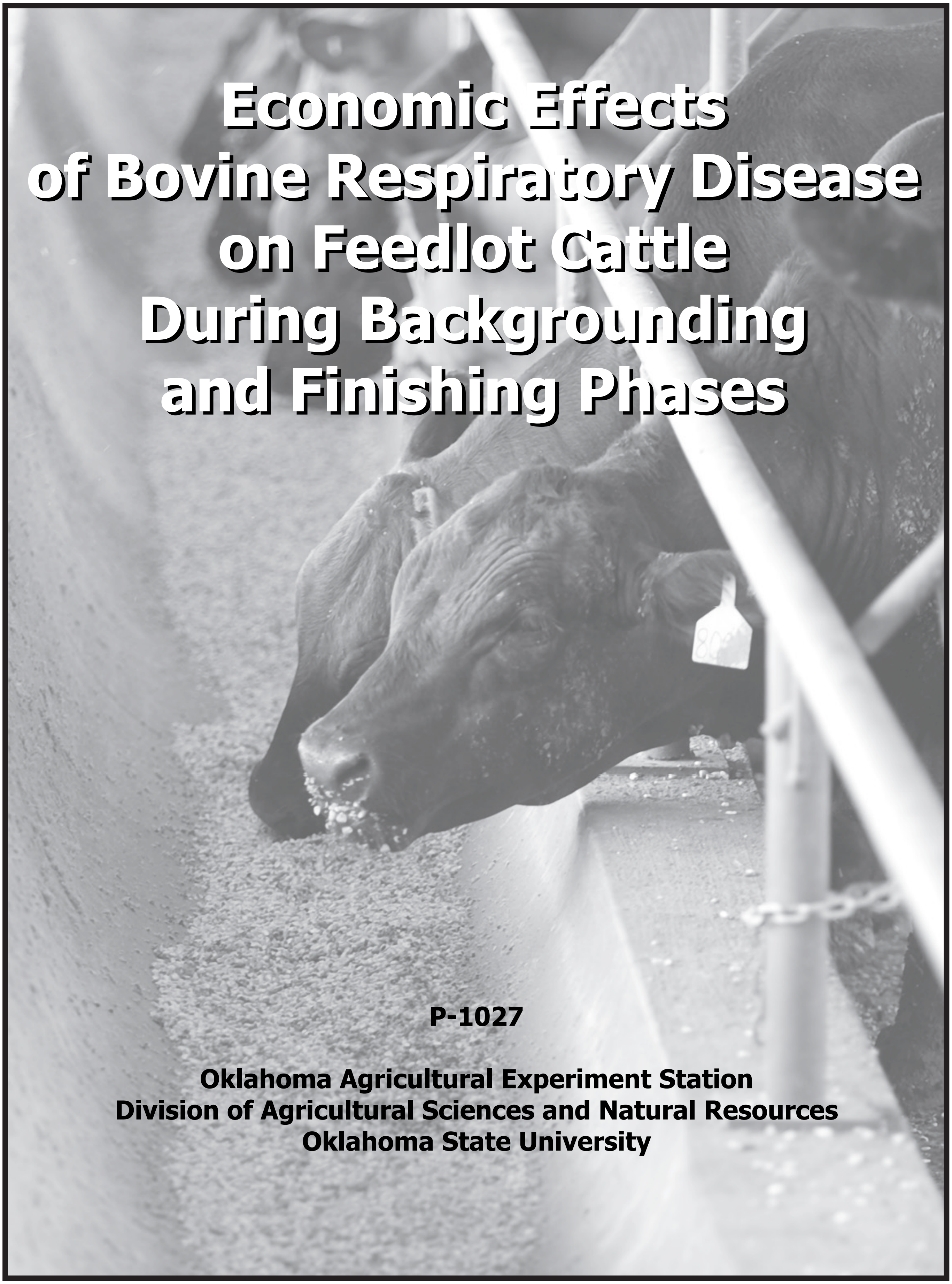

Economic Effects of Bovine Respiratory Disease on Feedlot Cattle During Backgrounding and Finishing Phases

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Abstract

Bovine respiratory disease (BRD) can lead to significant economic losses for cattle producers. The objective of this research was to determine economic effects from a risk assessment of calves based on haptoglobin (Hp) concentration and number of treatments for BRD in cattle backgrounding and finishing phases. During the backgrounding phase, 337 heifers were grouped by Hp level and monitored daily for signs of BRD. After the backgrounding phase, 193 heifers were then grouped by number of BRD treatments in the finishing phase. Net returns decreased in the backgrounding phase and the combined backgrounding-finishing phases as the number of BRD treatments increased. However, Hp concentration had no significant effect on net returns.

Key Words: animal health, bovine respiratory disease, cattle backgrounding, cattle feeding, haptoglobin, net returns

JEL Classifications: **Q10, Q12**

Introduction

Bovine respiratory disease (BRD) is the most common disease among feedlot cattle in the United States. It accounts for approximately 75 percent of feedlot morbidity and 50 percent to 70 percent of all feedlot deaths (Edwards, 1996; Galyean, Perino, and Duff, 1999; Loneragan et al., 2001). The majority of deaths due to BRD occur shortly after arrival to the feedlot or within the first 45 days (Edwards, 1996; Loneragan et al., 2001). In fact, Buhman et al. (2000) reported that about 91 percent of calves diagnosed with BRD were diagnosed within the first 27 days after arrival. BRD causes an estimated $800 million to $900 million annually in economic losses from death, reduced feed efficiency, and treatment costs (Chirase and Greene, 2001).

