University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Nebraska Beef Cattle Reports | Animal Science Department

January 1998

Use of the NRC Model for Predicting Nutrient Balances of Finishing Cattle

Greg Lardy
University of Nebraska-Lincoln

Rob McCoy
University of Nebraska-Lincoln

Drew Shain
University of Nebraska-Lincoln

Todd Milton
University of Nebraska-Lincoln

Dennis R. Brink
University of Nebraska-Lincoln, dbrink1@unl.edu

See next page for additional authors

Follow this and additional works at: https://digitalcommons.unl.edu/animalscinbcr

Part of the Animal Sciences Commons

Lardy, Greg; McCoy, Rob; Shain, Drew; Milton, Todd; Brink, Dennis R.; and Klopfenstein, Terry J., "Use of the NRC Model for Predicting Nutrient Balances of Finishing Cattle" (1998). *Nebraska Beef Cattle Reports*. 352.
https://digitalcommons.unl.edu/animalscinbcr/352

This Article is brought to you for free and open access by the Animal Science Department at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Nebraska Beef Cattle Reports by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Authors

Greg Lardy, Rob McCoy, Drew Shain, Todd Milton, Dennis R. Brink, and Terry J. Klopfenstein

This article is available at DigitalCommons@University of Nebraska - Lincoln: https://digitalcommons.unl.edu/animalscinbcr/352

Use of the NRC Model for Predicting Nutrient Balances of Finishing Cattle

Greg Lardy
Rob McCoy
Drew Shain
Todd Milton
Dennis Brink
Terry Klopfenstein[1]

The NRC Model is a useful tool for predicting degradable intake protein and metabolizable protein supply, requirement, and balance for feedlot cattle when accurate estimates of intake and protein degradability are available.

Summary

Trials conducted at the University of Nebraska's Research Feedlot were used to validate the NRC Beef Cattle Nutrient Requirements Model. Guidelines were developed for nutrient values for feedstuffs commonly fed in Nebraska feedlots. Generally, the NRC model predicted DIP and MP balances which were in agreement with performance data. The NRC Model generally underpredicted feed intake. The NRC model correctly predicted DIP deficiencies in dry-rolled corn diets which did not contain supplemental degradable protein. The effective NDF level of wet corn gluten feed appears to be higher than that of dry-rolled corn. The NRC model is a useful tool for predicting DIP and MP balances for finishing

cattle when accurate estimates of protein degradabilities and intake are available.

Introduction

Recently, the National Research Council (NRC) released the latest version of the Nutrient Requirements of Beef Cattle. One of the most significant changes is the move from expressing protein requirements on a crude protein (CP) basis to a system which uses degraded intake protein (DIP) and metabolizable protein (MP). Protein degraded in the rumen and available for use by the rumen microbes is referred to as DIP. MP is the protein utilized by the host animal and is the sum of the digestible bacterial protein produced in the rumen and the digestible undegraded intake protein (UIP) from the feedstuffs consumed. While crude protein systems incorrectly assume all feedstuffs have similar ruminal CP degrabilities, the NRC Model allows the user to enter CP degradabilities for each feedstuff in the ration.

In order for the NRC model to accurately predict nutrient supply to the animal, accurate estimates of digestibility, intake and ruminal protein degradability are necessary. Our objectives were to: 1) report protein degradabilities for feedstuffs commonly used in Nebraska; 2) use research trials previously conducted at University of Nebraska research facilities to validate the use of the NRC Model; and 3) present guidelines for successful use of the NRC Model for finishing cattle.

Procedure

Research trials previously conducted at the University of Nebraska Agricultural Research and Development Center near Mead, Nebraska were used as validation data sets. Diet composition, intake and performance data from each respective trial were used as inputs for the NRC model in order to predict NE_m, DIP and MP supply, requirement and balance for various diets. For complete details regarding diets and cattle management for each trial, refer to previous Nebraska Beef Reports, which are referenced in the discussion of each respective trial.

Results

Table 1 shows suggested model inputs for effective NDF (eNDF), TDN, CP and ruminal protein degradability of several feedstuffs commonly fed in Nebraska feedlots. The eNDF level is important because the model uses it to predict a diet's ruminal pH. The predicted pH is used by the model to calculate microbial efficiency, which impacts the DIP requirement and MP supply. Low ruminal pH reduces microbial efficiency because the microbial population expends energy on maintaining internal ion concentrations rather than using the energy for growth, reducing the DIP requirement and MP supply.

