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Asymmetric Value of Preconditioning Programs for Feeder Cattle

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Preconditioning includes management practices at the ranch to improve health and nutrition of calves, thus adding value to calves for buyers. Preconditioning is not new but has received considerable attention in recent years with interest in value-added programs for cow-calf producers, beef quality assurance programs, and strategic alliances in the beef industry.

One example of a preconditioning program is a VAC-45 program developed at Texas A&M University. This program requires a 45-day post-weaning phase with proper nutritional program, specified animal health program, dehorning, castration, and bunk feeding. The purpose is to reduce stress from shipping calves at weaning, improve the immune system, and boost performance in the feedlot.

Preconditioning is aimed at reducing industry costs for treating sick calves, estimated to be $35 per head annually (Lalman and Smith). However, preconditioning costs cow-calf owners considerably more than selling calves at weaning, about $60 per head. King found that preconditioned cattle sold through Superior Livestock auctions received a $3.33/cwt. premium compared with cattle not preconditioned. Thus, there is evidence buyers are willing to pay some premium for preconditioned calves, but by itself, not enough to cover preconditioning costs.

Two questions persist regarding preconditioning. Are buyers of preconditioned feeder calves paying a price premium close to the performance benefits they accrue from feeding and harvesting preconditioned calves? Is there information asymmetry in the value to the buyers compared to the premium they pay? This paper reports results of a two-pronged effort to address these questions.

Relevant Literature

Relevant research includes studies on price differentials for feeder cattle traits, production differences for healthy and preconditioned calves, and factors affecting cattle feeding profitability.

Feeder Cattle Price Differences

Considerable research has estimated the market value for various traits of feeder cattle (Buccola; Faminow and Gum; Lambert et al.; Marsh; Schroeder et al. 1988; Smith et al.; Troxel et al.; Turner, Dykes, and McKissick). Preconditioning affects traits such as weight, condition, horns, sex, and health, but not others, such as breed, frame size, and muscle thickness. Those traits affected by preconditioning will be discussed but not those unaffected.

Weight – Research consistently indicates prices decline as feeder cattle weight increases. Buyers typically pay lower prices for 500-600 lb. feeder cattle than for 300-400 lb. feeder calves. Preconditioning results in marketing heavier calves than when sold at weaning. Thus, cow-calf producers can expect lower prices for preconditioned calves due to heavier weights *ceteris paribus*. Some of this lower expected price may be offset by the seasonal price component associated with most preconditioning programs. Since preconditioning programs are geared toward spring calving programs, instead of selling calves at weaning in mid-October, for example, calves would be marketed 45 days later, in early December. The typical seasonal price pattern for feeder calves in many parts of the U.S. involves a higher price in December than October. Thus, preconditioning may enable cow-calf producers to capitalize on the normal seasonal price pattern for feeder calves.

Sex – Previous research also consistently shows significant price differences among steers, heifers, and bulls. Buyers typically pay higher prices for steers when compared to heifers and bulls. Therefore, to the extent that cow-calf producers sell bull calves at weaning vs. steers after preconditioning, they can expect higher prices for castration.

Horns – Feeder cattle with horns normally receive discounts when compared to polled cattle and often compared with dehorned cattle. Therefore, to the extent cow-calf producers market preconditioned, dehorned calves vs. horned calves at weaning, they can expect higher prices from dehorning calves.

Condition – Condition of cattle can significantly affect feeder cattle prices. However, the degree of price differences varies by time of study and market conditions. Sometimes thin cattle are discounted, especially if there is evidence of thinness being related to poor health or muscling. However, if associated with poor nutrition, thin cattle may receive a small premium, expecting compensatory gains after improving the nutritional level. Fleshy cattle are often discounted, recognizing that no compensatory gains are likely. However, in some cases, fleshy cattle are preferred as long as the degree of fleshiness in not larage and it is associated with health or thriftiness. Preconditioned calves typically have a high degree of nutrition and may appear fleshy. Thus, a small discount may result from marketing preconditioned calves due to their condition. Alternatively, some buyers may associate the increased fleshiness with higher nutrition and health and may pay a small premium for preconditioned calves.

Health – A survey of cattle feeders with a one-time capacity of 1.8 million head discovered that health was the most important feeder cattle trait (Northcutt et al.). Of all characteristics, health often has the most profound effect on price (S.C. Smith et al.; Schroeder et al. 1988; Troxel et al.). Preconditioned calves are expected to be healthier, less stressed, and have stronger immune systems than calves sold at weaning. Therefore, cow-calf producers should expect a price premium for preconditioned calves.

