Extension Extra

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Understanding Relative Feed Value (RFV) and Relative Forage Quality (RFQ)

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Feed quality of alfalfa harvested as haylage or hay depends, to a great extent, on the maturity of the stand. With increasing maturity, plant structural carbohydrates, as measured by the ADF and NDF fractions, increase. These fiber fractions represent the more indigestible parts of the plant. As a result, digestibility and energy obtained through fermentation decrease with maturity.

Relative feed value (RFV) has been used for years to compare the quality of legume and legume/grass hays and silages. Having one index to price hay and predict animal performance has been very useful for livestock producers and hay farmers.

Relative Feed Value (RFV)

The Relative Feed Value index estimates digestible dry matter (DDM) of the alfalfa from ADF, and calculates the DM intake potential (as a percent of body weight, BW) from NDF. The index is then calculated as DDM multiplied by dry matter intake (DMI as a % of BW) and divided by 1.29.

The index ranks forages relative to the digestible DMI of full bloom alfalfa, assuming 41% ADF and 53% NDF. The RFV index is 100 at this growth stage.

DDM = Digestible Dry Matter = 88.9 - (0.779 x % ADF)
DMI = Dry Matter Intake (% of BW) = 120 / (% NDF)
RFV = (DDM x DMI) / 1.29

where the numerator, **120**, in the DMI calculation indicates maximum feed intake in alfalfa-based dairy rations when NDF is 1.2 lb per 100 lb of body weight; the divisor, **1.29** in the RFV calculation was chosen so that the RFV of full bloom alfalfa has a value of 100.

Example: Alfalfa hay or haylage with 32% ADF
and 40% NDF
(Plug in values for ADF and NDF on a dry matter basis)

DDM = 88.9 - (0.779 x 32) = 63.97
DMI = 120 / 40 = 3
RFV = (63.97 x 3) / 1.29 = 149

Relative Feed Value reflects both digestibility (from % ADF) and intake potential (from % NDF) of alfalfa.

Limitations of the RFV method include:
1. DDM and DMI are assumed constants for all forages.
2. ADF and NDF are the only laboratory values used in the calculation.
3. Crude protein concentration of forage is not used.
4. RFV cannot be used in ration formulation or evaluation.

Forage quality parameters including RFV ranking for each type of forage are in Table 1.

Higher RFV values indicate higher forage quality. Since the RFV system was developed using legume forages and intake responses of lactating dairy cows, it works best when applied to that situation.

Relative Forage Quality (RFQ)

Relative feed value is calculated by estimating the digestibility of the forage dry matter, and how much the cow can eat based on its "filling" capacity. However, cows sometimes perform differently even when fed forages of identical RFV. Variations in the digestibility of the NDF fraction can probably account for these differences.

Table 1. Forage quality values of some forages at different growth stages.

Forage type	CP	ADF	NDF	RFV
			%	
Alfalfa-prebud	22	28	38	164
Alfalfa-bud	20	30	40	152
Alfalfa-early bloom	18	33	43	138
Alfalfa-full bloom	16	41	53	100
Alfalfa-seed pod	14	43	56	92
Alfalfa + grass	13	39	54	101
Bromegrass, late vegetative	10	35	63	91
Bromegrass-late bloom	7	49	81	58
Corn silage-well eared	10	28	48	133
Corn silage-few ears	8	30	83	115
Sorghum silage	8	32	52	114

Source: Dunham (1998)

Fiber from grass and legumes naturally differs in digestibility, as it also does when grown under different ambient temperatures. RFV of first-cutting alfalfa will be similar to that of second and third cuttings harvested at similar stages of maturity. However, fiber fraction digestibility from each cutting will be different, as this is influenced by ambient temperatures at the time of growth and development. Therefore, differences in fiber digestibility are not taken into account in the RFV calculation and cows may perform differently when fed forages from different cuttings.

Researchers at the University of Wisconsin have designed the relative forage quality (RFQ) index that uses fiber digestibility to estimate intake as well as the total digestible nutrients (energy) of the forage.

The RFQ index is an improvement over the RFV index for those that buy and sell forages, and it better reflects the performance that can be expected from cattle fed those forages.

One other advantage of the RFQ prediction is that it differentiates legumes from grasses.

The higher neutral detergent fiber in grasses will make RFQ a better predictor of quality than RFV. The RFQ emphasizes fiber digestibility while RFV uses digestible dry matter intake. Although grasses have

higher fiber fractions (ADF and NDF), they also have lower lignin content (Table 2).

