A field investigation of the economic impact of respiratory disease in feedlot calves

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Abstract

A trial involving 512 beef calves was conducted in a commercial research feedlot to determine the effect of bovine respiratory disease (BRD) on performance parameters and carcass characteristics. Two hundred and fifty-six calves that were deemed to be "sick" (S) from BRD were allocated to 16 pens and 256 calves that were considered to be "well" (W) were allocated to another 16 pens. The outcome variables that were measured included average daily gain (ADG), daily dry matter intake (DDMI), dry matter intake to gain ratio (DM:G), BRD treatment rate, death loss, carcass traits, and net profit per pen.

The data were partitioned into several time intervals including processing (P) to day -1, day 0 to day 27, day 28 to day 55, day 56 to day 83, day 84 to day 111, day 112 to day 139, day 140 to slaughter, day 0 to slaughter (0-Slaugh), and processing to slaughter (P-Slaugh). However, the most important interval was from processing to slaughter.

For the interval P-Slaugh, there were no significant ($p \geq 0.05$) differences between the S and W groups with respect to ADG and DM:G. Also, for the interval 0-Slaugh, the DDMI was similar for both groups. There were no significant ($p \geq 0.05$) differences between the S and W groups for carcass weight, average fat, grade fat, rib eye area, marbling score, cutability estimate, or carcass grade distribution.

The BRD treatment rates in the S and W groups were 6.6% and 4.7%, respectively. The mortality rates in the S and W groups were 0.78% and 0.39%, respectively. Also, there were no deaths attributable to BRD in either group.

In the economic model, there was no significant ($p \geq 0.05$) difference between the S and W groups with respect to net profit per pen.

We conclude that this trial did not validate the concept that BRD impacts performance parameters, because a sufficient disease challenge was not present. However, this study provides several observations that will enhance the experimental design of future studies that attempt to quantify the total economic impact of BRD.

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Résumé

Impact économique relié aux maladies respiratoires chez les veaux en parc d'engraissement, étude sur le terrain

L'objectif du projet visait à déterminer l'impact des maladies respiratoires bovines sur les paramètres de rendement et les caractéristiques de la carcasse des veaux en parc d'engraissement. Cinq cent douze veaux provenant de parcs commerciaux de recherche ont fait partie de l'étude. Deux cent cinquante-six veaux considérés à risque de présenter des maladies respiratoires ont été répartis dans 16 enclos et un autre groupe de 256 veaux jugés "en santé" ont aussi été partagés en 16 enclos différents. Les variables mesurées comprenaient le gain de poids moyen journalier, la consommation quotidienne en matière sèche, le ratio matière sèche : gain, la fréquence des traitements des maladies respiratoires, le taux de mortalité, les caractéristiques de la carcasse et le profit net par enclos. Les données ont été groupées selon des intervalles de temps : du jour de l'enregistrement (E) des animaux au jour –1; du jour 0 au jour 27; du jour 28 au jour 55; du jour 56 au jour 83; du jour 84 au jour 111; du jour 112 au jour 139; du jour 140 jusqu'au jour de l'abattage (A), du jour 0 jusqu'au jour de l'abattage et du jour de l'enregistrement jusqu'au jour de l'abattage. L'intervalle de temps le plus important a été du jour de l'enregistrement au jour de l'abattage (E-A).

Pour l'intervalle E-A, les paramètres de gain de poids journaliers et ratio matière sèche : gain ne présentaient pas de différences significatives entre les groupes d'animaux jugés à risque et ceux considérés en santé. Pour l'intervalle jour 0 au jour de l'abattage, le facteur consommation quotidienne en matière sèche était semblable pour les deux groupes. De plus, il n' y avait pas de différences significatives pour les variables suivantes : le poids de la carcasse, la garniture moyenne de gras, le grade du gras, la région de l'entrecôte, le pointage de la marbrure, l'estimation des coupes de dépeçage et le classement de la carcasse.

La fréquence des traitements pour maladies respiratoires était de 6,6 % pour le groupe "à risque" et de 4,7 % pour le groupe "en santé", alors que le taux de mortalité était respectivement de 0,78 % et de 0,39 %. De plus, les maladies respiratoires n'étaient pas responsables d'aucune des mortalités. Le modèle économique montre qu'il n'y avait pas de différences significatives entre les deux groupes concernant le profit net obtenu par enclos.

En conclusion, cette étude ne permet pas de valider le concept que les maladies respiratoires ont un impact sur les paramètres de rendement, car elle ne comportait pas un risque suffisant pour provoquer la maladie. Toutefois, cette étude fournit plusieurs

observations qui pourront être utilisées lors de la conception d'études expérimentales visant à quantifier l'impact économique des maladies respiratoires bovines.

