PEER REVIEWED

Comparison of Feedlot Health, Nutritional Performance, Carcass Characteristics and Economic Value of Unweaned Beef Calves with an Unknown Health History and Weaned Beef Calves Receiving Various Herd-of-origin Health Protocols

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Abstract

This study was conducted in a commercial feedlot to compare the health, nutritional performance, carcass characteristics and economic value of three groups of 600 lb (273 kg) beef steer calves—one group of unweaned calves of unknown health history and two groups of calves administered a herd-of-origin health protocol with at least a 45-day weaning period. Calves were purchased between December 1 and December 20, 2003, and were harvested between April 22 and June 2, 2004. Calves identified as persistently infected with bovine viral diarrhea virus remained in their respective treatment groups for the duration of the study. Mortality rates were low in all groups of steers and were unaffected ($P>0.14$) by treatment. Compared with steers administered health protocols, steers of unknown health history had higher ($P<0.05$) morbidity, lower average daily gain and lower feed intake, particularly early in the feeding period. Additionally, steers with an unknown health history were more likely than health protocol steers to receive multiple treatments for respiratory disease during the entire feeding period. Treatment costs were approximately $7 per head higher for steers of unknown health history. Although feed efficiency was not affected ($P>0.57$) by treatment, steers of unknown health history required an additional 16 days-on-feed to reach the desired back fat thickness. Neither quality grade nor yield grade was affected by treatment, but the trend was towards a lower (less favorable) quality grade and lower (more favorable) yield grade in calves of unknown health history. Unadjusted for days-on-feed, profit per head was not affected ($P=0.64$) by treatment; however, on the basis of an equal number of days-on-feed, steers administered the WeanVAC® health protocol at the herd of origin returned $33.71 more net income per head than steers of unknown health history, whereas steers administered other 45-day programs returned $11.36 more net income per head than steers of unknown health history.

Keywords: bovine, feeder cattle, preconditioning, morbidity

Résumé

Une étude indépendante a été menée dans un parc d'engraissement commercial afin de comparer l'état de santé, la performance de nutrition, les caractéristiques de la carcasse et la valeur économique dans trois groupes de bouvillons de boucherie de 600 lbs (273 kg). Ceux-ci incluaient un groupe de veaux non sevrés pour lesquels le programme de santé n'était pas connu et deux groupes de veaux encadrés par un programme de santé propre à leur troupeau d'origine et avec une période de sevrage durant au moins 45 jours. Les veaux ont été achetés entre le premier et le 20 décembre 2003 et ont été recueillis entre le 22 avril et le 2 juin 2004. Les veaux immunotolérants au virus de la diarrhée virale bovine sont restés dans leurs groupes respectifs pendant toute la durée de l'étude. À chaque jour durant la période d'engraissement, on notait la présence des signes cliniques et la prise alimentaire de matières sèches dans chaque enclos. Les taux de mortalité étaient faibles dans tous les groupes de bouvillons et ne variaient pas

selon le traitement ($P>0.14$). Par rapport aux bouvillons encadrés par un programme de santé, les bouvillons au statut de santé inconnu avaient un taux de morbidité plus élevé ($P<0.05$), un gain moyen quotidien moins élevé et une prise alimentaire moindre surtout dans la première partie de l'engraissement. De plus, les bouvillons au statut de santé inconnu avaient plus de chance que les bouvillons encadrés par un programme de santé de recevoir des traitements multiples pour des maladies respiratoires pendant toute la période d'engraissement. Le statut inconnu de santé rajoutait $7 en moyenne par tête aux coûts de traitement comparé au statut établi. Bien que le taux de conversion alimentaire n'était pas influencé par le traitement ($P>0.57$), les bouvillons avec statut inconnu nécessitaient 16 jours d'engraissement additionnel pour atteindre le niveau requis d'épaisseur du gras dorsal. Le traitement n'a pas influencé la catégorie de qualité ou de rendement bien que la catégorie de qualité ou de rendement tendait à être moins élevée (moins favorable) chez les bouvillons au statut inconnu. Le profit par tête sans ajustement pour le nombre de jours en engraissement n'était pas affecté par le traitement ($P=0.64$). Toutefois, pour un nombre égal de jours en engraissement, les bouvillons qui avaient reçu le programme WeanVAC, dans leur troupeau d'origine engendraient un retour net additionnel de $33.71 par tête par rapport aux bouvillons de statut inconnu. Les bouvillons qui avaient reçu un autre protocole de santé de 45 jours produisaient des bénéfices additionnels de $11.36 par tête par rapport aux bouvillons de statut inconnu.

Introduction

Analysis of data collected during nine years of the Texas A & M Ranch to Rail program indicates that feedlot sickness, primarily bovine respiratory disease, results in a major economic loss to the beef cattle industry.[19-27] Factors contributing to the lower economic returns of sick cattle include higher mortality rates, higher medical costs, lower average daily gains and lower carcass quality grades. While various studies have demonstrated that vaccination and preconditioning programs improve feedlot performance, a recent review and discussion of the literature by members of the Academy of Veterinary Consultants has challenged the validity of many of these studies.[1]

Numerous calf health management and vaccination programs have been developed during the past 30 years to help producers deliver low health-risk calves to stocker and feedlot operations. These programs have consistently increased the value of beef calves sold compared with similar calves that were not weaned or vaccinated against respiratory viral pathogens.[8-17] Additionally, the premium paid for these high-health-status calves has increased in recent years.[14-17] However, little scientific research has been done to document the effect of calf health programs administered at the herd of origin on feedlot performance, carcass characteristics and economic returns of beef calves. The objective of this study was to determine the relative value of three groups of calves enrolled in a commercial feedlot setting. Calves in one group were unweaned and of unknown health status, whereas calves in the second group were weaned and administered a commercial health program (WeanVAC[a]) at the herd of origin, and calves in the third group were weaned and administered other commercial health programs at the herd of origin.

