The Relative Forage Quality (RFQ) Index Replaces RFV

CPM Short Course, Nov. 26, 2002

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The Relative Feed Value (RFV) index was developed by the American Forage and Grassland Council's Hay Marketing Task Force nearly 25 years ago. Currently, RFV is an important tool in forage marketing and forage quality education. Commercial labs certified by the National Forage Testing Association generally report RFV values. Hay producers and buyers use RFV to determine a fair price, often at quality-tested hay auctions.

The basis of the RFV index is voluntary animal intake (consumption) of forage digestible dry matter (DDM). Intake of DDM by animals, and thus RFV, is determined by two animal responses: DM intake (DMI as a % of body weight) and DDM concentration (% of DM). These animal responses are often not related. RFV is a calculated value based on predicted values of DMI and DDM, and these values are based on lab analyses for neutral detergent fiber (NDF) and acid detergent fiber (ADF), respectively. The current equations used to predict RFV were proposed 15 years ago, and are as follows:

DMI, % of BW = 120 / NDF, % of DM

DDM, % of DM = 88.9 - .779 * ADF, % of DM

RFV = DMI * DDM / 1.29

The standard reference hay for the RFV index is full-bloom alfalfa with 41% ADF and 53% NDF, giving a predicted DDM intake of 1.29% of BW and a RFV of 100.

For nearly 25 years, the RFV index has served the forage-livestock industries well. However, new approaches are now available for predicting forage quality, and there is new information suggesting that RFV has some limitations as an index of forage quality. A new index is needed that more accurately estimates animal milk production and gain.

Several researchers have shown the limitations of ADF and NDF in predicting DDM and DMI of forages. Often barely half of the variation in DDM and DMI can be accounted for by ADF and NDF, which suggests that estimates of the former from the latter can sometimes be misleading. Current RFV equations often underestimate quality of higher quality grasses, and give unacceptable estimates in many cases. The RFV of high quality grasses is underestimated because DMI is underestimated.

RFV has not been incorporated into nutritional models probably because DDM is not a conventional measure of animal energy requirement. Nutritionists would more likely use an

index of forage quality if total digestible nutrients (TDN) were used to express the available energy. A forage quality index using both DM intake and TDN would be compatible with most nutrition models. A shortcoming of RFV is that it reflects only fiber concentration, and not other important characteristics of forage that influence forage intake and digestion, especially fiber digestion and crude protein.

Like RFV, the Relative Forage Quality (RFQ) index is an estimate of voluntary intake of available energy when forage is fed as the sole source of energy and protein. The intake component is DMI as a percentage of BW (as in RFV), and the available energy component is TDN (% DM) instead of DDM. **The calculation of RFQ is as follows:**

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

The principles behind this new index are as follows:

1. The equations used to predict RFV should not be changed; thus, a new index was developed.
2. The index relates to forage quality when forages are fed alone to non-lactating animals.
3. The conceptual base of RFQ is the same as for RFV, and RFQ has a similar mean and range as RFV.
4. Components of RFQ are useful in nutritional models for formulating or evaluating mixed diets for high-producing animals; so the intake component is DM intake as a % of BW, and the available energy component is expressed as TDN.
5. Prediction of RFQ is based on equations that are biologically sound yet uses a minimum number of input variables.
6. Laboratory methods to provide inputs into the RFQ prediction equations are reasonable in turn-around time and cost, and repeatable within and among labs.
7. The RFQ index and equations are expressed in terms that are understandable to all participants in the forage-livestock industries.

Accurate prediction of DMI is the greatest challenge in developing accurate RFQ prediction equations. There are two equations for predicting DMI depending on forage type. For legumes (alfalfa, clovers, and legume/grass mixtures), the DMI calculation is based on NDF (as was RFV) ***and*** in vitro NDF digestion. For grasses, DMI is calculated from TDN, ADF, and CP. In animal trials, TDN is the sum of digestible organic nutrients with an adjustment for the higher energy value of digestible fats. The TDN calculation is a summative equation that uses *in vitro* ("in test tube") NDF digestion to estimate the digestible NDF component.

