COMMON ABUSES OF HAY TESTING RESULTS

by Dan Putnam[1]

ABSTRACT

There is much concern about the reliability of hay test results and how lab results impact price and sales of hay. However, some of the concern about the reliability of laboratory results is brought about not by the performance of the labs themselves, but by unrealistic expectations, abuses, or misunderstandings of the whole hay testing process. Six common abuses of hay testing results are outlined below, and potential solutions to those abuses are outlined.

Keywords: ADF, TDN, NDF, CP, Hay testing, forage quality,

INTRODUCTION

Have you had a hay sale go bust because it was one or two tenths shy of the "premium" or "Supreme" category? Have you had an argument because duplicate hay test results didn't come back exactly the same?

These painful experiences are part of the daily lives of many hay growers and buyers. Although sometimes the lab is justifiably blamed for discrepancies and problems, this cannot be true in all cases. Often these problems result from a misuse of hay test results or misunderstanding of how hay is tested by the customers of the labs. This article reviews common abuses of hay testing results and suggests approaches to avoid these problems in the future.

MISUSE I: FAILURE TO EXPECT SOME VARIATION IN HAY TESTS

"My customer wanted 55% TDN hay, but my hay tested only 54.8%, so they refused it".

The above complaint has been heard by many growers over the years, and is the object of continuing discussion during many hay transaction. Overemphasizing small differences in lab results for the purposes of hay marketing is quite common. However, this is clearly an abuse of the hay testing process. With current technology of sampling and lab analysis, there is absolutely no reliable way to measure a 0.2% difference in TDN[2] value (or ADF value) between two hay lots. For all practical purposes, a 54.8% TDN cannot be differentiated from a 55% TDN hay just by the lab test.

---

[1] D.H. Putnam, Cooperative Extension Forage Specialist, UC Davis. Published IN Proceedings, 29th California Alfalfa Symposium, December 8-9, 1999, Fresno, CA. UC Cooperative Extension, University of California, Davis 95616. An earlier version of this article was first published in the California Alfalfa & Forage Review, Vol. 2, No. 3, Summer, 1999.

[2] ABBREVIATIONS: ADF=Acid Detergent Fiber, NDF=Neutral Detergent Fiber, CP=Crude Protein, TDN=Total Digestible Nutrients calculated from ADF, DM=Dry Matter, RFV=Relative Feed Value..

But isn't a lab value an exact value? Well, yes and no. Hay is a natural product and contains considerable variation in fiber and protein. Additionally, laboratory analyses are subject to some normal variation. There are several sources of variation that are simply a 'part of the landscape' in the process of predicting the feeding value of hay:

Sampling Variation is clearly the largest source of variation in lab analysis. Typically, less than one gram of sample is analyzed by the lab. This amount must represent tons and tons of hay! There are tremendous differences in quality between leaves and stems. There are also tremendous differences between individual stems within the field, not to mention the patchy influence of weeds. All of this must be represented in this tiny sample. Is it of any surprise that two people sampling the same stack will have slightly varying numbers?

Figure 1. Variation in Individual Core samples taken from a seemingly uniform hay lot
(UC Davis Data)