(Traduit par Dr Thérèse Lanthier)

Introduction

Bovine respiratory disease (BRD) has been extensively documented in the veterinary literature as the most important disease affecting feedlot cattle throughout North America (1–5). Also, the economic impact of BRD has been estimated based on the cost of preventive measures, treatment (labor and pharmaceuticals), and death loss. However, the entire economic impact of BRD may be underestimated, because the relationship between BRD and subsequent performance parameters is not adequately described in the scientific literature. Previous trials were conducted with principal objectives other than investigating the relationship between health and performance (6–8). In addition, some of the available information was derived from production systems that are not analogous to a western Canadian feedlot (9).

The fact that the dry matter intake to gain ratio (DM:G), the most important feedlot performance parameter, is measured at the pen level, whereas sickness occurs at the individual calf level, has made it very difficult to design field trials to properly assess the total economic impact of BRD in feedlot cattle.

The purpose of the study reported herein was to compare the performance parameters of calves that develop BRD shortly after arrival at the feedlot and were treated ("sick" calves) to calves that did not develop BRD ("well" calves). In addition, the economic impact of BRD on feedlot cattle was assessed by evaluating a model that included DM:G, average daily gain (ADG), therapeutic costs, and death loss.

Materials and methods

Trial facilities

The trial was conducted in a research feedlot near Airdrie, Alberta, which has a capacity of 1200 animals. The basic design of this feedlot is representative of standard design in western Canada. Open air, dirt floor pens are arranged side by side with a central feed alley. The dimensions of each pen are 3.7 m × 32.8 m. The pens are equipped with automatic watering bowls and concrete fenceline bunk feeders. In addition, the pens are protected by a 2.4 m high 20% porosity fence.

There is a hospital facility adjacent to the research pens. The hospital has a hydraulic squeeze chute equipped with an individual animal electronic scale to facilitate the weighing and treatment of cattle.

Trial animals

The animals utilized in the study were recently weaned, crossbred beef steer calves purchased from auction markets throughout western Canada. The calves were approximately five to ten months of age and weighed between 200 kg and 350 kg.

Upon arrival at the feedlot, the calves were sent to a designated pen for 24 h. Subsequently, the calves were moved through a hydraulic squeeze chute for a group of procedures known collectively as processing. All animals were ear tagged (to provide unique, individual animal identification), branded, implanted with a progesterone-estradiol implant (Synovex-S, Syntex Agribusiness, Mississauga, Ontario), and vaccinated against infectious bovine rhinotracheitis (IBR) and parainfluenza (PI_3) viruses and *Haemophilus somnus* (IBR-PI_3/Somnugen, Boehringer Ingelheim (Canada) Ltd., Burlington, Ontario). In addition, all animals received a multivalent clostridial vaccine (Tasvax 7, Coopers Agropharm Inc., Ajax, Ontario) and were treated topically with ivermectin (0.5%) at the rate of 1.0 mL/10 kg body weight (BW) (Ivomec Pour On, MSD Agvet, Kirkland, Quebec). Following processing, each processing group was returned to its original designated pen.

Experimental design

Using variance estimates for DM:G from trials previously conducted by Jim *et al* (unpublished observations), it was calculated that approximately 16 pens per treatment group would be required to have a 90% chance of detecting a difference in DM:G of 5% or larger, and to be 95% certain that this difference was not due to chance. Including 16 pens per treatment group would also result in a power of approximately 90% to detect a 6% difference in ADG.

During processing, the weight and rectal temperature of each calf was recorded. Calves with an elevated body temperature (≥40.5°C) were removed from the processing group and excluded from the trial.

For each processing group, the rectal temperature and body weight of all calves were recorded at 48 h (day −1) and 72 h (day 0) after processing. Calves with an elevated rectal temperature (≥40.5°C) on day −1 and day 0 after processing with no abnormal clinical signs attributable to organ systems, other than the respiratory system, were deemed to be "sick" (S) from BRD. Calves with a rectal temperature less than 40.3°C on day −1 and day 0 and exhibiting no abnormal clinical signs referable to any organ system were deemed to be "well" (W). Based on the number of S and W calves that were available, the number of pens, each to contain 16 animals, that could be completely filled was determined. Subsequently, calves were randomly assigned to pens so that an equal number of S and W pens were filled, each pen containing either 16 S or 16 W cattle. Pens were randomly allocated throughout the research feedlot. A total of 256 S calves were chosen to fill 16 S pens and 256 W calves were chosen to fill 16 W pens from four processing groups over a period of 14 days.

