Journal of Agricultural and Applied Economics, 31,2(August 1999):349–357

Elements of Cattle Feeding Profitability in Midwest Feedlots

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ABSTRACT

Conventional wisdom and earlier research have concluded that cattle feeding profitability is more determined by feeder and fed cattle prices than by animal performance. This study examined cross-sectional and time-series data from over 1600 pens of cattle in more than 220 feedlots in the upper Midwest where weather and lot conditions are thought to influence feedlot profitability. In addition to input and output prices and animal performance, other factors found to significantly impact cattle feeding profitability were sex, placement weight, facility design, and to a lesser extent placement season.

Key Words: cattle feedlots, profitability, risk.

Cattle feeding is a multi-billion dollar industry nationally and a significant value-added business or enterprise on farms and ranches in North America. It is also a highly competitive, narrow margin business (Cattle Fax, Iowa State University Extension). Cattle feeders compete in input markets for feeder cattle and feedstuffs and in the output market to sell a perishable product (narrow optimal marketing weight range) into a highly concentrated processing industry with a relatively fixed weekly capacity. Feedlots also must manage production uncertainty of animal performance that is impacted by weather, lot conditions, animal health and genetics. The growing trend toward value-based marketing that differentiates the selling price of cattle based on wholesale or retail value will further complicate the manager's production and marketing decisions. Cowherd owners throughout the U.S. considering retained ownership programs often have limited experience with the feedlot sector of the industry. They need to have a better understanding of what factors drive cattle feeding profitability before venturing into a new enterprise. Many price and performance factors impact the level and variability of cattle feeding profitability. Successful managers will be those that identify the risks that have the greatest potential impact and develop strategies that manage the financial impact of these risks.

Recent studies identified six variables that explained more than 90 percent of the variability of steer feeding profits. Schroeder *et al.* evaluated data from 6,696 pens of steers on feed from two western Kansas commercial feedlots placed on feed from 1980–1991. Their findings attributed 70 to 80 percent of profit variability to fed and feeder cattle prices, and 6 to 16 percent was attributed to corn prices. Feed efficiency and average daily gain combined for less than 10 percent of variation in profits. Langemeier, Schroeder, and Mintert examined monthly average closeout data on 10 years of feedlot data and found similar results. Both studies examined two feedlots in

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one geographical region. Did the similarity in weather, lot conditions, and management reduce the variation in performance-related feeding profits? Questions remain as to whether these results can be generalized across other cattle feeding regions, multiple feedlots, or production technologies.

Midwest cattle feeders face similar feeder and fed cattle and corn price risks to those of western Kansas commercial feedlots. However, climatic conditions suggest that cattle performance may play a larger role in Midwest feedlots. The objectives of this paper are twofold. First, to replicate the earlier Kansas studies on a cross-sectional data set to determine if profitability can be predicted as accurately across many feedlots as it can in two feedlots. Second, to extend the earlier research into other management decisions that may impact cattle feeding profitability. Specifically, what is the effect of feeding heifers relative to steers, the effect of placement weight and season on profitability, and does facility design impact cattle feeding profits?

Materials and Methods

Close-out information from cattle feeders using the Iowa State University Feedlot Monitoring Program (FMP) in Iowa and surrounding states was examined to identify factors that impact profitability on individual pens of cattle. FMP projects cattle growth based on feed intake and summarizes animal performance, efficiency, costs and returns on a pen basis. The program is available through Iowa State University Extension and private feed companies. Feedlots may send their data to the University for comparative analysis with other feedlots on a quarterly basis. Data from 1626 pens of cattle placed on feed between January 1987 and December 1996 in five states (Illinois, Iowa, Minnesota, Nebraska, and South Dakota) were examined and are summarized in Table 1a. The data include 1169 pens of steers and 465 pens of heifers from 223 feedlots. Nearly half of the observations are from feedlots that submitted only one pen of data for comparative analysis. A fourth of the observations are from feedlots submitting data from two to four pens of cattle. The largest feedlot had 211 pens of data over the 10-year period. Table 1b provides a distribution of the seasonal placement and the type of facilities used.

