Review of Feed Efficiency Measures in the Beef Industry

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Introduction

Current economic conditions dictate that the industry place greater concentration on factors affecting feed efficiency in the feedlot. Recently, a tremendous amount of attention has been given to how segment feed efficiency affects overall industry efficiency. This is important as new knowledge is gathered regarding impact of cow nutrition and early calf nutrition on post-weaning growth. It is important to recognize two items: 1) feed efficiency and, ultimately, system efficiency is the result of complex interactions beyond biochemical pathways, and 2) feed and system efficiency is driven by economic factors that affect each industry segment independently.

Beef Industry System Efficiency

Currently, decreases in the US cowherd and subsequent reductions in feeder calf supply without great impact on domestic beef production are sustained through finishing cattle at heavier weights. Indeed, carcass weights have increased five pounds yearly since 2000 (www.nass.usda.gov). This increase is likely reflected in lower feed conversion efficiency as evidenced by the BeefLinks database (www.beeflinks.com; Figure 1). Thus, although current economic conditions would dictate measured cost control by enhancing feed conversion efficiency in the feedlot, an economic driver—finished cattle price—is dictating a trend considered to be counterintuitive given costs of production.

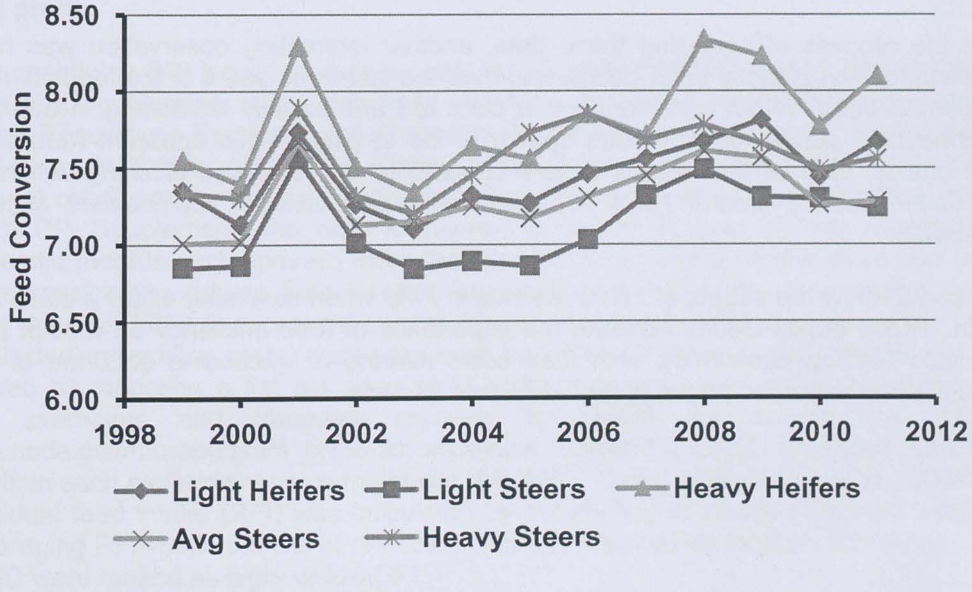

Figure 1. Changes in feed conversion over time from cattle entered in the BeefLinks database (www.beeflinks.com).

In the mid-1990s Dr. Robbi Pritchard with SDSU summarized the factors that affect feedlot profitability. In his review of these factors, Dr. Pritchard ranked, from greatest to least impact on feedlot profitability: fed price, feeder price, feed efficiency, feed intake, ration cost, daily gain, yardage, interest rate, veterinary costs, and death loss. Although 15 years have passed since that review, the ranking of these factors, at least on the ones of greatest impact, remains the same. However, in reviewing the results from the BeefLinks closeout summaries, a few additional items need to be brought into perspective:

1. The relationship between either fed or feeder price, or even corn price, and profit is not direct and is only partially influential. In other words, producers have made money with low price fed cattle and high priced corn.

2. Because of this observation, it is clear that many other factors are influencing profitability in complex interactions with each other. Once issues of cattle and grain prices are taken into account, management factors readily become influential.

3. Of the management factors evaluated, the single most important factor determining profitability is feed efficiency. However, because feed efficiency is a ratio of intake to gain, one needs to define which of the two on which to focus.