LEGUMES (includes alfalfa, clovers, and legume/grass mixtures):

$DMI_{legume} = [(.012*1350)/(NDF/100) + (NDFD – 45)*.374]/1350*100$

$TDN_{legume} = NFC*.98 + CP*.93 + FA*.97*2.25 + NDFn*NDFD/100 - 7$

GRASSES (includes cool- and warm-season grasses):

$DMI_{grass} = -2.318 + .442*CP - .01*CP^2 - .0638*TDN + .000922*TDN^2 + .18*ADF - .00196*ADF^2 - .00529*CP*ADF$

$TDN_{grass} = NFC*.98 + CP*.87 + FA*.97*2.25 + NDFn*NDFDp/100 - 10$

Where:

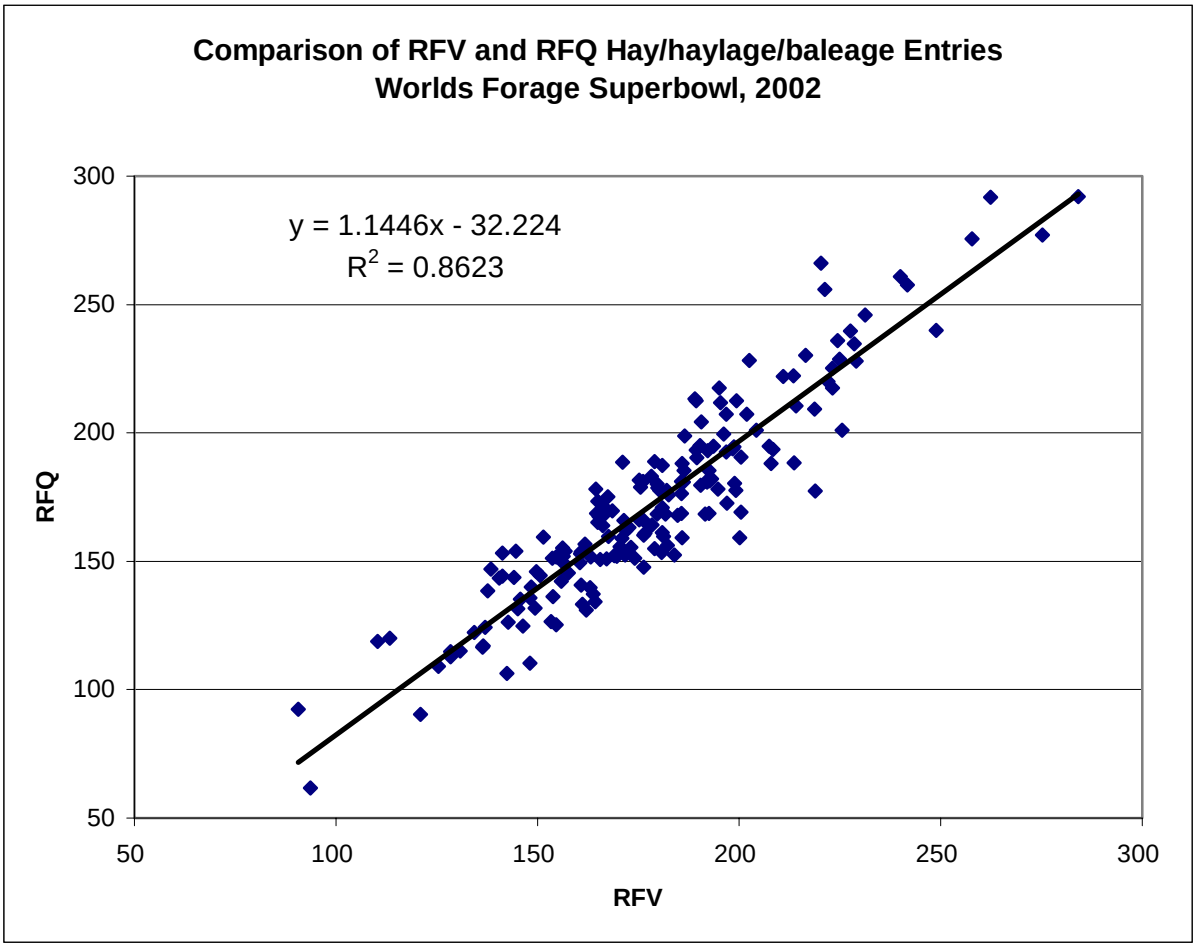
DMI = DM intake, % of BW
TDN = total digestible nutrients, % of DM
OM = organic matter = 100 – ash, % of DM
CP = crude protein, % of DM
FA = fatty acids = EE – 1, % of DM
EE = ether extract, % of DM
NFC = non-fiber carbohydrates = OM – CP – EE – NDFn, % of DM
ADF = acid detergent fiber, % of DM
NDF = neutral detergent fiber, % of DM
NDFn = NDF free of CP = .93*NDF, % of DM
NDFD = 48 hr in vitro NDF digestion, % of NDF
NDFDp = 22.7 + .642*NDFD, % of NDF (grasses only)
.012 = base NDF intake of 1.2% of BW (legumes only)
1350 = body weight in pounds of a typical cow (legumes only)
45 = laboratory mean of NDFD (legumes only).