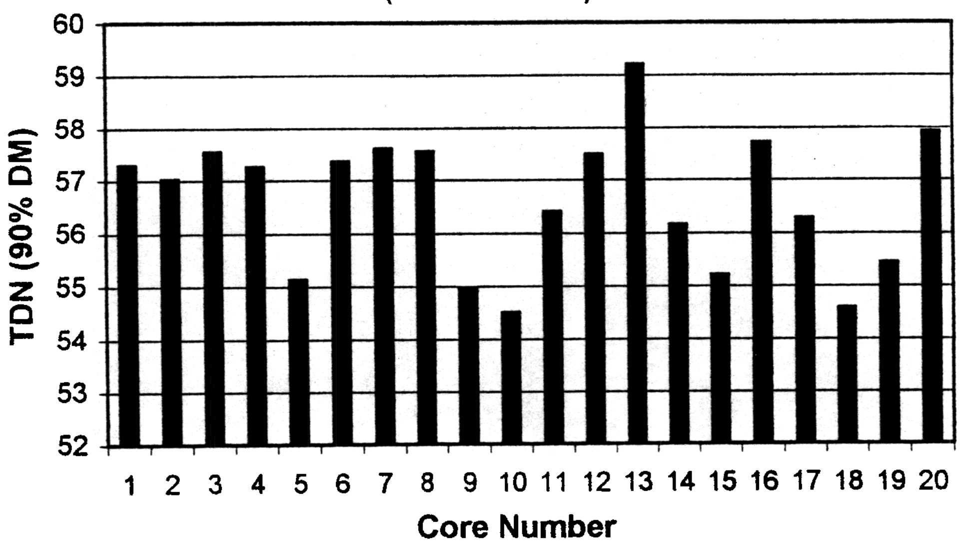
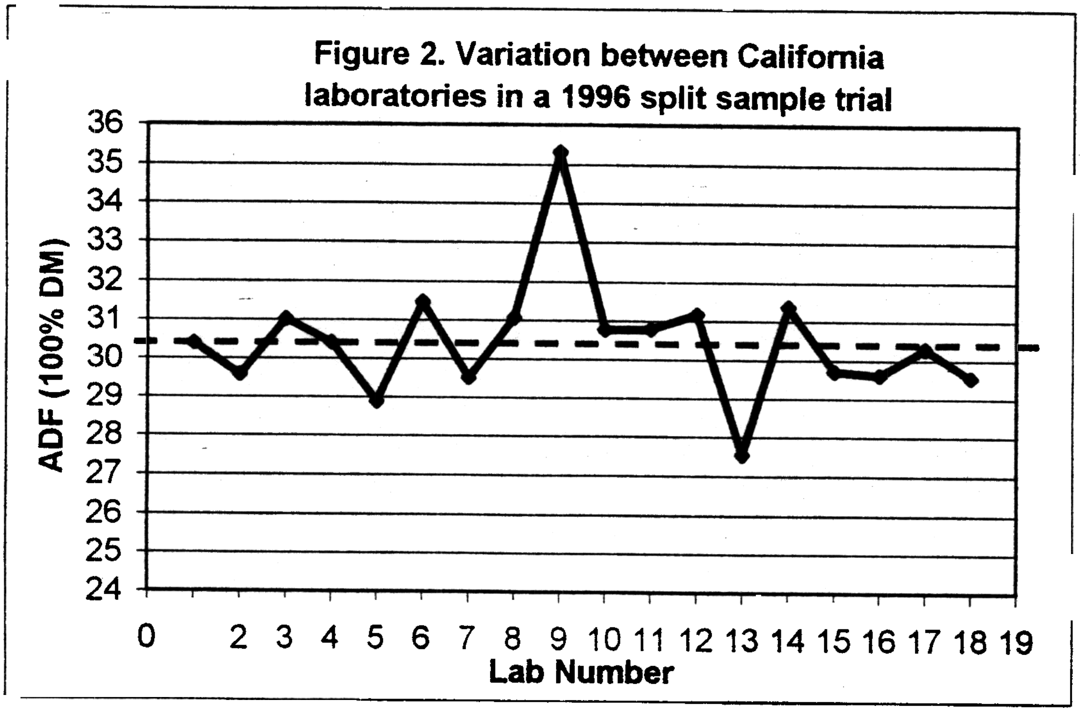


Figure 1 shows data from 20 individual cores taken from a seemingly uniform stack of pure alfalfa hay. The TDN ranged from about 54.5 to 59.2, illustrating the wide range of variation within this stack (TDN calculated from ADF using the California equation). We know that if at least 20 cores are combined, we have a good chance of narrowing the range of variation, but we should always expect some variation due to sampling. This is likely to be at least 0.5% ADF from two properly taken samples from the same stack.

Lab Variation must also be considered. Few analytical techniques can be performed without at least a little variation each time it is performed. The 'normal' range of variation is considered to be about +/-0.5% points Crude Protein, +/- 0.7% points Acid Detergent Fiber (ADF) and about +/- 1% points Neutral Detergent Fiber (NDF). Since

TDN is calculated from the ADF value, the normal range of TDN is about +/- 0.5% points. These are within-lab ranges; when different labs perform a test, the variation is likely to be greater.



In a 1996 split-sample test of California labs, values for ADF for the same sample ranged from 27.6 to 35.3, a disturbing amount of variation (Figure 2). However, if the two extreme labs are taken out, the range is much tighter--about 0.8% Standard Deviation between labs, which is actually very reasonable for lab-lab differences. Although it would be desirable to reduce this amount further (e.g. by choosing a 'California Recognized' and 'NFTA Proficient' lab), <u>some</u> variation due to within- and between-lab variation should be expected.

