1/10/2007

The Effect of Early Vs. Normal Calf Weaning on Feedlot Performance and Herd Management: A Cross-Discipline Case Study.

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JEL Code: Q12

Selected Paper prepared for presentation at the
Southern Agricultural Economics Association Annual Meetings
Mobile, Al, February 4-7, 2007

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Abstract

A study of early vs. normal weaning of calves concludes that early weaning improves feedlot production efficiency, reducing per day and per pound feedlot production costs. Early weaned steers finished lighter; thus feedlot profitability was not affected. Early weaning has a positive affect on cow health, and pasture utilization rates.

Introduction

The western region of the Dakotas can be described as a semi-arid region of the Northern Plains. Cow/calf operations are a very important segment of the agricultural sector in this region. However, with the exception of recent historically high profits from cattle marketing, profit margins in cow/calf production are slim due to high production costs (Taylor and Field, 1995). The majority of costs in cow/calf businesses are for harvested feed (Taylor and Field, 1995). Systems that rely more on grazing and less on harvested and purchased feedstuffs have a higher potential to be profitable (Adams et al., 1994), but these systems can be stressed during periods of low precipitation and drought. The development of systems that lower production costs while adding value to calves would be beneficial to sustaining and improving rural communities in the drier regions of the western United States.

Early weaning is a herd management strategy that has drawn the interest of scientists investigating cow/calf production and marketing issues. Research has shown calves weaned at 100 to 150 days of age were heavier and younger at slaughter than normal weaned (weaned at 225-250 days) calves (Peterson et al., 1987). Meyers et al.

(1999) reported that an early weaning herd management strategy improved the percentage of steers grading average choice or higher and also improved feed efficiency relative to a normal weaning strategy. These results reported by Meyers et al. (1999) suggest early weaning can improve profitability.

In this paper we present the research results for the first two years of an ongoing cow/calf herd management project being conducted in the western Dakotas by North and South Dakota State Universities. The primary objective of this paper is to report on the effect of early vs. normal weaning of steer calves on carcass characteristics and feedlot performance (economic and physiological). The second objective is to report preliminary results of an early weaning strategy on cow health and pasture utilization rates. Research protocols employed in this research were reviewed and approved by the Institutional Animal Care and Use Committees in North Dakota and South Dakota.

Experimental Design[1]

Over a two-year period, cow herds from the SDSU Antelope Range and Livestock Research Station (136 cows) and the NDSU Dickinson Research Extension Center (176 cows) were used in the study. At each location, spring-born calves were weaned from cows at approximately 140 days (mid-August) or 215 days of age (early November). During the second year of the study, the cow herd at the Antelope Station became compromised with persistently infected BVD virus and did not participate.

The steer calves from Antelope Station (Yr. 1) were transported immediately after weaning to the NDSU Hettinger Research Extension Center for backgrounding. The project protocol required early (EW) and normal (NW) weaned steers to undergo a backgrounding phase that lasted, on average, 52 days after weaning. Normal weaned

steers nursed, on average, 80 days longer than early weaned steers. The background diet for both groups consisted of locally grown forage and a commercial co-product pellet. Two to four weeks prior to each weaning date, calves were immunized against bacterial and viral diseases and were administered a booster vaccination at weaning. The project design did not allow the early weaned steers to stay on feed at home for an additional 52 days before being transferred to the commercial feedyard. Therefore, feedlot arrival weight and age for the early weaned steers was 578 lbs. and 195 days old, as compared to 748 lbs. and 274 days old for the normal weaned steers.

Following the backgrounding phase, Antelope and Dickinson steers were transported to Decatur County Feed Yard, Oberlin, Kans. The timing decision for marketing of finished cattle was based on the electronic cattle management system employed at the Decatur County Feed Yard. Finished steers were marketed either using a fat depth end point signal of 10 mm or when the system indicated the animal reached its optimal weight. Steers were slaughtered at a commercial plant and carcass data were collected.

Economic Methodology

The decision to retain ownership of a steer calf and place it into a feed yard instead of selling it after weaning can be looked upon as an investment decision. The capital being invested is the market value of the calf at time of feedlot placement. The variable *CREV* is defined as the individual calf's estimated market value, based on the Decatur feed yard price slide for each calf upon its entry into the feed yard. Profit

generated by a calf during the feedlot phase of its life cycle is defined as accounting profit (*AP*). Feedlot revenue per head (FLREV) is equal to the difference between finished steer revenue (SREV) determined at slaughter minus the total feedlot costs (*TOTCOST*). AP is equal to Feedlot revenue minus the estimated revenue the producer would have received by selling that individual (ith) steer as a calf at time of feedlot placement:

1) $FLREV_i = SREV_i - TOTCOST_i$.