Table 1c summarizes the relative variability of the key variables in this data set and the Schroeder *et al.* study. The coefficient of variation (standard deviation divided by the mean) provides an index to compare the relative variation between variables and between the two data sets. Placement weight and sales weight are less variable because the placements are sorted by weight and the optimal marketing weight for a pen of cattle is in a relatively narrow range. With the exception of feeder and fed cattle prices, data from two commercial feedlots is less variable than the data from the many Midwest feedlots, but the difference is relatively small. While the individual variables that determine profitability are relatively stable, profits themselves are very volatile. This 200- to 330-percent range in the coefficient of variation re-enforces the low-margin high-risk nature of the cattle feeding enterprise.

Data on cattle performance and market information provided in the FMP included placement weight (PWT), sale weight (SWT), feed efficiency (FE), average daily gain (ADG), total cost per hundredweight gain (TCGAIN), breakeven price (BEP), and additional information. Missing fed cattle prices (FEDP) were replaced by the weekly average Iowa Direct Trade price for the week the cattle were sold. Corn prices (CRNP) included in the FMP data are reported at the discretion of the feedlot operator and may represent a locally reported average price over the feeding period or local price when the cattle were placed on feed. Missing corn prices were replaced by mid-month corn prices for Central Iowa for the month the cattle were placed on feed (USDA-AMS). Missing interest rates (INT) were replaced by commercial agricultural loan rates quoted for the placement month. Feeder cattle prices (FDRP) were not included in the data but were calculated as:

$$(1) \quad FDRP = (BEP \cdot SWT - TCGAIN \cdot GAIN) \div PWT.$$

Table 1a. Summary statistics for steers and heifers by placement weights

Steer wgt. Categories	<600		600–699		700–799		>800	
Number of pens	186		296		347		340	
	Avg.	SD*	Avg.	SD	Avg.	SD	Avg.	SD
Placement wgt. (lbs)	535	55.06	648	25.92	753	29.30	856	45.98
Days on feed	240	39.85	202	34.97	154	27.15	133	22.72
Sale weight (lbs)	1153	93.21	1196	81.28	1215	74.77	1264	70.69
Conversion (feed/gain)	7.49	1.04	7.67	1.07	7.55	0.92	7.80	0.95
Avg. daily gain (lbs)	2.60	0.32	2.75	0.35	3.02	0.39	3.11	0.44
Cost ($/cwt gain)	50.99	9.42	52.50	8.64	52.32	8.43	53.73	7.98
Avg. corn price ($/bu)	2.35	0.43	2.35	0.45	2.38	0.42	2.36	0.40
Interest rate (%)	10.17	1.22	10.01	1.28	10.08	1.26	10.04	1.22
Feeder price ($/cwt)	90.82	11.44	85.92	8.28	81.18	8.15	78.32	8.34
Profit	72.27	5.48	72.49	5.48	71.98	5.42	72.04	5.43
Net return ($/head)	34.52	82.47	22.63	74.33	21.62	67.22	22.18	64.81
BEP** ($/cwt)	69.31	5.08	70.59	4.98	70.21	4.97	70.29	5.52
Placement wgt. (lbs)	537	53.86	652	28.43	743	27.39	850	48.38
Days on feed	218	49.51	171	30.51	140	22.57	123	26.18
Sale weight (lbs)	1037	94.29	1079	73.51	1110	55.33	1192	78.60
Conversion (feed/gain)	8.18	1.12	8.34	1.33	8.53	1.23	8.86	1.84
Avg. daily gain (lbs)	2.31	0.34	2.52	0.35	2.65	0.39	2.82	0.48
Cost ($/cwt gain)	53.50	8.99	56.46	10.10	58.45	10.38	61.13	13.01
Avg. corn price ($/bu)	2.35	0.37	2.38	0.42	2.37	0.48	2.27	0.39
Interest rate (%)	10.03	1.31	9.71	1.16	9.59	1.01	9.41	1.00
Feeder price ($/cwt)	85.09	9.13	79.66	9.62	76.97	9.07	73.43	8.53
Fed price ($/cwt)	72.35	4.83	71.58	5.33	72.04	5.49	72.22	5.70
Profit ($/head)	28.17	67.15	13.22	73.34	13.88	63.92	30.47	84.63
BEP ($/cwt)	69.64	5.36	70.39	5.84	70.79	5.65	69.79	6.48

* Standard deviation.
** Break even price.

