How Do We Calculate Relative Forage Quality in Georgia?

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1.0 Introduction

In simple words, forage quality is a final number which is a reflection of various laboratory nutrient analyses profiles. A direct impact of forage quality is expected on the ultimate animal performance, which is the sole purpose of commercial livestock operations. For a livestock producer, animal performance, for example, means milk production, body weight gain, or rate of rebreeding success etc.

For forage trading (i.e, buying or selling), one number to describe different hays is more convenient rather than comparing their full nutrient analyses profiles. Such a single index called, Relative Feed Value (RFV), was in place and had been very useful for livestock producers and hay farmers for long time to price hay and predict animal performance. However, with the availability of neutral detergent fiber digestibilities (NDFD), the RFV has been replaced by another index called Relative Forage Quality (RFQ), which takes into account digestible fiber and other nutrients supplying energy (Moore and Undersander, 2002a, 2002b). However, the animal nutritionists use neither RFV nor RFQ to formulate rations; and anyone of these two indices should not be used for corn silages because they don't reflect starch availability.

The RFQ incorporates new advances in knowledge and technology into the existing RFV system. The University of Georgia has worked in cooperation with the University of Wisconsin to include warm season forages like bermudagrass, bahiagrass and perennial peanut in the RFQ equations. It is currently being used in the UGA Feed and Water Testing Laboratory to evaluate hay and silage samples. RFQ has been used in Georgia to judge many hay contests. Georgia Farm Bureau, Piedmont Hay Contest, and the Southeastern Hay Contest all utilize RFQ as the major judging criteria.

2.0 How do we calculate RFQ and how does it differ from RFV?

2.1 RFV calculation:
The RFV is calculated based on the two laboratory determined parameters, NDF and ADF levels in a forage, as follows:

❖ **RFV = DDM (% of DM) × DMI (% of BW) ÷ 1.29**

Where, DDM (digestible dry matter) and DMI (dry matter intake) are calculated from ADF and NDF as:
- DDM (% of DM) = 88.9 – 0.78 × ADF (% of DM)

- DMI (% of BW) = 120 ÷ NDF (% of DM)

The RFV is calculated based on the two laboratory determined parameters, NDF and ADF levels in a forage. The NDF has been used as an indicator of forage intake because it takes into account all fiber components (lignin, cellulose and hemicellulose), the ADF has been used as an indicator of digestibility since it includes cellulose and lignin. Thus together, ADF and NDF take into account the most important traits of a forage, intake potential and digestibility, and are used to calculate RFV.

2.2 RFQ calculation:

The RFQ uses NDF Digestibility (NDFD) to account for DMI and true TDN, and is calculated (Moore and Undersander (2002a) as:

❖ **RFQ = DMI (% of BW) × TDN (% of DM) ÷ 1.23**

Whereas the old RFV equation DDM is based on only ADF concentrations, the TDN of RFQ equation is estimated as the sum of predicted energy contributions from all potential nutrient fractions. The TDN in RFQ measures the total energy consumed by the animal, not just based on fiber, but also on CP, ADF, NDF, fat, ash and NDFD. All of these parameters have an energy value, but are not accounted for in DDM used in RFV. Thus, RFQ is a better predictor of forage quality than is RFV.

2.3 The RFV versus RFQ numbers:

A full bloom alfalfa hay containing 41% ADF and 53% NDF on a dry matter basis has an RFV of 100 and is considered the average score. Forages with RFV greater than 100 are of higher quality than a full bloom alfalfa hay, and forages with a value lower than 100 are of lower value than full bloom alfalfa. The above equation for RFQ includes the adjustment factor 1.23 which allows the RFQ to have the same scoring system as RFV with an average score of 100 as well as to have a mean and range similar to RFV. The NSC, NDF, and NDF digestibility of a forage sample will determine whether RFQ value will be higher or lower than the corresponding RFV index. For example, at the same level of NDF and ADF concentrations, a forage with higher NDF digestibility will have higher RFQ than another forage with lower NDF digestibility, even though both of them will have the same RFV number.

