PEER REVIEWED

Estimating the Effects of Animal Health on the Performance of Feedlot Cattle

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Abstract

It is generally accepted that performance of feedlot cattle is negatively impacted as health problems increase. The magnitude of impact that health problems have on overall or specific performance parameters is not well defined for feedlot cattle. This study determined the effect of animal health on the performance of feedlot cattle. Multiple regression models were developed to aid in the performance analysis for feed conversion, average daily gain, added cost and cost of gain.

Results of this study showed that for each percentage increase in mortality in a pen of cattle the feed conversion ratio increased by 0.27 pounds (lb) (0.12 kg), the average daily gain decreased 0.08 lb (0.036 kg) per day and added costs increased $1.00 per head. For each percentage increase in treatments for a pen of cattle, death loss increased by 0.143%. A 10% treatment rate would equate to a 1.7% death loss.

These data should be useful to estimate performance of fed cattle. The study confirms and quantifies the negative effect of adverse health on fed-cattle performance.

Résumé

On croit généralement que la performance des bovins en parc d'engraissement diminue avec l'augmentation des problèmes de santé. Chez les bovins en parc d'engraissement, l'amplitude des retombées de ces problèmes de santé au niveau des indices de performance généraux ou ciblés n'est pas bien établie. Cette étude avait pour but de déterminer l'effet de la santé animale sur la performance chez les bovins en parc d'engraissement. Des modèles de régression multiple ont été utilisés dans l'analyse de la performance pour la conversion alimentaire, le gain moyen quotidien, le coût accru et le coût du gain.

Les résultats indiquent que pour chaque augmentation d'un pourcent du taux de mortalité dans un enclos de bovins, il y avait une augmentation de 0.27 lb (0.12 kg) dans la conversion alimentaire, une diminution de 0.08 lb (0.036 kg) dans le gain moyen quotidien et une augmentation de $1.00 par tête des coûts accrus. Les pertes imputables à la mort augmentaient de 0.143% pour chaque augmentation d'un pourcent des traitements dans un enclos de bovins. Un taux de traitement de 10% serait l'équivalent d'une perte imputable à la mort de 1.7%.

Ces données devraient être utiles pour estimer la performance des bovins en engraissement. Cette étude a permis de confirmer et de quantifier les retombées négatives d'une mauvaise santé au niveau de la performance des bovins en engraissement.

Introduction

The cattle feeding industry in the United States is a capital intensive, high-risk business that relies heavily on economies of scale to minimize costs and maximize returns. Profit margins for fed cattle are often small and variable, while losses can be large. One tool cattle feeders utilize to manage economic risk is estimating the performance of fed cattle, then applying that information to cattle currently on feed or to future purchases of cattle.

Numerous variables affect performance of feedlot cattle. Some variables are more easily managed than others, such as purchase weight, origin of cattle, type or genetic makeup of cattle, and background. Health liabilities cattle may experience are more difficult to manage.

Several studies have provided benchmarks for health measurements within feedlots.[3,10,12,15,16] Average death loss for fed cattle has been reported to range from 1 to 1.3%,[3,10,12,16] with an average morbidity rate of 8%, which represented 16 years of records and over 7 million head of cattle.[3] The most frequent cause of illness in feedlot cattle is bovine respiratory disease (BRD).[3,12,15]

Estimated cost to treat fed cattle has also been reported. In a 1999 US Department of Agriculture survey, *The Health Management and Biosecurity of U.S. Feedlots: Part III*, the cost to treat sick cattle within a feedlot ranged from $16.49 per head to treat acute interstitial pneumonia to $6.14 for digestive disease.[15] In another study, a 10% morbidity rate was associated with a medicine cost of $2 for each animal marketed.[3]

A review of the literature reveals that there are important health concerns for feedlot cattle, with the most commonly reported disease being Bovine Respiratory Disease (BRD). There is a significant relationship between animals with lung lesions at slaughter, those treated for respiratory disease and decreased average daily gains. Additionally, it has been demonstrated that performance of feedlot cattle (average daily gain, feed conversion) has a significant effect on profitability.

Studies have evaluated the relationship between cattle with lung lesions at slaughter and/or treatment for respiratory disease and the associated effect on average daily gain (ADG).[2,4,5,6,7,17] Cattle with lung lesions associated with cranial-ventral bronchopneumonia had a 0.073 pound (lb) (0.03 kg) reduction in ADG.[2] Wittum *et al* evaluated treatment of cattle for respiratory disease and the associated weight gain and found no significant association between treatment of cattle for respiratory disease and weight gain. There was, however, a significant association between lung lesions found at slaughter and weight gain. Cattle with pulmonary lesions had 0.167 lb (0.075 kg) less ADG.[17]