Table 2 shows the effect of urea level on dry matter intake, gain and feed efficiency, as well as DIP and MP supply, requirement and balance for

(Continued on next page)

Table 1. Suggested values for feedstuffs commonly used by Nebraska feedlots.

	eNDF	TDN	CP	DIP
Grains				
High-moisture corn	0	93	8.4	60
Dry corn	0	88	8.45	40
Rolled sorghum grain	0	79	10.5	40
Byproducts				
Distillers solubles (dry milling)	0	88	28	80
Distillers solubles/steep liquor (wet milling)	0	88	36	80
Wet corn gluten feed	18	88	22	75
Sorghum distillers grains + solubles (wet)	18	96	34	40
Corn distillers grains + solubles (wet)	18	106	30	40
Protein meals				
Soybean meal	0	88	49.9	70
Feather meal	0	90	85.8	30
Blood meal	0	90	93.8	25
Harvested forages				
Corn silage	71	75	7.4	75
Alfalfa hay	100	60	16	82
Brome hay, mid bloom	100	66	14.4	84
Alfalfa hay, early vegetative	100	74	30	93
Alfalfa hay, late vegetative	100	67	20.3	85
Prairie hay[a]	100	49	6.8	80
Prairie hay[a]	100	53	7.7	75

[a]Match to nearest CP value.

Table 2. Effect of urea level on intake, gain, feed efficiency and DIP and MP supply, requirement and balance for finishing yearlings.

	Treatment			
CP Level	9.7	12	13.5	15
Item Urea Level	0	0.88	1.34	1.96
Dry matter intake, lb/day	25.57	26.17	25.72	25.93
Daily gain, lb[a]	2.67	2.91	2.86	2.94
Feed/gain[bc]	9.56	8.99	8.98	8.84
Predicted dry matter intake, lb/day	22.1	22.3	22.0	23.7
DIP supply, g	484	763	928	1123
DIP requirement, g	795	823	802	807
DIP balance, g	-311	-60	126	316
MP supply, g	944	974	948	954
MP requirement, g	724	753	741	758
MP balance, g	220	221	207	196

[a]No urea versus urea treatments, P<.01.
[b]No urea versus urea treatments, P<.05.
[c]Feed/gain was analyzed as gain/feed. Feed/gain is the reciprocal of gain/feed.

finishing yearlings fed a dry rolled corn-based finishing diet (1995 Nebraska Beef Report, pp. 21-22). Gain and feed efficiency were improved by providing supplemental DIP from urea. The NRC model predicted a slight DIP deficiency with the 12% CP level. However, no improvements in gain or efficiency were noted when diets containing more than 12% CP were fed. Metabolizable protein balances were positive for all diets, but the NRC model assumes DIP deficiencies will be met when it calculates MP supply. Due to the deficiencies in DIP, the MP supply with the 9.7% CP diet would be reduced by 199 g assuming no additional recycling. This would still be adequate MP for the midpoint of the trial. The cattle may have been deficient in MP during the first half of the trial, although the model does not predict a deficiency. Deficiencies in DIP can also reduce ruminal fermentation of carbohydrate, reducing energy available to the animal. Because the ruminant has the ability to recycle nitrogen, excess undegraded intake protein (UIP) in the diet may substitute to some degree for deficiencies in DIP. This may explain why no advantages in finishing performance were noted diets contained greater than 12% CP. Excess DIP, however, cannot substitute for deficiencies in MP.

The NRC model underestimated dry matter intake of these finishing yearlings by approximately 3 lbs (Table 2). Accurate estimates of intake are a critical input for successful use of the model. In general, the NRC model intake prediction equations tend to underestimate intake for finishing yearlings, as well as that of calf-feds, early in the finishing period. When no information about historical performance is available for a particular situation, we recommend using dry matter intakes equal to 3.0% of body weight when the finisher diet is first fed for both finishing calves and yearlings. This will be equal to approximately 20 pounds of dry matter intake for finishing calves and 25 pounds for finishing yearlings. Intakes don't vary markedly on the finisher diet from early to late in the feeding period. However, if historical intake estimates for a particular class of cattle are available, use them instead.

Table 3. Effect of supplemental protein source on dry matter intake, gain and feed efficiency and DIP and MP supply, requirement and balance for finishing calves.