Preconditioning Effects – One study by King of Superior Livestock auctions found premiums of $3.33/cwt. for preconditioned calves. However, most cow-calf producers do not precondition calves, in part because price premiums fail to cover the added costs of preconditioning. There are several preconditioning programs and sponsoring organizations. Some may have misled producers into expecting large price premiums for their preconditioned calves. Often, producers enrolling in these programs have experienced lower-than-expected price premiums, especially for the first few years as the program builds a reputation (Turner, McKissick, and Dykes; Stough). These programs must be given time to develop a reputation with buyers. Buyers of these cattle offer premiums for what they feel is the quality of the cattle, plus the confidence they have that producers treated the animals according to the specified program (Lawrence and Yeboha).

Effect of Health on Feedlot and Carcass Performance

Bovine respiratory disease is estimated to have cost the industry nearly $624 million in 1991 alone (Gardner et al.1999). Morbidity was found to be dependent on immunity as 98% of non-vaccinated cattle became infected compared to 20% of vaccinated calves (Nyamusika et al.). A study by Gardner et al. (1996) found medical costs to have the largest influence on profitability of all performance traits.

The Texas A&M Ranch to Rail program found that the treatment of sick feeder calves from 1992 through 2000 cost from $20.76 to $37.90/head and added $4.15 to $7.58/cwt. to the cost of gain (Smith). Calves not treated gained 0.09 to 0.39 more per day then calves treated once and 0.40 to 1.21 greater average daily gain (ADG) than calves treated more then once (Smith). The Gardner et al. (1999) study found more then 14 pounds reduced weight gain for each day that calves were held in the hospital.

Nyamusika et al. found that through the use of vaccination and treatment for sickness, the return to vaccination was $44/head. A study by one large cattle feeding firm compared 1166 non-preconditioned calves with 1180 preconditioned calves. The benefit of the preconditioned calves was found to be $11.04/cwt.or $60.72/head (Cravey). Healthy calves in the Texas A&M ranch to rail program had returns of $61.23/head while sick cattle realized losses of $31.97/head (McNeill). Gardner et al. (1999) found cattle with no lung lesions returned $732/head while cattle with inactive lung lesions returned $72.22 less than cattle with no lesions and cattle with active lung lesions $75.88 less than cattle without lesions. Carcass value was found to be reduced by $4/head for cattle treated once and $15/head for cattle treated twice or more compared with calves not treated (Stovall et al.)

As the industry moves towards grid pricing, keeping cattle healthy becomes more important. The biggest finding the Texas A&M Ranch to Rail study found was the impact health had on the ability of cattle to express their genetic potential and the cost of sick cattle due to carcass performance (McNeill). When calves become sick during the feedlot phase of production, the percent Choice grade carcasses was reduced by 7 to 19% (Smith). In a study by Stovall et al. it was found that heifers treated once yielded 6.8% fewer Choice carcasses and if treated twice or more yielded 25.1% fewer Choice carcasses than those not treated. Cattle with inactive lung lesions yielded 8.1% fewer Select carcasses and 9.4% more Standard carcasses then steers without lesions, while cattle without lesions yielded 19.6% more Select and 24.7% fewer Standard carcasses than calves with active lung lesions (Gardner et al. 1999).

Factors Affecting Cattle Feeding Profits

Several studies have investigated factors affecting cattle feeding profitability (Lawrence, Wang, and Loy; Langemeier, Schroeder, and Mintert; Schroeder et al.1993). A few factors consistently affect profitability, i.e., feeder and fed cattle prices, cattle performance, and carcass characteristics. In most studies, the factor having the largest effect on profit was fed cattle price. Second most important in most studies was feeder cattle purchase price.

At lighter placement weights, corn prices, feed efficiency, and interest rates gained importance due to the longer feeding period (Lawrence, Wang, and Loy). As placement weight increases, feeder cattle cost increases while interest and feed cost decrease (Langemeier, Schroeder, and Mintert). The influence of ADG on profitability typically increased with placement weight and increased ADG led to increased profitability. Increased feed conversion resulted in higher cost of gain, lower ADG, and decreased profits.