Gardner *et al* reported a significant relationship between treating cattle and reduced gains. Cattle treated for respiratory disease averaged 19.8 lb (9 kg) less total gain than untreated cattle.[6] It has been noted that the total number of cattle with lung lesions at slaughter is much greater than the number of animals treated for respiratory disease while on feed.[2,6,17] Gardener *el al* reported that 37% of 102 head of untreated cattle had lung lesions at slaughter, while 48% of the treated cattle exhibited lung lesions. Wittum found lesions in 68% of untreated animals, and Bryant reported 47% of a group of calves had lung lesion at slaughter, with 17% of those calves diagnosed with respiratory disease.[2,6,17] These findings suggest there may be a significant number of animals with inapparent or subclinical respiratory disease, and treating clinically affected cattle may be inadequate to prevent significant production losses attributable to respiratory disease.[2,6,17]

Economic impact of respiratory disease in steers during the finishing period is significant. Gardener compared cattle with lung lesions and associated active or inactive lymph nodes to cattle with no lung lesions. Cattle without lung lesions had a $20.03 higher net return compared to cattle with lung lesions and inactive lymph nodes. Steers with lung lesions and active lymph nodes had $73.78 lower net return than cattle with no lesions.[4,5] Results from the 2000-2001 Texas A&M Ranch to Rail Program indicated healthy steers had an average profit of $176, while sick steers averaged $23 profit.[14]

Factors contributing to cattle feeding performance and profitability have been reported.[1,8,9,11,14] Fed cattle sales price, feeder cattle purchase price, corn prices, feed conversion (FC), ADG and interest rates all significantly contribute to profit of fed cattle. Price risk accounted for 85-95% of profit variability, and animal performance accounted for 5 to 10% of profit risk.

Variables that significantly impact the cost of gain for fed cattle are corn price, FC and ADG. These variables explained 92 to 94% of the variability in cost of gain (COG).[1] Another study concluded that in addition to input prices, output prices and animal performance, gender, placement weight, facility design, and to a lesser extent placement season, significantly impact cattle feeding profitability.[9]

There is limited data on the impact of disease on the performance of pens of fed cattle. While animal performance is not the major determinant of cattle feeding profitability, it does have an effect. This study focuses on effects of animal health on performance of feedlot cattle. More specifically, it attempts to quantify the effects of animal health on three measures of performance: FC, ADG and COG. These performance measures are used as benchmarks when comparing sets of cattle. They are often used when evaluating feedlots on their ability to feed cattle for maximum performance, least cost and highest net return.

Materials and Methods

Feedlot data were collected from customer close-out sheets from two western Kansas commercial feedlots. Data obtained from the close-out sheets included head count, gender, percent mortality, number of cattle treated, date in, date out, average head days, average in-weight, average out-weight, gain per head, FC (dry matter [DM] basis), ADG, COG, average feed consumption per head (DM basis), ration cost, added cost, origin and background. Data were collected for steers, heifers and mixed pens of cattle placed on feed from August 2000 through January 2001. The total number of pens was 673 (53,890 head): 332 pens of steers (26,061 head); 220 pens of heifers (18,828 head); and 121 mixed pens containing both steers and heifers (9,001 head).

Linear regression models were developed to analyze the data and develop statistics for FC, ADG, added cost (AC) and percent mortality (MORT).

EViews, developed by Quantitative Micro Software, was utilized to provide estimated coefficients and associated statistics for the multiple regression models.

Multivariate regression models were used,, represented by the following equation:

$$\mathbf{Y_i = \beta_0 + \beta_1 X_i + \beta_2 X_i + ... + \beta_n X_i + e_i}$$

where: $\mathbf{Y_i}$ is the dependent variable to be estimated, $\beta_0 ... \beta_n$ are the estimated regression coefficients, and $\mathbf{X_i}$ are the independent variables, with **i** representing a pen of cattle and $\mathbf{e_i}$ as the error term.[13]

Dependent variables were FC, ADG, AC and percent mortality (MORT). Pen-level data for the independent variables was obtained from close-out sheets from pens of fed cattle.

Independent variables for the FC, ADG and AC models were identical. These variables were MORT, average in-weight per head (AVIWT), average out-weight per head (AVOWT) and dummy variables. Dummy variables were gender of cattle within a pen—steers (ST), heifers (HFR) or mixed (MX); quarter of the year the pen of cattle were shipped, (Q1, Q2, Q3 and Q4); origin of the cattle, Kansas (KS), Oklahoma (OK), Texas (TX), Southeast (SE), or Northeast (NE); background of the cattle (sale barn, preconditioned, grass, or wheat); and the feedlot where the cattle were fed, yard 1 or yard 2. Default variables for the dummy groups were ST for the gender, Q1 for the quarter of the year the pen was shipped, KS for the origin, sale barn for the background variable, and yard 1 for the feed yard where cattle were fed. The independent variable for the percent mortality model (MORT) was percent treatments (TRT).

Models were evaluated by considering the sign on each estimated coefficient, evaluating the statistical significance for each estimated coefficient utilizing a t-statistic and probability value obtained from a two-tailed t test, looking at the coefficient of determination or (R^2) for each model, a measure of how well the independent variables explain the dependent variable, and utilizing an F-test to evaluate the significance of the groups of independent variables.

