Estimating Beef Cow Maintenance Efficiency with a Fasting Protocol

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Summary and Implications

A fasting protocol seems to provide a simple means by which the maintenance efficiency of a cow in a given contemporary group could be assessed relative to her herd mates and provide a means by which the herdsman can screen, rank and select cows that are efficient in terms of maintaining themselves.

Introduction

Generally feed efficiency is discussed and described in the context of growing cattle and their conversion of feed dry matter to pounds of beef. The feed to gain or gain per unit feed measure result and the meaning is fairly clear, but conversion of feed to beef is only one component of the efficiency equation. The conversion of feed to milk and the conversion or utilization of feed for maintaining existing tissues are also components that cannot be ignored, especially when improvements in the efficiency of the cow herd are the focus. As it is, we can recognize breed differences in these other components of feed efficiency. For instance comparing the Holstein dairy cow with the Hereford stock cow we would conclude that the Holstein cow is superior in feed efficiency if the measure involved only the conversion of feed to milk; while if the measure was based on the maintenance or growth components alone the Hereford stock cow would be superior. If differences exist between breeds, differences will exist within breeds but the differences are subtle and measurement of feed intake is difficult to obtain in a commercial setting. A proposed system of an induced fast and the subsequent weight loss measurement may be a means by which this trait can be evaluated and selected for in a commercial setting, with minimal investment in equipment and effort.

Material and Methods

A privately owned herd of 54 Simmental, Angus and Sim-Angus cows ranging in age from first to tenth parity were evaluated starting in late fall after weaning through the first couple weeks of the third trimester of pregnancy at the Hays Beef Development Center located near Diagonal IA. Cows selected for the trial had weaned their calves about 3 weeks before the beginning of the trial. Cows were then pregnancy tested using ultrasound and those cows carrying a single calf and being within a 40 day window of conception (50 to 90 days bred) were used in the trial. Cows selected for the trial had ultrasonic scans of carcass ribeye area, 12th rib back fat and rump fat at the start and then at the end of the trial. Feed intake of the corn silage based ration was monitored on an individual basis using the farm's feed intake monitoring system designed by ID-ology of Eau Claire WI. Feed intake data was collected for three weeks prior to the first fast and then again after the fast to determine average, daily dry matter intake. Empty body weights were obtained at the start and end of the intake periods and then the fasting protocol was applied. The fast was set up in the following manner:

*Day 1- Cows were removed from feed, but allowed water.
*Day 2 – After 24 hours without feed, cows are weighed and then left without feed. Water is also removed at this time.
*Day 3 – After another 24 hours have passed, cows having fasted from feed for 48 hours and water for 24 hours were weighed again. The weight loss is evaluated in terms of the percent of weight that is retained after the fast. After the fast the cows were placed back on their ration they were receiving before the fast.

This same procedure was then repeated at the end of the trial period approximately two months later (late December) as a check of what this relationship may be now at a point one month into the third trimester of pregnancy and provides weights to determine residual feed intake (RFI). The measure of the weight retention in the cows is compared with their RFI.

Residual Feed Intake was calculated on the cows by regressing metabolic body weight and daily weight gain over measured dry matter intake. The residual intake of estimated minus actual feed dry matter intake (DMI) provides a way to rank cows in terms of efficiency as the industry may currently do, but now was compared to the retention values. SAS Proc GLM was used to derive the RFI and test other components that may contribute to a reasonable RFI comparison. This same procedure was used to quantify the amount of the RFI that could be explained by the observed retention and the bias that measures such as metabolic weight may have on the retention measure.

Results and Discussion

Fasting Protocol

The cows were hungry at the time they were again allowed access to their previous ration, but they did not exhibit any vocal or behavior distress during the time of the fast, nor did they have any problems in resuming consumption of their previous ration. The cows did have access to an open front building during the time of the fast

and the weather conditions were quite dry with day time temperatures around 40 degrees Fahrenheit minimizing any environmental "stresses" that may have changed the situation. It was interesting when comparing the first round of the fasting treatment to the second round, the animals retained more weight in the second by about one percentage point of total body weight (see Tables below). The cows themselves did seem to be in good shape from a body condition score (BCS) coming into the trial, but remarkable, positive changes in ribeye area and body fat over the two month observation period indicated that they were still recovering from lactation and that body lean tissue had been mobilized to some extent. The difference in retention percentage between the two rounds of fasting may have been due in part to the increase in body fat reserves available at the end of the trial that can supply more energy per unit of weight than muscle tissue.

Table 1. Beginning and Ending Measures.

	Retention start (%)	Retention end (%)	REA start (in.2)	REA end (in.2)	Ribfat start (in.)	Ribfat end (in.)	Rumpfat start (in.)	Rumpfat end (in.)
Average	96	97	11.3	12.2	0.23	0.30	0.28	0.34
St.D.	1	1	1.3	1.4	0.13	0.14	0.15	0.16

Table 2. Starting Measures with Trial ADG and DMI.