Table 1b. Summary statistics for placement season and facility type

	Number of pens	Percent of total observations (%)
Placement season*		
Spring	247	15.1
Summer	379	23.2
Autumn	622	38.1
Winter	386	23.6
Facility type		
Confinement	270	16.6
Partial confinement	439	27.0
Open lot	917	56.4

* Placement season: Spring = March-May, Summer = June-August, Autumn = September-November, Winter = December-February.

Additional data reported by the feedlot include sex of the cattle, placement and marketing date, and facility type (total confinement, partial confinement, or open lot).

Ordinary least-squares regression analysis was used to identify the significant variables that impact cattle feeding profitability. Following Schroeder *et al.*, the regression model estimating profit per head (*PROFIT*) is defined as:

$$(2)\quad PROFIT_i = B_0 + B_1\text{FEDP}_i + B_2\text{FDRP}_i + B_3\text{CRNP}_i + B_4\text{FE}_i + B_5\text{ADG}_i + B_6\text{INT}_i + \epsilon_i.$$

The variables in the regression equation are defined above and an intercept term (B_0) and an error term (ϵ_i) have been included. Equation

Table 1c. Coefficient of variation for selected variables in two cattle feeding regions*

Placement weight	Midwest 600–699	Kansas 600–699	Midwest 700–799	Kansas 700–799	Midwest >800	Kansas Over 800
Number of Pens	296	1557	347	3536	340	1603
Placement weight (lbs)	4.0%	4.1%	3.9%	3.7%	5.4%	3.2%
Days on feed	17.3%	11.6%	17.6%	11.9%	17.1%	12.9%
Sale weight (lbs)	6.8%	4.9%	6.2%	4.9%	5.6%	5.0%
Feed conversion (feed/gain)	14.0%	10.2%	12.2%	10.4%	12.2%	12.0%
Avg. daily gain (lbs)	12.7%	11.4%	12.9%	10.7%	14.1%	12.0%
Cost per cwt. Gain ($/cwt)	16.5%	13.5%	16.1%	14.0%	14.9%	15.7%
Feeder price ($/cwt)	9.6%	14.4%	10.0%	14.6%	10.6%	15.2%
Fed price ($/cwt)	7.6%	10.5%	7.5%	10.5%	7.5%	10.5%
Profit ($/head)	328.5%	206.3%	310.9%	230.3%	292.2%	225.0%

* Kansas data represents two commercial feedlots in Southwest Kansas for cattle placed in 1980–1991. Midwest data represents data from 223 feedlots in five states (Iowa, Minnesota, Nebraska, Illinois, and South Dakota) placed in 1987–1996.

1 is a regression equation rather than an accounting identity that calculates a net profit per head based on actual price and quantity of inputs and outputs, and other expenses. The profit per head that is reported in the tables is an accounting identity defined as:

$$(3) \quad PROFIT_t = (FEDP_t - BEP_t) \cdot SWT_t.$$

This basic equation was modified to examine additional factors hypothesized to impact profitability. Separate equations were estimated for steers and heifers in four placement weight categories (less than 600 pounds, 600 to 699 pounds, 700 to 799 pounds, and 800 pounds and over). These regression coefficients were further analyzed using the coefficients of a separate determination procedure to identify the proportion of the variability that is accounted for by each variable. The entire data set was combined and dummy variables were used to also examine individual variables such as placement season and facility type while holding other factors constant.

Results and Discussion

Equation 2 explained a relatively high percentage of the variability in profits indicating that the variables identified are important determinants of cattle feeding profits (Table 2). The coefficients were generally significant and had the expected sign. Those that did not have the expected sign were not significant ($p < .05$). The predictive performance of the model was quite good as it explained 70 to 91 percent and 73 to 88 percent of the variability of the profits in heifer and steer feeding, respectively. The conditional indices for regression models reported in Table 2 are between 91 and 106. According to Belsley *et al.* a conditional index in excess of 20 suggests some potential for multicollearity problems. However, multicollearity is not thought to be a significant problem with this data because the coefficients have the expected sign and plausible magnitude and the results were stable as additional data were included in analysis.

