RFQ – A NEW WAY TO RANK FORAGE QUALITY FOR BUYING AND SELLING

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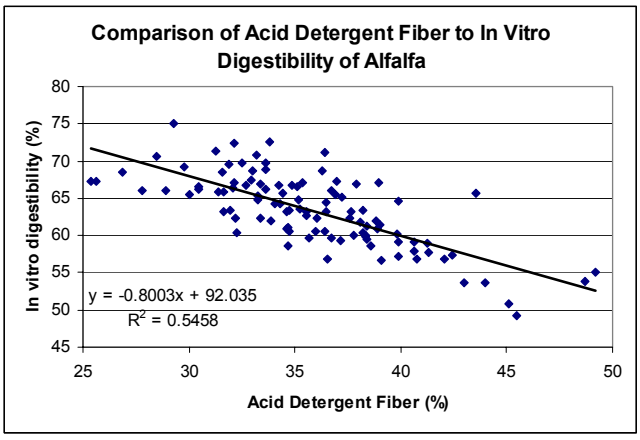
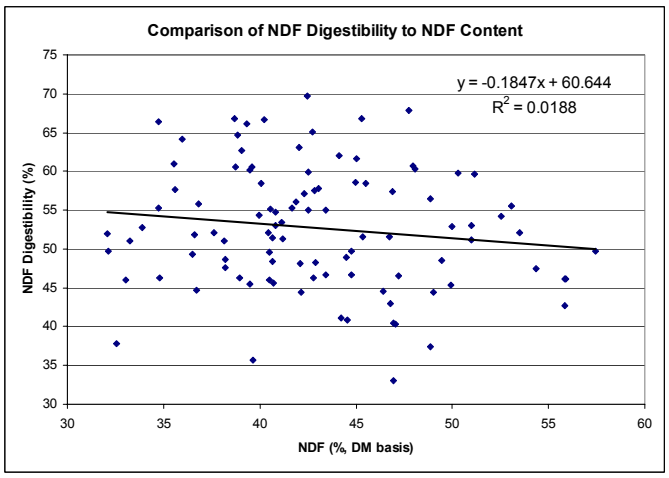


Acid detergent fiber (ADF) has been used to estimate digestible dry matter (DDM) for the last 25 years even though it was never designed for this purpose. When using any fiber determination to estimate digestibility the assumption is made that there is a close relationship between fiber concentration and digestibility. This is definitely not true as reported previously (Moore et al., 1998) and as shown in the graph above where the correlation between acid detergent fiber and in vitro digestibility among a data set of alfalfa and alfalfa/grass samples was only 0.55. Acid detergent fiber developed as a preparatory step for lignin analysis and was never intended for any other use.

While in vitro and in situ estimates of digestibility have long been recognized as being more closely related to animal performance than chemical extractions, this procedure has not been used commercially because of the expense and lack of access to a fistulated animal. The procedure is also difficult to get repeatability across runs and across different laboratories (Weiss, 1994.) A number of laboratories and researchers have attempted to use enzymatic methods to estimate digestibility. While these techniques have produced acceptable rankings within a forage species, the enzymatic techniques do not produce acceptable correlations with in vivo or in vitro digestibility over a broad range of forage samples.

Digestible fiber is an important component of forage energy and intake and is quite variable. Note from the graph below that there is even less relationship between NDF and digestible NDF, DM basis (dNDF) than there is between ADF and in vitro digestibility for a group of alfalfa and alfalfa/grass received by laboratories from farmers. We have developed Near Infrared Reflectance Spectroscopy equations for commercial release that measure digestible fiber.



Relative Feed Value has been of great value in ranking forages for sale or inventorying and assigning forage to animal groups according to their quality needs. With the introduction of the new approaches to determining animal requirements in National Research Council Nutrient Requirements for Dairy Cattle (2001), there is an opportunity to improve upon this quality index through use of newer analyses and equations.

Relative Feed Value was based on the concept of digestible dry matter intake relative to a standard forage according to the following:

RFV = (DMI, % of BW) * (DDM, % of DM) / 1.29

Where: DMI = dry matter intake
DDM = digestible dry matter

Dry matter intake was estimated from NDF and DDM from acid detergent fiber. The constant, 1.29, was chosen so that RFV = 100 for full bloom alfalfa. The constant was the expected DDM intake, as % of BW, for full-bloom alfalfa based on animal data.