Finishing Period			
	Treatment[a]		
Item	U	SBM/U	FM/U
Dry matter intake, lb/day	19.62	19.43	19.29
Daily gain[b], lb	2.88	2.97	2.97
Feed/gain[cd]	6.80	6.54	6.49
Predicted dry matter intake lb/day	19.99	19.35	19.45
DIP supply	640	600	590
DIP requirement	640	630	630
DIP balance	0	-30	-40
MP supply	760	860	840
MP requirement	720	720	720
MP balance	40	140	120
First 63 Days			
Predicted dry matter intake (lb/day)	17.01	16.81	16.99
Actual dry matter intake (lb/day)	21.20	20.60	20.96
DIP supply (g/day)	689	658	638
DIP requirement (g/day)	665	653	657
DIP balance (g/day)	24	5	-19
MP supply (g/day)	787	882	875
MP requirement (g/day)	834	833	828
MP balance (g/day)	-47	49	47

[a]U=urea, SBM=soybean meal, FM=feather meal.
[b]U vs average of SBM/U and FM/U (P<.10).
[c]U vs average of SBM/U and FM/U (P<.05).
[d]Feed/gain analyzed as gain/feed. Feed/gain is the reciprocal of gain/feed.

Table 4. Effect of energy and protein source on finishing performance and predicted DM intake, and DIP and MP supply, requirement and balance for finishing calves.

	Treatment[a]			
Item	DRC/Urea	DRC/EP	WCGF	WCGF/EP
DM intake[b], lb/day	22.73	22.52	21.67	21.97
Daily gain, lb	3.81	3.83	3.72	3.80
Feed/gain[c]	5.96	5.88	5.83	5.78
Predicted DM intake, lb/day	18.37	17.89	17.87	17.94
MP supply, g/day	867	939	848	938
MP requirement, g/day	817	820	809	816
MP balance, g/day	50	119	39	122
DIP supply, g/day	732	729	814	829
DIP requirement, g/day	749	739	834	842
DIP balance, g/day	-17	-10	-20	-13

[a]DRC=dry rolled corn, EP=escape protein, WCGF=wet corn gluten feed.
[b]DRC vs WCGF (P<.05)
[c]Feed/gain analyzed as gain/feed. Feed/gain is the reciprocal of gain/feed.

Table 3 shows the effect of supplemental source of CP on finishing performance and DIP and MP supply, requirement and balance for finishing calves. Control and high-lysine corn were dry rolled and supplemented with urea, soybean meal or feather meal (1994 Nebraska Beef Report, pp. 30-32). No protein supplement by corn type interactions were detected (P>.15) so data were pooled across corn type. Over the entire trial, the NRC model predicted intake similar to actual dry matter intake. Daily gain and feed efficiency were improved with the addition of soybean meal and feather meal compared to urea alone. Over the entire trial, the NRC model predicted MP was adequate for all treatments, while DIP was slightly deficient for the soybean meal and feather meal supplemented diets. It is possible for excess UIP in the diet to meet DIP deficiencies through recycling. For the first 63 days of the finishing period, the NRC model pre-

Table 5. Suggested inputs and guidelines for use of the 1996 NRC model.

1. **Units and Levels Section.**
   Use only Level 1, unless rates of digestion of all feed fractions are known.
2. **Animal Section.**
   Remember that your choice of breed affects maintenance energy requirements.
   Bos indicus cattle have lower NE_m requirements, while dairy and dual purpose breeds have higher requirements. This is discussed in detail in the textbook accompanying the NRC Model.
3. **Management Section.**
   A. **Microbial Yield.** With growing and finishing diets the model uses the effective NDF values of the feedstuffs to predict a ruminal pH, which is used to calculate microbial yield or efficiency. Use effective NDF values listed in Table 1. Do not adjust the microbial yield in the model for cattle fed finishing diets because the model will do this automatically using effective NDF.
   B. **Diet NE_m and NE_g Adjusters.** Use these to adjust performance predicted by the NRC Model to match the actual closeout performance or pen projected performance. The model may calculate unrealistically high feed efficiency and ADG for calves early in the finishing period. We suggest using the following adjustments for Diet NE_m and NE_g. For every 100 lb from the midpoint weight, change both NE_m and NE_g adjusters by 6 percentage units. For example, if calves are being fed from 600 lb to 1200 lb, the midpoint is 900 lb. When the calves weigh 700 lb, set the NE_m and NE_g adjusters at 88. At 1100 lb the adjusters would be 112. Use this as a guideline only.
   C. **Additive.** Select the proper implant and additive used. The model will adjust predicted DMI and NE_m requirements appropriately for the use of ionophores and implants.
   D. Do not use the **On Pasture** feature for growing and finishing cattle which are in a pen-fed situation. This feature increases NE_m requirements to account for the impact of grazing activity on nutrient requirements.
4. **Environment Section.**
   A. **Temperature.** Because of daily fluctuations in temperature, it is difficult to state a temperature which the cattle are subjected to. Interactions also exist with other environmental factors which are discussed below. We recommend using long term average temperatures for a given month or season at a given location.
   B. **Wind speed.** Caution is needed when using this feature. Because cattle behavior is impacted by wind speed, cattle are not subjected to reported wind speeds. Wind speed is generally measured by anemometers positioned 10' above ground. Cattle are seldom subjected to these wind speeds because they will find ways to minimize the effect of wind on them. We recommend using wind speeds of less than 5 miles per hour in most cases.
   C. **Hair Depth.** Use .25 inches in the summer and .5 inches for winter coats.
   D. **Hide.** Use 1 (thin hide) for Bos indicus and dairy breed types, and 2 (average) or 3 (thick) for most English and Continental breeds.
5. **Feeds Section.**
   A. Use the **Feed Library** (a feature separate from the model) to make global changes to feedstuff composition. Use the **Feed Composition** feature to make feed composition changes specific to a ration or problem (composition changes made in this manner will be specific to that input file only).
   B. When estimates of feed intake are unavailable or unknown, use the NRC estimated intake as a guideline. As a general guideline, use 3% of body weight when the finisher diet is first fed as an estimate of feeding period intake for calves and yearlings.