RFQ and RFV are designed to have the same mean and range so rules of thumb and pricing from RFV should apply to RFQ. However, individual values will differ significantly, with RFQ more accurately relating to animal performance, and hence the need for the new index.

About 200 alfalfa hay and haylage samples from 20 states and two Canadian provinces were entered in the 2002 Worlds Forage Superbowl at the World Dairy Expo. RFQ and RFV were compared for these samples (Figure 1). These samples had an average RFV of 179 and an average RFQ of 172, which is remarkably similar. The ranges were also similar. These results were reassuring, as the RFQ index was designed to have approximately the same mean and range as RFQ so that RFQ could be substituted for RFV without making economic and other management changes.

The overall correlation was moderately high (r=0.86) due to the large range of data values. However, the important distinction is that RFQ of individual samples varied by as much as 40 points higher or lower than RFV, and 22% of samples varied by 20 points or more (Figure 1). Also, NDF Digestibility among these entries ranged from 25 to 60% of NDF. Where RFQ was higher than RFV, the hay seller could have gotten more for the hay (or the buyer got a good deal). Where RFQ was lower than RFV, the cows would not have milked as well as expected based on RFV.

Figure 1. Comparison of RFQ and RFV for about 200 alfalfa hay, haylage, and baleage entries from 20 states and two Canadian provinces in the 2002 Worlds Forage Superbowl (Source: Dan Undersander, Univ. of WI).



Initial data analyses conducted at the University of Wisconsin indicate that RFV and RFQ are linearly related for scissors cuts from 1st cutting alfalfa. This means we can probably continue to use the PEAQ sticks. Where will RFV and RFQ likely be different? We're still learning, but what we know so far is:

- Fiber is more digestible in forage grown under cooler conditions, so:
  - 1st cutting will tend to have more highly digestible fiber than later cuttings grown under higher temperatures.
  - The same crop grown in northern states or Canada will tend to have more digestible fiber than when grown in states to the south.
  - Alfalfa grown in higher mountain valleys of the West will have more digestible fiber than that grown in lower valleys.
- Fiber of leaves is both lower in content and higher in digestibility. Thus, harvest losses will result in greater RFQ loss than RFV.
- RFQ is reduced by heat damage but RFV is not.

- Thus, there will likely be greater differences between RFQ and RFV on harvested forage than fresh cut, and bigger differences between cuttings.

Commercial labs in the NIRS Consortium have already begun reporting RFQ on forage test reports. This is good news for forage growers and feeders. The bottom-line for producers is that RFQ should provide a better estimate than RFV of how their forages will perform when fed.

References

Moore, John E., and Daniel J. Undersander. 2002. Relative Forage Quality: A Proposed Replacement for Relative Feed Value. Proc. National Forage Testing Association Workshop, June 11, 2002, Des Moines, IA.

Undersander, Dan. 2002. Status of RFQ. NIRS Consortium News. Summer 2002.