Summary

Preconditioning affects several feeder calf traits that in turn affects prices paid and received for feeder calves. Several of these could be lumped together into a single category, improved health. Research has shown the importance of feeder cattle health to feedlot and carcass performance. In turn, feedlot and carcass performance are among the key factors affecting profitability of fed cattle. Therefore, it is important to study the economic implications of preconditioning programs on the beef industry.

Price Premium Data and Procedures

One component of this study was to estimate the market price premium for preconditioned calves. The price for a given lot of feeder cattle can be expressed as

(1) *Price = f (FCT, MRF)*

where FCT are sets of feeder cattle traits and MRF are market-related factors. The focus of this research is on the coefficients related to preconditioned feeder calves relative to non-preconditioned calves. Two data sets were studied.

Time Series Data

Data were collected on preconditioned and regular monthly sales in Joplin, Missouri at the Joplin Regional Stockyards from December 1997 to March 2001. Data consisted of 1333 sale lots grouped and reported by the United States Department of Agriculture (USDA) market news service for each sale. Information for each sale included sale type, month, year, sex, class of cattle, number of head, condition, average weight, and average price. The feeder cattle weight range was limited to 300 to 699 pounds. Data were aggregated into like lots of fifty-pound weight groups by the USDA. Thus, while the term sale lot is used here, technically each observation is an aggregation of cattle in a given weight group.

Cross Section Data

The second data set also came from the Joplin Regional Stockyards. However, data were collected from two preconditioned and one regular monthly sale on three consecutive days in December 2000. Data were recorded by a trained evaluator on a wide range of feeder cattle characteristics. Data consisted of sale type, number of head, sex, breed, presence of horns, frame score, muscle thickness, fill, condition, uniformity, health, weight, and price for each lot. Feeder cattle weights were limited also to 300 to 699 pounds. Note with this data set, each observation is one sale lot transaction.

Price Premium Models

Models were specified to estimate the premium buyers paid for preconditioned calves at special preconditioned sales compared with regular monthly sales. Two hedonic price models were specified, i.e., the price of a given lot was dependent on attributes of the cattle and sale lot characteristics (Chvosta, Rucker, and Watts).

The model for the time series data was

(2) Price = f (Head, Head2, AvgWt, AvgWt2, Sale, Sex, Month-Year,
Frame, Condition)

where Price is feeder cattle price, Head is number of head in the sale lot, AvgWt is average weight of the lot, Sale is sale type, Sex is sex of the cattle, Month-Year are month and year interaction for sale dates, Frame is frame score, and Condition is degree of flesh. Variables chosen were common to similar models estimated in previous research discussion above. The model was estimated using the REG procedure in SAS (SAS Institute). One variable from each set of dummy variables (sale type, sex, month-and-year interaction, class, and quality) was dropped to properly estimate the model. The variables dropped will be denoted subsequently as the base variables for comparison.

The sale type dummy variable was used to represent the different sale types. The preconditioned sale variable was compared with the regular monthly sale to measure the premium received for preconditioned calves.

The second model estimated was

(3) Price = f (Head, Head2, AvgWt AvgWt2, Sale, Sex, Breed, Horns, Frame
Muscle, Fill Condition, Health, Uniformity)

where Price is feeder cattle price, Head is number of head in the sale lot, AvgWt is average weight of the lot, Sale is sale type, Sex is sex of the cattle, Breed is dominant or identifiable breed of the cattle, Horns is the status of horns, Frame is frame score, Muscle is muscle thickness, Fill is gut fill, Condition is degree of flesh, Health is health condition, and Uniformity is uniformity of the lot. Again, variables chosen were similar to those in previous research. The model was estimated using the REG procedure in SAS. To estimate it properly, one variable from each group (sale, sex, breed, horns, frame, muscle, fill, condition, health, and uniform) was dropped and served as a base for comparison. The base variables will be so noted in subsequent discussion.

The group of three dummy variables for sale type was used to determine the difference between preconditioned and non-preconditioned calves. There are two variables to represent two different preconditioning programs. The first preconditioned calf sale (Precon1) is expected to generate higher premiums due to it having a single preconditioning protocol for its program. The second preconditioning calf sale (Precon2) offers several alternative protocols.