Medical costs attributable to the treatment of BRD are substantial, and the economic impacts of BRD on carcass merit and meat quality further increase the economic costs. Medicine costs accounted for 21 percent of the decrease, while 79 percent was attributable to lower carcass weight (8.4 percent less) and lower quality grade (24.7 percent more USDA Standard quality grade carcasses). BRD can also cause economic losses due to decreased gain and carcass values (Duff and Galyean, 2007). A Texas Ranch-to-Rail study found BRD morbidity accounted for 8 percent higher production costs, not including losses related to decreased performance (Griffin, Perino, and Wittum, 1995). They found cattle with BRD had a 3 percent decrease in gain compared with healthy cattle and cost the program $111.38 per sick animal. Snowder et al. (2006) estimated economic losses in a 1,000-head feedlot from BRD infection due to lower gains and treatment costs to be approximately $13.90 per animal.

Demand for higher quality products and increased value-based marketing have heightened beef producers' awareness of health management practices with potential to increase profitability and beef product quality. Feedlot producers able to purchase calves more likely to remain healthy during the feeding period could potentially increase profits through reduced costs and higher revenues. Previous studies document the economic impact from BRD in either backgrounding or finishing programs. The majority of those studies are from animal scientists and veterinarians. Current research relating to animal disease in agricultural economics journals deals with major outbreaks of infectious diseases (e.g. bovine spongiform encephalopathy or bovine brucellosis), tracking systems, and eradication programs (Amosson et al., 1981; Elbakidze, 2007; Hennessy, Rossen, and Jensen, 2005; Kuchler and Hamm, 2000). Limited research on BRD in feedlot cattle is reported in agricultural economic journals. Nyamusika et al. (1994) however, using a stochastic simulation model of BRD, found significant returns to vaccination of cattle. The simulation found vaccination programs, combined with treatment of BRD, increase net revenues by $44. Further analysis on the economic effects of BRD in the backgrounding phase is warranted along with the effects in the finishing phase and the phases combined.

Knowing the economic impact of BRD on both backgrounding and finishing phases is important. A tool enabling producers to determine whether animals will remain healthy could potentially increase producers' profits. Serum haptoglobin (Hp) concentration has been suggested as a tool for making management decisions based on data that shows cattle requiring treatment for BRD had a higher Hp concentration upon arrival than calves that remained healthy throughout the preconditioning phase (Berry et al., 2005; Step et al., 2008). Hp is an acute-phase protein produced by the liver in response to cellular injury. Based upon Hp concentration upon arrival producers could potentially determine animals that would remain healthy.

The overall objective of this research was to determine the economic effects of BRD on backgrounding and finishing phases individually, as well as the two phases combined for the same cattle. In addition, this research measures the effectiveness of using serum Hp concentration to predict BRD occurrence and the impact of multiple treatments for BRD in backgrounding on both backgrounding and cattle feeding performance.

Conceptual Framework

Cattle producers are assumed to maximize expected profits. The question is whether the use of serum Hp concentration to predict BRD occurrence has an effect on those expected profits and whether multiple treatments for BRD affect the returns on infected cattle.

Producers' objective function can be expressed as:

$$(1)\quad \max_x E(NR) = \boldsymbol{P}'\boldsymbol{Y(x)} - \boldsymbol{r}'\boldsymbol{x}$$

where E(*NR*) is the expected net revenue per head from their operation, *P* is the vector of output prices, ***r*** is the vector of input prices, ***Y(x)*** is the final weight of cattle produced, and ***x*** is the vector of inputs.

Equation (1) does not consider the Hp risk group. Cattle producers would want to maximize expected net returns subject to costs and the Hp risk group. Producers could test serum Hp prior to purchasing calves to estimate their Hp risk group, considered to be low, medium, and high risk in this research. Equation (1) then becomes:

$$(2)\quad \max_{x,v} E(NR) = \max\{\boldsymbol{P}_v'\boldsymbol{Y}_v\boldsymbol{(x)} - \boldsymbol{r}'\boldsymbol{x}_v \mid \boldsymbol{v} = \boldsymbol{1, 2, 3}\}$$

where E(*NR*) is expected net returns per head from the operation, is the vector of expected prices for risk group *v* (*v*=1, 2, 3), ***r*** is the vector of input prices, $\boldsymbol{Y}_v\boldsymbol{(x)}$

is the final weight or number of cattle produced in risk group v, and x is the vector of inputs for risk group v. The producer would then be maximizing net returns per head.

Data

Backgrounding phase

For this study, 337 cross-bred heifers were purchased by Eastern Livestock order buyers and assembled at the West Kentucky Livestock Market at Marion, KY in September 2007. Heifers were processed after arrival to Stillwater, OK on September 12 and 14 (day 0) and assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp<1.0 mg/dL), Medium (1.0 mg/dL <serum Hp<3.0 mg/dL), and High (serum Hp>3.0 mg/dL). Of the 337 heifers, 86 (25.52 percent) were in the low-risk group, 98 (29.08 percent) were in the medium-risk group, and 153 (45.40 percent) were in the high-risk group. Heifers were fed twice daily, ad libitum, a 65 percent concentrate receiving/growing ration during the 63-day backgrounding phase.

Heifers were evaluated daily for signs of BRD according to standard facility protocol (Step et al., 2008) in which animals were assigned a clinical attitude score (CAS; 1 to 4) based on depression, appetite, and respiratory signs. Antimicrobial therapy was administered when CAS was 1 (mild) or 2 (moderate) and rectal temperature was ≥ 40 C, or when CAS was 3 (severe) or 4 (moribund) regardless of temperature. The first treatment was 10 mg tilmicosin/kg body weight (Micotil 300, Elanco Animal Health, Greenfield, IN), second treatment was 10 mg enrofloxacin/kg BW (Baytril 100, Bayer Animal Health, Shawnee Mission, KS), and third treatment was two doses of 2.2 mg ceftiofur/kg BW (Excenel, Pharmacia & UpJohn, New York, NY) administered 48 hours apart. Chronically ill animals were pulled on or after day 21. Conditions necessary to be considered a chronic were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight during the preceding 21 days on feed.