Solution to Misuse I: Each reported lab value examined for the purposes of trade should have an 'error' term associated with it. This is likely to be <u>at least</u> 0.7% ADF (0.5% TDN), 1% NDF, and 0.5% CP. In practice it is likely to be closer to 1% TDN due to potential differences in sampling and between labs. This should be considered when arguments over hay test values occur.

MISUSE II: PROBLEM OF BIASED SAMPLING

"I went out to the stack and took 4-5 cores from the end of the stack because it was a hot day. That should be enough, shouldn't it?"

Sometimes people will submit samples to the lab that do not fairly represent the hay lot. In some cases this is deliberate (e.g. submitting only the leafy parts), but in most cases it is due to failure to follow proper sampling procedures. California and most other states recommend taking at least 20 cores taken from randomly-chosen bales around the stack to help represent a hay lot (more if it's variable). There are other recommendations with regards to sampling probe, angle of the probe and sample handling.

Some labs have reported that customers will bring in a whole flake of hay or a small teaspoon of hay particles. This sampling is clearly inadequate. Such testing is useless, since the sample does not accurately reflect the hay lot or the feeding value. It is not surprising that different people who sample the same stack will sometimes come back with different results.

Solution to Misuse II: Follow accepted protocols for sampling, including combining 20 cores, using good sharp coring devices, and using accepted techniques. If a sample does not represent the hay lot, do not bother to analyze it. For a complete review of proper sampling techniques, contact the author.

MISUSE III: ENCOURAGING LAB BIAS

'It seems that Lab X always gives values that are 2 points above Lab Y" says one client "Since it suits my purposes, I'll just insist upon using Lab X".

While some amount of random variation (+ or -) between labs is normal, a consistent difference of several points, always in one direction, is a significant problem. Some of this is the lab's problem, but part of the problem is in the willingness of customers to exploit these differences to gain economic advantage. Some labs will in turn, respond to the pressure of their customers, but I believe that most labs take a very professional view of their work, and want to obtain the <u>right</u> answer, regardless of the customer. However, it is up to the customers of the labs to insist upon unbiased hay analysis methods by their laboratory.

Solution: Only work with those labs that are interested in standardizing their methods, and perform well on NFTA and/or the California Recognized programs or other programs. Disputes may still arise which reveal lab-lab differences. In these cases, clients should request return of the remainder of their ground sample from the lab in question, and check it with other labs (<u>never</u> send an un-ground split sample to labs to test them--it doesn't work!). <u>Do not use labs</u> that are unwilling to give your ground sample back for further testing!

MISUSE IV: MISINTERPRETING CALCULATED TDN OR RFV VALUES

"My buyer said that the TDN was OK but the ADF was not good enough" said one grower "as a result, the deal fell through".

This discussion revealed a lack of understanding (or alternatively a deliberate misrepresentation) of how TDN values are derived. Let's be clear: since the TDN value is calculated directly from the ADF lab value, THERE IS NO DIFFERENCE IN MEANING BETWEEN AN ADF AND TDN VALUE for alfalfa hay.

TDN is a calculated energy value, and should give the same answer as ADF. Adding to the confusion, sometimes, different TDN equations are used (there are a number of TDN calculations published). In California, a single TDN equation for alfalfa and alfalfa mixtures [TDN = 82.38-(.7515xADF) at 100% DM] is recommended.

Confusion can also arise due to expression of TDN on either a 90% or 100% or 'as received' basis. Most people in the California hay trade express TDN on a 90% DM basis. Traders should assure that a quoted TDN value is standardized to the same moisture value, and using the same equation.

Similar sources of confusion can enter in with Relative Feed Value, although I believe that mostly the same equation is used nationwide (there are exceptions, so this should be checked). Relative Feed Value (RFV) is an index calculated from the ADF and NDF lab values and used in some parts of the country to trade hay. There is no separate analysis for RFV. Since it is calculated from two separate lab values, RFV may contain greater variation than the ADF and NDF values alone. When in doubt about the interpretation of RFV values, the original ADF and NDF lab values should be compared.

Solution to Misuse IV: When confusion arises between tests or hay lots over TDN or RFV, always refer to the original analyzed values (ADF or NDF at 100% DM).