Performance and Profitability Data and Procedures

A second component to this study was to assess the effects preconditioning had on feedlot and carcass performance and on profitability. Performance for a given lot of feeder cattle can be expressed as

(4) $$Performance = f\,(FCT, MRF)$$

where FCT are sets of feeder cattle traits and MRF are market-related factors. Similarly, cattle feeding profitability can be described as

(5) $$Profit = f\,(FdrCP, PERF, FdCP)$$

where FdrP is feeder cattle price, PERF are performance factors, and FdCP is fed cattle prices. Two sets of data were obtained for this portion of the study.

Feedlot Manager Survey

A survey instrument was mailed to 89 managers of Texas Cattle Feeders Association member feedlots. Managers were asked to estimate performance differences between preconditioned calves and non-preconditioned calves. Performance measures included percent sick, percent dead, ADG, feed conversion, percent choice and percent "outs". Managers were also asked their opinion on how much premium (if any) should preconditioned calves receive. Seventeen responses were received (19.1%).

Feedlot Closeout Data

Closeout performance and economic data were collected from a commercial feedlot in the Texas Panhandle. Data were for feeder cattle placed on feed between 500 and 699 pounds, with placement dates from October to March and harvest dates between June to September in 2000 and 2001. Cattle coded as preconditioned were compared with other purchase backgrounds, i.e., cattle off grass, sale barn low risk, and sale barn high risk.

Performance and Profitability Models

Several hedonic type performance models were estimated via OLS regression. Models took the general form of equation (4) above. Specific models are not shown here for space reasons. Performance models were estimated for percent death loss, ADG, conversion, medicine costs, and cost of gain. Feeder cattle attributes common to each model included placement weight, sex, flesh condition, inbound shrink, quality score, and breed. Market factors common to each model included placement month and year, geographic region of origin, and purchase background. Appropriate performance measures were included as independent variables in models explaining variation in another performance measure.

The profit model was

(6) Profit = f (Placement weight, Sex, Flesh, Shrink, Breed, Quality, ADG, Conversion, DaysFed, Death%, Placement month, Placement year, Region of origin, Purchase background, Medicine cost, Feed cost, Miscellaneous cost, Feeder cattle price, Fed cattle price, %Choice, %Yield grade1-2)

where Profit is average profit per head for the sale lot, Placement weight is the average weight of feeder cattle when placed on feed, Sex is sex of cattle in the lot, Flesh is the condition of cattle when placed, Shrink is the inbound shrink percentage, Breed are several breed categories, Quality is a frame and muscling grade assigned to the cattle, ADG is average daily gain, Conversion is feed efficiency, DaysFed is number of days on feed, Death% is percentage of cattle in the pen that died while in the feedlot, Placement month and Placement year placement dates, Region of origin was the purchase location of the cattle (Missouri, Oklahoma, and four regions in Texas), Purchase background was the variable of primary interest in this model, Medicine cost was cost of treating sick animals, Feed cost was the ration cost, Miscellaneous cost was interest and other costs, Feeder price was the purchase price of the lot, Fed cattle price was the reported price when cattle were slaughtered, %Choice was the percentage of Choice grade carcasses in the lot, %Yield grade 1-2 was the percentage of carcasses in the lot that yield graded 1 and 2.

Results

Time Series Data

The Breusch-Pagan test was used to test for heteroskedasticity and the null hypothesis of homoskedasticity was rejected. To alleviate the problem, Harvey's procedure was used to create weights for the Feasible Generalized Least Squares (FGLS) (Greene). Heteroskedasticity was attributed to the aggregated nature of sale lot data. The model had an adjusted R^2 of 0.942.

Results for most variables were consistent with previous research. An exception was lot size. The lot size variable was not significant. Again, data aggregation was the likely cause. Average lot size (recall each lot is an aggregation of individual sale lots by the market reporter) for this data set was 118 head, much unlike most public market data for individual lots.

Of primary interest was the sale type variable. Over the four-year period, preconditioned calves received a premium of $2.59/cwt. when compared to their non-preconditioned counterparts. Note that the preconditioned price is based upon two different preconditioning programs that are separated in the second data set. One program has a single, strict protocol while the second has several modifications of the vaccination and feeding program. This difference could explain the lower price premium for preconditioning compared with King.

Cross Secton Data

The model using data from three consecutive-day sales had an adjusted R^2 of 0.720. This model explained less of the variation in individual sale lot prices despite having more information about the characteristics of each lot. However, note that the standard deviation of price in the time series was $13.68/cwt. over a four-year period, whereas for the sequential data set, it was nearly as large ($12.26/cwt.) even though sales covered only three consecutive days. The Breusch-Pagan test rejected the null hypothesis of homoskedasticity. Harvey's procedure was used to produce weights for the FGLS estimates (Greene).