2) $AP_i = FLREV_i - CREV_i$.

Return on investment (%RET) is defined as the simple return to a steer at slaughter based on the value of the calf at the time of entry into the feedlot:

3) $\%RET_i = (AP_i / CREV_i)*100\%$.

Data and Empirical Methodology

Decatur Feed Yard Company provided complete feedlot cost and production records for each calf placed in the feedlot. The research team kept complete records on each calf from birth until its placement into the feedlot. The feedlot provided the data on feedlot performance and final carcass characteristics. A total of 200 steer calves were entered into the experiment during the two-year test period: a) 145 steer calves in year 1 and 55 steer calves in year 2, and b) 102 steers calves were early weaned and 98 normally weaned. Sixteen of the steers (4 early, 12 normal) were branded animals and the feedlot did not provide quality grade data on those animals and thus they were dropped from the data set. A list of variables for which data was collected is provided in Table 1.

The project's experimental design has one treatment effect (weaning program) and two potential confounding effects (location, year). In addition, the unfortunate BVD

outbreak in South Dakota during the second year of the study has resulted in the data set being unbalanced. Given the characteristics of the data set, a 3-way ANOVA procedure designed to generate *least squared means* was selected to determine if "weaning age" affected calf feedlot performance, carcass characteristics, and economic value. The estimated least squared means were adjusted for all interaction effects revealed in the preliminary analysis.

Ordinary Least Squares regression analysis was used to analyze calf feedlot production performance on total feedlot cost (TOTCOST), and carcass characteristics on steer revenue (SREV). The weaning treatment effect and the two confounding effects (year, location) were also included in each regression.

Empirical Results

Least Square Means Results

The SAS (2002) GLM procedure was utilized to conduct a 3-way ANOVA analysis on each of the variables listed in Table 1. The purpose of the ANOVA analysis is to determine if the early weaning treatment affected any of the calf performance variables listed in Table 1. The performance variables can be broken down into three categories: 1) feedlot performance, 2) carcass characteristics, and 3) economic performance. Table 2 provides the analysis of variance results.

Early weaned steers arrived at the feedlot approximately 80 days younger and 170 pounds lighter than their normal weaned counterparts. Early weaned steers spent, on average, 31 days longer in the feedlot but were 50 days younger and 92 pounds lighter at slaughter (live wt.). These data agree with the findings of Peterson et al. (1987) that reported early weaned steers were younger at slaughter, but does not agree that early

weaned steers will be heavier at slaughter. Early weaned steers, on average, gained more weight in the feedlot, but average daily gain was not affected by the treatment. Early weaning did improve feeding efficiency by approximately 18.5%. This result agrees with the findings of Meyers et al. (1999) who also reported an increase in feed efficiency.

There is no statistical evidence that weaning treatment affected carcass yield grade, fat depth, or dressing percentage. However, normal weaned dressed carcasses were, on average, 53 pounds heavier. This HCW differential explains a majority of the $55 dressed carcass revenue differential advantage normal weaned steers had relative to early weaned steers. On the issue of quality grade, normal weaned steers did have a slightly higher average quality grade, which was statistically significant at the 6% level. This result is in contrast to the findings of Meyers et al. However, the Meyers et al. study reported data on early weaned steers that were heavier and much closer in age at slaughter to the normal weaned group relative to the steers in our study. In comparison our early weaned steers were 358 days old at harvest as compared to 429 days in year 1 and 440 days in year 2 of the Meyers et al. study. We believe age and weight are the factors causing the contrast in quality grade results between the two studies. This issue is under investigation at this time.

On the issue of economic return, accounting profit and rate of return were higher for normal weaned steers; however these results were not statistically significant. Increased feed efficiency does appear to have an affect on the cost side of the feedlot profit equation ($SREV_i$ - $TOTCOST_i$). Early weaned steers, on average, only incurred an additional $10.68 per head in total feedlot cost relative to normal weaned steers, and this differential was not statistically significant. This minimal cost differential occurred

despite early weaned steers spending an additional 31 days in the feedlot and incurring, on average, an additional $3.09 per head in medical expenses while in the feedlot. The improvement in feed efficiency of early weaning appears to have resulted in a decline in the average cost per pound gained in the feedlot of approximately 19%, declining from $0.62 per lb. for normal weaned steers to $0.50 per lb. for early weaned steers.