MISUSE V. CONFUSION OVER DRY MATTER

"My hay was high in moisture, but tested 'Supreme' in quality. My buyer said that because of the high moisture, the forage quality should be evaluated on an 'as-received' basis, and therefore should be lower in price"

This particular situation was encountered in 1999 during a hay transaction between a grower and a dairy. The expression of any lab value at a lower DM content causes the value to appear lower (for example a 60% TDN at 100% DM will be about a 54% TDN at a 90% DM basis and a 51% TDN on an 85%DM basis). Confusion over dry matter and interpretation of lab reports has been a commonly problem with hay testing. Other closely related incidences occur related to whether TDN is compared based upon a 90% or a 100% DM basis.

In this situation, they buyer was mistaken. While high moisture hay contributes a greater amount of water in the tonnage, it should have no affect on forage quality, which is independently measured. Therefore, the interpretation of TDN on an 'as-received' basis should have no validity when determining economic value. This is especially true since dry matter changes so readily in hay stacks.

A buyer (or seller) is completely justified in adjusting tonnage of the hay based upon the as-received dry matter content. If the dry matter content is significantly below about 90% (the most commonly-observer dry matter for hays that have come to equilibrium with atmospheric moisture in California), then they are shipping more water, and the tonnage should be adjusted. However, if there is a lot of time that has passed between when the sample has been taken and when the tonnage is measured (eg when the truck passes the scales), then the 'as-received' moisture may be meaningless, since haystacks can loose or gain moisture. This can be a legitimate point of negotiation. However, the forage quality measurement should not be affected.

It should be noted that very high moisture or very low moisture can affect forage quality in other ways, but not in ways that can be tested by labs. High moisture hay can mold, affecting palatability, and very low moisture hay can become very 'prickly', also affecting intake. This can only be observed by visual inspection and subjective evaluation.

Solution to Misuse V: ADF, CP, NDF, and TDN (as well as RFV) should only be compared on a standardized moisture basis. For ADF, CP and NDF, 100% DM basis is appropriate. The industry in California is accustomed to using TDN on a 90% DM basis, which is sometimes confusing, but should be OK if a standard equation is used and calculated correctly. When using TDN, it should be confirmed that a uniform TDN calculation from ADF is used at a uniform standardized DM basis.

MISUSE VI. FAILURE TO ACOUNT FOR OTHER QUALITY FACTORS

This hay is only '54 TDN' hay but will likely feed like a premium-quality hay

The standard hay test (ADF, NDF, and CP) reveals certain things about a hay lot, but not all. The use of ADF or TDN calculated from ADF greatly simplifies the estimation of 'feeding value', sometimes to the point that it fails to predict the actual feeding value of the hay. There are many other factors that may contribute to true feeding value.

Thus the above statement may very well be true. Many dairy producers and nutritionists can point to hay that "tests" poorly but feeds well, due to quality factors that ADF misses. Additionally, some hay may test well but feed poorly due to poor condition (mold), physical characteristics (e.g. very dry hay), or low fiber digestibility.

There are limitations to the way in which a standard hay test can predict milk production, and there are some aspects of hay quality that are not fully understood or are difficult to measure. In particular, it is known that the non-structural component of the hay (sugars), and the digestibility of the fiber component are important feed quality aspects, but these are only partly predicted using the standard hay test. Efforts to research methods to measure these aspects of forage quality for routine analysis are ongoing.

Digestibility estimates (eg. In Vitro Digestible Dry Matter) have been used for a number of years to help predict feeding values, but they have historically been too time consuming and or sufficiently repeatable for routine analysis. However, better testing methods are being developed, and we should watch closely to see if these methods can be used to help describe and determine feeding value in the future. Meanwhile, it's important to recognize the limitations of the standard hay test, and the importance of visual observation and experience for predicting the feeding value of alfalfa hay.

Solution to Misuse VI: Use hay test results along with subjective visual analysis to determine value. It is especially important to examine hay for the presence of weeds (especially toxic weeds), mold, and physical characteristics that may affect the feeding value of the hay. Additional measurements (such as digestibility estimates) may become more important in the future.

CONCLUSIONS

Hay testing has proven to be an invaluable tool in predicting feeding value. However, hay analysis is meant to be an instrument, not a hammer to bludgeon prices. We can avoid abusing hay test results by 1) understanding the range of normal variation in hay test results, 2) using proper sampling methods, 3) choosing from 'NFTA Proficient" and 'California Recognized' labs (see related article), 4) interpret lab values expressed at a uniform DM content and 5) understanding the limitations of hay tests, only using them in addition to subjective visual evaluation of hay quality.