4. It appears that top profit operators reporting on the BeefLinks database were able to be efficient by delivering fewer pounds of dry matter (either daily or for the entire feeding period), and also by achieving greater daily gains on their cattle. Thus, efficiency needs to be accomplished by a combination of strategies that limit intake while enhancing gain.

5. Interestingly, albeit of smaller impact, death loss differed between operators designated as top and those designated as average profit. This emphasizes the need to spend time and money managing for disease prevention and observing cattle behavior.

6. When a more complex analysis of the relative impact of these factors on profit was made, it was clear that of all the factors affecting profit for which a feedlot operator can manage, intake is the single most important factor on which to focus.

7. In the process of analyzing these data, another interesting observation was made: feed efficiency has actually been decreasing over the last three years in the feedlots reporting to this database. When considering that diets fed are actually increasing in energy for that same time period, other factors appear to be at play in this apparent reduction in feed efficiency. One of the biggest factors appears to be increased finishing weights; likely a reflection of the greater costs associated with purchasing a replacement animal for the feedlot.

Tables 1 and 2 show the impact of improvements in FTG when assuming either a static intake or a static gain. These tables clearly illustrate the importance of feed efficiency on feedlot profitability. Current cattle feeding economics, with feed costs nearing or exceeding $300/ton of DM, force producers to maximize each pound of feed delivered to cattle.

Table 1. Effect of improvement in feed conversion through increased average daily gain on feedlot cattle profitability[a].

FTG	DMI, lb/d	ADG, lb	DoF	CoG, $/100 lb	Profit or Loss, $/hd	Breakeven, $/cwt
7.0	22.0	3.14	223	$115.18	($58.73)	$134.35
6.8	22.0	3.24	216	$111.97	($36.26)	$132.69
6.6	22.0	3.33	210	$108.76	($13.80)	$131.02
6.4	22.0	3.44	204	$105.55	$ 8.66	$129.36
6.2	22.0	3.55	197	$102.34	$31.13	$127.69
6.0	22.0	3.67	191	$ 99.13	$53.59	$126.03

[a]FTG = Feed-to-gain; DMI = dry matter intake; ADG = average daily gain; DoF = days on feed; CoG = cost-of-gain. Assumptions: Cattle purchased mid-October 2012 at 650 lbs and $155/cwt. Cattle sold at 1,350 lbs and $130/cwt. Yardage cost of $0.45/hd/day accounts for yardage, bedding, and interest. Vet med costs of $20/head. Feed costs of $280/ton DM.

Table 2. Effect of improvement in feed conversion through decreased feed intake on feedlot cattle profitability[a].

FTG	DMI, lb/d	ADG, lb	DoF	CoG, $/100 lb	Profit or Loss, $/hd	Breakeven, $/cwt
7.0	22.0	3.14	223	$115.18	($58.73)	$134.35
6.8	21.4	3.14	223	$112.39	($39.22)	$132.91
6.6	20.7	3.14	223	$109.59	($19.62)	$131.45
6.4	20.1	3.14	223	$106.79	($ 0.02)	$130.00
6.2	19.5	3.14	223	$103.99	$19.58	$128.55
6.0	18.8	3.14	223	$101.19	$39.19	$127.10

[a]FTG = Feed-to-gain; DMI = dry matter intake; ADG = average daily gain; DoF = days on feed; CoG = cost-of-gain. Assumptions: Cattle purchased mid-October 2012 at 650 lbs and $155/cwt. Cattle sold at 1,350 lbs and $130/cwt. Yardage cost of $0.45/hd/day accounts for yardage, bedding, and interest. Vet med costs of $20/head. Feed costs of $280/ton DM.

Modeling profit

A dataset containing 346 individual data records for 39 heifers and 307 steers finished in the Calan Broadbent feeding facilities at the University of Minnesota North Central Research and Outreach Center and Rosemount Research and Outreach Center was used to model feedlot performance traits affecting profitability (Table 3). Cattle in the dataset were fed under various diets and management conditions for various experiments, but diets contained at least 62 Mcal NEg/cwt DM and 12.5% CP. Supplements fed were formulated to deliver at least 280 mg monensin/hd daily. Because cattle records encompassed more than one production year, feeder price was modeled by multiple regression procedures from lot size, sex, and weight from the results of Superior Video Auction of July 13, 2012 to represent current feeder prices. Also, DM price for a ton of feed and yardage (including bedding costs) were calculated based on $224/ton and $0.50/day. Gross income was derived by modeling a flat bid price of $1.85/lb or a grid-based price that consisted of the summary premiums and discounts reported by USDA on August 10, 2012 (http:// www.ams.usda.gov/mnreports/lm_ct155.txt; accessed August 10, 2012). Expected feed intake was derived within each experiment using metabolic BW ($BW^{0.75}$) and ADG (Arthur et al., 2001) to predict DMI. Residual feed intake (RFI) was calculated by subtracting expected DMI from observed DMI. Cattle averaging RFI within 0.5 SD of predicted DMI were ranked as medium RFI. Cattle with RFI > or < 0.5 SD were ranked as high- or low-RFI.

