RELATIVE FORAGE QUALITY (RFQ) - INDEXING LEGUMES AND GRASSES FOR FORAGE QUALITY

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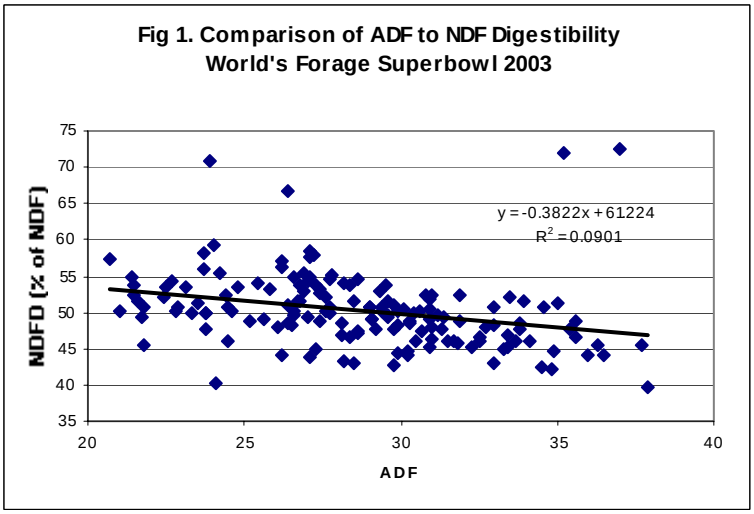
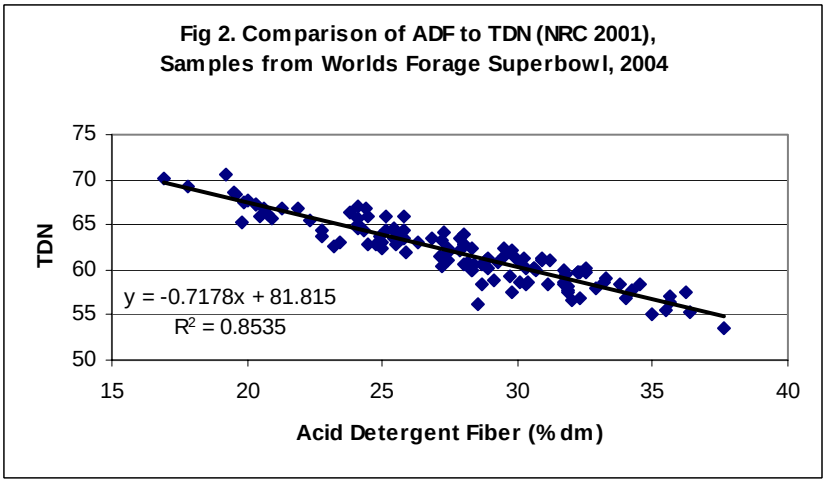
Acid detergent fiber (ADF) has long been used to estimate energy content of forages. However the relationship is not very good and this has caused nutritionists to minimize hay in dairy rations because the actual performance was not very predictable. Using ADF to estimate energy presumes that all ADF has the same digestibility. As the graph at the right shows, ADF varies significantly in digestibility even in alfalfa samples and thus is a poor indicator of forage energy. The relationship is even less good across species. To overcome this problem, the National Research Council in the last revision of Nutrient Requirements for Dairy Animals (2001) went back to the old definition of TDN where:



$$TDN_{1\text{-}X} = tdCP + (tdFA \times 2.25) + tdNDF + tdNFC - 7$$

Where: tdCP is total digestible crude protein
tdFA is total digestible fatty acid
tdNDF is total digestible NDF (NDF times NDF digestibility)
tdNFC is nonfibrous carbohydrates

The graph at the right shows the low correlation between ADF and TDN. Nutritionists tell us that switching from ADF to TDN and using ash estimates have improved accuracy of ration balancing from about 60 to 90%.



Relative Feed Value has been of great value in ranking forages for sale or inventorying and assigning

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forage to animal groups according to their quality needs. The advantage that it has over simply ADF estimates (or values calculated from ADF) is that it involves both ADF and NDF; therefore an estimate of both energy and intake.