Feed conversion is defined as the amount of feed consumed per pound of gain, and is reported on an as-fed basis, or on a dry basis. In this study, FC on a dry basis was analyzed. Feed conversion was calculated by dividing the total amount of feed fed to a group of cattle by the total pounds gained by that group of cattle. It is reported in close-out sheets with deads-in or deads-out. In this study, FC with deads-in was evaluated.

Average daily gain is a measure of the average gain per day for cattle in a pen. Average daily gain was calculated by dividing average feed consumption per day by the feed conversion ratio. Average daily gain was evaluated on a deads-in basis.

Added costs include the cost of medicine to treat sick cattle, processing, metaphylaxis, yardage, association dues and insurance. Yardage, association dues and insurance are standard costs associated with each pen of cattle. Cost of medicine, processing and metaphylaxis will vary between pens. Close-out sheets sum added costs and feed costs to obtain the total cost for a pen.

Cost of gain is reported as the total cost (feed cost plus added cost) to produce one hundred pounds of live gain. It is reported as dollars per hundred weight of gain. Cost of gain is calculated by dividing the total cost for a pen of cattle while on feed by the total pounds of gain for that pen. Cost of gain is reported in close-out data with the death loss included (deads-in) or excluded (deads-out). In this study, the cost of gain is evaluated with death loss included (deads-in).

Percent mortality or death loss for a pen was calculated by dividing the number of cattle that died within a pen by the total number of cattle received for that pen. Percent treated was determined by dividing the number of cattle pulled and treated within a pen by the total number of cattle received for that pen. Each animal pulled and treated with one "round of therapy" and returned to the home pen before another regimen was administered was considered to have undergone one treatment. A round of therapy was defined as a treatment regime outlined by the veterinarian in charge, and usually involved an animal being treated or maintained in the hospital for three to four days, receiving a single round of treatment with a specific antibiotic before being sent back to its home pen. If an animal was returned to the home pen and subsequently re-pulled and retreated, that was considered a second treatment. If an animal was pulled and treated with two rounds of therapy before going back to the home pen, that was considered as one pull and one round of treatment. Cattle pulled as bullers were not considered in the data set.

To analyze the relationship between death loss and the individual measures of performance, FC, AC, or ADG, the individual models for FC, AC and ADG were utilized. To analyze the relationship between percentage of cattle treated and performance, two steps were involved. First the relationship between mortality and the percent of cattle treated within a pen was estimated utilizing the MORT model. Then values for percent mortality utilizing the MORT model were calculated for differing percentages of cattle treated within a pen. The second step was substituting the values calculated from the MORT model as the values for the percent mortality variable in the FC, AC and ADG models. Values obtained from these models were reported as the relationship between percent treatments, and FC, ADG and AC.

Evaluating the effects of animal health, (percent mortality, percent treatments) on cost of gain involved the AC, FC and MORT models and an Excel spreadsheet. The models provided inputs for feed conversion, added cost or death loss to a spreadsheet designed to represent a fed cattle close-out performance record. The spreadsheet performed the calculations to determine the associated COG. When evaluating mortality, COG was recalculated when inputs from the FC and AC model changed as percent mortality, an independent variable, was changed in these models.

To evaluate the relationship between percent treatments and COG, the MORT model was utilized along with the FC and AC models. The MORT model estimated the effects of treatments on mortality. The value for percent mortality from the MORT model provided a means to evaluate the effect of percent treatments on fed cattle performance. The percent mortality from the MORT model was substituted as the value for the percent mortality variable in the FC and AC models. The values obtained from the FC and AC models were then utilized as inputs into the COG spreadsheet. The values obtained from the COG spreadsheet reflected the COG associated with varying levels of treatment.

COG for a pen of fed cattle is reported as the total cost to produce 100 lb of live gain. Total cost for a pen of fed cattle is determined by adding two components, total added cost and total feed cost. The cost per ton of dry feed in this study was held constant at the mean cost per ton of dry feed ($143.83) obtained from the data set when determining total feed cost.

Results

The summary statistics for the pens of cattle used in this study may be found in Table 1 and Table 2. The average in-weight was 782 lb (355.4 kg) for steers, 701 lb (318.6 kg) for heifers and 785 lb (356.8 kg) for mixed pens. The average out-weight was 1299 lb (590.4 kg) for steers, 1183 lb (537.7 kg) for heifers and 1272 lb (578.2 kg) for mixed pens.

Multicollinearity was a problem in this study. There was a positive correlation (.678) between percent treatments and percent mortality. As the percent of treatments increases or decreases, the percent of cattle dying also increases or decreases. The more highly correlated two (or more) independent variables are, the more difficult it becomes to accurately estimate the coefficients of the true model.[13] To deal with the problem of multicollinearity, either percent mortality or percent treated was used as one of the independent variables, with no models utilizing both as independent variables.

Feed Conversion Model

The FC model had an R-squared of 0.56; the independent variables thus explained 56% of the variation in the dependent variable. Table 3 provides the estimated coefficients, their associated t-statistics and probability values for the FC model. A variable with a probability ≤0.05 was considered significant.