	Weight (lb)	ADG (lb/day)	BCS start	Cow Age (years)	Milk EPD	DMI (lbs/hd/day)	Day of Gestation	Hip Ht. (in.)
Average	1357	0.7	5.1	5.0	4.7	27.7	85.7	54.4
St.D.	140	0.5	0.6	2.6	5.7	5.3	14.3	1.7

RFI Equation

Typical RFI calculations include animal metabolic weight (MW) which may be average empty body weight while on test or starting empty body weight at the beginning of the test raised to the 0.75 power along with average daily gain (ADG) both regressed over actual DMI to generate an equation that provides an estimated DMI per unit of body weight and gain. The estimated DMI equation calculated from the cows in this trial using MW and ADG is as follows:

RFI = Actual DMI – Estimated DMI

Estimated DMI = -7.75 + 0.16 x MW + 1.49 x ADG

	R^2	Prob > F
Model DMI	0.30	< 0.0001
Parameter MW	-----	< 0.0001
Parameter ADG	-----	0.2495

The model provided an R^2 of 0.30 and of the two parameters only the MW was of a significant contribution to the model. This may be partially because cows were used and weight gain was relatively minimal during the trial. Reconstruction of the model using other variables like differences in cow age, typical milk output (based on EPD) and ultrasound carcass measures such as ribeye area (REA), rump fat (RF), back fat (BF) or changes in these measures from the beginning to end of the two month observation time were also tried in order to create a DMI model of less error. The results of the regressions did not suggest including any of these variables to fit a better regression line at this point for estimation of DMI.

RFI vs. Retention

Using the RFI value as an indication of efficiency, cow weight retention after the initial 48 hour fast was compared and correlated to the RFI results. The moderate, but significant correlation between these two measures was -0.37. This negative correlation was encouraging since the favorable RFI is a negative value while the favorable retention is a positive value. Regressing the initial weight retention value ($WtR^{1)}$ on RFI indicated that WtR^1 was a significant variable in the resulting RFI explaining 14% of the variation seen in RFI values and could be used to infer cow efficiency.

RFI = 160.6 – 168.4 x WtR[1]

	%of RFI Explained	Prob > F
Parameter Retention	14%	0.006

Considering the remaining 84% of the variation it was realized that the following model explained the above calculated RFI quite well with a 0.98 correlation to the actual RFI. As noted WtR[1] explained a portion of this RFI, but the second WtR value when expressed as the first WtR percent minus the second WtR (WtRdiff) significantly explained more of this variation with those cows exhibiting greater retention having the more preferred RFI. The WtRdiff may indicate some adaptability of the cow for maintaining herself or indicates the body composition changes during the recovery time that assists in maintaining the animal with less weight loss later. The carcass REA per unit of empty body weight (REAWt) as it increases indicates more muscle per unit of body weight and therefore more metabolically active tissue per unit of body weight and a reduction in maintenance efficiency since it has a higher maintenance requirement. DMI per unit empty body weight (DMIWt) also reflects a less favorable RFI since higher DMI per unit of body weight implies a larger appetite and possibly a faster passage rate and subsequent lower digestibility. Many of these parameters just described are not possible or practical to measure commercially, but the animal weight generally is attainable and the fasting protocol is a fairly simple, effective way to begin selecting for animals that maintain themselves efficiently. The photos that follow provide images of cows that did very well and very poorly in RFI and weight retention in the above trial. The conformation may give some hints of efficiency, but without a measurement it is quite difficult to make any solid selections.

RFI ~ 23.8 – 56.1 x WtR[1] + 48.9 x WtRdiff + 430.1 x REAWt + 206.8 x DMIWt

	R^2	Prob > F
Model RFI	0.95	< 0.0001
Parameter WtR[1]	-----	0.0042
Parameter WtRdiff	-----	0.0014
Parameter REAWt	-----	0.0144
Parameter DMIWt	-----	< 0.0001

Cows Exhibiting the Most Favorable RFI and Weight Retention

								Adj. Yearling Values			
ID	**Empty Wt**	**DMI**	**Days Preg.**	**Birth Year**	**HipHt.**	**rea**	**bf**	**wt**	**rea**	**bf**	**imf**
903	1514	28.4	95	1999	54.5	13.4	0.62	?	?	?	?
1w96	1341	21.6	65	2009	55	12.11	0.2	805	7.7	0.06	2.2

Top 25% of Cows in RFI and Wt. retention in Evaluated Herd)

*Wt. retention = 98.7 to 97%, RFI = -7.9 to -3.6

Cows Exhibiting the Least Favorable RFI and Weight Retention

ID	Empty Wt	DMI	Days Preg.	Birth Year	HipHt.	rea	bf	Adj. Yearling Values wt	rea	bf	imf
118t	1370	30.0	95	2007	55	12.7	0.62	850	11.14	0.12	2.82
1t06	1366	30.1	94	2007	55.5	9.96	0.34	884	10.86	0.16	5.63

Bottom 25% of Cows in RFI and Wt. retention in Evaluated Herd)

* Wt. retention = 96 to 94%, RFI = 6.3 to 3.0

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