Table 1 shows the number of BRD treatments given to heifers across the risk groups. Of the 337 heifers, there were a total of 113 never treated (33.53 percent), 98 treated once (29.08 percent), 42 treated twice (12.46 percent), 43 treated three times (12.76 percent), 12 classified as chronics (3.56 percent), and 29 that died (8.61 percent) during the backgrounding phase. High mortality may be attributed to the use of high-risk cattle. The heifers in the study were most likely weaned immediately prior to transporting to the auction market, where they were commingled, then shipped to the Oklahoma State University feedlot where they appeared stressed.

Heifers were individually weighed on days 0, 7, 14, 21, 42, and 63. Production data included average daily gain (ADG) during the 63-day backgrounding phase, feed intake and costs, vaccination costs, feed conversion, Hp risk group, number of BRD treatments, and cost of BRD treatments. Feed intake could not be directly measured in the preconditioning phase. Intake was calculated based on gains and energy density of the diet according to the National Research Council equations (NRC, 1996). Feed intake for animals that died was calculated based on the average dry matter intake per day from animals that lived times the number of days the dead animal was on the trial. Average daily gain for animals that died was the last recorded weight minus their initial weight divided by the number of days they were on trial. The initial price and day 63 price were estimated using USDA Agricultural Marketing Services (AMS) feeder cattle weighted-average sale data. The sale data were for the same week of arrival and day 63 price as the price at the Oklahoma City market, with adjustments for weights (KO_LS795 for week of 9/12/2007 and 11/14/2007). An ordinary least squares regression for price as a function of the

Table 1. Health Outcome Category of Heifers across Haptoglobin Risk Groups[1] in Backgrounding Phase.

Risk Group	*Number of Bovine Respiratory Treatments*						*Total*
	Zero	*One*	*Two*	*Three*	*Chronics*[2]	*Dead*	
Low	38	25	10	6	2	5	86 (25.52%)
Medium	35	25	11	13	5	9	98 (29.08%)
High	40	48	21	24	5	15	153 (45.40%)
Total	113 (33.53%)	98 (29.08%)	42 (12.46%)	43 (12.76%)	12 (3.56%)	29 (8.61%)	337

[1] Heifers were assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp<1.0 mg/dL), Medium (1.0 mg/dL<serum Hp<3.0 mg/dL),and High (serum Hp>3.0 mg/DL).

[2] Conditions necessary to be considered a chronic were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight over the preceding 21 days on feed.

number of head sold per pen, average weight per pen, weight squared, and grade was estimated for both arrival price and day 63 price using the AMS data.

Finishing phase

After the backgrounding phase (63 days), heifers were allocated to finishing pens based on the number of times they were treated for BRD. There were six heifers per pen except three pens of calves treated three times had seven heifers per pen. Initial classification based on arrival serum Hp was disregarded in the finishing phase. Due to pen space and number of antimicrobial treatments, only 193 heifers from the backgrounding phase were also in the finishing phase. Of the 193 heifers, 54 (27.98 percent) had zero treatments, 54 (27.98 percent) had one treatment, 34 (17.62 percent) had two treatments, 39 (20.21 percent) had three treatments, and 12 (6.22 percent) were classified as chronics. Animals were considered chronically ill if they had been assigned a BRD severity of ≥3, had a net weight loss during at least 21 days in the backgrounding phase, and had been given all eligible treatments with antimicrobials according to protocol. Severity scores were based on signs of BRD (listed above) and were on a scale from 1 to 4. Cattle were fed according to standard procedure at the facility and weighed every 28 days.

Finishing phase production data included ADG, feed intake and cost, vaccination costs, feed conversion, and total days on feed. Feed intake in the finishing phase per animal was calculated using as fed pounds per day per pen divided by the number of head in the pen. Heifers were harvested in three groups at the end of the feedlot phase on April 21, May 13, or May 28, 2008 (152, 174, or 189 days on feed, respectively). Harvest dates were based on live weight and estimated carcass backfat of 0.4 inches using ultrasound. All chronics were harvested on the final date (189 days on feed). Carcass data included marbling, yield grade, hot carcass weight (HCW), and back fat measurement. Heifers were priced on a commonly used industry grid from the commercial packing plant where they were slaughtered. Estimated prices were also calculated using alternative grid premiums and discounts based on AMS data (LM_CT155) but were not found to be significantly different from the packing plant's grid prices (National Weekly Direct Slaughter Cattle-Premiums and Discounts for the week of: 4/21/2008, 5/12/2008, and 5/26/2008).

During the finishing phase, two heifers were treated for signs of BRD. One heifer was from the twice-treated group and remained in her home pen throughout the duration of the finishing phase. The other heifer was in the chronic group and died. Three more animals died due to digestive causes, one each from the zero treatment group, the three treatment group, and the chronic group. Four additional heifers were not included in final statistics because of incomplete carcass data, two heifers each from the two and three treatment groups.

