PREDICTING VOLUNTARY FORAGE INTAKE IN CATTLE

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Summary

A large database was compiled of forage intake observations published during the past 20 years. Inputs included a wide range of factors believed to be related to voluntary intake. An analysis was designed to pinpoint which feed and animal characteristics were most valuable in predicting voluntary intake across a range of feeding situations and to compare the ability of different models to predict intake. Results emphasized the complexity of intake prediction. A wide range was evident in the variables included in the optimal models for predicting intake within different data subsets. In many cases, we observed that ratios between feed values (e.g., forage acid detergent fiber:forage crude protein) were more useful in predicting intake than the measures themselves.

(Key Words: Forage Intake, Multiple Regression, Prediction Models.)

Introduction

Accurate estimation of an animal's feed intake is necessary to formulate diets or predict performance on a particular diet. However, current intake prediction models are not sufficiently accurate, especially when applied across varied feeds, cattle types, and supplementation programs. To address these limitations, we compiled a large diverse data set of intake observations published during the past 20 years, then identified which variables consistently exerted the greatest impact on voluntary intake. In addition, this data set was used to evaluate whether models that would improve intake prediction could be constructed from currently available data.

Experimental Procedures

Intake observations were included from published data sets that reported measured voluntary intake, animal type and body weight, forage crude protein (CP), and diet digestibility. In addition, all information listed in Table 1 was recorded or, if necessary, estimated, based on predetermined standards.

The complete database included 240 treatment means from 42 published papers. The majority of the observations were made with growing cattle, and 80% of the test animals were steers. Nutrient contents of the forages ranged from 1.9 (dormat prairie hay) to 27.8 (fresh-cut wheat forage) % CP, 42 to 82% NDF, and 37 to 78% OMD.

Once the data set was complete, statistically significant correlations between the variables were identified. Simple regressions were run with pairs of intake and predictor variables that showed significant correlations. Stepwise multiple regressions were conducted, both on the entire set and within selected feed and animal groupings, to evaluate the potential for improving predictive accuracy. Several measures of intake were considered: dry matter intake (DMI), organic matter intake (OMI), and total digestible organic matter intake (TDOMI). All intake values were expressed both as a percentage of body weight (BW) and per unit of metabolic body weight ($BW^{.75}$). In

addition, we also evaluated the changes in forage and total intakes seen with supplementation when compared with unsupplemented cattle in the same trial and eating the same forage.

Results and Discussion

Unsupplemented Cattle. We identified five forage variables that in a single-variable regression model, could explain approximately half the variation seen within this data set in intake per unit of $BW^{.75}$:OMD, OMD:CP; and the squares of values for CP, DIP (expressed as a percent of CP), and OMD:NDF. A "best fit" multiple regression utilizing OMD:CP, ADF, DIP, DIP^2, CP^2, and OMD:NDF was able to account for nearly 75% of the variation observed in voluntary forage intake. From a practical viewpoint, it would be beneficial to limit predictor variables to those available from typical feed analysis. Multiple regression using simple feed analysis values yielded a model with CP, ADF, and NDF. Lignin content was not found to be a useful predictor. However, this model had an R^2 of just .41 (that is, it only explained 41% of the observed variation in intake). This was increased to nearly 60% with the addition of ADF:CP.

Supplemented Cattle. The best single predictor of forage intake in cattle fed supplement in conjunction with forage was the ratio between forage ADF and forage CP, which explained about 33% of the variation in forage intake. No other single-variable model had an R^2 greater than .25. A multiple regression using a combination of forage factors (NDF, CP^2); supplement factors (DIP, NDF, CP, % supplement in total diet); and one ratio (forage ADF:forage CP) was able to explain nearly 50% of the variation in forage intake. Subsequent work showed that the ability to predict intake of supplemented cattle depended upon the forage quality and supplementation approach. For example, predicted intake deviated more from actual intake when animals were receiving energy (i.e., grain) supplements compared with high-fiber or protein supplements. When the data were grouped by supplementation level (low, medium,or high), R^2 values were lower for diets containing intermediate amounts of supplement but were higher at either extreme. Similarly, intake prediction was more effective in diets based on high (>60%) or low (<45%) digestibility forages and less accurate with roughages of moderate quality. In the case of low-quality forages, the three highly significant variables in the model were forage CP^2, diet digestibility, and forage ADF. Predictions with high-quality hays were tied most closely to forage CP, forage ADF, and forage DIP.

All Cattle. Regression analysis was conducted on the entire data set (including both supplemented and unsupplemented cattle) and gave results very similar to those seen with supplemented cattle. Forage ADF:forage CP was the most powerful single predictive variable, but by itself, it could account for only 30% of the observed variation in forage intake. The best multiple regression developed for the complete data set had an R^2 of just .30, with virtually no improvement over the simple ADF:CP model. Improvements were not seen when the data were sorted by forage digestibility, but separate analysis of the information collected on dairy breed animals allowed development of a model that accounted for about 75% of the variation seen in that subset. Although none of these analyses generated a highly successful prediction model, the complexities of intake prediction were illustrated, and some key interrelationships were identified. In addition, several ratios between key feed characteristics, most notably forage crude protein and forage ADF levels, were identified as effective predictor variables.

Table 1. Additional Data Included in the Intake Data Set to Determine Variables Affecting Prediction of Voluntary Forage Intake in Cattle

Geographic location	Forage form
Confinement; yes or no	Forage dry matter (DM); organic matter (OM); CP degradable intake protein (DIP); neutral detergent fiber (NDF); acid detergent fiber (ADF); lignin OM digestibility (OMD); DM digestibility (DMD)
Class; breeding or growing	
Age; weanling, yearling or mature	
Sex	
Lactating; yes or no	
Breed or breed type	
Days on trial	
Season of year	Supplement type
Ionophore use; yes or no	Supplement ingredients
Daily gains	Supplement form
Name of forage	Supplement DM; OM; CP; DIP; NPN; NDF; ADF; starch
Forage type; grass or legume	
Forage type; C3 or C4	Diet DMD
Forage stage of growth	Diet OMD
	Diet NDF digestibility