We kept the same concept and format for Relative Forage Quality (RFQ) except that TDN will be used rather than DDM. Thus RFQ will be as follow:

RFQ = (DMI, % of BW) * (TDN, % of DM) / 1.23

Where the divisor, 1.23, is used to adjust the equation to have a mean and range similar to RFV (Moore and Undersander, 2002). The following two equations are recommended depending on whether or not the primary forage is legume or grass:

1) For alfalfa, clovers, and legume/grass mixtures the equations for TDN and DMI will be:

Total digestible nutrients for alfalfa, clovers and legume/grass mixtures are calculated from the new NRC recommendations using in vitro estimates of digestible NDF as follows:

TDN_{legume}= (NFC*.98) + (CP*.93) + (FA*.97*2.25) + (NDFn * (NDFD/100) – 7 (NRC, 2001)

where:
CP = crude protein (% of DM)
EE = ether extract (% of DM)
FA = fatty acids (% of DM) = ether extract - 1
NDF = neutral detergent fiber (% of DM)
NDFCP = neutral detergent fiber crude protein
NDFn = nitrogen free NDF = NDF –NDFCP, else estimated as NDFn = NDF*.93
NDFD = 48-hour in vitro NDF digestibility (% of NDF)
NFC = non fibrous carbohydrate (% of DM) = 100 – (NDFn + CP + EE + ash)

Dry matter intake calculations for alfalfa, clover and legume/grass mixtures will be:

DMI_{Legume} = 120/NDF + (NDFD – 45) * .374 / 1350 * 100 (Mertens, 1987 with NDFD adjustment proposed by Oba and Allen (1999). 45 is an average value for fiber digestibility of alfalfa and alfalfa/grass mixtures.
Where DMI is expressed as % of body weight (BW), NDF as % of DM and NDFD as % of NDF.

$RFQ = (DMI_{legume}, \%\ of\ BW) * (TDN_{legume}, \%\ of\ DM) / 1.23$

2) For warm- and cool-season grasses the equations for TDN and DMI will be:

Total digestible nutrients for warm- and cool-season grasses are calculated as:

$TDN_{grass} = (NFC*.98) + (CP*.87) + (FA*.97*2.25) + (NDFn*NDFDp/100) – 10$
(Moore and Undersander, 2002)

Where terms are as defined previously and NDFDp = 22.7 + .664*NDFD

Dry matter intake calculations for warm- and cool-season grasses will be:

$DMI_{Grass} = -2.318 + 0.442*CP - 0.0100*CP^2 - 0.0638*TDN + 0.000922*TDN^2 + 0.180*ADF - 0.00196*ADF^2 - 0.00529*CP*ADF$
(Moore and Kunkle, 1999).

Where DMI is expressed as % of BW, and CP, ADF, and TDN are expressed as % of DM

$RFQ = (DMI_{grass}, \%\ of\ BW) * (TDN_{grass}, \%\ of\ DM) / 1.23$

How does RFQ work in the field?

We analyzed the hay, haylage and baleage samples entered in the Worlds Forage Superbowl at the World Dairy Expo. There were approximately 200 alfalfa hay and haylage samples entered from 20 states and two Canadian provinces.

When we designed RFQ, we wanted approximately the same mean and range as RFV so that RFQ could be substituted for RFV without making economic and other management changes. The samples at the Worlds Forage Superbowl had a mean RFV of 179 and a mean RFQ of 172 which is remarkably similar. The graph below also shows that the range was similar.

The overall correlation (relationship between the two measures) was high (0.86) due to the large range of data values. However, RFQ of individual samples varied by as much as 40 points higher or lower than RFV, and 22% of the samples varied by 20 points or more, as shown on the graph. Where RFQ was higher than RFV, the hay seller could have gotten more for the hay (or the buyer got a good deal) and where RFQ was lower than RFV the cows would not have milked as expected.

In summary, it appears that RFQ and RFV average about the same so RFQ can be substituted for RFV in pricing, contracts and other uses. However, individual samples vary significantly and, when this occurs, growers should use RFQ because it is a better measure of animal performance.

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