Data were used to determine the effects of Hp risk groups for BRD, treatment of sick animals, and the risk-treatment interaction on net returns, costs, and animal performance for the backgrounding phase, the finishing phase, and the backgrounding and finishing phases combined.[1]

Procedure

The performance and net return differences across risk groups and number of BRD treatments were analyzed using Least Squares Means (LS Means) and the following model:

$$(3)\quad Z = \alpha_0 + \sum_{i=1}^{2}\alpha_i RG_i + \sum_{j=1}^{3}\beta_j C_j + \sum_{i=1}^{2}\alpha_{ij} RG_i C_j$$

where Z is the independent performance measure, RG_i is the risk group i (i=1, 2), and is the number of BRD treatments j (j=0, 1, 2, 3). Significant differences across means were tested using *t*-tests. Performance measures included ADG, feed-to-gain conversion, feed costs, day 63 weight, and number of BRD treatments for the backgrounding, finishing, and the phases combined. Carcass measures included hot carcass weight (HCW), marbling score, and yield grade. Net returns for the backgrounding, finishing, and the two phases combined were also analyzed. Feed conversion is the amount of feed consumed per pound of gain. Feed conversion was calculated by dividing total amount of feed intake (as fed) per animal by total pounds gained per animal. Final live weights for cattle were taken at the feedyard on day 63 prior to slaughter and were used for finishing phase gain calculations.

The most important factors affecting net returns were also determined. Of interest are the relative effects of each regressor on net returns.

$$(4)\quad E(NR_{ji}) = \beta_{j0} + \beta_{j1}x_1 + \beta_{j2}x_2 + \ldots + \beta_{jn}x_n + \varepsilon_{ji}$$

where $E(NR_{ji})$ is the net returns per head to be estimated, β's are the estimated standardized betas, and the x_i are the variables used for the standardized betas, where *i* represents the individual heifer, *j* represents either the backgrounding phase, the finishing phase, or the total, and, ε_{ji} is the residual error term.

The units of the variables in equation (4) are different; therefore the magnitudes of the individual regression coefficients cannot be directly compared. Variables were normalized to have a mean of zero and a variance of one to compare relative importance of independent variables. Regressing these variables on the normalized net returns yields standardized beta coef-

[1] Complete summary statistics on data collected can be obtained from the author.

ficients (SBC). SBCs were calculated from a regression model to determine the influence of the each variable on net returns. Standardized beta coefficients were calculated for net returns using the following model:

$$(5) \quad \frac{NR - \overline{NR}}{\sigma\gamma} = \sum_i \beta_i^* \frac{x_i - \overline{x}}{\sigma_{x_i}} + \in$$

where *NR* is the net revenue, σ is the standard deviation, β_i^* is the *i*th independent variable of interest, and is the SBC for the *i*th independent variable. The new coefficients are calculated:

$$(6) \quad \beta_i^* = \beta_i \frac{\sigma_{x_i}}{\sigma_Y}$$

The SBCs are proportions and the absolute value therefore can be used to rank the relative importance of the independent variables. Coefficients are interpreted such that if x_i increases by one standard deviation, then *Y* changes by β_i^* standard deviations (Wooldridge, 2006).

The variables for the backgrounding phase included initial body weight (IBW), average daily gain (ADG), feed conversion, BRD treatment costs, feed costs on as fed basis, Hp risk group, and the number of BRD treatments. Variables for the finishing phase included initial finishing phase body weight, ADG in the finishing phase, feed conversion, feed costs on as fed basis, hot carcass weight, marbling score, yield grade, Hp risk group, and number of BRD treatments. The combined phase included IBW, ADG for the entire trial, feed conversion, BRD treatment costs, total feed costs on as fed basis, hot carcass weight, marbling score, yield grade, Hp risk group, and number of BRD treatments.

Net returns were calculated for the backgrounding phase by subtracting the purchase cost of the calves, BRD treatment costs, vaccination costs, and feed costs from the transfer revenue/cost in the backgrounding phase. Transfer revenue/cost is the 63-day price that is used as the revenue for the backgrounding phase and the initial cost in the finishing phase. Vaccination costs varied, depending on the initial body weight of the animals. Of all BRD treatment costs, 99.7 percent were incurred during the 63-day backgrounding phase and a chute charge of $0.50 for the first treatment was added to the respiratory treatment costs to account for processing the animals.

Average net returns for the backgrounding, finishing, and combined phases can be found in Table 2. The net returns for the finishing phase were calculated by subtracting transfer revenue/cost, vaccination costs, and feed costs for the finishing phase from ending revenue. The total net returns were calculated by subtracting placement cost, all vaccination costs, feed costs, and BRD treatment costs from ending revenue. Ending revenue is $/head based on grid prices. All net revenues were calculated independent of market conditions.

Average net returns per head attributed to dead animals in the backgrounding phase and the combined

Table 2. Average Net Returns for Backgrounding[1], Finishing[2], and Combined Phases across Haptoglobin Risk Group[3] and Number of Bovine Respiratory Disease Treatments.

		Number of Bovine Respiratory Disease Treatments						
Haptoglobin Risk Group	*Data*	*0*	*1*	*2*	*3*	*Chronics[4]*	*Dead*	*Grand Total*
Low	Backgrounding Phase	8.33	-8.45	-51.97	-77.82	-89.05	-677.75	-51.73
	Finishing Phase	-115.23	-68.87	-62.50	-192.88	-5.69		-92.45
	Combined Phase	-100.54	-80.92	-106.70	-267.42	-94.75		-111.89
Medium	Backgrounding Phase	10.88	-8.75	-37.67	-86.21	-117.57	-631.07	-77.96
	Finishing Phase	-107.46	-53.76	-118.32	-45.50	-210.32		-92.86
	Combined Phase	-89.37	-64.60	-152.20	-124.00	-327.88		-92.86
High	Backgrounding Phase	6.60	-12.74	-37.90	-81.56	-100.84	-675.96	-89.83
	Finishing Phase	-108.90	-98.56	-39.64	-39.73	-201.57		-80.00
	Combined Phase	-105.29	-119.31	-69.53	-119.82	-302.41		-117.04
Total Average Backgrounding Net Returns		8.51	-10.63	-41.19	-82.44	-105.85	-662.34	-76.66
Total Average Finishing Net Returns		-110.15	-77.60	-64.20	-60.99	-172.57		-86.90
Total Average Combined Net Returns		-98.37	-93.04	-98.82	-139.92	-278.41		-116.55