Signs for the estimated coefficients were as predicted, except for the sign on the coefficient for the heifer variable. Heifers were hypothesized to have a higher feed conversion ratio when compared to steers. The model estimated the heifer FC ratio to be -0.11 lb (-0.05 kg) lower than the FC ratio for steers, but the difference was not statistically significant.

Estimated coefficient for percent mortality was significant with a value of 0.27. For every percentage increase in mortality, keeping all other variables constant, the FC ratio increased by 0.27 lb (0.12 kg) of dry feed for each pound of gain.

Estimated coefficients for the average in-weight and the average out-weight were also significant. The FC ratio increased by 0.008 lb (0.0036 kg) for each pound of increase in the average in-weight, and decreased by 0.006 lb (0.0027 kg) for each pound of increase in the average out-weight. There was no significant difference in FC between the different genders. Cattle from the southeast had significantly smaller FC ratios, while cattle from the northeast had significantly higher FC ratios when compared to cattle originating from Kansas. The FC ratio for cattle shipped in the second quarter was significant and estimated to be lower by -0.36 lb (-0.16 kg) compared to cattle shipped during the first quarter. The signs on the coefficients for the background of cattle were as hypothesized: preconditioned cattle and cattle off wheat would have decreased FC ratios, while cattle off grass would have increased FC ratios. None of the estimated coefficients dealing with cattle background were significant, however. Cattle fed in yard 2 had significantly lower FC ratios compared to cattle fed in yard 1. An F-test was performed on each group of dummy variables. The quarter of the year the cattle were shipped and the origin of cattle were found to be significant.

Average Daily Gain Model

The model for ADG had an R-squared of 0.75, indicating that 75% of the variability in ADG was explained by the independent variables. Table 4 provides the estimated coefficients, their corresponding t-statistics and probability values.

The percent mortality variable was statistically significant with an estimated negative coefficient of 0.07726, meaning ADG would decrease by 0.08 lb (0.036 kg) for each 1.0% increase in death loss.

AVIWT and AVOWT were both significant. The estimated coefficient for AVIWT was a negative 0.0013, indicating as the average weight of an animal placed on feed increased by one pound, ADG would decrease 0.0013 lb (0.0006 kg). The coefficient for AVOWT was 0.0037 indicating, as the average close-out weight increased by

Table 1. Summary statistics for feedlot performance data.

Variable	Mean	Median	Min	Max	Standard deviation
Head count per pen	80	70	4	290	41
Mortality (%)[a]	2.30%	1.16%	0.00%	26.51%	3.83%
Treated (%)[b]	13.62%	6.06%	0.00%	113.25%	17.76%
Head days	148.43	142.00	72.00	282.00	29.17
In-weight (lb)[c]	756.33	754.00	350.00	1101.00	113.63
Out-weight (lb)[d]	1256.95	1258.00	1006.00	1525.00	107.32
Gain per head (lb)[e]	500.62	497.00	220.00	800.00	77.40
FC (lb feed /lb of gain)[f]	6.67	6.41	3.65	28.48	1.60
Feed consumption [g]	21.05	21.31	13.36	28.14	2.87
ADG (lb / day)	3.24	3.29	0.65	4.97	0.61
Cost of gain ($ / cwt)	$53.20	$50.34	$31.38	$274.05	$15.66
Ration cost ($ / ton)[h]	$143.83	$143.39	$135.87	$153.97	$3.73
Added cost ($ / hd)[i]	$22.57	$19.29	$3.40	$61.63	$8.81

[a] Mortality expressed as a percentage of cattle received.
[b] Percent treated expressed as a percentage of cattle treated per number of cattle received.
[c] In-weight is the average weight per head of cattle received.
[d] Out-weight is the average weight per head for cattle shipped.
[d] Gain per head is the difference between the in-weight and the out-weight.
[f] Feed conversion is expressed on a dry basis.
[g] Feed consumption is the average daily consumption and expressed on a dry basis.
[h] Ration cost is dollars per ton of dry ration.
[i] Added cost is the cost per head other than feed. Includes yardage, medicine, feed processing, insurance, Kansas Livestock Association dues.

Table 2. Summary statistics for model dummy variables.

Variable	Mean	Median	Min	Max	Standard deviation
Steers[a]	0.49	0	0	1	0.50
Heifers	0.33	0	0	1	0.47
Mixed	0.18	0	0	1	0.38
Q1[b]	0.24	0	0	1	0.43
Q2	0.19	0	0	1	0.40
Q3	0.25	0	0	1	0.44
Q4	0.32	0	0	1	0.47
Kansas[c]	0.36	0	0	1	0.48
Oklahoma	0.08	0	0	1	0.28
Texas	0.04	0	0	1	0.20
Southeast	0.46	0	0	1	0.50
Northeast	0.06	0	0	1	0.23
Sale barn[d]	0.52	1	0	1	0.50
Preconditioned	0.19	0	0	1	0.39
Grass	0.25	0	0	1	0.44
Wheat	0.04	0	0	1	0.20
FY1[e]	0.70	1	0	1	0.46
FY2	0.30	0	0	1	0.46

The default dummy for each set of dummy variables was:
[a] steers for gender of the pen,
[b] quarter 1 for the quarters of year cattle were shipped,
[c] Kansas for the origin of cattle,
[d] sale barn for the background,
[e] feedlot 1 for where cattle were fed.