Table 3. Feedlot performance and carcass characteristics for individually-fed cattle.

	Hi RFI heifers		Med RFI heifers		Low RFI heifers		Hi RFI steers		Med RFI steers		Low RFI steers	
Item	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD
n	12		14		13		123		71		113	
In BW, lb	952	61.54	998	78.31	964	72.68	832	176.84	878	167.86	836	175.73
Final BW, lb	1,291	66.57	1,328	102.21	1,304	93.60	1,331	112.77	1,335	105.37	1,314	119.48
DoF	112	0	112	0	112	0	138	33	127	36	133	34.03
ADG, lb	3.02	0.33	2.95	0.42	3.03	0.38	3.64	0.71	3.69	0.86	3.62	0.73
DMI, lb/d	20.78	1.10	19.71	1.37	18.72	1.20	24.25	2.45	23.30	2.34	20.14	2.94
FTG	6.91	0.43	6.75	0.57	6.22	0.42	6.94	0.23	6.62	1.48	5.75	1.24
Carcass, lb	838	53.13	856	88.52	834	66.75	835	81.75	838	80.05	828	85.77
Flat carcass price profit [b], $	238.60	82.68	280.77	185.15	255.88	99.48	113.39	119.24	143.86	123.33	175.21	123.87
Grid carcass price profit [b], $	207.60	74.39	256.67	138.95	225.53	108.54	85.04	125.76	104.70	135.27	131.67	132.06

[a]BW= body weight; FTG = feed-to-gain; DMI = dry matter intake; ADG = average daily gain; DoF = days on feed. Cattle purchase price based on Superior Livestock Auction July 13, 2012 report. Yardage cost of $0.50/hd/day accounts for yardage, bedding, and interest. Feed costs of $224/ton DM.

[b]Flat-carcass bid was $1.85/lb or a grid structure based on USDA summary of premiums and discounts for August 10, 2012.

Regression procedures were conducted using the Mixed procedure of SAS to determine effect of independent variables including initial BW, ADG, DMI, feed conversion (analyzed as the ratio of gain:feed DM), RFI and the effects of sex and origin. The effect of experiment was considered random. Models were initially tested with the complete independent variable dataset; variables remained in the model if they were significant ($P < 0.10$).

Prediction of profit using feedlot performance indicators yielded a greater coefficient of determination (i.e. it accounted for a greater proportion of the variation) when modeling profit derived from a flat-carcass price rather than a grid-based price structure (Table 4). Determination coefficients and *P*-values for a model to predict net profit assuming a flat carcass bid are presented in Table 4. At dietary and yardage costs modeled, initial BW ($P = 0.0011$) and ADG ($P = 0.0002$) were positively correlated with net profit. Finishing heifers to sell on a flat carcass bid was not as profitable ($P = 0.0739$) as finishing steers. Also, cattle that consumed more DM during the finishing phase were less ($P = 0.0022$) profitable. However, RFI was not a significant ($P = 0.5681$ for the overall effect of RFI) predictor of profit.

Table 4. Models predicting profit using a flat- or grid-based carcass price [a]

	Profit based on flat carcass price			Profit based on grid carcass price		
Item	Coefficient	SE	*P*-value	Coefficient	SE	*P*-value
Intercept	-600.07	85.02	0.0010	-790.09	77.63	<0.0001
In BW, lb	0.7231	0.1228	0.0011	0.7813	0.1160	0.0008
ADG, lb	144.82	17.32	0.0002	142.84	16.14	0.0001
High RFI	-1.47	5.27	0.7806	5.31	9.69	0.5842
Low RFI	5.45	5.36	0.3104	-0.52	9.64	0.9568
DMI, lb/d	-15.50	2.37	0.0022	-13.84	1.44	< 0.0001
Heifer	-514.32	230.41	0.0739	NA	NA	NA
Origin	NA	NA	NA	8.66	14.26	0.0565
R^2	89.29			73.07		

[a] Flat-carcass bid was $1.85/lb or a grid structure based on USDA summary of premiums and discounts for August 10, 2012.