1 Backgrounding phase consisted of 337 heifers of which 29 died.
2 Finishing phase and combined phase consisted of 193 heifers.
3 Heifers were assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp<1.0 mg/dL), Medium (1.0 mg/dL<serum Hp<3.0 mg/dL),and High (serum Hp>3.0 mg/DL).
4 Conditions necessary to be considered a chronic were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight over the preceding 21 days on feed.

phases were calculated as follows: average net returns per head for that phase times 337 or 222 heifers for the backgrounding and combined phase, respectively, minus the average net returns for dead animals times the 29 head that died. The differences were divided by 308 or 193 for the backgrounding and overall, respectively, to estimate the average net returns per head attributed to dead animals.

Results

Least squares means

Risk Group. Least squares means by Hp risk group are in Table 3. No significant differences were found across risk group for any of the net returns. However, Hp risk group one was significantly different ($P \le 0.05$) than risk group three for marbling score. Risk groups one and three were significantly different than risk group two for background feed:gain conversion and backgrounding cost of gain ($P \le 0.05$). Four heifers in risk group two had negative ADG in the backgrounding phase, i.e., lost weight, that led to negative feed:gain conversion and negative cost of gain. When these heifers were removed from the analysis, no significant differences were found across risk groups. Wittum and Perino (1995) and Step et al. (2008) also found Hp concentration upon arrival unrelated to severity of the case or the need for treatment in feedlot cattle. However, Hp has been found to have some value in assessing treatment efficacy (Carter et al., 2002; Wittum et al., 1996).

BRD Treatment Groups. Least squares means by the number of BRD treatments are in Table 4. Beginning weight was not statistically significant ($P \le 0.05$) across BRD treatments; however, weights at the end of backgrounding and the start of finishing were significantly different across all treatment groups. Heifers classified as chronics in the backgrounding phase gained 2.16 lbs/day, 1.83 lbs/day, and 1.23 lbs/day less than heifers never treated, treated once, or twice, respectively ($P \le 0.05$). Buhman et al. (2000) also reported heifer calves had a lower mean daily gain when sick calves were compared with those not sick or not removed for treatment. Gardner et al. (1999) showed similar results of increased average daily gain for

Table 3. Least Squares Means for Production Characteristics by Haptoglobin Risk Group[1,2]

		Risk Group		
	Description	*Low*	*Medium*	*High*
IBW[3]	Beginning Weight (lbs)	532.95	521.28	529.72
IBW[4]		533.35	527.18	526.88
Precadg	ADG-Backgrounding (lbs/day)	2.14	2.06	2.08
Preconv	Background Feed:Gain Conversion	12.74[a]	5.39[b]	11.48[a]
Rtreatcost	BRD Treatments Drugs ($/head)	22.06	21.80	22.26
Pcostasfed	Cost of Feed Backgrounding ($/Head)	59.41	59.04	58.86
Preccog	Background Cost of Gain ($/lb of gain)	1.20[a]	0.32[b]	1.14[a]
avgFO[*]	End Background Start Finishing Weight (lbs)	666.03	656.66	660.15
avgFO[**]		672.44	663.49	656.28
Pnetret	Net Returns-Backgrounding ($/head)	-149.43	-145.05	-150.40
fadg	ADG - Finishing (lbs/day)	3.19	3.21	3.20
finconv	Finishing Feed:Gain Conversion	9.15	8.78	8.75
fcostasfed	Cost of Feed finishing ($/head)	498.70	493.35	478.71
fincog	Finishing Cost of Gain ($/lb of gain)	0.98	0.94	0.94
fulladg	Overall ADG (lbs)	2.95	2.96	2.91
totalcon	Total Feed:Gain Conversion	8.99	8.69	8.65
totalcog	Overall Cost of Gain ($/lb of gain)	0.91	0.88	0.88
HCW	HCW (lbs)	744.17	736.45	731.44
Marbscore	MARBSCORE	479.82[a]	450.63[a,b]	433.49[b]
YG	Yield Grade	3.22	3.18	3.10
Fnetret	Net Returns Finishing ($/head)	-89.04	-107.07	-97.68
Netret	Net Returns ($/head)	-130.07	-151.61	-143.27

[a,b] Indicate means in the same row with a different superscript letter differ ($P<0.05$).
[1] Deads are included in net return calculations but not in physical performance measures (average daily gain, cost of gain, or conversion).
[2] Heifers were assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp<1.0 mg/dL), Medium (1.0 mg/dL<serum Hp<3.0 mg/dL),and High (serum Hp>3.0 mg/DL).
[3] Indicates 337 heifers in backgrounding phase.
[4] Indicates 193 heifers in finishing phase and overall.