Table 3. Results for feed conversion model (lb dry feed / lb of gain).

Variable	Estimated coefficient	Std. Error	t-Statistic	Prob.
Intercept	7.76	0.68	11.43	0.00
Percent mortality	0.27	0.04	5.94	0.00
Ave. in-weight	-0.01	0.00	6.68	0.00
Ave. out-weight	0.01	0.00	-5.58	0.00
Mixed	0.01	0.20	0.04	0.97
Heifers	-0.11	0.11	-1.11	0.27
Q2	-0.36	0.11	-3.23	0.00
Q3	-0.09	0.18	-0.50	0.63
Q4	-0.05	0.17	-0.32	0.75
Oklahoma	0.15	0.12	1.33	0.18
Texas	-0.09	0.20	-0.43	0.67
Southeast	-0.15	0.06	-2.25	0.02
Northeast	1.00	0.44	2.24	0.03
Preconditioned	-0.01	0.09	-0.14	0.89
Grass	0.11	0.09	1.15	0.25
Wheat	-0.13	0.14	-0.95	0.34
Feedlot 2	-0.24	0.07	-3.13	0.00
R-squared	0.56	Mean dependent var	6.67	
Adjusted R-squared	0.55	S.D. dependent var	1.60	
S.E. of regression	1.07	F-statistic	52.73	
Sum squared resid	755.55	Prob (F-statistic)	0.00	
Log likelihood	-993.88			

673 observations

Table 4. Results for average daily gain model (lb per day).

Variable	Estimated coefficient	Std. Error	t-Statistic	Prob.
Intercept	-0.32	0.22	-1.46	0.14
Percent mortality	-7.73	0.41	-18.64	0.00
Ave. in-weight	0.00	0.00	-6.19	0.00
Ave. out-weight	0.00	0.00	15.01	0.00
Mixed	-0.07	0.04	-1.74	0.08
Heifers	0.05	0.03	1.52	0.13
Q2	0.11	0.04	2.73	0.01
Q3	0.19	0.04	4.86	0.00
Q4	0.16	0.04	4.67	0.00
Oklahoma	-0.17	0.04	-3.94	0.00
Texas	-0.14	0.06	-2.37	0.02
Southeast	0.09	0.03	3.11	0.00
Northeast	-0.08	0.09	-0.93	0.35
Preconditioned	0.10	0.03	3.13	0.00
Grass	0.09	0.03	2.91	0.00
Wheat	0.10	0.06	1.65	0.10
Feedlot 2	-0.31	0.03	-9.85	0.00
R-squared	0.75	Mean dependent var	3.24	
Adjusted R-squared	0.75	S.D. dependent var	0.61	
S.E. of regression	0.31	F-statistic	124.51	
Sum squared resid	62.76	Prob (F-statistic)	0.00	
Log likelihood	-156.63			

673 observations

a pound, ADG for cattle in that pen was increased by 0.0037 lb (0.0017 kg).

The ADG for pens containing mixed genders or heifers was not significant when compared to the ADG for pens of steers. ADG for cattle shipped during the second, third and fourth quarters of the year was greater and significantly different compared to cattle shipped in the first quarter.

Cattle from Oklahoma and Texas had significantly lower ADG than Kansas cattle, while cattle out of the southeast had significantly higher ADG. Cattle preconditioned or off grass also had significantly higher ADG than sale barn cattle.

When looking at the different groups of variables, the gender of the cattle, the quarter shipped, the origin of the pen of cattle and the background of the cattle were all significant.

Added Cost Model

The AC model had an R-squared of 0.679, meaning 68% of the variability in added cost was explained by the independent variables. Table 5 provides the estimated coefficients, their corresponding t-statistics and probability values.

Percent mortality was significant when estimating AC. For each percentage increase in death loss for a pen of cattle, AC would increase $1.00 per head.

Average in- and out-weights were also significant when estimating AC. The estimated coefficient for AVIWT was a negative $0.028, meaning as cattle come into the yard heavier their AC decreases. The coefficient for AVOWT was $0.006, which means the AC increases by $0.006 per lb of animal shipped.

The AC associated with shipment dates was significant. Cattle shipped in the second, third and fourth quarters of the year had $2.66 per head lower AC on average compared to cattle shipped in the first quarter of the year. Cattle from Oklahoma and the Northeast had significantly higher AC compared to Kansas cattle. Cattle that were preconditioned, or off wheat or grass, all had significantly lower AC, averaging $2.70 per head compared to sale barn cattle.

When looking at significance of the groups of variables, gender of cattle, quarter of the year when cattle were shipped, origin and cattle background were all significant.