The analysis of variance results indicate that the benefits of early weaning are improved feedlot efficiency, a reduction in the lifecycle of the animal and a reduction in average cost of feedlot production. The disadvantage is directly related to the lower slaughter weights, which translate into lower carcass revenue. It should be noted that if early weaned steers would have been fed for another 30 days, they would have, on average: a) gained an additional 96 pounds, b) increased HCW weight by 61 lbs., c) increased carcass revenue by $61, d) increased total cost by $48, and e) increased profit by $13. While this back of the envelope estimate (based on estimated statistics in Table 2) indicates no change in statistical significance for profit between groups, additional feeding may have a positive effect on quality grade.

Regression Analysis

The results of the analysis of variance procedures suggest that early weaning has a positive economic effect on feedlot cost but a negative effect on slaughter revenue. OLS regression is used to investigate the effect of early weaning on total slaughter steer revenue and total feedlot cost variability.

First, per head carcass revenue (SREV) is regressed on carcass characteristics (HCW, YG, QG, %Dress, REA) along with dummy variables to capture the weaning treatment effect and the two confounding effects of *year* and *location.*[1] The OLS results

are presented in Table 3. The estimated OLS regression has very good explanatory power (R^2 = .93). The carcass characteristics parameter estimates are consistent with previous findings in the literature (Feuz et al. 1993). The treatment effect dummy variable is positive and highly significant. This result indicates that early weaning does have a positive effect on carcass revenue ($19.68) relative to normal weaned steers once other influences are accounted for. This finding is consistent with the LS means result that normal weaned steers had a higher level of per head carcass revenue than early weaned steers once you consider that carcass weight explains 82% of the variability in the regression equation. Evaluating the LS means result in light of the regression result indicates that the weight differential between early and normal weaned steers dominates the positive effect of the early weaning treatment on revenue. This suggests that early weaning will also have a positive effect on carcass revenue if early weaned calves are sold at heavier weights. Adjusting the background regime for early weaned steers to maximize profitability is an issue currently under investigation.

Next, per head total feedlot cost is regressed on calf feedlot performance variables (feed efficiency, total weight gain, vet treatment, days on feed), along with dummy variables to capture the weaning treatment effect and the two confounding effects (year, location). The OLS results are presented in Table 4. The estimated OLS regression has excellent explanatory power (R^2 = .948). All of the parameter estimates have the expected sign and are significant except the year dummy variable. Focusing on the treatment effect, early weaned steers, on average, have a $23.85 total cost advantage relative to normal weaned steers. Another interesting result is the effect of an animal being pulled for medical evaluation. Regression analysis reveals that if an animal is

pulled, its total feedlot cost increases by $21.57. Subtracting average medical cost of $15.14 (Table 1) from of $21.57, you have an increase of $6.43 in total cost due to lost productivity in the feedlot. Vigilant health management is an important key to increasing profitability.

Additional Benefits of Early Weaning for Herd Management

Preliminary evidence of an early weaning effect on herd management suggest a positive benefit for cow health and pasture carrying capacity relative to normal weaning. The pasture management data was collected at the NDSU Dickinson Research Extension Center. Currently, research on the effect of early weaning on pregnancy rates, grazing intensity rates, and the economic benefits to the cow/calf production system of increasing those rates is ongoing.

With respect to carrying capacity, the data indicate that forage disappearance for cows that had calves weaned early was 803 kg per ha, whereas forage disappearance for the normal weaning treatment group that nurse their calves an additional 75 days was estimated at 1109 kg per ha. This preliminary result suggests early weaning reduced forage disappearance by approximately 28%.

The research protocol selected cow body weight and cow body conditioning score as the proxies for cow health. Normal and early weaning treatment cows were weighed and evaluated to determine their body condition score (BCS) in August and November (Table 5). Cows in the early treatment group, on average, gained 16 pounds and their BCS score improved from 5.18 to 6.09.[3] Cows in the normal treatment group, on average, lost 137 pounds and their average BCS declined from 5.26 to 4.70. These preliminary results suggest that early weaning may provide potential economic benefits

to producers by increasing the production efficiency of their cow/calf production system relative to the traditional alternative of normal weaning.