dicted the urea diet was deficient in MP while the soybean meal and feather meal diets were adequate. Metabolizable protein requirement is higher during the early part of the finishing period because gains are higher. We believe the response to escape protein occurred in the first two months of the feeding period, when relative protein requirements of calves would be higher.

Table 4 shows the effect of energy and protein sources on performance and DIP and MP balances for finishing calves. Dry-rolled corn and wet corn gluten feed were fed with and without supplemental UIP in a 2 x 2 factorial treatment design. Details on calf and yearling feeding management are found in the 1995 Nebraska Beef Report (pp. 28-30). No differences in gain or efficiency were noted for either energy or protein source. The NRC model predicted each diet was slightly deficient in DIP but had adequate MP. The NRC model underpredicted intake by approximately 4 lbs. Because of the higher protein degradability of wet corn gluten feed, a deficiency in MP may be expected when feeding it. However, metabolism research (1997 Nebraska Beef Report, pp. 61-65) indicated ruminal pH is higher when wet corn gluten feed is included in the diet at the expense of dry rolled corn. The NRC model uses the eNDF of the diet to adjust microbial efficiency downward when eNDF is less than 20%. For diets with greater than 20% eNDF, the model makes no adjustment. For each 1% decrease in eNDF from 20%, the model decreases microbial efficiency by 0.29% (beginning at 13%). For example, if the diet contained 5% eNDF (common with a grain based finishing diet containing 7.5% roughage), microbial efficiency would be reduced by 4.35% and would be equal to 8.65% [13%-4.35%]. Biologically, the reason for this efficiency reduction is related to microbial physiology in the rumen. When pH drops, the microbial population spends more energy for maintenance rather than growth. Therefore, microbial protein production is reduced, resulting in decreases in MP supply, as well as decreases in the amount of DIP required by the microbes.

Table 5 lists the guidelines recommended for successful use of the model with growing and finishing cattle. Like any computer program, the model is highly dependent on user-given inputs. Key areas when considering inputs are: 1) Microbial yield; 2) Diet NE_m and NE_g adjusters; and 3) the Environment section. For finishing diets, leave 13% as the default value for microbial yield. The model will automatically calculate the predicted yield. Use the diet NE_m and NE_g adjusters to adjust performance of the cattle to match projected or actual gain and feed efficiency. The model is very sensitive to wind speed and temperature inputs. Consequently, the predicted energy requirement can fluctuate a great deal depending on environmental inputs.

The NRC model is useful for predicting DIP and MP balance when realistic estimates of intake and ruminal protein degradability are available. Without these estimates however, the user may not get accurate predictions. In general the NRC model tended to underpredict DM intake of both finishing calves and yearlings. If historical estimates of intakes for a particular class of cattle are known, they should be used for NRC model calculations.

[1]Greg Lardy, Rob McCoy, Drew Shain, former graduate students; Todd Milton, Assistant Professor; Dennis Brink and Terry Klopfenstein, Professors, Animal Science, Lincoln.