EVALUATION OF A FEED INTAKE MODEL FOR THE GRAZING BEEF STEER

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Story in Brief

A feed intake model for grazing beef steers was evaluated with respect to changes in model parameters and forage input values. Supplementation effects on forage intake were quantified by supplementing all forage diets with 2.2 pounds of a corn supplement. Without supplements, systematic underprediction of the model occurs with low quality forages and subsequent overprediction is observed on high quality diets. Model behavior was insensitive to microbial composition and growth parameters. Intake was sensitive to changes in nutrient use parameters for fiber and insensitive to protein and starch. The model is highly sensitive to the amount of non-degradable fiber in the forage diet. Supplementation of the forage diet with energy resulted in substitution ratios consistent with literature results. As forage quality increased, greater substitution of concentrate for the forage occurs. The model correctly predicts the effects of energy supplementation on forage intake.

(Key Words: Feed Intake, Grazing Beef Steer)

Introduction

Several approaches to predict feed intake of feedlot cattle have been successfully developed (Plegge and Goodrich, 1987). Most approaches for pen-fed cattle have used regression relationships and applied adjustment factors to predict results. The lack of knowledge of the plant-animal interface has resulted in a deficiency in the literature regarding models that can be used to predict intake of grazing cattle. For grazing cattle, animal factors such as body weight, physiological state and ruminal fill interact with forage quality to determine feed intake. Because of the extensive variation associated with forage type and quality, most regression relationships can only be applied to the forage condition for which they were developed. Previous work by the authors described the primary equations and conceptual basis of a mathematical model to predict feed intake of the grazing beef steer (Hyer et al., 1988).

If a mechanistic model is to be used with confidence, it must meet two criteria: it must accurately predict animal response (i.e. feed intake) and appropriately represent the biology of the function being studied (i.e. supplementation effects on fermentation in the rumen). The objective of this work was to evaluate the feed intake model for the grazing steer and determine if model behavior is in agreement with validated biological concepts which influence intake.

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Materials and Methods

Parameters of a dynamic feed intake model (Hyer et al., 1988) for grazing cattle were estimated using 42 data points representing a broad range of forage composition (Table 1). Criteria used to select reference data points included complete forage quality information and ad libitum grazed intake measurements. Twenty-four of the data points were native grasses, 4 wheat pasture, and 12 perennial ryegrass. Sensitivity analysis of rate constants, model parameters and forage input values was accomplished using the simplex fitting procedure described by Nelder and Mead (1965). Literature values were used to determine the range of analysis for each parameter estimate and nutrient input. Supplementation of each of the reference data points was accomplished using rolled corn (1 kg) as an energy supplement.

Results and Discussion

A plot of the predicted versus observed intake and the fitted regression line is illustrated in Figure 1. The relationship between residual intake (observed-predicted) and the dietary non-degradable fiber, DNBH, indicates that systematic underprediction occurs on lower quality diets and overprediction is apparent with higher quality forages (Figure 2).

Sensitivity of the model for each of the parameter values and rate constants was tested. In general, intake was insensitive to small changes in microbial growth and composition parameters. Figure 3 demonstrates the sensitivity of the microbial nutrient use rate constants for starch (KAH), fiber (KBH) and protein (KPROT). Parameter estimates used in the model were .407, .460 and .262, respectively. Intake is insensitive to changes in KAH and KPROT over a wide range of parameter values. However, model behavior was highly sensitive to changes in KBH below the reference level of .460.

The fibrous fraction of the forage is most highly related to the filling effect in the rumen. Sensitivity of the model to the diet non-degradable fiber is shown in Figure 4. Intake is sensitive to the percent of DNBH over the entire range tested.

Table 1. **Description** of **nutrient composition** (%) of 42 forages.

Item	AH[1]	BH	NBH	NPROT	PROT	NPN	WSC
Mean	3.6	48.0	13.0	2.0	10.6	2.2	11.9
Standard deviation	2.8	5.2	4.6	.7	4.2	1.7	7.1
Minimum	.8	33.6	5.9	1.1	3.1	.9	2.3
Maximum	9.7	55.4	18.5	3.9	19.6	9.4	28.3

[1]AH is alpha hexose, BH is degradable beta hexose, NBH is non-degradable beta hexose, NPROT is non degradable protein, PROT is degradable protein, NPN is non-protein nitrogen, WSC is water soluble carbohydrate.