The equation improved with heavier placement weights and the equation had a higher r^2 for heifers than for steers. The coefficients for steers in the three heavier weight classes are comparable to those reported in Schroeder *et al.* The level and relative magnitude of the coefficients in this study are similar to the earlier findings for fed and feeder cattle prices. However, the corn price coefficient tended to vary more across weight classes in this study than it did in the analysis of only two large commercial Kansas feedlots. Fed cattle price is more important at heavier placement weights with the exception of steer calves placed at less than 600 pounds. As Schroeder *et al.* noted, this result suggests that heavier placed cattle are fed to heavier weights. However, their

Table 2. Estimated regression equations of factors explaining steer and heifer feeding profitability by placement weight, 1st quarter 1987–4th quarter 1996

Weight (lbs)	<600		600–699		700–799		>800	
Steers	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std Error
Constant	−195.35	108.58	−210.39	81.17	−44.59	52.85	−27.52	40.09
Fed price	12.39	0.69	10.76	0.53	10.92	0.32	11.84	0.30
Feeder price	−4.05	0.37	−5.01	0.37	−6.74	0.24	−8.03	0.21
Corn price	−38.75	9.22	−38.19	6.92	−47.69	4.30	−39.57	3.71
Feed/gain	−24.25	5.00	−15.64	3.40	−14.29	2.74	−16.23	1.98
ADG*	17.65	15.77	30.15	10.17	33.97	6.17	24.25	4.23
Interest rate	−6.98	3.07	1.00	1.96	−5.36	1.20	−2.89	1.07
R-Squared	0.73		0.68		0.83		0.88	
Weight (lbs)	<600		600–699		700–799		>800	
Heifers	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Constant	43.21	109.12	−296.65	96.92	36.84	54.50	−329.03	120.66
Fed price	9.60	0.73	10.02	0.59	10.21	0.36	12.02	0.84
Feeder price	−4.18	0.42	−4.80	0.42	−6.87	0.29	−7.31	0.64
Corn price	−42.31	10.52	−23.78	9.27	−41.20	5.28	−28.15	12.50
Feed/gain	−26.99	4.52	−10.84	2.79	−16.81	2.02	−9.29	3.31
ADG	−12.22	14.34	50.81	10.92	13.52	6.34	30.56	14.18
Interest rate	−0.63	2.69	−0.62	2.56	−2.54	1.73	9.38	4.11
R-squared	0.70		0.82		0.90		0.91	

* Average daily gain.

analysis did not include cattle placed weighing less than 600 pounds. Light placement weight steer calves may also be fed to heavier weights in Midwest lots where the calves are first grown, then finished in the same feedlot. Feeder cattle prices have a greater impact on profits at heavier placement weights as the total cost of the feeder increases. The effect of feed efficiency decreases and the effect of average daily gain increases as placement weight increases, reflecting the higher energy diets of the heavier placed cattle.

Table 3 summarizes further analysis of the regression equations using variability decom-

Table 3. Percentage of total explained cattle feeding net return attributable to selected factors, by placement weight, 1st quarter 1987–4th quarter 1996

Weight (lbs)	<600		600–699		700–799		>800	
Variable	Steer	Heifer	Steer	Heifer	Steer	Heifer	Steer	Heifer
Fed price	58.07	41.17	51.03	40.60	50.46	40.90	43.80	40.39
Feeder price	2.30	14.41	4.84	23.89	19.31	40.45	31.82	27.45
Corn price	5.29	2.93	5.71	0.00	4.19	−0.02	2.50	3.38
Feed/gain	7.22	13.00	3.69	8.71	3.55	8.28	5.46	6.84
Avg. daily gain	1.36	−1.33	2.96	8.94	6.31	2.21	4.77	10.39
Interest rate	1.55	−0.44	0.36	−0.07	−0.38	0.41	−0.86	2.88
Total explained	75.79	69.74	68.59	82.07	83.44	92.23	87.49	91.33