Materials and Methods

Animals

Steer calves weighing approximately 600 lb (273 kg) were purchased at regular and special sales (only calves from a value-added health program) through Joplin Regional Stockyards, Carthage, Missouri, or Fort Scott Livestock, Fort Scott, Kansas, between December 1 and December 20, 2003. The calves were either of unknown health history and unweaned, enrolled in Pfizer Animal Health's WeanVAC (WV) program, or enrolled in other 45-day weaning health programs. Calves enrolled in the WV health and weaning program were vaccinated against clostridial and respiratory diseases, treated for internal and external parasites, and weaned for at least 45 days prior to shipping (Table 1). Calves enrolled in the other 45-day programs were marketed as vaccinated and weaned, but limited documentation was available. Calves in all study groups were transported separately on the day of sale in single-treatment truckload lots (approximately 50,000 lb; 22,727 kg) directly to Decatur County Feed Yard, Oberlin, Kansas. Within 24 hours of delivery, all calves received the same standard feedlot arrival program: a 5-way viral respiratory vaccine,[b] a 7-way clostridial bacterin-toxoid,[c] an endectocide[d] and a growth promotant implant.[e] Additionally, all calves were weighed, measured for hip height, tagged with visual and electronic ear tags, entered in the feedlot's electronic cattle management system,[f] measured for back fat by ultrasound, assessed for hide hair color and ear notched for identification of calves persistently infected (PI) with bovine viral diarrhea virus (BVDV). Calves identified as BVDV-PI remained in their respective treatment group for the duration of the study. All calves were re-processed approximately 85 days after arrival. At re-processing, calves were treated for external parasites,[g] had their back fat measured by ultrasound and were weighed. From the time of purchase through the entire feeding period, study groups were never commingled. According to study design, steers were sold for harvest to Excel Beef, Dodge City, Kansas, when the pen average for back

Table 1. Weaned calf health protocols at herd of origin.

Program type	Program options	Vaccination Requirements and Timing: Clostridial 7-Way	4- or 5-way respiratory viral vaccine	*Mannheimia* (*Pasteurella*) vaccine	Other requirements
Weaned calf	Option 1	Vaccinated 2 to 8 weeks prior to weaning and at weaning, with 2 to 6 weeks between vaccinations	Vaccinated 2 to 8 weeks prior to weaning and at weaning, with 2 to 6 weeks between vaccinations	Administered at either the initial viral vaccination or at the time of the second viral vaccination, but no later than 14 days prior to shipment and/or sale	Weaned at least 45 days prior to shipping (beginning at weaning)
	Option 2	Vaccinated at weaning and 2 to 6 weeks postweaning, with the second vaccination at least 14 days prior to shipment and/or sale	Vaccinated at weaning and 2 to 6 weeks postweaning, with the second vaccination at least 14 days prior to shipment and/or sale	Administered at either the initial viral vaccination or at the time of the second viral vaccination, but no later than 14 days prior to shipment and/or sale	Endectocide prior to sale

fat equaled approximately 0.45 inch (1.14 cm), but, due to market conditions, were sold earlier than planned and only had a pen average of approximately 0.35 inch (0.89 cm) back fat.

Study Design

Following arrival, calves were observed daily for clinical signs of disease by pen riders masked to the study group assignments. Calves exhibiting clinical signs of disease were pulled, examined and treated according to the feedlot's standard treatment protocol. Under this protocol, calves pulled for the first time were treated with oxytetracycline[h] if they showed mild clinical signs of respiratory disease with a temperature less than 104°F (40°C). First-pull calves with a temperature less than 104°F but with more severe signs of respiratory disease or with a rectal temperature higher than 104°F were treated with either florfenicol[i] or tilmicosin.[j] All first pulls were identified with a chalk color specific for the day of treatment and returned to their pens of origin. Calves pulled for a second time were treated with either florfenicol or tilmicosin, marked, and returned to their pens of origin. Calves pulled for a third time were administered a 3-day treatment regimen with procaine penicillin G[k] and placed in a hospital pen where they were evaluated on a bi-weekly basis. Calves in the convalescent pen that did not recover were railed. The following information was recorded at each treatment: calf identification number, lot identification number, pen identification number, treatment date, disease condition, calf weight, calf rectal temperature, antimicrobials administered and dosages, destination pen and treatment costs. Calves that died were submitted for necropsy in accordance with standard feed yard procedures and appropriate data were recorded.

Dry matter intake was recorded for each pen on a daily basis throughout the feeding period. The mean daily dry matter intake per head was determined for each pen by dividing the dry matter intake for the day for a pen by the number of calves in the pen on that day.

Each pen of steers was harvested at Excel Beef as a group when average back fat thickness of the steers in the pen was approximately 0.35 inch. Data collected at slaughter included hot carcass weight, back fat thickness, percent marbling, carcass quality grade, carcass yield grade and percentage Certified Angus Beef.

Cattle were marketed on a grid basis, and economic returns were calculated.

Statistical Methods

Outcomes of interest in this study included both continuous and dichotomous data types. The continuous outcomes were average daily gain, pen dry matter intake, pen feed efficiency, treatment cost, percent marbling, days-on-feed, hot carcass weight, carcass back fat thickness and net financial return. Dichotomous outcomes included mortality, morbidity, quality grades of Choice or better, yield grades of 2 or better and percentage of acceptance into Certified Angus Beef.

Continuous data outcomes were analyzed using multiple regression models developed using a backwards selection procedure in SAS.[1,18] An independent factor remained in the model if the P-value was <0.05. These models allowed for the comparison of treatment

groups while adjusting for the potential confounding effects of additional independent variables that were not completely accounted for in the study design. The effect of the pen nested within treatment group was forced into all models as a random effect. Multiple pairwise comparisons of factors significantly affecting continuous outcomes were accomplished by using the Tukey-Kramer adjustment.

Multivariable logistic regression was used to quantify the effects of independent factors on dichotomous data outcomes.[7] As with the continuous data models, a backwards selection procedure was used, and the effect of the pen nested within treatment group was forced into all models as a random effect. The effects of independent factors on dichotomous outcomes were expressed as adjusted odds ratios. No appropriate methods for multiple pairwise comparisons are available for dichotomous outcomes.

In the original models for mortality rate, morbidity rate, treatment cost, average daily gain, days-on-feed, hot carcass weight, percent marbling, carcass back fat thickness, quality grades of Choice or better, yield grades of 2 or better, Certified Angus Beef acceptance and profit, the following independent variables were used: health program, calf hide color, BVDV-PI pen status (no PI calves, one or more PI calves, next to a PI pen), initial weight, initial back fat thickness, initial hip height and number of purchase sources making up a pen. Factors included in the pen dry matter intake and feed efficiency models were: health program, number of calves in the pen, mean weight of the pen at the beginning of the feeding period, BVDV-PI status of the pen and the number of purchase sources making up the pen.