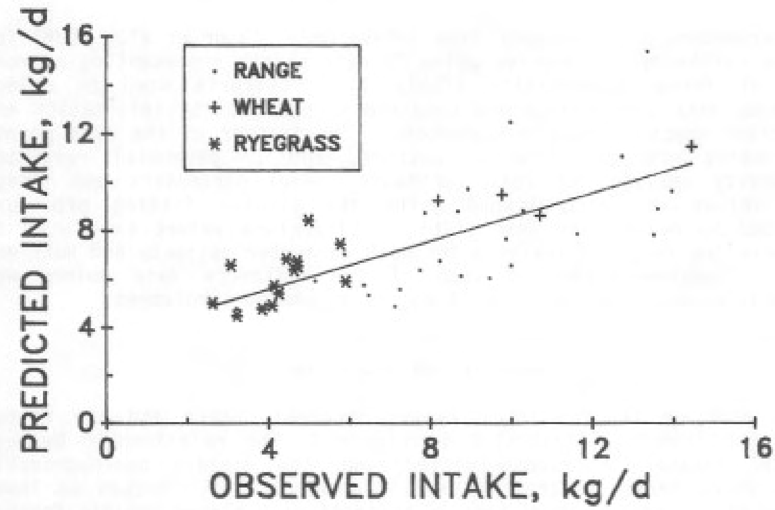

Figure 1. Model predicted versus observed forage intake.

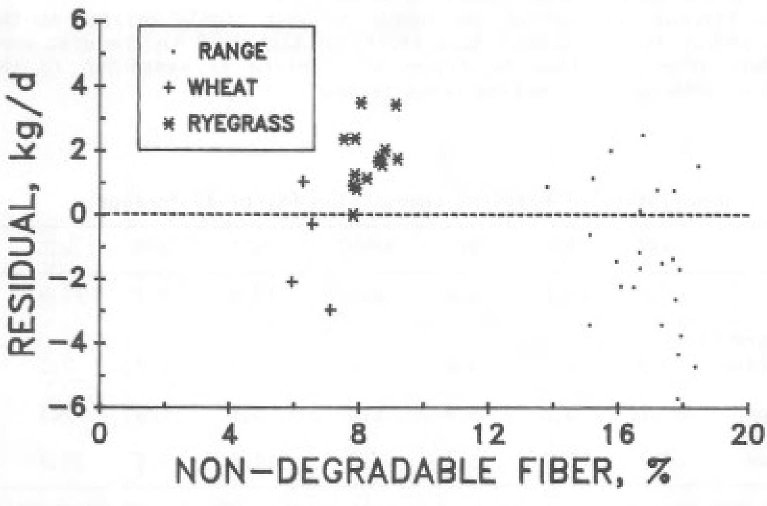

Figure 2. Residual intake (observed - model predicted) versus dietary non-degradable fiber.

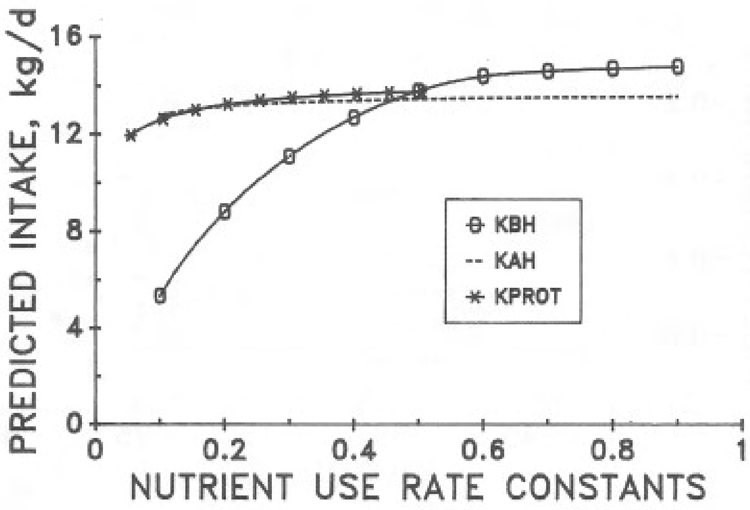

Figure 3. Sensitivity of model predicted forage intake to microbial use rate constants for fiber (KBH), starch (KAH) and protein (KPROT).