Table 4. Placement weight effect on profitability

	Steer		Heifer	
Variable	Coeff.	Standard Error	Coeff.	Standard Error
Constant	−49.06	35.06	−107.08	49.12
Fed price	11.01	0.23	9.87	0.32
Feeder price	−5.83	0.16	−5.24	0.22
Average corn price	−41.01	3.06	−30.71	4.74
Feed conversion	−17.73	1.70	−14.54	1.66
Average daily gain	27.53	4.17	26.96	5.85
Interest rate	−2.47	0.89	−0.37	1.37
600–699 lbs	−44.13	3.55	−38.21	4.39
700–799 lbs	−75.40	3.91	−57.48	4.75
Over 800 lbs	−90.92	4.35	−63.84	6.86
R-square	0.74		0.78	
Observations (pens)	1169		465	

position of returns (coefficients of separate determination, Burt and Finley). This analysis estimates the relative contribution of each variable to the explanatory power of the equation. FEDP is the single largest factor impacting cattle feeding returns. It was relatively more important for steers than heifers with the same placement weight. Except for steers placed weighing less than 700 pounds, FDRP is the second most important factor impacting profit variability. It had a greater importance for heifers than steers except at the heaviest weight class. Generally speaking, heifer profits are relatively more influenced by the purchase price and performance than steer feeding profits. The two price variables, feeder cattle prices and fed cattle prices, explained over 70 percent of the profitability for all groups except for heifers under 600 pounds. This result is comparable to, but slightly less than, the Schroeder *et al.* results. Relative to the Kansas study, animal performance explained a higher percentage of the variation in profits. FE and ADG were generally the next two important variables, explaining six to 15 percent, except for the lightest weight class. This difference may be due to more climatic variation in Iowa versus Kansas. It is also likely due to greater differences across feedlots. Over 200 feedlots were in this study versus two in the Schroeder *et al.* study. Corn price was generally more important in the study of two commercial feedlots. At lighter weights, corn prices, feed efficiency, and interest rates become more important as the feeding period lengthens. CRNP and INT had relatively little impact on profitability in the Midwest data.

Analysis was performed that examined the interaction of variables on feeding profits. Regression analysis using Equation 1 was modified to compare the results of only selected variables while taking into account all other factors. Steer and heifer data were examined separately for the impact of placement weight and season on profitability. A dummy variable was used for each of the three weight classes—600–699, 700–799, and over 800 pounds—and cattle placed weighing less than 600 pounds were the basis for comparison. Table 4 summarizes the result of placement weight on profitability by sex. The under-600-pound placement group is the most profitable group because the coefficients of the other weight classes are negative and significant. Profit per head relative to the base group declines as placement weights increase. Keep in mind that the *PROFIT* equation does not explicitly account for overhead cost of yardage that is typically charged on a per-day basis. Thus, the negative relationship between placement weight and returns reflects the higher overhead cost resulting from added days on feed for the lighter placement weight cattle.

The effect of placement season was examined by including dummy variables of three placement seasons—spring, summer, and fall

Table 5. Placement season effect on profitability

	Steer		Heifer	
Variable	Coeff.	Standard Error	Coeff.	Standard Error
Constant	−62.37	35.21	−135.15	49.02
Fed price	11.10	0.23	10.02	0.32
Feeder price	−5.79	0.16	−5.12	0.22
Average corn price	−40.56	3.05	−30.26	4.70
Feed conversion	−17.54	1.67	−14.07	1.64
Average daily gain	27.42	4.16	29.31	5.84
Interest rate	−2.39	0.89	−0.23	1.37
600–699 lbs	−44.30	3.57	−37.43	4.40
700–799 lbs	−75.93	4.00	−55.54	4.75
Over 800 lbs	−90.24	4.36	−61.66	6.79
Spring	9.13	3.60	3.06	5.06
Summer	−5.67	3.20	−14.10	4.71
Autumn	0.44	2.82	−6.85	4.35
R-square	0.74		0.79	
Observations (pens)	1169		465	

defined as March–May, June–August, and September–November, respectively. Winter placements (December–February) were the basis of comparison. Table 5 indicates that heifers placed during June–August and September–November are less profitable than winter placements. Steers placed in spring are more profitable while summer-placed steers were less profitable than winter placements. Seasonal effects were not significant otherwise. In general, the seasonal effects were less significant than the placement weight and the variables in Equation 1. However, note that many of the factors related to seasonal feeding conditions (i.e., prices, weather, and lot conditions) are already accounted for in the other price and performance variables and that the seasonal placement variables added little to the explanatory power of the equation.