Results and Discussion

Animals

Of the total 1,576 calves purchased at Joplin Regional Stockyards or Fort Scott Livestock between December 1 and December 20, 2003, 502 were unweaned and of unknown health history (treatment group T1); 671 were calves that had been weaned for at least 45 days and had received a WeanVAC® calf health protocol at the herd of origin (group T2); 111 were calves that had received a PreVAC™ calf health protocol at the herd of origin and were sold directly off of the cow (group T3); and 292 were calves that had been weaned for at least 45 days and had received other commercial health programs (group T4). Soon after initiation of the study, it was learned that there were limited numbers of T3 calves available for sale at the auctions where calves in the other three treatment groups were purchased, and inadequate numbers of T3 calves could be obtained to meet the sample size requirement of the study design. Thus, the T3 treatment group was excluded from the analysis. The T4 group not only included steers that had been on pre-weaning/weaning health programs but also some calves that had been on a supplemental mineral and/or feed supplement program prior to sale.

During initial processing at Decatur County Feed Yard, four calves in T2 were determined to be heifers and were removed from the study. A total of nine calves in T1 either died (n=6) or were railed (n=3) as did three calves in T2 (2 died and 1 railed), and five calves in T4 (3 died and 2 railed). Altogether, 493 calves in T1, 664 calves in T2 and 287 calves in T4 were harvested, for a total of 1,444 (Table 2).

Three calves in the T2 group and three in the T4 group were determined to be PI with BVDV. Because additional information on the health performance of these calves in the feedlot was thought to be useful to the industry, the decision was made to retain the PI calves in the study. One of the T2 calves was pulled and treated five times and subsequently died. The other two T2 calves remained clinically healthy and completed the study, one finishing among the lowest performing steers and one among the highest for average daily gain, carcass weight and quality grade. One of the T4 PI calves was pulled and treated four times before dying; a second was pulled and treated once and then railed after becoming crippled; and a third remained clinically healthy and completed the study. Health performance

Table 2. Accounting of calves enrolled in Decatur County Feed Yard study evaluating effects of health protocols on health, nutritional performance, carcass quality and economic return.

Cattle enrolled	T1 no health history	T2 health protocol at herd of origin	T4 health protocols at herd of origin	Totals
Purchased	502	671	292	1,465
Heifers removed	0	4	0	4
PI BVDV	0	3	3	6
Died	6	2	3	11
Railed	3	1	2	6
Harvested	493	664	287	1,444

differences detected between study groups occurred despite the presence of the PI steers in the T2 and T4 health protocol groups.

Descriptive data for calves in the three treatment groups are shown in Table 3. The average weight, back fat and height were similar for the three groups. The T2 health protocol group contained a higher percentage of black calves (55.92%) than the T1 group of calves of unknown health history (38.84%), whereas the T4 group of other health programs had the highest percentage of black calves (67.81%).

Mortality

Mortalities during the periods from arrival through second processing and from arrival through harvest were low and were not significantly ($P>0.14$) affected by health program or any other factor (Table 4). The odds of mortality across the entire feeding period were 4.02 times higher for calves with an unknown health history than for calves administered the T2 health protocol. Similarly, the odds of mortality were 3.50 times higher for T4 health program calves than for T2 program calves.

Morbidity

Morbidity data for the 1,461 steer calves are summarized in Figure 1 by post-arrival assessment intervals. During the first 28 days, 6.9% of T2 calves and 6.85% of the T4 calves exhibited signs of respiratory disease and were treated as compared with 32.27% of the T1 calves of unknown health history, a significant ($P=0.0092$) improvement during the first 28 days in the feedlot for the health protocol calves. The data also indicated that calves of unknown health history had 6.5 times higher odds and calves in the T4 other health programs group 1.15 times higher odds of becoming ill due to respiratory diseases during the first 28 days in the feedlot than calves receiving the T2 health protocol. From Day 0 (day of arrival) through second processing on Day 85, 13.64% of the calves in T2 and 14.04% of the calves in T4 showed clinical signs of respiratory disease and required treatment. In comparison, 41.43% of the calves in T1 required treatment ($P=0.0084$). Odds of morbidity from Day 0 to Day 85 were 4.42 times higher in calves with an unknown health history and 1.07 times higher in T4 group calves receiving other health programs than in calves administered the T2 health protocol. For the entire feedlot period, 15.44% of T2 calves and 15.41% of T4 calves exhibited clinical signs of respiratory disease and required treatment as compared with 42.63% of the T1 calves, a significant ($P=0.0079$) health advantage for calves receiving the herd-of-origin health protocols. The odds of respiratory disease occurring during the entire feeding period were 4.02 times

Table 3. Descriptive data for steer calves at initial processing in Decatur County Feed Yard study.

Descriptive factor	T1 no health history	T2 health protocol at herd of origin	T4 health protocols at herd of origin
Weight (lb)	603.6	607.8	611.3
Back fat (in)[a]	0.085	0.089	0.090
Hip height (in)	46.46	46.46	46.17
Color			
Black (%)	38.84	55.92	67.81
Other colors (%)	61.16	44.08	32.19

[a] Back fat was measured using ultrasound technology.

Table 4. Mortality by treatment group during the period from arrival through harvest.

Health program	Number of steers arrival	Number died (entire feeding period)	% mortality (entire feeding period)	Odds Ratio	95% CI of Odds Ratio	*P*-value
						0.1444
T1 no health history	502	6	1.20	4.02	1.01 to 16.06	
T2 health protocol	667	2	0.30	—	—	
T4 health protocols	292	2	1.03	3.50	0.70 to 17.41	

CI = confidence interval

higher in the calves with an unknown health history and 1.03 times higher in calves receiving the T4 protocols as compared with calves receiving the T2 protocol. Also showing a significant ($P<0.05$) effect on morbidity at Day 28, second processing (Day 85) and for the entire feeding period was calf weight at first processing. The odds of respiratory disease occurring in heavier weight calves were significantly lower during the first 28 days ($P=0.0126$), at second processing ($P=0.0110$) and during the entire feeding period ($P=0.0067$) than in lighter weight calves (data not shown).