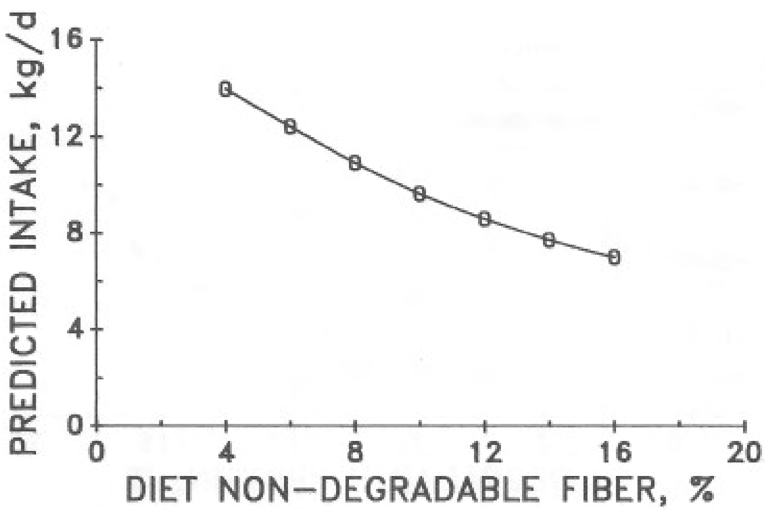

Figure 4. Sensitivity of model predicted forage intake to dietary non-degradable fiber.

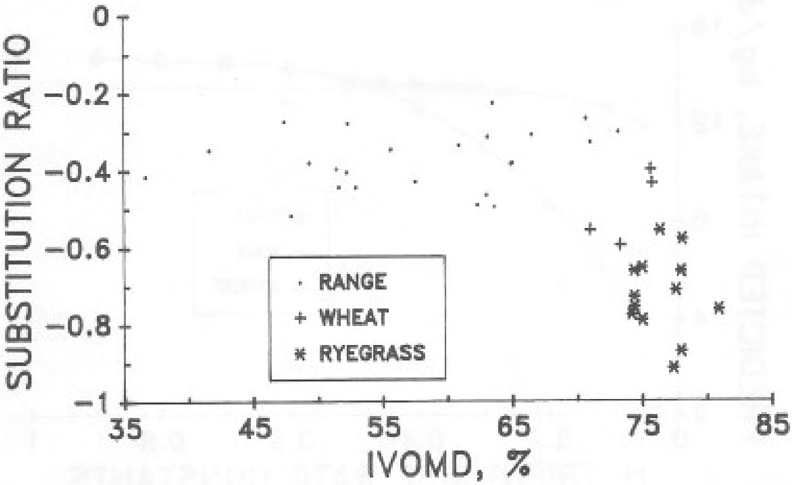

Figure 5. Change in model predicted forage intake (substitution ratio, kg forage/kg corn supplement) for forages of different in vitro organic matter digestibility (IVOMD).

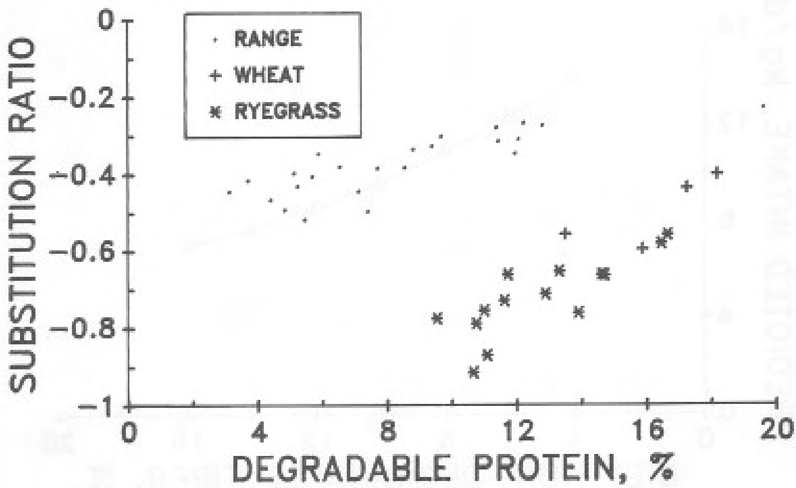

Figure 6. Change in model predicted forage intake (substitution ratio, kg forage/kg corn supplement) for forages of different degradable protein content.

Horn and McCollum (1987) found that the substitution effect of concentrate supplements on forage intake for both cattle and sheep become more pronounced (i.e. ratios become more negative) as forage digestibility increases. Supplementation of the 42 forage data points with 1 kg corn resulted in substitution effects consistent with literature values (Figure 5). Substitution ratio is equal to the model predicted intake with 1 kg corn minus the predicted intake without the supplement. As forage in vitro organic matter digestibility (IVOMD) increases above 65%, substitution ratios become more negative. The relationship between substitution effects and degradable protein in the forage (Figure 6) indicates that at higher levels of available protein (12 to 16%) greater substitution of concentrate for higher quality forage occurs.

Initial results with energy supplementation indicate that the model responds favorably regarding fermentation changes that occur by adding small amounts of concentrate to the forage diet. The systematic errors observed for unsupplemented diets may be a reflection of forage type and source of data.

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