Summary

The economic and statistical analysis of the data from the two-year early weaning study conducted in the western Dakotas reveals that early weaning has the potential to increase profitability of slaughter steers relative to normal wean steers. Early weaning provides a cost efficiency advantage resulting from improved feed efficiency, but early weaned steers are at a disadvantage due to lower slaughter weights and subsequent lower carcass revenue per head relative to normal weaned steers.

Preliminary results also suggest that early weaning has the potential to increase the efficiency of a producer's cow/calf production system. Our research indicates that early weaning improves pasture carrying capacity and cow health. Increased stocking rate and the potential to improve reproductive rates will contribute to the producer's bottom line. However, additional research is needed to determine if these positive system effects can offset the lower slaughter weights.

Calf health also seems to be an important variable in determining profitability. The regression results revealed that when an animal is pulled for medical reasons, total cost increases by almost 10%. The LS means analysis indicated that 71% of the early weaned steers had been pulled at least once for vet care, as compared to only 44% of the normal weaned steers, which further validates the importance feedlot entry age has on the incidence of feedlot disease events requiring intervention. Illness affects feed efficiency and average daily gain, as well as total feedlot cost. The cost associated with diminished

feedlot productivity is estimated to average approximately $6.43 per head for the 184 steers in our study.

Steers in this study were subjected to an aggressive animal health management program that included pre- and post-weaning vaccination and early disease detection in the feedlot. Aggressive early detection and treatment with long-acting new generation antimicrobials reduced death loss among early weaned steers, but treatment cost directly related to calf age averaged $3.09 higher per head relative to normal weaned steers. Backgrounding early weaned steers longer may be one solution for reducing medical cost and lost productivity in the feedlot.

Results from this case study imply that post-weaning growth can be managed very effectively and that early weaning can be used as a management tool during periods of low precipitation when cattlemen are forced to separate calves from their mothers. The data also implies that early weaning efficiencies can be effectively captured and used during periods of adequate precipitation as a means to increase stocking rate or renovate previously overgrazed pastures.

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Table 1: Summary Statistics

Variable	N	Mean	Standard Deviation
Frame	184	4.3690	1.1829
ADG	184	3.2612	0.4995
QG	184	2.8587	0.5031
YG	184	2.6524	0.5507
REA	184	12.3875	1.4947
HCW	184	714.6467	85.7827
Location: ND=1	184	0.6196	0.4868
Vetcharge ($)	184	15.1364	15.3965
Calfvalue (CREV)	184	650.7671	83.2567
Inwt	184	643.0435	110.0892
finwt	184	1142.08	131.8298
DOF (days on Feed	184	154.7935	41.9296
feedeff	184	5.4199	0.8689
fatdp	183	0.4843	0.1339
Age at slaughter	184	389.7119	41.4163
Treatment: Early=1	184	0.5326	0.5003
Carcass Revenue (SREV)	184	972.7121	133.0521
Feedlot Revenue (FLREV)	184	708.69	105.06
Acct Profit (AP)	184	57.9246	93.6035
Rate of Return (%RET)	184	0.0957	0.1459
feedlotentage	184	234.9185	45.5268
feedlotgain	184	499.0380	132.2468
TOTCOST	184	264.0205	79.0646
avgcostday	184	1.7189	0.2705
avgcostlb	184	0.5338	0.0976
Vet: pulled=1	184	0.6257	0.4852
Dressing percent	184	62.5906	2.5807

Table 2. Three-Way ANOVA: Testing for Treatment Effect with Location and Year as Confounding Affects.[a]