The model to predict profit when carcass price is determined by a grid structure that favors marbling did not include a term for RFI (overall RFI $P = 0.8550$) or sex ($P = 0.2857$). Instead, and as observed for the profit prediction model based on a flat carcass bid, initial BW ($P = 0.0008$) and ADG ($P = 0.0001$) were positively correlated with profit. The effect of sex was not significant, instead genetic merit, as determined by cattle origin, was significant ($P = 0.0565$). Genetic merit would be expected to be a determinant of profit when carcass price is determined by carcass quality traits. As observed for the model to predict profit based on a flat carcass bid, DMI was negatively ($P < 0.0001$) correlated with profit. Interestingly, the coefficients for DMI in either model were quite similar (-$15.5 vs -$13.8/lb DMI, respectively). Coefficients for other variables that were not fully described by discrete variables such as initial BW and ADG were similar between models predicting profit from a flat- or grid-based price. Initial BW and ADG had coefficients of $0.72 or $0.78, and $144.8 or $142.8/lb, respectively, for prediction of profit using a flat- or grid-based price.

Because RFI failed to explain variation in profitability derived either by a flat carcass bid or a grid based price, the original deviations from expected income using the model suggested by Arthur et al. (2001) was used as an independent variable, instead of RFI classification. Other discrete (initial BW, ADG, DMI) and class variables (sex and origin) were retained to test full models. Resulting models included significant ($P < 0.05$) coefficients for initial BW, ADG, and the differential between observed and expected DMI. Similar to previously listed models (Table 4), sex significantly ($P = 0.10$) or origin ($P = 0.09$) were retained as class variables determining profit when selling cattle on a flat carcass or a carcass grid basis, respectively (data not tabulated). The coefficient for differences between observed and expected averaged $16 impact on profit per head for every lb differential between observed and expected DMI for models predicting profit based on a flat carcass bid ($15/hd) or on a carcass grid basis ($17/hd). Using this value to determine profit for cattle consuming DMI one standard deviation away from the mean for observed minus expected DMI (2.2 lb) would lead to changes in profitability of $30/hd. A deviation of 2.2 lb from the average would represent a 10% change in DMI for steers in the dataset. This means that producers must manage DMI within 10% of predicted. Feeding cattle outside this range can easily change feed efficiency and cost of gain from a profit to a loss scenario. Considering how difficult it is to control intake in the feedlot, these narrow ranges represent management opportunities for producers, particularly at a time of high-grain and co-product prices.

Managing Feed Intake to Improve Beef Profitability

As evidenced by our analyses, management of feed intake is a key indicator of feedlot profitability. However, it is important to remember that responses in profitability to reduced, or managed, intake will only be realized if feed efficiency is improved. The following is a list of tips that can be utilized to manage intakes to improve efficiency:

- Moderate step-up procedures to ensure a strong finish (less is more at the beginning)
- Moderate feed offerings
    - Monitor cattle—how many are eagerly waiting at the bunk?
    - Monitor weather
    - Limit increases according to energy and feeder crew
- Accurate loading and unloading
    - Too many mistakes reading batch sheets
    - Weekend help—29% of the week's chores
    - Highly dependent on feeding area layout and vehicle flow
    - Deliveries in the bunk on the alleyways or aprons
- Adequate mixing order and timing
- Feed conversions below 6.5 are achievable (and necessary)

Take Home Points

- Feed efficiency is a moving target dependent upon both feed intake and weight gain, but is a better predictor of feedlot profit than either of its constituent parts.
- With current feedlot economics, it appears that calves placed in feedlots this fall will need a feed conversion of 6.5:1 or better to realize a profit.
- Feed intake and average daily gain are more reliable predictors of profit than residual feed intake or initial body weight.
- Management of intake is critically important, as a 10% change in DMI can lead to a $30 swing in per head returns.

Literature Cited

Arthur, P.F., G. Renand, and D. Krauss. 2001. Genetic and phenotypic relationships among different measures of growth and feed efficiency in young Charolais bulls. Livest. Prod. Sci. 68:131-139.