Table 4. Least Squares Means for Production Characteristics by Number of Bovine Respiratory Disease Treatments[1]

		Number of Treatments					
	Description	*0*	*1*	*2*	*3*	*Chronics*	*Dead*
IBW[3]	Beginning Weight (lbs)	535.38	530.15	528.35	532.06	519.52	522.44
IBW[4]		533.50	536.06	524.36	532.25	519.52	
Precadg	ADG-Backgrounding (lbs/day)	3.11[a]	2.78[b]	2.18[c]	1.45[d]	0.95[d]	
Preconv	Background Feed:Gain Conversion	7.84[a]	7.99[a]	13.87[b]	9.03[a]	10.62[a,b]	
Rtreatcost	BRD Treatments Drugs ($/head)	0.00[a]	9.63[b]	23.62[c]	35.71[d]	35.34[d]	27.93[e]
Pcostasfed	Cost of Feed Backgrounding ($/Head)	85.05[a]	76.93[b]	63.47[c]	50.53[d]	44.12[d,e]	34.54[e]
Preccog	Background Cost of Gain ($/lb of gain)	0.47[a]	0.54[a,c]	1.32[b]	0.94[b,c]	1.16[a,b,c]	
avgFO[3]	End Background Start Finishing Weight (lbs)	731.19[a]	705.13[b]	665.51[c]	623.44[d]	579.47[e]	
avgFO[4]		734.92[a]	703.95[b]	672.22[c]	629.77[d]	579.47[e]	
Pnetret	Net Returns-Backgrounding ($/head)	8.63[a]	-9.98[b]	-42.51[c]	-81.87[d]	-102.49[e]	-661.56[f]
fadg	ADG - Finishing (lbs/day)	3.10	3.20	3.26	3.31	3.13	
finconv	Finishing Feed:Gain Conversion	9.47[a]	9.21[a,b]	8.75[a,b]	8.72[a,b]	8.30[b]	
fcostasfed	Cost of Feed Finishing ($/head)	486.18[a]	494.20[a,b]	484.11[a]	516.81[b]	469.97[a]	
fincog	Finishing Cost of Gain ($/lb of gain)	1.02[a]	0.99[a,b]	0.94[a,b]	0.93[a,b]	0.89[b]	
fulladg	Overall ADG (lbs)	3.13[a]	3.06[a,b]	3.01[a,b]	2.88[b,c]	2.62[c]	
totalcon	Total Feed:Gain Conversion	8.92	8.84	8.61	8.82	8.67	
totalcog	Overall Cost of Gain ($/lb of gain)	0.85[a]	0.87[a]	0.88[a,b]	0.93[b]	0.93[a,b]	
HCW	HCW (lbs)	756.70[a]	743.75[a,b]	733.69[a,b]	747.63[a,b]	705.00[b]	
Marbscore	MARBSCORE	480.43	465.33	444.75	453.56	429.17	
YG	Yield Grade	3.35[a]	3.25[a,b]	3.10[a,b]	2.94[b]	3.19[a,b]	
Fnetret	Net Returns Finishing ($/head)	-110.53	-73.73	-73.49	-92.71	-139.19	
Netret	Net Returns ($/head)	-98.40[a]	-88.28[a]	-109.48[a,b]	-170.41[b,c]	-241.68[c]	

[a,b,c,d,e] Indicate means in the same row with a different superscript letter differ ($P<0.05$).
[1] Deads are included in net return calculations but not in physical performance measures (average daily gain, cost of gain, or conversion)
[2] Conditions necessary to be considered a chronic were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight over the preceding 21 days on feed.
[3] Indicates 337 heifers in backgrounding phase.
[4] Indicates 193 heifers in finishing phase and overall.

steers never treated compared to those treated once or more than once (Gardner et al., 1999; Wittum and Perino, 1995). During the finishing phase, no significant differences were found across the risk groups for average daily gain. When combining the backgrounding and finishing phases, chronics had significantly lower gains compared to those never treated or those treated only once or twice. The majority of the BRD incidence occurred during the backgrounding phase. Early detection and proper treatment could contribute to the calf's recovery and compensatory gain during the finishing phase. Similar research found that compensatory gain was evident in the feedlot after proper treatment for BRD (Snowder et al., 2006).

Cost of gain increased as the number of BRD treatments increased during the preconditioning phase with those treated more than twice having the highest. During the finishing phase cost of gain per head for the zero-treatment group was significantly higher ($P \leq 0.05$) than the cost of gain for those classified as chronics ($1.02/lb of gain versus $0.89/lb of gain, re-

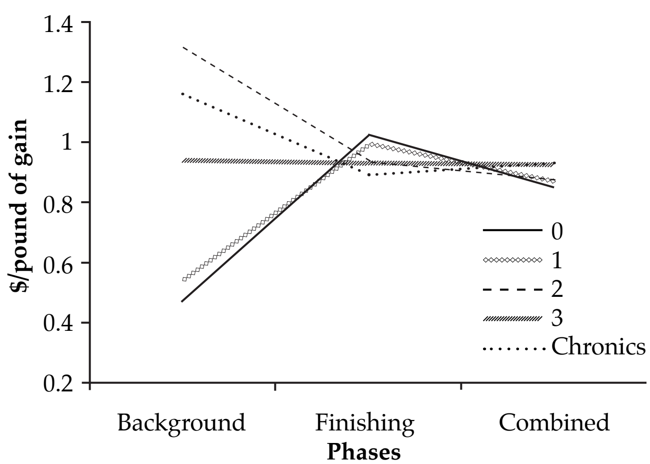

Figure 1. Differences in Cost of Gain ($/lb of gain) by Number of Bovine Respiratory Disease Treatments for the Background, Finishing, and Combined Phases.

spectively). Figure 1 shows the cost of gain across the number of BRD treatments for all three phases. From the figure, the wide differences in cost of gain during the backgrounding phase are shown, however in the finishing phase and subsequently overall the cost of gain is not as widely spread out between the treatment groups.

As the number of BRD treatments increased, the cost of BRD treatment increased significantly ($P \leq 0.05$). The zero-treatment group were significantly different ($P \leq 0.05$) than those treated at least once. Those treated once averaged $9.63 per head in BRD treatment costs while those treated three times or considered chronic had more than $35 per head in BRD treatment costs. Those treated three times or considered chronic were not significantly different. BRD treatment costs have been found to range from zero to $21.70 per head (Edwards, 1996; Fulton et al., 2002). As the number of BRD treatments increased, backgrounding net returns decreased significantly. On average heifers with zero treatments had $111.12 higher net returns compared to heifers classified as chronics. Heifers treated once, twice, or three times had $92.51, $59.98, and $20.62, respectively, higher backgrounding net returns than chronics ($P \leq 0.05$). There was an average economic cost associated with death loss of $661.56 in the backgrounding phase per dead heifer.