Both steer and heifer data were combined to examine effect on facility type, placement weight, and sex effect on profitability. Facility type is reported in the FMP data by the cooperator marking one of three categories: total confinement, partial confinement, or open lot. The facility effect was examined by including dummy variables for the three placement weights over 600 pounds, total confinement and partial confinement (Table 6). Cattle in open lots placed weighing less than 600 pounds were the basis for comparison. The coefficient is −$12.20 per head and is significant for total confinement relative to open lots indicating that the higher cost of total confinement facilities is not offset by improved cattle performance. The coefficient for partial confinement is positive relative to open lots but not significant ($p < .05$), suggesting that there is no difference in profitability between the two systems for Midwest cattle feeding.

Table 6 also summarizes the effect of sex on cattle feeding profitability. Dummy variables were included for the three placement weight classes over 600 pounds and for heifers. Compared with steers, heifer feeding was $12.30 per head less profitable and the coefficient was significant. After accounting for the discounted heifer feeder cattle purchase price relative to steers, heifers are still less profitable to feed. Seventy-five percent of the variation in profitability was explained by this equation and the coefficients had the expected sign and were significant.

As a final analysis, we included placement weight, facility type, and placement season variables in the same regression using the combined steer and heifer data. F tests were conducted to indicate the joint significance of each set of variables. The F-statistics (160.7, 21.35, and 8.79) were much higher than the

Table 6. Facility and sex effect on profitability

	Facility effect		Sex effect	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Constant	−110.73	27.69	−77.47	28.03
Fed price	10.54	0.19	10.64	0.19
Feeder price	−5.33	0.12	−5.61	0.13
Average corn price	−35.24	2.55	−38.08	2.57
Feed conversion	−16.89	1.24	−15.74	1.20
Average daily gain	30.01	3.37	28.77	3.36
Interest rate	−0.95	0.75	−1.86	0.74
600–699 lbs	−37.46	2.79	−41.25	2.78
700–799 lbs	−62.41	3.19	−69.02	3.05
Over 800 lbs	−74.87	3.70	−84.30	3.59
Confinement	−12.20	2.67		
Part. Confinement	1.51	2.13		
Heifer			−12.30	2.25
R-squared	0.75		0.75	
Observations (pens)	1626		1634	

corresponding five percent level critical values (2.60, 3.00, and 2.60). Therefore, all three sets of variables had jointly significant effects on feeding profitability.

Summary and Implications

Pens of cattle from more than 200 feedlots in the Midwest were examined. This analysis produced results similar in explanatory power, significant coefficients, and relative importance to those of Schroeder *et al.* and Langemeier *et al.* that examined only two commercial feedlots in southwest Kansas. It supports the earlier findings and confirms that relatively few variables explain the majority of difference in profits between pens of cattle. Fed cattle prices and feeder cattle prices explained over 70 percent of profitability for each weight group except heifers under 600 pounds. This result emphasizes the importance of proper marketing and price-risk management. One difference from the Schroeder *et al.* and Langemeier *et al.* studies is that corn price had less impact than feed efficiency and average daily gain. This result is in spite of corn prices during 1987–1996 ranging from under $2.00 to near $5.00 during the period studied. Animal performance was slightly more variable across 200 Corn Belt feedlots in this study than it was in two feedlots in the previous Kansas research.

This analysis also suggests that predictability of profits is as accurate in smaller farmer feedlots represented in the FMP data as it is in the large commercial feedlots. If operators can manage the variables in the equation shown to affect profits, they should be able to accurately predict profitability. The largest unknown and the most significant variable is selling price.

All else being equal, profits declined as placement weights increased, and steers were more profitable than heifers. Open lots were more profitable than total confinement but not significantly different from partial confinement. After accounting for the identified variables, placement season had little effect on profitability. Over 50 percent of variation in profit between pens of cattle is caused by fed cattle price. An additional 20 percent of profit variation results from feeder cattle price. These results confirm the importance of careful marketing and price-risk management.

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