Overall, the data support previous work and bias that the vast majority of respiratory illness in the feedlot occurs within the first weeks after arrival (Figure 2). Few new cases of respiratory disease occurred in this study after the second processing (1.2%, 1.8% and 1.4% increases for T1, T2 and T4, respectively, after Day 85). Additionally, the data show that calves with an unknown health history showed clinical signs of respiratory disease significantly ($P<0.05$) earlier after feedlot arrival (19.24 days) than steers in the T2 health protocol (32.57 days) when calculated up to the time of the second processing (Table 5). No significant difference ($P>0.05$) was observed between the T1 (19.24 days) and T4 (28.83 days) groups or between the T2 (32.57 days) and T4 (28.83 days) groups. Because new cases of respiratory disease after the second processing occurred later in the feeding period, the mean number of days to the first clinical signs of respiratory disease for the period from arrival to harvest increased in all three treatment groups compared with their values up to the second processing. However, the relationship between health programs remained similar, as calves with an unknown health history showed clinical signs of respiratory disease significantly ($P<0.05$) earlier (20.70 days) than calves that received a health protocol (41.50 days for T2 group calves and 36.27 days for T4 group calves).

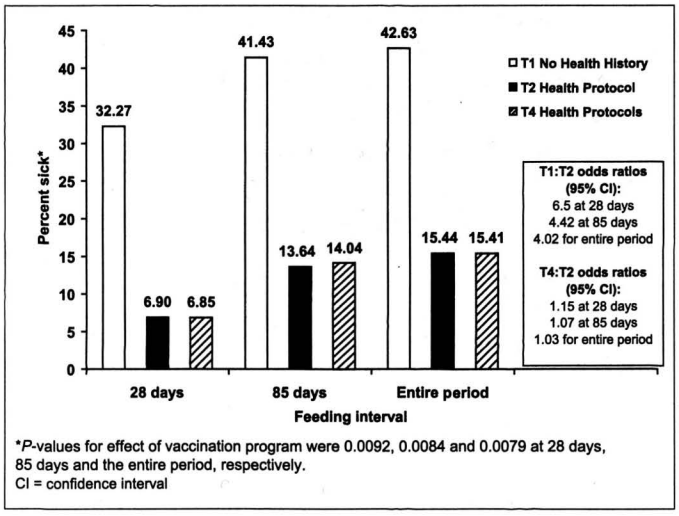

Figure 1. Morbidity (%) of steer calves at 28 and 85 days after feedlot arrival and for the entire feeding period.

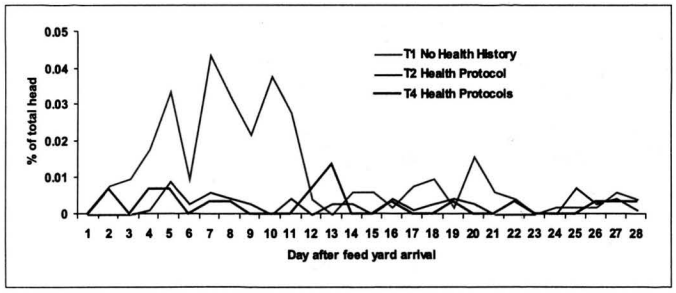

Figure 2. Epizootic curve showing time of first pulls for clinical signs of respiratory disease and percentage of calves affected.

Pulls / Retreatments

Through the first 85 days in the feedlot (day of second processing), a lower percentage of calves in the T2 and T4 health protocol groups were treated for respiratory disease conditions on two or more occasions than calves of unknown health history (Figure 3). During the same period, calves in the T2 and T4 health protocol groups also had a lower mean number of pulls per head than unvaccinated calves (Table 6). For the entire feeding period, both the percentage of calves pulled once, twice, or three-plus times and the mean number of pulls per head remained lower in the T2 and T4 groups of calves than in the T1 group (Figure 4, Table 7).

Treatment Costs

The total cost of medications for treating sick calves in each group was assigned to the entire group, and an average per head treatment cost was determined for each group. For the periods from arrival through second processing and arrival through harvest, the cost per head of treating respiratory disease conditions was significantly ($P<0.05$) lower in the T2 group calves ($2.65 at Day 85 and $2.91 for the entire period) and T4 group calves ($2.16 at Day 85 and $2.37 for the entire period) than in the T1 group calves of unknown health history ($8.99 and $9.35, respectively; Table 8).

Nutritional Performance

The nutritional performance of calves in all treatment groups is summarized in Table 9. The number of days-on-feed was significantly ($P<0.05$) higher for steers in the unknown health history group (161.4 days) compared with steers in the T2 group (145.7 days) or calves in the T4 group (147.6 days). Calves of unknown health history had a significantly ($P<0.05$) lower average daily gain (ADG) during the period from arrival through second processing when compared with weaned calves

Table 5. Mean number of days to first pull for respiratory disease by treatment group during the periods from arrival to second processing and from arrival to harvest.

	Total no. steers showing clinical signs		Mean no. days to first pull	
Mean no. days	Day 0-Day 85	Day 0-harvest	Day 0-Day 85	Day 0-harvest
T1 no health history	208	214	19.24[a]	20.70[a]
T2 health protocol	91	103	32.57[b]	41.50[b]
T4 health protocols	41	45	28.83[ab]	36.27[b]

[a,b]Values within the same column with different lower case superscripts are significantly ($P<0.05$) different.

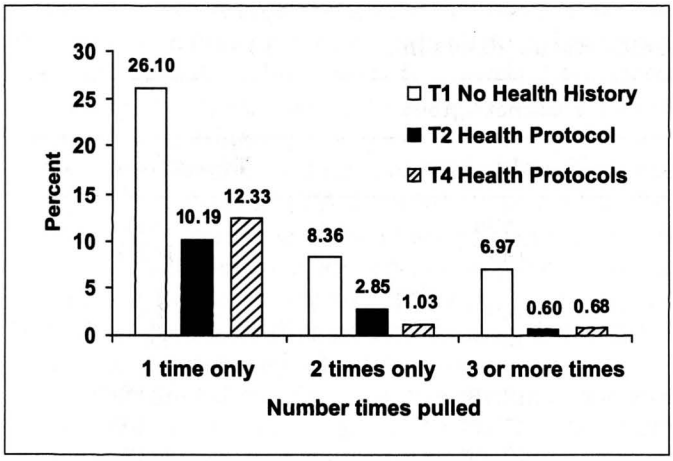

Figure 3. Percentage of pulls for respiratory disease conditions by treatment group during the period from arrival through second processing (Day 85).