No significant differences were found in finishing phase net returns across BRD treatments. This may be attributed to the fact that heifers were slaughtered based on live weight and estimated carcass backfat of 0.4 inches using ultrasound and that heifers classified as chronics tended to improve in efficiency during the finishing phase. Figure 2 shows net returns across the number of BRD treatments for all three phases. Overall, heifers classified as chronics had significantly lower net returns compared to those with zero, one, or two treatments. Chronic heifers lost significantly more ($143.28) than those with zero treatments and $153.40 and $132.20 more than those treated once or twice, respectively. Overall net returns for chronics and heifers treated three times were not significantly different ($P \leq 0.05$). Similar findings have shown calves never treated for BRD had significantly higher returns than calves treated once or more than once (Fulton et al., 2002). If producers can find a way to determine if the animals will remain healthy throughout the overall phase, then they could cut losses during the backgrounding phase with animals treated three times or classified as chronics.

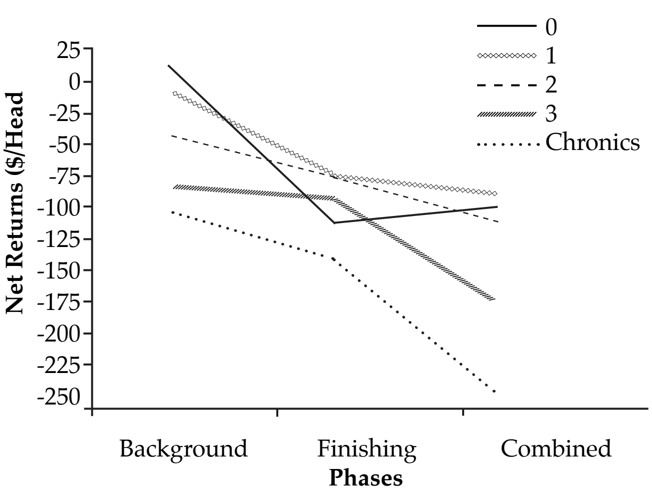

Figure 2. Differences in Net Return ($/Head) by Number of Bovine Respiratory Disease Treatments for the Background, Finishing, and Combined Phases.

Standardized beta coefficients

Risk Groups. The purpose of calculating standardized beta coefficients was to determine the most important factors affecting net returns. Tables 5, 6, and 7 report the standardized beta coefficients for the backgrounding, finishing, and combined phases, respectively. ADG was the most significant factor attributed to backgrounding net returns followed by cost as fed and then the amount of BRD treatments given to the heifer. Recall from the least squares means, those never treated had significantly higher ADG compared to those treated at least once. The number of times treated for BRD could have caused the ADG to be affecting net returns.

BRD Treatment Groups. During the finishing phase, physical characteristics, hot carcass weight, finishing phase start weight, and cost of feed, attributed the most to net returns. When the two phases are combined, hot carcass weight had the greatest impact on net returns. This is similar to research by Ward and Johnson (2005), where weight was the strongest market signal compared to carcass quality characteristics when using grid pricing systems. Those never treated for BRD or only treated once significantly impacted net returns compared to chronics based on the least squares means. Performance characteristics, initial body weight, ADG, and feed-to-gain conversion, also significantly affected net returns. BRD treatments tend to affect other performance characteristics. As BRD treatments increase, animal performance decreases, especially in the backgrounding phase.

Summary and Conclusions

The overall objective of this research was to determine the economic effects of bovine respiratory disease (BRD) on both backgrounding and finishing phases and on the two phases combined. In addition,

Table 5. Standardized Beta Estimates for Backgrounding Phase Net Returns ($/head)[1]

Variable	*Description*	*Estimate*	*Standard Error*	*t Value*	*P-Value*	*Standardized Estimate*
Intercept	Intercept	-63.332	2.285	-27.72	<.0001	0.000
IBW	Beginning Weight (lbs)	-0.077	0.005	-15.16	<.0001	-0.064
precadg	ADG-Backgrounding (lbs/day)	59.759	0.7793	76.68	<.0001	1.339
preconv	Background Feed:Gain Conversion	-0.004	0.014	-0.28	0.7810	-0.001
pcostasfed	Cost of Feed Backgrounding ($/head)	-1.269	0.037	-34.21	<.0001	-0.592
R1	Low Haptoglobin Risk Group with respect to High Risk Group	-0.082	0.347	-0.24	0.8138	-0.001
R2	Medium Haptoglobin Risk Group with respect to High Risk Group	-0.177	0.336	-0.53	0.5992	-0.002
c0	Zero BRD Treatments with respect to Chronics	35.489	0.880	40.33	<.0001	0.389
c1	One BRD Treatments with respect to Chronics	25.960	0.862	30.13	<.0001	0.275
c2	Two BRD Treatments with respect to Chronics	12.385	0.877	14.13	<.0001	0.097
c3	Three BRD Treatments with respect to Chronics	-0.125	0.834	-0.15	0.881	-0.001

[1] R^2=0.997, n=308

Table 6. Standardized Beta Estimates for Finishing Phase Net Returns ($/head)[1]