	Weaning Date		HO: $LSM_E = LSM_N$	Interaction Effect Treatment and :	
Variables of Interest	Early LS MEAN N=98	Normal LS Mean N=86	P Value Pr> |t|	Year F-Stat Pr>F	Location F-Stat Pr>F
Carcass Rev per head (SREV)	$954.47	$1010.00	.02	NS	NS
Calf Market Value per head	$665.13	$724.88	.01	0.01	NS
Total Cost per head	$263.61	$252.93	.44	NS	NS
Feedlot Revenue pre head	$690.76	$757.28	.01	0.01	NS
Acct Profit per head	$23.26	$37.39	.28	0.01	0.06
Return on Investment per hd	4.30%	5.70%	.49	0.01	0.04
Total Feedlot Gain lbs.	521.25	423.94	.01	0.01	0.08
Avg Daily Gain lbs per day	3.214	3.209	.95	NS	0.01
Feed Efficiency	5.11	6.27	.01	0.01	0.01
Medical Cost per head	$16.22	$13.13	.24	NS	NS
Proportion of Steers Pulled for Med (VET)	0.71	0.44	.01	NS	NS
Avg Feedlot Cost per day	$1.60	$1.91	.01	.03	NS
Avg Cost per lb. Gained	$0.50	$0.62	.01	0.01	0.02
Yield Grade	2.668	2.674	.95	NS	NS
Quality Grade	2.95	2.81	.06	NS	NS
Fed Depth (inches)	.486	.50	.55	NS	0.10
Frame Score	3.71	4.70	.01	0.2	0.03
Hot Carcass Weight	690	743	0.01	NS	NS
Dressing Percentage	63.11%	62.67	0.31	0.05	NS
Feedlot Entry Age (days)	195	274	.01	0.10	0.01
Feedlot Entry Weight	578	748	.01	0.01	0.06
Days on Feed	164	133	.01	0.01	NS
Slaughter Age (days)	358	408	.01	0.01	0.02
Finished Live Weight	1094	1186	.01	NS	NS

a. NS denotes not significant.

Table 3: OLS Estimates:
Dependent Variable: Carcass Sales Rev (SREV)
GLOBAL F TEST STAT = 332.56 P-VALUE= .01
REG RSQ = 0.938 ADJ RSQ = 0.935
Number of Obs. =184

Variables	DF	Parameter Estimate	Standard Error	T Statistic	P Value
Intercept	1	262.77	65.87	3.99	0.01
Quality Gr	1	-83.70	5.31	-15.74	0.01
Yield Gr	1	-21.69	4.89	-4.43	0.01
HCW	1	1.28	0.03	36.78	0.01
%Dress	1	-0.19	1.07	-0.80	0.86
Treatment	1	19.68	5.41	3.64	0.01
Year	1	43.12	6.62	6.51	0.01
REA	1	6.16	2.03	3.03	0.01
Location	1	4.74	5.74	0.83	0.41

1) A test for heteroscedasticity was performed [Newbold (1995)] and its presence was not detected.
2) Variance Inflation Factor analysis indicated that there was no significant evidence of multicollinearity in the model.
3) SAS (2002) software was used to conduct the statistical analysis.

Table 4: OLS Estimates:
Dependent Variable: Total Cost
GLOBAL F TEST STAT = 464.83 P-VALUE= .0001
REG RSQ = 0.948 ADJ RSQ = 0.946
Number of Obs. = 184

Variables	DF	Parameter Estimate	Standard Error	T Statistic	P Value
Intercept	1	-153.24	11.63	-13.17	0.01
Vet	1	21.57	3.07	7.03	0.01
Feed Eff	1	23.12	1.91	12.10	0.01
Days on Feed	1	0.49	0.08	6.13	0.01
Total Gain	1	0.44	0.021	19.94	0.01
Treatment	1	-23.85	3.85	-6.20	0.01
Year	1	3.43	3.94	0.87	0.39
Location	1	-5.67	3.20	-1.77	0.08

1) VET is a dummy variable. If VET=1 then the animal incurred a vet charge, otherwise Vet=0
2) A test for heteroscedasticity was performed [Newbold (1995)] and its presence was not detected.
3) Variance Inflation Factor analysis indicated that there was no significant evidence of multicollinearity in the model.
4) SAS (2002) software was used to conduct the statistical analysis.

Table 5. Cow Performance Summary Statistics

Variable/Treatment	Early Weaning Cows: n=88		Normal Weaning Cows: n =87	
	Mean	Standard Deviation	Mean	Standard Deviation
Aug Cow Wt.	1298.58	119.87	1335.36	121.47
Nov Cow Wt.	1314.15	125.00	1198.25	134.55
Aug BCS	5.18	0.94	5.26	1.01
Nov BCS	6.09	0.96	4.70	1.24

Endnotes:

1. For a more detailed discussion of the experimental design of the two-year study see Landblom et al. (2006). The carcass acronyms are defined as follows: a) HCW is hot carcass weight, b) QG is quality grade, c) YG is yield grade, d) %Dress is carcass dressing percentage, e) REA is rib-eye area.

2. The use of carcass characteristics to explain per-head revenue variability is a common approach in the ag-econ literature. For example see Feuz et al. (1993).

3. For a comprehensive discussion of the methodology for determining body conditioning scores for beef cows see Eversole et al. (2000).