3.0 How do we calculate TDN and DMI of RFQ equation?

The equations used to calculate DMI and TDN for legumes and legume/grass mixtures are different from those used to calculate them for warm and cool season grasses. Therefore, proper identification of forage type is essential before RFQ calculation. The two recommended equations for DMI and TDN calculations depending on whether or not the primary forage is legume or grass are given below:

3.1 Equations for calculation of TDN

According to new NRC recommendations (NRC, 2001), the TDN for alfalfa, clovers and legume/grass mixtures are calculated based on *in vitro* estimates of digestible NDF as follows:

❖ **TDN_{legume}(% of DM) = (CP × 0.93) + (FA × 0.97× 2.25) + [NDFn × (NDFD ÷ 100)] + (NFC × 0.98) − 7**

Where:

- NDFn = nitrogen free NDF = NDF – NDFCP, also estimated as NDFn = NDF $\times$ 0.93
- NDFCP = neutral detergent fiber crude protein
- NDFD = 48-hour *in vitro* NDF digestibility (% of NDF)
- NFC = non fibrous carbohydrate (% of DM) = 100 – (NDFn + CP + EE + Ash)
- EE = ether extract (% of DM)

The TDN for warm and cool season grasses are calculated as:

❖ **TDNgrass (% of DM) = (NFC $\times$ 0.98) + (CP $\times$ 0.87) + (FA $\times$ 0.97 $\times$ 2.25) + [NDFn $\times$ (NDFDp ÷ 100)] – 10**

Where:
- All other terms except NDFDp are as defined previously and
NDFDp = 22.7 + 0.664 $\times$ NDFD

2.2 Equations for calculation of DMI
The equation for DMI calculations for alfalfa, clover and legume/grass mixtures according to Mertens (1987) with NDFD adjustment proposed by Oba and Allen (1999) is:

❖ **DMI$_{Legume}$ (% of BW) = (120 ÷ NDF) + {(NDFD – 45) $\times$ 0.374 ÷ 1350 $\times$ 100}**

Where:
- 120 is a base NDF intake of 1.2% of BW (legumes only)
- 45 is an average value for fiber digestibility of alfalfa and alfalfa/grass mixtures, and
- 1350 is the BW in pounds of a typical cow (used for legumes only)
- NDF (Neutral Detergent Fiber) as % of DM (Dry Matter) and NDFD (48-hour *in vitro* NDF digestibility) as % of NDF.

Similarly, a robust way of DMI calculations for warm and cool season grasses (Moore and Kunkle, 1999) is:

❖ **DMI$_{Grass}$ (% of BW) = –2.318 + 0.442 $\times$ CP – 0.0100$\times$CP^2 – 0.0638 $\times$ TDN + 0.000922 $\times$ TDN^2 + 0.180 $\times$ ADF – 0.00196 $\times$ ADF^2 – 0.00529 $\times$ CP $\times$ ADF**

Where:
- CP (Crude Protein), ADF (Acid Detergent Fiber), and TDN (Total Digestible Nutrient) are expressed as % of DM

Note: *DMI calculation based on the general equations given above for two different forage types is for the purpose RFQ calculation for the forge type in question. However, actual DMI is the total effects of the condition of the animal (animal type, age, body weight, pregnancy status, and level of milk production etc), the feed factors (like palatability, balance of the diet, quality of the feed, and accuracy of the diet relative to the animals' needs) and the feeding environment (i.e., environmental factors like temperature and others).*

4.0 Comparison Between RFV and RFQ
The RFQ equation is designed so that the RFQ Index for an average quality alfalfa should generate an index value similar to the RFV. RFQ was designed to have a similar mean and range of values as

RFV. The RFQ value will run higher or lower than the corresponding RFV index based on the NSC, NDF, and NDF digestibility of the sample. As a hay-crop material includes more grass with generally higher NDF digestibility, the RFQ will show an advantage to the forage over the RFV. It is recommended that RFQ be used when the two values are different.

5.0 RFQ-based forage grading system in the southeast region
The advent of RFQ led to the development of a forage grading system (Table 1) that is now being used and promoted in the southeastern U.S. This grading system allows the categorization of forages into generalized grades for marketing purposes.

Table 1. An RFQ-based forage grading system being used and promoted in the Southeast.

Forage Quality Grade	RFQ
Supreme	> 185
Prime	160-185
Choice	140-160
Select	110-140
Standard	90-110
Utility	< 90

For more information on RFQ, visit the RFQ information page (direct link: http://www.caes.uga.edu/commodities/fieldcrops/forages/questions/rfq.html) on the UGA Forages website (www.georgiaforages.com).

6.0 Literature Cited
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