Coefficients for nearly all feeder cattle traits were consistent with previous research. The focus again was on the sale type variable. The premium price for the preconditioning program with a single protocol (Precon1) was $3.36/cwt. compared with the regular weekly auction. The second program (Precon2) generated premiums of $1.96/cwt. compared with the regular weekly auction. The lower premium for the second program could be attributed to having several different vaccination and weaning guidelines. Both results are consistent with other previous results; i.e., $3.33/cwt. by King and $1.98/cwt. by Turner, McKissick, and Dykes.

Feedlot Manager Survey

ANOVA and a paired t-test were conducted on the survey data. All comparisons between performance estimates for preconditioned calves and non-preconditioned calves were significantly different. Managers' estimated performance differences between preconditioned and non-preconditioned calves were economically important.

	Preconditioned calves	Non-preconditioned calves
% Sick	9.2	36.4
% Death loss	1.5	4.3
ADG (lbs/day)	2.9	2.6
Conversion (lbs/gain)	6.3	6.9
% Choice carcasses	50.4	35.8
% Outs	2.5	6.9

Overall, managers indicated that preconditioned calves were worth $5.25/cwt. more than preconditioned calves. Note that difference was higher than previous research and higher than estimates from the two data sets in this study. One reason for the difference may have to do with the reputation and integrity of preconditioning programs. Cattle feeders may pay up to the estimated premium if there was high perceived assurance and confidence that cow-calf producers followed the preconditioning protocol, thus resulting in performance differences the managers estimated. Without that assurance, cattle feeders will bear a portion of the risk by bidding less than the "true" or estimated value difference.

Performance and Profitability

All performance models and the profitability model were tested for heteroskedasticity with the Breusch-Pagan test and all failed to reject the null hypothesis. A Kolmogorov-Smirov test indicated all models failed to reject the null hypothesis of normally distributed errors.

Results for the performance models varied, some performing as expected and some performing poorly. Most discussion focuses on the effects purchase background had on performance and profitability.

Few variables were significant in explaining death loss percentage and many had incorrect signs. The adjusted R^2 was 0.537. Unexpectedly, sale barn high risk cattle had lower dead loss percent (2.91%) compared with preconditioned cattle. This was not expected, based on how feedlot managers perceived death loss differences for preconditioned and non-preconditioned cattle.

Results for the ADG model were significantly better, with an adjusted R^2 of 0.933. The coefficient on the sale barn high risk cattle was significant and positive. ADG for high risk cattle was 0.14 lbs./day higher than for preconditioned calves. This, also, was not expected, given responses from the feedlot managers.

The conversion model explained 86.2% of the variation in feed conversion. Sale barn low risk cattle had significantly lower conversion (0.14 lbs/gain) than preconditioned cattle. More significant differences were expected given the managers' survey responses.

The cost and profitability models resulted in more significant differences between purchasing backgrounds than the performance models. The medicine cost model had an adjusted R^2 of 0.842. Sale barn low risk cattle and grass cattle had slightly increased medicine costs ($0.32 and $0.21/cwt., respectively) compared with preconditioned cattle, while sale barn high risk cattle had much higher medicine costs (2.65/cwt.) compared with preconditioned cattle. This was in line with expectations. Perhaps the higher medicine costs for sale barn high risk cattle resulted in the lower death loss compared with preconditioned cattle.

The cost of gain model explained 84.9% of cost of gain variation. Sale barn low risk cattle had lower cost of gain ($1.19/cwt.) compared to preconditioned cattle while high risk cattle had considerably higher costs ($6.25/cwt.) and grass cattle had slightly higher costs ($0.72/cwt.). One factor significantly affecting cost of gain was medicine costs and recall that sale barn high risk cattle had the highest medicine costs.

The adjusted R^2 for the profitability model was 0.868. Given the importance of this model, some additional discussion is merited. Steers were $12.48 per head more profitable than heifers. For cattle origin, cattle purchased from Central Texas were significantly less profitable ($18.20/head) than others. Average daily gain was associated with increased profits, which was consistent with previous research. Higher feed conversion (lower feed efficiency) and longer time on feed both led to increased profits, unlike previous research. Increased medicine costs decreased profits ($7.05/head) and increased feed costs decreased profits ($6.54/head). Higher purchase prices for feeder cattle and heavier placement weights reduced profits by $5.71 and $0.11/head, respectively, whereas higher fed cattle prices increased profitability by $9.36/head. An increase in the percentage of Choice grade carcasses and yield grades 1 and 2 carcasses increased profits by $0.74 and $0.47/head, respectively.