A comparison of data generated by the Olson Biochemistry Laboratory, SDSU shows that RFQ is slightly higher than RFV for the same sample. A rela-

tionship between RFV and RFQ has been derived from this limited data set and is presented in Figure 1.

The RFV generally penalizes grasses because of the higher fiber fraction compared with alfalfa. The RFQ credits grasses because the grass fiber tends to be more digestible than alfalfa fiber. Table 2 shows higher cell wall digestibility for timothy than alfalfa when incubated for 72 hr in rumen fluid-buffer solution.

Relative Forage Quality Calculation

In the RFQ calculation total digestible nutrients (TDN) substitutes for DDM. Intake and TDN are calculated from fiber digestibility obtained in the laboratory.

For RFQ:

$$RFQ = (DMI, \% \text{ of } BW) * (TDN, \% \text{ of } DM) / 1.23$$

The value 1.23 ensures the equation has a mean and range similar to that of RFV.

Calculations to estimate TDN and DMI for alfalfa, clovers, and legume/grass mixes are as follows:

For TDN:

$$TDN = (NFC*.98) + (CP*.93) + (FA*.97*2.25) + (NDFn * (NDFD/100)) - 7$$

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).

Table 2. Nutrient composition of selected forages.

Forage type	CP	NDF	ADF	Lignin	Cell wall digestibility*
			%		
Alfalfa	16	49	34	7	46
Corn silage	10	51	28	4	68
Timothy	10	66	34	4	57

* The % of NDF lost in 72 hr of incubation.

Source: Collins (1988)

For DMI:

DMI = 120/NDF + (NDFD – 45) * .374 / 1350 * 100

Where: DMI is expressed as % of body weight (BW)
    NDF as % of DM
    NDFD as % of NDF
    45 = average value for fiber digestibility of
        alfalfa and alfalfa/grass mixtures.

Conclusion

Relative feed value continues to be widely used as an index to assess quality, compare forage varieties, and price forages. However, differences in the digestibility of the fiber fraction can result in a difference in animal performance when forages with a similar RFV index are fed.

The RFQ index has been developed to overcome this difference. This index takes into consideration the differences in digestibility of the fiber fraction and can be used to more accurately predict animal performance and match animal needs.

Although hay base prices vary with supply and demand, the market premium for quality is fairly constant. Long-term auction data indicate that the premium for quality forage is worth $0.90/ton as RFQ changes from one value to another; therefore improving RFQ of harvested forage can improve profitability.

Table 3. Forage quality needs of cattle by relative forage quality.
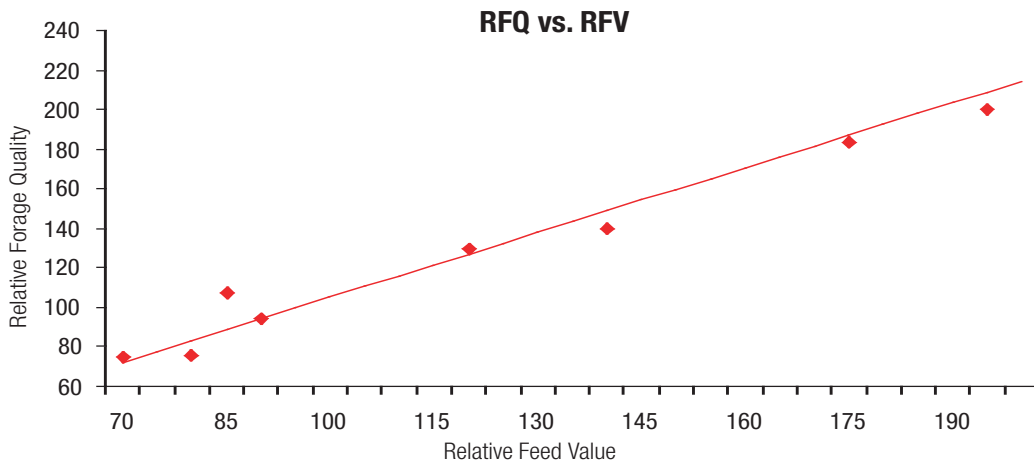
Relative Forage Quality	Suggested Cattle Type
100-200	Heifer, 18-24 mo
	Dry cow
115-130	Heifer, 12-18 mo
	Beef cow and calf
125-150	Dairy, last 200 days
	Heifer, 3-12 mo
	Stocker cattle
140-160	Dairy, 1st three months of lactation
	Dairy calf

Source: Undersander (2003)

References

Collins, M. 1988. Composition and fiber digestion in morphological components of alfalfa-timothy sward. Anim Feed Dci Tech 19:135-143.

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Fig 1. Relative Forage Quality versus Relative Feed Value.

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