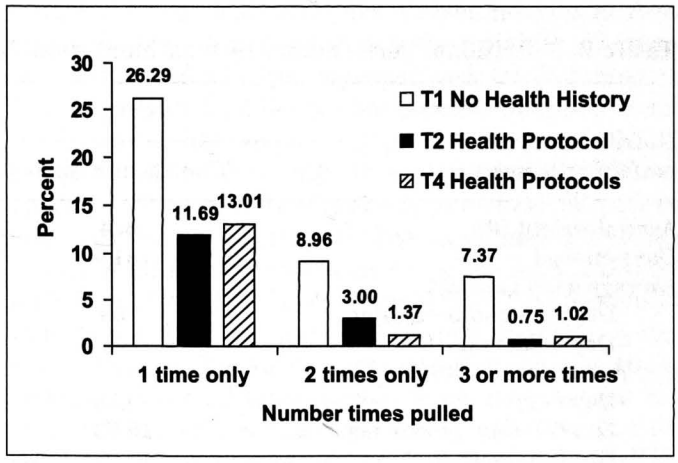

Figure 4. Percentage of pulls for respiratory disease conditions by treatment group during the period from arrival through harvest.

Table 6. Mean number of pulls for respiratory disease conditions by treatment group during the period from arrival through second processing (Day 85).

Health program	Total number of steers	Mean number of pulls/head
T1 no health history	502	0.68
T2 health protocol	667	0.18
T4 health protocols	292	0.17

Table 7. Mean number of pulls for respiratory disease conditions by treatment group during the period from arrival through harvest.

Health program	Total number of steers	Mean number of pulls/head
T1 No health history	502	0.71
T2 health protocol	667	0.20
T4 health protocols	292	0.20

administered the T2 and T4 health protocols. The ADGs were 3.53, 3.96 and 3.87 lb (1.60, 1.80 and 1.76 kg) for unknown health history steers and the T2 and T4 health protocol steers, respectively. Other factors significantly affecting ADG during the period from arrival to second processing were hide color, weight at first processing, back fat thickness at first processing and hip height at first processing (data not shown). Calves that weighed more and were taller at first processing gained slightly faster, whereas calves with more back fat gained slower than calves with less back fat. During the entire feeding period, steers administered the T2 health protocol gained at a significantly ($P<0.05$) faster rate (ADG=3.44 lb; 1.56 kg) than steers with an unknown health history (ADG=3.29 lb; 1.50 kg), while steers in the T4 group had an ADG of 3.42 lb (1.55 kg), which was not different than the gain of steers in the T2 group.

The ADG in steers showing no clinical signs of disease from arrival to the second processing was also significantly affected ($P<0.05$) by health program (Table 9). A comparison of this subset of animals within groups showed that clinically healthy T1 steers had an ADG of

Table 8. Cost per head of treating respiratory disease in steer calves from arrival to second processing (Day 85) and from arrival through harvest.

Health program	Number of steers	Least squares mean of treatment cost ($/head)	
		Arrival-Day 85	Arrival-harvest
T1 no health history	502	8.99[a]	9.35[a]
T2 health protocol	667	2.65[b]	2.91[b]
T4 health protocols	292	2.16[b]	2.37[b]

[a,b]Values within the same column with different lower-case superscripts are significantly ($P<0.05$) different.

Table 9. Nutritional performance by treatment group and health status (deads in).

Nutritional performance measure	Treatment group		
	T1 no health history	T2 health protocol	T4 health protocols
Arrival weight (lb)	604	608	611
Days-on-feed	161.4[a]	145.7[b]	147.6[b]
Average daily gain (lb)			
–Day 0-second processing	3.53[a]	3.96[b]	3.87[b]
–Day 0-harvest	3.29[a]	3.44[b]	3.42[ab]
Dry matter intake (lb)			
–Day 0-28	13.83[a]	16.18[b]	16.73[b]
–Day 0-second processing	15.73[a]	17.26[b]	17.55[b]
–Day 0-harvest	17.01[a]	17.89[b]	17.98[b]
Feed efficiency (lb feed/lb gain)	5.16	5.16	5.30
	Steer calves showing no clinical signs of disease		
	T1 no health history	T2 health protocol	T4 health protocols
No. head	293	574	249
Average daily gain (lb)			
–Day 0-second processing	3.76[a]	4.01[b]	3.92[ab]
	Steer calves by health status (Includes T1, T2, and T4 calves)		
	Sick calves	Healthy calves	
No. head	336	1,108	
Average daily gain (lb)			
–Day 0-harvest	3.06	3.50	

[a,b]Values within the same row with different lower-case superscripts are significantly ($P<0.05$) different.

3.76 lb (1.71 kg), whereas clinically healthy T2 steers had an ADG of 4.01 lb (1.82 kg), and clinically healthy T4 steers had an ADG of 3.92 lb (1.78 kg). These results suggest that T2 and T4 health protocol steers had a reduced level of subclinical disease in this study compared with T1 unknown health history steers that allowed the health protocol steers to gain at a faster rate. For the entire feeding period, however, treatment had no effect on ADG ($P=0.5491$) in steers that showed no clinical signs of disease. Across all treatment groups,

illness reduced ADG by 0.44 lb (0.20 kg). Regardless of treatment protocol, the 336 sick calves had an ADG of 3.06 lb (1.39 kg) compared with 3.50 lb (1.59 kg) in the 1,108 clinically healthy calves. Dead and railed calves were excluded from the ADG calculations for the entire feeding period.

The health and weaning program significantly ($P<0.05$) influenced pen dry matter intake/head during the first 28 days after arrival and during the periods from arrival to second processing and from arrival through harvest (Table 9). No other factor included in the original model had a significant effect on pen daily dry matter intake/head; however, all models were adjusted for the effect of the mean weight of the calves at the beginning of each feeding period. In the first 28-day period from arrival and in the periods from arrival to second processing and from arrival to harvest, steers in the unknown-health-history group consumed significantly ($P<0.05$) less feed on a daily basis than steers in the group that received the T2 or T4 health protocols. The lower dry matter intake of the unknown health history steers during the entire feeding period appears to be due to the lower feed consumption of this group during the earliest days of the feeding period when morbidity rates in this group were the highest (Figure 2).