Mortality Model

The R squared for the MORT model was 0.45, meaning 45% of the variability in percent mortality was explained by the independent variable, percent treated. The estimated coefficient for percent treated was significant, with a value of 0.14%. Using the estimated coefficient for percent of cattle treated, for each percent-

Table 5. Results for added-cost model (dollars per head).

Variable	Estimated coefficient	Std. Error	t-Statistic	Prob.
Intercept	36.33	3.20	11.36	0.00
Percent mortality	1.00	6.05	16.55	0.00
Ave. in-weight	-0.03	0.00	-10.12	0.00
Ave. out-weight	0.01	0.00	1.88	0.06
Mixed	0.66	0.58	1.15	0.28
Heifers	-0.96	0.52	-1.85	0.08
Q2	-2.18	0.69	-3.17	0.01
Q3	-2.84	0.63	-4.54	0.00
Q4	-2.96	0.57	-5.18	0.00
Oklahoma	2.57	0.77	3.35	0.00
Texas	-0.76	1.15	-0.66	0.51
Southeast	-0.92	0.50	-1.85	0.06
Northeast	5.63	1.12	5.05	0.00
Preconditioned	-2.13	0.55	-3.84	0.00
Grass	-2.78	0.56	-5.00	0.00
Wheat	-3.22	1.06	-3.05	0.00
Feedlot 2	3.76	0.56	6.65	0.00
R-squared	0.68	Mean dependent var	22.57	
Adjusted R-squared	0.67	S.D. dependent var	8.81	
S.E. of regression	5.05	F-statistic	86.78	
Sum squared resid	16749.65	Prob (F-statistic)	0.00	
Log likelihood	-2036.59			

673 observations

age increase in treatments, death loss would increase by 0.14%. Using the model, a 10% treatment rate would predict a 1.7% death loss for a pen of cattle.

Cost of Gain Spreadsheet

Table 6 examines the impact of increased mortality on FC, ADG, AC and COG. When values for mortality, varying from 0 to 10%, were utilized in the AC and FC models, keeping other independent variables at their means with dummy variables set to their defaults, FC went from 6.25 lb to 8.92 lb (2.84-4.05 kg), ADG ranged from 3.36 lb to 2.36 lb (1.52-1.07 kg) and AC ranged from $22.56 to $32.57 per head. Substituting values for FC and AC into the cost of gain spreadsheet, COG ranged from $49.49 to $72.85 per cwt.

Table 7 examines the impact of increases in the percent of animals treated on FC, ADG, AC and COG. Values obtained from the mortality model were plugged into the FC, ADG, or AC models to evaluate effect of treatments on performance parameters. When values for percent treatment ranged from 0 to 100%, FC went from 6.34 lb (2.88 kg) when no cattle were treated to 10.24 lb (4.65 kg) when all cattle were treated; ADG went from 3.32 lb when no cattle were treated to 2.06 lb (0.93 kg) when all cattle were treated; and AC ranged from a low of $22.86 per head when no animals were treated to $37.51 when all cattle were treated. COG increased from $50.13 per cwt. when no animals were treated to a high of $85.66 per cwt. when all cattle were treated.

Impact of individual variables on FC, ADG, AC and COG are provided in Table 8. A base value was established utilizing mean values for percent mortality, AVIWT, AVOWT, with dummy variables set to their defaults which were steers, shipped in the first quarter, from Kansas, out of a sale barn, and fed in feedlot 1. The impact of each independent variable was then increased by 1 standard deviation, with all other variables set to their means or default values. To evaluate the impact of each dummy variable, the independent variables were reset to their mean values, and each dummy was individually changed, while the other sets of dummies were set to their default values of zero.

Discussion

Animal health was found to have a significant effect on performance of feedlot cattle. As incidence of disease (measured by animal health treatments) increased, performance and profitability of cattle decreased. For the pens of cattle in this study, percent mortality or percent of treatments had the most impact

Table 6. Relationship of percent mortality to feed conversion, average daily gain, added cost and cost of gain.

Percent mortality	Feed conversion (lb)[a]	Average daily gain (lb)[b]	Added cost[c]	Cost of gain[d]
0.00	6.25	3.36	$22.56	$49.49
0.50	6.39	3.29	$23.06	$50.55
1.00	6.52	3.23	$23.56	$51.76
1.50	6.65	3.16	$24.06	$52.82
2.00	6.79	3.10	$24.56	$54.05
2.50	6.92	3.04	$25.06	$55.12
3.00	7.05	2.98	$25.56	$56.18
3.50	7.19	2.93	$26.06	$57.44
4.00	7.32	2.87	$26.56	$58.51
4.50	7.45	2.82	$27.06	$59.79
5.00	7.59	2.77	$27.06	$60.87
5.50	7.72	2.73	$28.06	$61.94
6.00	7.86	2.68	$28.56	$63.26
6.50	7.99	2.63	$29.06	$64.33
7.00	8.12	2.59	$29.56	$65.68
7.50	8.26	2.55	$30.06	$66.77
8.00	8.39	2.51	$30.56	$67.85
8.50	8.52	2.47	$31.06	$69.24
9.00	8.66	2.43	$31.56	$70.32
9.50	8.79	2.39	$32.07	$71.76
10.00	8.92	2.36	$32.57	$72.85

[a] Feed conversion is dry lb of feed per lb of gain
[b] Average daily gain is lb per head per day
[c] Added costs is in dollars per head
[d] Cost of gain is measured in dollars per cwt.