Somewhat surprisingly, purchase background was not found to significantly affect profits. Yet, recall that managers indicated performance differences favored preconditioned calves and that those differences could be translated into higher prices ($5.25/cwt.) for preconditioned calves.

Summary and Conclusions

Two sets of market data were used to estimate the premium price paid by buyers for preconditioned calves. Using four-year time series data, the estimated premium for preconditioned calves was $2.59/cwt. For a second set of data, from three consecutive sales, two special sales and the regular public sale, the premium for preconditioned calves was found to be higher ($3.36/cwt.) for one preconditioning program and lower ($1.96/cwt.) for the other compared with the public sale. These premiums are relatively consistent with previous research.

Feedlot managers indicated in a mail survey a significant perceived performance difference favoring preconditioned cattle. Significant benefits were expected for death loss percentage, percentage of sick cattle, ADG, feed efficiency, and carcass traits, i.e., percent grading Choice and percent yield grading 1 and 2. Those differences, in turn, increased the value of preconditioned calves for feedlot managers by $5.25/cwt.

Analysis of feedlot closeout data failed to confirm all the survey findings. Performance results were mixed. There were differences in performance measures, but not always favoring preconditioned cattle. Preconditioned cattle had significantly lower cost of gain and medicine costs than sale barn high risk cattle, but lower ADG and higher death loss.

Unexpectedly, no significant differences were found in profitability among the purchase backgrounds. Given expected differences in performance, differences were expected in profitability, favoring preconditioned cattle.

One explanation for differences in the performance and profitability models than what was expected involves a potential data problem. No information was available as to the criteria for classifying cattle as high risk or low risk and the consistency of these classifications over time. Similarly, some preconditioned cattle were ranch preconditioned and some may have been purchased from a backgrounding lot. Performance benefits for the two methods of handling cattle prior to feedlot placement may confound results.

The initial hypothesis was that there was asymmetry of information on the benefits of preconditioning. It was thought that cattle feeders knew more clearly than cow-calf producers the performance and profitability differences associated with preconditioned calves, but that they did not pay price premiums closely representing those expected benefits.

Did the evidence from this study confirm or refute the hypothesis? A price premium was confirmed and of an amount comparable to previous studies. Feedlot managers confirmed the expectations of performance differences but feedlot closeout data did not strongly confirm those differences. Thus, it appears feedlot buyers pay what it takes to purchase preconditioned calves. That premium may be less than the expected value of preconditioned calves, but the evidence of such is not strong from this research. Potential data problems may have confounded the findings. A controlled experiment is needed to determine the benefits preconditioning has for cattle feeders. Specific data analysis for alternative preconditioning programs and protocols may also be of value.

References

Buccola, Steven T. "An Approach to the Analysis of Feeder Cattle Price Differentials." *Amer. J. Agr. Econ.* 62(1980):574-80.

Chvosta, J., R. R. Rucker, and M. J. Watts. "Transaction Costs and Cattle Marketing: The Information Content of Seller-Provided Presale Data at Bull Actions." *Amer. J. Agr. Econ.* 83(2001):286-301.

Cravey, Matt D. "Preconditioning Effect on Feedlot Performance." Paper presented at Southwest Nutrition and Management Conference, Phoenix, AZ, 1996.

Faminow, M. D., and R. L. Gum. "Feeder Cattle Price Differentials in Arizona Auction Markets." *West. J. Agr. Econ.* 11(1986):156-163.

Gardner, B.A., H.G. Dolezal, L.K. Bryant, F.N. Owens, and R.A. Smith. "Health of Finishing Steers: Effects on Performance, Carcass Traits, and Meat Tenderness." *J. Anim. Sci.* 77(1999):3168-3175.

Gardner, B.A., S.L. Northcutt, H.G. Dolezal, D.R. Gill, F.K. Ray, J.B. Morgan, and C.W. Shearheart. "Factors Influencing Profitability of Feedlot Steers." Anim. Sci. Res. Rep. P-951:164, Oklahoma State, Stillwater, OK, 1996.