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:

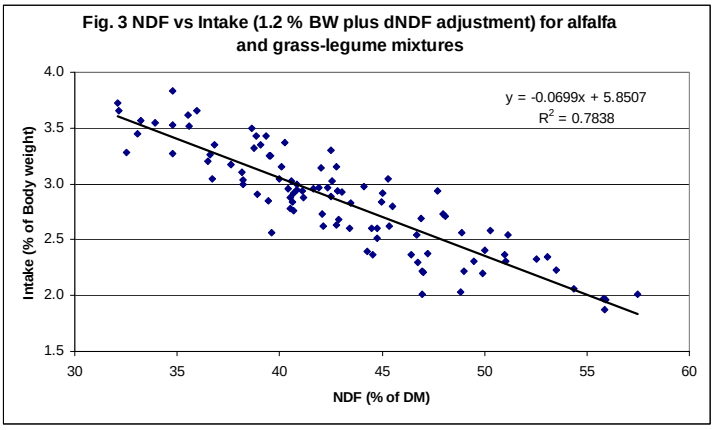
RFV = (DMI, % of BW) * (DDM, % of DM) / 1.29

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.

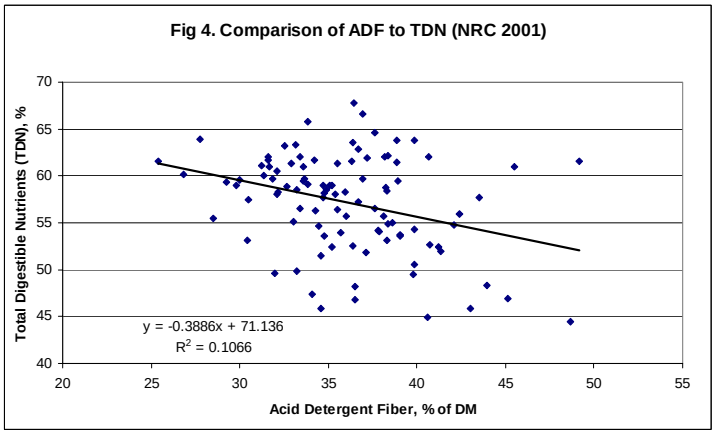
We are keeping the same concept and format for Relative Forage Quality (RFQ) except that TDN will be used rather than DDM. Thus RFQ will be as follows:

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



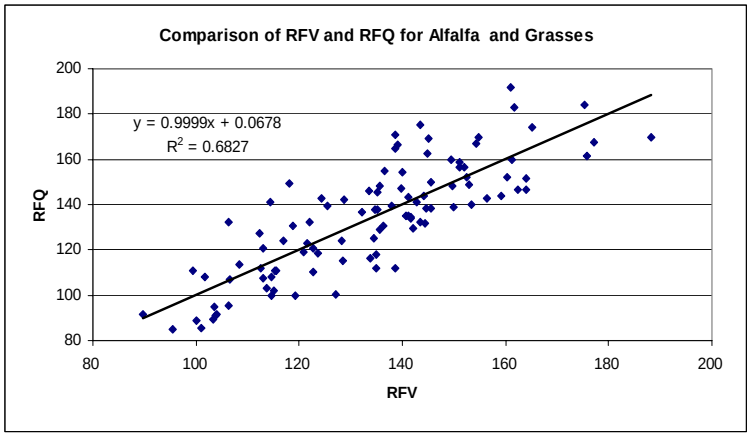
The exact equations are presented following this discussion.

Figures 3 and 4 show the impact of the changes on a batch of samples sent to forage testing laboratories. Intake estimates are correlated as the first figure indicates. This would be expected because both intake estimates are based on NDF content. The new equation adjusts intake for digestible fiber (NDFD). Research has shown that intake is affected by the digestibility of the fiber. It is interesting to note that, while the overall trend is the same, individual samples vary by up to 0.5% BW intake from the mean predicted by NDF alone.



As the second graph suggests, the relationship is between ADF (formerly used to estimate energy) and TDN as

recommended by NRC (with digestible NDF measured in vitro) is not good (R^2 = 0.1066). These samples contained various legumes and cool season grasses. The poor correlation indicates why we have had trouble predicting energy of forage.



The final graph shows the relationship between RFV and RFQ. There is a strong correlation in this data set (R^2 = 0.6827). The graph suggests that RFQ is performing as intended. That is that the mean and generally trend is similar. So RFQ can be substituted for RFV wherever it has been used. It appears that RFV and RFQ will be similar for about 60% of the samples. Note, however, numerous individual samples varied by over 20 points. When differences occur, we believe that RFQ will be a better estimate of animal performance than RFV.

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

References

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