Pen feed efficiency for the entire feeding period was not affected by health program ($P=0.5790$). Although steers in the unknown health history group gained at a slower rate when compared to the two groups of health-protocol steers, they ate significantly ($P<0.05$) less feed than the health-protocol steers, which resulted in similar feed efficiencies when compared to the T2 and T4 treatment groups.

Carcass Data and Meat Quality

Results of carcass and meat quality for steers in the feedlot study are summarized in Table 10. The health program had no effect on hot carcass weight, percent marbling, mean back fat thickness of carcasses, percentage of carcasses graded either Prime or Choice, percentage of carcasses that had Yield Grades of 1 or 2, or percentage of black-hided calves that qualified for the Certified Angus Beef program. Calves heavier at first processing had heavier hot carcass weights, whereas calves that had a higher degree of back fat thickness at first processing had lighter hot carcass weights. Black calves had a higher percentage (2.24%) of marbling compared with calves with other hide colors (1.93%), as did calves that were heavier or had more back fat at first processing (data not shown). The mean back fat thicknesses of all treatment groups (T1=0.34 inch; T2=0.36 inch; T4=0.39 inch; 0.86, 0.91 and 0.98 cm, respectively) were lower than the desired 0.45 inch specified in the study design. Due to market conditions at the time, cattle were slaughtered earlier than the protocol required. Black calves had more back fat (0.41 inch; 1.04 cm) than calves of other colors (data not shown). The percentage of Prime/Choice carcasses in all treatment

Table 10. Carcass and meat quality data of steer calves enrolled in Decatur County Feed Yard study evaluating effects of health protocols (deads and chronics out).

	Treatment group		
Measurement	T1 no health history (161.4 DOF; 493 head)	T2 health protocol (145.7 DOF; 664 head)	T4 health protocols (147.6 DOF; 287 head)
Hot carcass weight (lb)	714.3	696.3	702.4
Live weight (lb)	1,142	1,113	1,121
Dressing % (calculated)	62.5	62.6	62.6
% Marbling	2.01	2.07	2.17
% Yield Grade 1 or 2*	77.62	70.64	63.78
Back fat (in)	0.34[a]	0.36[ab]	0.39[b]
% Prime or Choice†	17.65	22.14	26.48
% Certified Angus Beef‡ (Black-hided steers only)	2.05	3.49	1.52

DOF = days on feed

[a, b]Values within the same row with different lower-case superscripts are significantly ($P<0.05$) different.
*T1:T2 odds ratio=1.12, T4:T2 odds ratio=0.83 at 95% confidence interval
†T1:T2 odds ratio=0.90, T4:T2 odds ratio=1.12 at 95% confidence interval
‡T1:T2 odds ratio=0.58, T4:T2 odds ratio=0.43 at 95% confidence interval

groups was lower than the industry average, which could be attributed to too few days-on-feed, genetics with low predisposition to marbling, or management factors that occurred prior to purchase. It is likely that if calves had been allowed to feed longer, a higher percentage would have graded Choice or higher. Insufficient time on feed may have contributed to the low percentage of differences between treatment groups. The odds of carcasses grading either Prime or Choice were increased if the calves were black hided, heavier or had more back fat at first processing (data not shown). Calves that were not black or larger framed at first processing had increased odds of producing Yield Grade 1 or 2 carcasses, whereas the odds of achieving Yield Grades of 1 or 2 were decreased in steers that were heavier or had more back fat at first processing (data not shown). The percentage of black-hided calves that qualified for the Certified Angus Beef (CAB) program was low in all treatment groups, with the unknown health history group steers having 2.05%, the T2 health-protocol steers having 3.49% and the T4 health-protocol steers having 1.52%. The percentage of calves qualifying for the CAB program was not significantly affected by the health program.

Economics

Table 11 summarizes costs and returns by treatment group of steers enrolled in the Decatur County Feed Yard study. Treatment did not affect (P=0.64) net profit per head. A contributing factor to this outcome was that calves of unknown health history were purchased at a lower cost per head than the weaned calves administered the T2 health protocol ($28.80/head lower) or the T4 health protocol ($24.41/head lower) at the auction market. While calves of unknown health history had higher feed costs because they were fed for a longer period and higher medication costs than the health-protocol calves, these costs did not completely offset the lower purchase price of this group. Thus, the total cost for the calves of unknown health history was approximately $7.80/head lower than the calves in the group administered the T2 health protocol and $9.20 lower than the T4 health-protocol calves. The cattle were sold on Decatur County Feed Yard's grid that rewarded both quality grade and yield grade. While the health program did not affect (P>0.60) quality or yield grade, the T2 and T4 health-protocol calves had a numerical advantage in quality grade, whereas calves of unknown health history had an advantage in yield grade. These two effects neutralized each other and total carcass value was similar for all groups. The net profits per head in this study were $50.46 for calves of unknown health history, $49.51 for calves administered the T2 health protocol and $37.66 for calves administered the other commercial health protocols.

A final economic analysis (Table 11) of net profit per head per day on feed favored calves in the T2 group; calves in T1 returned $0.313/head/day, calves in T4 returned $0.257/head/day and calves in T2 returned $0.340/head/day, resulting in a non-statistical difference of approximately $0.03/head/day for calves receiving the

Table 11. Mean costs and returns by health program of steer calves in feedlot study at Decatur County Feed Yard (deads in).

Cost/return ($/head)	T1 No health history (n=502)	T2 health protocol at herd of origin (n=667)	T4 health protocols at herd of origin (n=292)
Receiving cost[a]	624.47	653.27	648.88
Feed cost	236.15	222.86	229.08
Yardage cost	8.10	7.30	7.39
Processing cost[b]	6.67	6.64	6.67
Treatment cost	9.36	2.91	2.31
Other costs[c]	9.50	9.07	9.12
Total cost	894.25	902.05	903.45
Total carcass value	944.71	951.56	941.11
Profit	50.46	49.51	37.66
Net profit/head/DOF	0.313	0.340	0.257

DOF = days-on-feed

[a]Receiving cost included the purchase cost of the calves, commission, and transportation cost from auction market to the feed yard.
[b]Processing cost included only the cost of vaccines, parasite control products, and implants.
[c]Other costs included alliance fees, Kansas Livestock Association dues, and catastrophic loss.

