: Nasco Corporation, 4825 Stoddard Rd., Modesto, CA. 95356-9318. Phone: (800) 558-9595.

Description: "DRILL TYPE" Stainless steel 1 1/8” diameter X 18” long. Available with 3/8” round shank adapter for use with electric or breast drill or square shank for use with hand brace. Replaceable cutting tip. Comes with dowel plunger to remove sample.

Sierra Hay Probe. Contact: Sierra Testing Service, 9450 E. Collier Rd., Acampo, CA 95220. Phone (209) 333-3337.

Description: "PUSH TYPE" golf club type probe. This is a 16 1/2" stainless steel golf club shaft that cuts a 1/2" core. The shaft has a 7 1/2" x 1 7/8" tube handle attached at 90^{o} at the end of the golf club shaft. The probe has a clean out rod that aids in cleaning out the probe when the sample is completed.

Star Forage Probes. Contact: Star Quality Samplers, 5719-114A Street, Edmonton, AB, Canada, T6H 3MB. Phone (780) 434-3367.

Description: "PUSH TYPE" Star Multi-Forage Sampler: Stainless steel 5/8” diameter probe barrel, 18” long. 3” or 4” diameter PVC canister is the handle used to push the probe, with a plastic bag attachment. Star Uni-Forage Sampler: Stainless steel 1 1/8” diameter X 18” long.

Summary

Variation in field and storage conditions results in significant bale-to-bale variation in hay quality within a single lot. Thus, a number of bales must be sampled and composited in order to obtain an average value that is representative of the entire lot of hay. For small packages, most states recommend sampling about 20 bales per lot. For larger packages there have been fewer studies evaluating sampling techniques but recommendations have been developed suggesting that multiple cores be taken on each bale and that several bales be sampled from each hay lot.

References

Collins, M., V. Owens, D. Putnam, P. Meyer, G. Smith, and M. Wolf. 2000. Hay Sampling Workshop. National Forage Testing Association Annual Meeting. 5 June, 2000. Sioux Falls, SD.

Marble, V.L., and W.C. Templeton. 1985. Development of a national alfalfa quality assessment procedure in the United States. p. 963-964. In Int. Grassl. Congr., Proc. 15th. Kyoto, Japan.

Martin, N.P., R.L. Ellingboe, and J.G. Linn. 1988. Hay sampling and testing. p. 92-102. In Proc. National Alfalfa Symposium, St. Joseph, Missouri.

Putnam, D., V. Owens, T. Ackerly. 2000. NFTA listing of hay probes. http://agronomy.ucdavis.edu/alfalfa.wg/SUBPAGES/ForageQuality/ListofHayProbes.htm

Turnquist, P.K., C.E. Johnson, E.A. Dowding, L.D. Kamstra, and C.R. Drueger. 1976. Sampling techniques for hay quality in large hay packages. Trans. ASAE. 19:463-464.

Whitesides, R.E. and D.A. Chandler. 1998. The importance of hay sampling- a 'how to' demonstration. p. 150-158. In Proc. California/Nevada alfalfa symposium. Reno, Nevada.