Variable	*Description*	*Estimate*	*Standard Error*	*t Value*	*P-Value*	*Standardized Estimate*
Intercept	Intercept	-287.764	122.635	-2.35	0.0201	0.000
avgFO	End Background Start Finishing (lbs)	-0.901	0.109	-8.26	<.0001	-0.623
fadg	ADG-finishing (lbs/day)	9.566	23.579	0.41	0.6855	0.044
finconv	Finishing Feed:Gain Conversion	-3.944	6.676	-0.59	0.5554	-0.064
fcostasfed	Cost of Feed Finishing ($/head)	-0.531	0.186	-2.85	0.0049	-0.177
HCW	Hot Carcass Weight	1.453	0.132	11.01	<.0001	0.870
MARBSCORE	Marbling Score	0.126	0.050	2.53	0.0122	0.109
YG	Yield Grade	-16.882	5.083	-3.32	0.0011	-0.139
R1	Haptoglobin Risk Group 1 with respect to Group 3	1.448	9.873	0.15	0.8836	0.006
R2	Haptoglobin Risk Group 2 with respect to Group 3	-8.225	9.274	-0.89	0.3764	-0.037
c0	Zero BRD Treatments with respect to Chronics	19.610	21.471	0.91	0.3624	0.087
c1	One BRD Treatments with respect to Chronics	32.138	20.639	1.56	0.1213	0.143
c2	Two BRD Treatments with respect to Chronics	15.445	20.724	0.75	0.4571	0.057
c3	Three BRD Treatments with respect to Chronics	14.173	19.924	0.71	0.4778	0.055

[1] R^2=0.763, n=185

Table 7. Standardized Beta Estimates for Total Net Returns ($/head)[1]

Variable	*Description*	*Estimate*	*Standard Error*	*t Value*	*P-Value*	*Standardized Estimate*
Intercept	Intercept	-89.922	120.111	-0.75	0.4551	0.000
IBW	Beginning Weight (lbs)	-0.814	0.133	-6.12	<.0001	-0.282
fulladg	Overall ADG (lbs/day)	-64.821	21.440	-3.02	0.0029	-0.264
totalcon	Total Feed:Gain Conversion	-32.858	7.765	-4.23	<.0001	-0.370
totalcostasfed	Cost of Feed Backgrounding ($/head)	-0.269	0.194	-1.39	0.1668	-0.078
HCW	Hot Carcass Weight	1.362	0.133	10.24	<.0001	0.780
MARBSCORE	Marble Score	0.109	0.049	2.23	0.0268	0.089
YG	Yield Grade	-18.079	5.001	-3.61	0.0004	-0.142
R1	Haptoglobin Risk Group 1 with respect to Group 3	5.072	9.714	0.52	0.6023	0.020
R2	Haptoglobin Risk Group 2 with respect to Group 3	-9.155	9.101	-1.01	0.3159	-0.039
c0	Zero BRD Treatments with respect to Chronics	68.948	21.147	3.26	0.0013	0.291
c1	One BRD Treatments with respect to Chronics	74.451	20.279	3.67	0.0003	0.316
c2	Two BRD Treatments with respect to Chronics	46.313	20.873	2.22	0.0278	0.164
c3	Three BRD Treatments with respect to Chronics	25.831	19.326	1.34	0.1831	0.095

[1]R^2=0.7912, n=185

this research measured the effectiveness of using serum haptoglobin (Hp) concentration to predict BRD occurrence and the impact of multiple treatments for BRD on cattle performance and net returns.

BRD treatment costs were significantly higher for chronic heifers compared with those receiving two or fewer treatments. Net returns decreased per head, as the number of BRD treatments increased in the backgrounding phase and the combined phases. Previous research found similar results (Fulton et al., 2002). In the finishing phase, net returns were not significantly different as the number of BRD treatments increased. Heifers classified as chronics tended to catch up to those receiving three or fewer treatments. Dead animals in the backgrounding phase reduce overall net returns by approximately $22 per head and $163 per head in the combined phases.

Backgrounding phase cost of gain was significantly different between heifers in risk group three compared with risk groups one and two treatments. The current study found no significant relationship between heifer risk group based on Hp concentration and the number of BRD treatments. It also found no relationship between risk group and net returns. Previous research has found similar results in steers where arrival Hp concentration was a poor predictor of the number of antimicrobial treatments (Step et al., 2008). Further studies need to be conducted to further examine the economic efficiency given the cost of using Hp concentration to predict the number of BRD.

Standardized beta coefficients determine the influence of each independent variable on net returns. In the backgrounding phase, ADG had the highest influence on net returns followed by cost of feed. However in the finishing phase, the beta coefficients show that HCW had the highest influence on finishing net returns followed by initial weight in the finishing phase and cost of feed. Overall, HCW and feed-to-gain conversion had the highest influence on overall net returns, followed by number of BRD treatments compared to chronics.

Knowing the potential number of BRD treatments required in a backgrounding feedlot phase for heifers could potentially increase net revenues for stocker operations and feedlot managers. The ability to choose animals remaining healthy throughout the phase would decrease cost of treatment. Producers could also pay less for high risk cattle; precondition them, and then potentially resale at higher prices. Step et al. (2008) found weaning steers on the ranch for 45 days prior to shipping to feedlots resulted in healthier cattle. A high percentage of calves (91 percent) are diagnosed with BRD within the first 27 days after arrival at the feedlot (Buhman et al. 2000) and the majority of deaths due to BRD occur shortly after arrival to the feedlot or within the first 45 days (Loneragan et al., 2001; Edwards, 1996). Potential decreases in BRD outbreaks and increased net revenues for stocker operations and feedlot managers could be seen if cattle were in a 45-day backgrounding phase prior to shipment to the feedlot.

The research presented here was conducted on heifers only. Further research should address the economics of other alternative indicators of risk and whether differences exist in the impact of BRD treatments between heifers and steers in the backgrounding, finishing, and combined system. Further research is also needed to determine differences in Hp concentration on predicting BRD treatments in both steers and heifers.

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