Table 12. Adjusted (145.7 DOF) mean costs and returns by health program of steer calves in feedlot study at Decatur County Feed Yard (deads in).

Cost/return ($/head)	T1 No health history (n=502)	T2 health protocol at herd of origin (n=667)	T4 health protocols at herd of origin (n =292)
Receiving cost[a]	624.47	653.27	648.88
Feed cost[b]	213.58	222.86	226.13
Yardage cost[b]	7.33	7.30	7.30
Processing cost[c]	6.67	6.64	6.67
Treatment cost	9.36	2.91	2.31
Other costs[d]	9.50	9.07	9.12
Total cost	870.91	902.05	900.41
Total carcass value[b]	886.71	951.56	927.57
Profit	15.80	49.51	27.16
Advantage vs T1	—	33.71	11.36
Advantage vs T4	—	22.35	—

DOF = days-on-feed
[a]Receiving cost included the purchase cost of the calves, commission, and transportation cost from auction market to the feed yard.
[b]Feed cost, yardage cost, and total carcass value of T1 steers was adjusted to equal the same number of days on feed as the T2 steers (145.7 days) and adjusted to represent the greater number of animals of lower quality grade (-$.05).
[c]Processing cost included only the cost of vaccines, parasite control products, and implants.
[d]Other costs included alliance fees, Kansas Livestock Association dues, and catastrophic loss.

T2 health protocol over the T1 calves and more than $0.08/head/day over the T4 calves.

Adjustments

The study model reflecting the best estimate of treatment effects on net profit per head is shown in Table 12 and is based on adjustments used in previous published studies.[5,6,31] Calculations were made with deads included by adjusting the number of days-on-feed for T1 calves in the unknown health history group (161.4 days) and T4 calves in other health programs group (147.6 days) to equal the number of days-on-feed for calves in the T2 health-protocol group (145.7 days).

Accordingly, for the 502 T1 group calves, the mean total carcass value of $944.71 was lowered by $58.00 to $886.71. This figure was determined by adjusting the live final weight (562,995 lb; 255,907 kg) of 493 harvested head of the original 502 T1 group calves by 23,452.5 lb (10,660.2 kg) to 539,542.5 lb (245,246.6 kg) (562, 995 lb – [15.7 days x ADG of 3.03 lb* x 493 head]), which resulted in an adjusted mean live weight of 1,074.8 lb (488.5 kg) for the 502 T1 group calves. The mean hot carcass weight was then determined to be 671.75 lb (305.3 kg) (62.5% dressing percentage x 1,074.8 lb), and thus the adjusted mean carcass value of steers in the unknown health history group was $886.71 (671.75 lb x $1.32). Feed and yardage costs for steers in the T1 unknown health history group were similarly adjusted by 15.7 days. Total feed costs were reduced by $22.57/head to an adjusted cost of $213.58/head, and yardage costs were reduced by $0.78 to $7.33/head.

For the 292 T4 group calves, the mean total carcass value of $941.11 was lowered to $927.57. This figure was obtained by subtracting 1,543.2 lb (701.5 kg) (1.9 days x ADG of 2.83 lb† x 287 harvested head) from the original weight of the 292 calves (321,833 lb – 1,543 lb; 146,288 kg – 701 kg) for an adjusted mean live weight of 1,096.9 lb (498.6 kg) for the 292 T4 group calves. The mean hot carcass weight was determined to be 687.1 lb (312.3 kg) (62.6% dressing percentage x 1,096.9 lb), and the adjusted mean carcass value of steers in the T4 group was $927.57 (687.1 lb x $1.35). Feed and yardage costs for steers in the T4 group were similarly adjusted by 1.9 days. Total feed costs were reduced by $2.95/head

*3.03 lb (1.38 kg) was the ADG of T1 group calves from Day 85 through harvest.
†2.83 lb (1.29 kg) was the ADG of T4 group calves from Day 85 through harvest.

to an adjusted cost of $226.13/head, and yardage costs were reduced by $0.09 to $7.30/head.

Therefore, on the basis of an equal number of days-on-feed, calves of unknown health history returned a net profit of $15.80/head while calves in the T4 group and T2 group returned a net profit of $27.16 and $49.51/head, respectively. These results showed an advantage of $33.71 and $22.35 per head for calves in the T2 group as compared with the T1 and T4 group calves, respectively. Figures do not include labor and management costs associated with pulling and treating sick calves, which for this yard were approximately $6/head. If pull costs were added to treatment costs, economic performance would even more strongly favor the T2 and T4 health-protocol groups because of much lower morbidity rates in these groups.

Results of this study reported here strongly indicate that the purchase of weaned calves from a commercial health protocol resulted in decreased mortality, morbidity and cost of treatment when compared with calves of unknown health history. Calves administered the T2 and T4 health protocols consumed more feed and required fewer days-on-feed to reach market than calves of unknown health history. These latter results are consistent with those of other studies showing that preconditioned calves are associated with improved nutritional performance—due to reduced illness and death loss—and sometimes with improved carcass quality.[2-4,19-28,30]

Additional Considerations

In preparing the protocol for this commercial feedlot study, the authors recognized that an undertaking of such scope and complexity would have certain inherent limitations. First, because study cattle were sourced from multiple sites, we could not assure that all calves across all assessment groups would be equally matched. However, because all study calves were sourced through a sale barn over a period of several weeks, they provide a reasonable representation of each type of steer calves (except for the T3 group) that enter a feed yard from this region of the United States. Second, due to cost considerations, we knew that very large multiple repetitions of the study would not be feasible. In this study, the T1 group had six replicates, the T2 group had eight replicates, and the T4 group had four replicates. Additional replicates were to have been added, but the month in which the study was initiated (December 2003) was the month when bovine spongiform encephalopathy (BSE) was first diagnosed in the U.S., an event that disrupted further acquisition of cattle into the feed yard for a period of time. And last, we acknowledged that carcass value likely would be affected by breed selection and animal management practices other than those assessed in the study. In this study, breed distribution has been reported based on hide color, and carcass value would tend to favor the T4 group with the highest proportion of black-hided cattle. The authors also readily acknowledge that calves enrolled in precondition programs may also be calves originating from herds that practice additional management practices such as cow herd vaccination programs, improved feeding programs, improved genetics programs, and other unspecified programs. Nonetheless, the authors maintain that the Decatur feed yard study is an accurate and statistically meaningful representation of an observation study of "real" cattle entering a "real" feedlot in the time frame described and their final outcomes.