Table 7. Relationship of percent of cattle treated on feed conversion, average daily gain, added cost and cost of gain.

Percent treated[a]	Feed conversion (lb)[b]	Average daily gain (lb)[c]	Added cost[d]	Cost of gain[e]
0.00	6.34	3.32	22.86	50.13
5.00	6.53	3.22	23.59	51.83
10.00	6.73	3.13	24.33	53.39
15.00	6.92	3.04	25.06	55.11
20.00	7.12	2.96	25.79	56.86
25.00	7.31	2.88	26.52	58.43
30.00	7.51	2.80	27.26	60.21
35.00	7.70	2.73	27.99	61.78
40.00	7.90	2.66	28.72	63.60
45.00	8.09	2.60	29.45	65.45
50.00	8.29	2.54	30.19	67.03
55.00	8.48	2.48	30.92	68.92
60.00	8.68	2.43	31.65	70.51
65.00	8.87	2.37	32.38	72.45
70.00	9.07	2.32	33.12	74.05
75.00	9.26	2.27	33.85	76.05
80.00	9.46	2.22	34.58	78.09
85.00	9.65	2.18	35.31	79.71
90.00	9.85	2.14	36.05	81.83
95.00	10.04	2.10	36.78	83.46
100.00	10.24	2.06	37.51	85.66

[a] Percent of treatments for pen
[b] Feed conversion dry lbs feed per lb of gain
[c] Average daily gain in lb per head per day
[d] Added cost in dollars per head
[e] Cost of gain in dollars per cwt.

on animal performance. Either of these animal health parameters (mortality or treatments) impacted FC, ADG and the AC component of COG.

Analysis of this data provided some helpful thumb rules for correlating animal health to pen-level performance.

1. **Feed Conversion:** feed conversion ratio increased by 0.27 lb (0.12 kg) for each percentage increase in death loss.
2. **Average Daily Gain:** average daily gain decreased by 0.08 lb (0.04 kg) for each percentage increase in death loss.
3. **Added Costs:** added costs increased by $1.00 per head for each percentage increase in death loss.
4. **Mortality:** death loss for a pen of cattle can be estimated by multiplying the percent treated by 0.14.

The mortality model described in this study provides insight to the range of impact of treatments on FC, ADG and the AC portion of cost of gain. The data and models from this study suggest that if no animals are treated, the FC ratio would be 6.34, ADG would be 3.32 lb (1.15 kg) and AC would be $22.86. Conversely, using the same model with all cattle receiving treatment, the FC ratio would be 10.24, ADG would be 2.06 lb (0.94 kg) and AC would be $37.51. This would result in COG values ranging from $50.13 per cwt. if no animals were treated to $85.66 per cwt. if all cattle were treated.

Conclusions

Data presented in this study are from two feedyards located in Kansas. Values estimated for the independent variables in this study are helpful when evaluating fed cattle performance. Values obtained from this study directly apply to two commercial feedyards located in Kansas, and may not apply to feedyards in other geographic regions. It would be interesting to examine data from other feedyards and regions to determine if similar trends were observed. The $35.00 per cwt spread in cost of gain between a pen of cattle with no animals treated and a pen of cattle with all animals treated is economically relevant and important to the cattle feeding industry.

References

1. Albright ML, Schroeder TC, Langemeier MR: Determinants of cattle feeding cost of gain variability. *Production Ag* 7:206-210, 1994.

Table 8. Impact of individual independent variables on feed conversion, average daily gain, added cost and cost of gain.

Variable	Feed conversion (lb)	Average daily gain (lb)[k]	Added costs	Cost of gain
Base[a]	6.87	3.06	$24.86	$54.68
Treated[b]	7.56	2.78	$27.48	$60.64
Mortality[c]	7.89	2.67	$28.69	$63.54
Ave. in-weight[d].	7.80	2.70	$21.63	$62.20
Ave. out-weight[e].	6.21	3.39	$25.51	$49.08
Mixed[f]	6.88	3.06	$25.52	$54.88
Heifers	6.75	3.12	$23.90	$53.66
Quarter 2[g]	6.51	3.23	$22.67	$51.63
Quarter 3	6.78	3.10	$22.02	$53.46
Quarter 4	6.81	3.09	$21.89	$53.66
Oklahoma [h]	7.02	3.00	$27.43	$56.34
Texas	6.78	3.10	$24.09	$53.89
Southeast	6.72	3.13	$23.94	$53.44
Indiana/Iowa	7.87	2.67	$30.48	$63.10
Preconditioned[i]	6.85	3.07	$22.73	$54.14
Grass	6.98	3.01	$22.08	$54.91
Wheat	6.74	3.12	$21.63	$53.05
Feedlot 2[j]	6.63	3.18	$28.61	$53.74