Greene, William H. *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall, 2000.

King, M. E. "The Effects of Value Added Health Programs on the Price of Beef Calves Sold Through 13 Superior Livestock Auctions in 2000." Final Report. Pfizer Animal Health, Exton, PA, 2001.

Lalman, D., and R. Smith. "Effects of Preconditioning on the Health, Performance, and Price of Weaned Calves." Okla. Agri. Exp. Sta. Exten. Fact Sheet F-3031. Oklahoma State, Stillwater, OK, 2001.

Langemeier, M.R., T.C. Schroeder, and J. Mintert. "Determinants of Cattle Feeding Profitability." *S. J. Agr. Econ.* 24(December 1992):41-48.

Lambert, C. D., M. S. McNulty, O.C. Gruenwald, and L. R. Corah. "An Analysis of Feeder Cattle Price Differentials." *Agribusness*, 5(1989):9-23.

Lawrence, J.D., Z. Wang, and D. Loy. "Elements of Cattle Feeding Profitability in Midwest Feedlots." *J. Agr. App. Econ.* 31,2(August 1999):349-357.

Lawrence, J.D., and G. Yeboha. "Estimating the Value of Source Verification in Iowa Feeder Cattle Markets." A.S. Leaflet R1725, 2000 Beef Res. Rep., Iowa State, Ames, IA 2000.

Marsh, John M. "Monthly Price Premiums and Discounts Between Steer Calves and Yearlings." *Amer. J. Agr. Econ.* 67(1985):307-14.

McNeill, John W. "Value Added Calves." Available at http://animalscience-extension.tamu.edu/frameset.html, 1999. Accessed January 15, 2002.

Northcutt, S.L., B.A. Gardner, H.G. Dolezal, N. Torrance, and D.R. Gill. "Survey of Cattle Feeders: Feeder Cattle Specifications for the Twenty-First Century." Anim. Sci. Res. Rep. P-951: 189, Oklahoma State, Stillwater, OK, 1996.

Nyamusika, N., T.H. Spreen, O. Rae., and C. Moss. "The Bioeconomic Analysis of Bovine Respiratory Disease Complex." *Rev. Agr. Econ.* 16(1994):39-53.

SAS Institute. 2000. SAS^{TM} system under Microsoft Windows. Release 8.1. SAS Institute Inc., Cary, North Carolina

Schroeder, T.C., J. Mintert, F. Brazle, O. Grunewald. "Factors Affecting Feeder Cattle Price Differentials." *West. J. Agr. Econ.* 13(1988):71-81.

Schroeder, T.C., M.L. Albright, M.R. Langemeier, and J. Minter. "Factors Affecting Cattle Feeding Profitability." *J. Amer. Soci. Farm Mgrs. Rural Appra.* 57:1(May 1993):48-54.

Smith, Robert A. “Effects of Feedlot Disease on Economic, Production, and Carcass Value.” *The Amer. Assoc. Bovine Practioners.* 34(2000):125.

Smith, S. C., D. R. Gill, C. Bess III., B. Carter, B. Gardner, Z. Prawl, T. Stovall, J., Wagner. “Effect of Selected Characteristics on the Sale Price of Feeder Cattle in Eastern Oklahoma.” Okla. Agri. Exp. Sta. Exten. Fact Sheet. E-955Oklahoma State, Stillwater, OK, 2000.

Stough, Jann. “The Preconditioning Puzzle.” *Drovers Journal.* 127:8(1999):20-21.

Stovall, T.C., D.R. Gill, R.A. Smith, and R.L. Ball. “Impact of Bovine Respiratory Disease During the Receiving Period on Feedlot Performance and Carcass Traits.” Anim. Sci. Res. Rep. P-980:82, Oklahoma State, Stillwater, OK, 2000.

Turner, S.C., N.S. Dykes, and J. McKissick. “Feeder Cattle Price Differentials in Georgia Teleauctions.” *So. J. Agr. Econ.* 23(1991):75-84.

Turner, S.C., J. McKissick, and N.S. Dykes. “Reputation Selling in Feeder Cattle Teleauctions.” *Rev. Agr. Econ.* 15:1(1993):9-19.

Troxel, T.R., S. Gadberry, S. Cline, J. Foley, G. Ford, D. Urell, R. Wiedower. “Improving the Value of Feeder Cattle.” University of Arkansas Cooperative Extension Service.