Conclusions

Economically, steer calves in the Decatur County Feed Yard study that were administered a commercial health protocol at the herd of origin returned a net profit to the feedlot that exceeded the premium paid to acquire this class of calf ($33.71 for calves in the T2 health protocol and $11.36 for calves in the T4 health protocol). This suggests that feeders may assume less financial risk by buying calves that have been administered certified herd-health protocols and can justify paying premiums for calves that will consistently meet or surpass the health expectations of their feedlot operation.

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Footnotes

[a]WeanVAC®, Pfizer Animal Health, New York, NY
[b]Titanium® 5, Intervet Inc., Millsboro, DE
[c]Vision® 7, Intervet Inc., Millsboro, DE
[d]Ivomec®, Merial Ltd, Duluth, GA
[e]Revalor®-S, Intervet Inc., Millsboro, DE
[f]ACCU-TRAC®, Micro Beef Technologies, Ltd, Amarillo, TX
[g]CyLence®, Bayer Animal Health, Shawnee Mission, KS
[h]Bio-Mycin 200®, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[i]Nuflor®, Schering-Plough Animal Health Corporation, Summit, NJ
[j]Micotil®, Elanco Animal Health, Greenfield, IN
[k]Pen-G, Phoenix Pharmaceuticals Inc., St. Joseph, MO
[l]SAS, Version 8.2, SAS Institute Inc., Cary, NC
[m]PreVAC, Pfizer Animal Health, New York, NY

References

1. Apley M, O'Connor A, Larson B: An evidence-based medicine approach to preconditioning programs, in: *Proc Acad of Vet Consultants,* Oklahoma City, OK, April 1-3, pp 28-48, 2004.
2. Cravey M: Preconditioning effect on feedlot performance, in: *Proc Southwest Nutrition and Management Conf,* Phoenix, AZ, pp 33-37, 1996.
3. Gardner BA, Northcutt SL, Dolezal HG, *et al*: Factors influencing profitability of feedlot steers. Oklahoma State University Animal Science Research Report P-951, 164, 1996.
4. Gardner BA, Dolezal HG, Bryant LK, *et al*: Health of finishing steers: Effects on performance, carcass traits, and meat tenderness. *J Anim Sci* 77:3168-3175, 1999.
5. Guiroy PJ, Tedeschi LO, Fox DG, *et al*: The effects of implant strategy on finished body weight of beef cattle. *J Anim Sci* 80:1791-1800, 2002.
6. Gwartney BL, Calkins CR, Rasby RJ, *et al*: Use of expected progeny differences for marbling in beef: II. Carcass and palatability traits. *J Anim Sci* 74:1014-1022, 1996.
7. Hosmer DW, Lemeshow S: *Applied Logistic Regression*. New York, John Wiley & Sons, 1989, pp 25-37.
8. King ME, Wittum TE, Odde KG: The effect of value added health programs on the price of beef calves sold through seven Superior Livestock video auctions in 1995. *CSU Beef Program Report* pp 167-173, 1996.
9. King ME, Wittum TE, Odde KG: The effect of value added health programs on the price of beef calves sold through nine Superior Livestock video auctions in 1996. *CSU Beef Program Report* pp 159-165, 1997.
10. King ME, Odde KG: The effects of value added health programs on the price and no-sale rate of beef calves sold through 10 Superior Livestock video auctions in 1997. *CSU Beef Program Report* pp 85-93, 1998.
11. King ME: The effects of value added health programs on the price and no-sale rate of beef calves sold through eight Superior Livestock video auctions in 1998. Final Report, Pfizer Animal Health, 1999.
12. King ME: The effects of value added health programs on the price and no-sale rate of beef calves sold through nine Superior Livestock video auctions in 1999. Final Report, Pfizer Animal Health, 2000.
13. King ME: The effect of value added health programs on the price of beef calves sold through 13 Superior Livestock video auctions in 2000. Final Report, Pfizer Animal Health, 2001.
14. King ME: The effect of value added health programs on the price of beef calves sold through seven Superior Livestock video auctions in 2001. Final Report, Pfizer Animal Health, 2002.
15. King ME: The effect of value added health programs on the price of beef calves sold through nine Superior Livestock video auctions in 2002. Final Report, Pfizer Animal Health, 2003a.
16. King ME: The effect of value added health programs on the price of beef calves sold through six Superior Livestock video auctions in 2003. Final Report, Pfizer Animal Health, 2003b.
17. King ME: The effect of value added health programs on the price of beef calves sold through eight Superior Livestock video auctions in 2004. Final Report, Pfizer Animal Health, 2004.
18. Kleinbaum DG, Kupper LL, Muller KE: Multiple regression analysis, in: *Applied Regression Analysis and Other Multivariable Methods*, ed 2. Boston, PWS-Kent Publishing Co, 1988, pp 102-103.
19. McNeill JW: 1992-1993 Texas A&M Ranch to Rail Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1993.
20. McNeill JW: 1993-1994 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1994.
21. McNeill JW: 1994-1995 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1995.
22. McNeill JW: 1995-1996 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1996.
23. McNeill JW: 1996-1997 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1997.
24. McNeill JW: 1997-1998 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1998.
25. McNeill JW: 1998-1999 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 1999.
26. McNeill JW: 1999-2000 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 2000.
27. McNeill JW: 2000-2001 Texas A&M Ranch to Rail—North/South Summary Report. Texas Agricultural Extension Service, Texas A&M University, College Station, 2001.
28. Nyamusika N, Spreen TH, Rae O, *et al*: A bioeconomic analysis of bovine respiratory disease complex. *Review of Ag Econ* 16:39-53, 1994.
29. Odde KG, Clement JC, Lancaster KB: The economic value of Pfizer's SelectVac calf health protocols in beef steers fed at Decatur County Feed Yard in 2004. Final Report: Study Number 3933R-60-03-342, Pfizer Animal Health, 2004.
30. Roeber D, Umberger W: The value of preconditioning programs in beef production systems. Paper presented at Western Agricultural Economics Association Annual Meeting, Long Beach, California, July 29, 2002.
31. Story CE, Rasby RJ, Clark RT, *et al*: Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. *J Anim Sci* 78:1403-1413, 2000.

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