[a] Base values in the performance sheet set to the means of the data, and dummy variables at their default.
[b] Percent treated was changed by its mean plus one standard deviation
[c] Percent mortality was changed to a value equal to its mean plus one standard deviation.
[d] Average in-weight was changed to a value equal to its mean plus one standard deviation.
[e] Average out-weight was changed to a value equal to its mean plus one standard deviation
[f] Mixed and heifers are dummy variables compared to the default, which was steers.
[g] Quarters 2-4 are dummy variables compared to the default, which was quarter 1.
[h] Oklahoma, Texas, Southeast, and Indiana/Iowa are dummy variables for origin of cattle compared to the default, which was Kansas.
[i] Preconditioned, grass, and wheat are dummy variables compared to the default sale barn cattle.
[j] Feedlot 2 is a dummy variable; default is cattle fed in feedlot 1.
[k] Average daily gain is pounds of gain per head per day.

2. Bryant LK, Perino LJ, Griffin DD, Doster AR, Wittum TE: A method for recording pulmonary lesions of beef calves at slaughter, and the association of lesions with average daily gain. *Bov Pract* 33:163-173, 1999.
3. Edwards AJ: Respiratory diseases of feedlot cattle in central USA. *Bov Prac* 30:5-7, 1996.
4. Gardner BA, Northcutt SL, Dolezal HG, Gill DR: Factors influencing profitability of feedlot steers. Oklahoma State University Animal Science Research Report. 1996, No P-951, pp 164-172.
5. Gardner BA, Dolezal HG, Owens FN, Bryant LK, Nelson JL, Schutte BR, Smith RA: Impact of health on profitability of feedlot steers: Oklahoma State University Animal Science Research Report. 1998, No P-965, pp 102-108.
6. Gardner BA, Dolezal HG, Bryant LK, Owens FN, Smith RA: Health of finishing steers: Effects on performance, carcass traits, and meat tenderness. *J Anim Sci* 77:3168-3175, 1999.
7. Guillermo FG, Berg JL: Efficacy of a feed additive antimicrobial combination for improving feedlot cattle performance and health. *Can Vet J* 36:223-229, 1995.
8. Langemeier M, Schroeder T, Mintert J: Determinants of cattle finishing profitability. *Southern J Ag Economics* 24:41-47, 1992.
9. Lawrence JD, Wang Z, Loy D: Elements of cattle feeding profitability in midwest feedlots. *J Ag and Applied Econ* 31:349-357, 1999.
10. Loneragan GH, Dargatz DA, Morley PS, Smith MA: Trends in mortality ratios among cattle in US feedlots. *J Am Vet Med Assoc* 219:1122-1127, 2001
11. Schroeder TC, Albright ML, Langemeier MR, Mintert J: Factors affecting cattle feeding profitability. *J Amer Society of Farm Managers and Rural Appraisers* 57:48-54, 1993.
12. Smith RA, Stokka GL, Radostits OM, Griffin DD: Health and production management in beef feedlots, in Radostits OM (ed): *Herd Health Food Animal Production Medicine*, ed 3. Philadelphia: WB Saunders Co, pp 581-588, 2001.
13. Studenmund AH: *Using Econometrics A Practical Guide*, ed 4. Boston: Addison Wesley Longman, Inc, 2001.
14. Texas A&M University Extension Animal Science. TAMU Ranch to Rail: Annual Ranch to Rail Summaries. http://animalscience-extension.TAMU.edu/.
15. USDA. 2000. Part III: Health management and biosecurity in U.S. feedlots, 1999: USDA: APHIS:VS, CEAH, National Animal Health Monitoring System. Fort Collins, CO. #N336.1200, 1999.
16. Vogel GJ, Parrot C: Mortality survey in feedyards: the incidence of death from digestive, respiratory, and other causes in feedyards on the great plains. *Comp Contin Ed Pract Vet* 16:227-234, 1994.
17. Wittum TE, Woollen NE, Perino LJ, Littledike ET: Relationship among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of gain in feedlot cattle. *J Am Vet Med Assoc* 209:814-818, 1996.

Abstract

Bovine Tuberculosis: Controlling Cattle-to-Cattle Transmission

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Cattle Practice 13(4):441-446, 2005

Bovine tuberculosis is mainly a disease of the respiratory system with up to 20% of infected animals excreting *M. bovis* at any point in time. Transmission of infection is reported to occur at a slow rate with an incidence of between 1 – 20 per 100 cow-years. Contiguous infection, purchased cattle and increased herd size are the main herd risk factors. Incidence of *M. bovis* increases with animal age. Operating a closed herd with sound farm boundary fencing that will prevent nose-to-nose contact with other cattle, is the ideal method for preventing cattle-to-cattle transmission of *M. bovis*. Where replacement cattle have to be purchased, then the sources of such cattle should be from herds which have had no evidence of TB for a considerable period of time and which also operate a relatively closed herd policy. Intradermal tuberculin testing for any replacement cattle prior to their introduction will help to minimize the risk to the herd.