At the time of allocation (day 0), both the S and W calves received a single subcutaneous injection of tilmicosin (Micotil, Provel, London, Ontario) at the rate of 10 mg/kg BW.

Feeding program

A standard mixed complete feedlot diet was offered *ad libitum*. The diet was blended by combining dry-rolled barley, barley silage, alfalfa-grass hay, and pelleted supplement in a truck-mounted mixer-box (Roto-Mix 490-14, Roto-Mix Inc., Dodge City, Kansas, USA) equipped with electronic load cells. The diet was formulated to meet or exceed National Research Council nutrient requirements for feedlot cattle (10). The supplement was manufactured by a commercial feed mill (Shur Gain Division, Canada Packers Inc., Calgary, Alberta).

Table 1. Average daily gain (ADG) summary by experimental group for the defined time intervals

	Group S Mean ± S.D.	Group W Mean ± S.D.
Weight (kg)[a]		
Processing (P)	265.6[c] ± 9.3	260.2[d] ± 8.2
Slaughter (Slaugh)	562.3 ± 12.9	557.2 ± 21.2
ADG (kg gain/animal/day)[b]		
Interval (days)		
(P-(−1)	−0.51[c] ± 0.60	1.53[d] ± 0.52
0–27	1.58[c] ± 0.22	1.42[d] ± 0.20
28–55	1.34 ± 0.19	1.41 ± 0.25
56–83	1.49 ± 0.25	1.52 ± 0.35
84–111	1.68 ± 0.12	1.61 ± 0.13
112–139	1.68 ± 0.24	1.61 ± 0.25
140-Slaugh	1.48 ± 0.19	1.45 ± 0.15
0-Slaugh	1.54 ± 0.07	1.51 ± 0.08
P-Slaugh	1.49 ± 0.05	1.51 ± 0.08

[a]Least square means adjusted for processing group
[b]Least square means adjusted for processing group and processing weight
[c,d]Means in the same row with different superscripts are significantly different ($p<0.05$)

The diets were delivered to the pens once daily. The amount of feed delivered to each pen was recorded. Water was provided *ad libitum*. Feed remaining in the bunk (orts) on the mornings of day 28, day 56, day 84, day 112, day 140, and slaughter and any spoiled feed removed from the bunk were weighed and subtracted from the weight of the delivered feed.

The animals were on starter diets for the first 45 to 60 days of the feeding period. Subsequently, the animals were adapted to a series of finishing diets by increasing the proportion of dry-rolled barley and decreasing the proportion of barley silage.

Silage was sampled daily and the dry matter content was determined. From these data, a weekly average dry matter content was calculated and used to compute the weekly dry matter intake for each pen.

Animal health

Following allocation, the calves were observed once daily by experienced pen checkers who were blind to the experimental status of each pen. Calves considered to be "sick" were moved to the hospital facility, diagnosed, and treated as per written treatment protocols. The treatment events, including date, presumptive diagnosis, drug(s), and dosage, were recorded. The case definition for BRD was an elevated rectal temperature (≥40.0°C) and a lack of clinical signs referable to organ systems other than the respiratory system. Bovine respiratory disease cases were treated with a single subcutaneous injection of tilmicosin (Micotil, Provel) at the rate of 10 mg/kg BW.

All animals that died during the study were necropsied by the attending feedlot veterinarians. If the cause of death could not be ascertained by gross postmortem examination, tissues were submitted to the Regional Veterinary Diagnostic Laboratory in Airdrie, Alberta, to aid in determining the cause of death.

Marketing

After day 140 of the feeding period, the animals were sold under normal marketing procedures, whereby the feedlot manager, based on visual appraisal, determined that a specific number of animals were ready for sale from each pen. The cattle were offered for sale on a sealed bid system. The highest bidder purchased the cattle, and they were trucked to a packing plant.

Data collection and management

The outcome variables measured to assess performance were ADG, daily dry matter intake (DDMI), and DM:G.

Individual animal weights were recorded at processing. In addition, all trial calves were individually weighed on day 0 (the day of trial initiation), day 28, day 56, day 84, day 112, and day 140 of the feeding period. Also, the calves were individually weighed at slaughter.

Average pen weights at processing, day 0, day 28, day 56, day 84, day 112, day 140, and slaughter were calculated from the individual animal weights. The average pen weights and the average number of days on feed for each pen were used to calculate the pen-based ADG for the periods: processing (P) to day −1 (P-(−1)); day 0 to day 27 (0–27); day 28 to day 55 (28–55); day 56 to day 83 (56–83); day 84 to day 111 (84–111); day 112 to day 139 (112–139); day 140 to slaughter (140-Slaugh); day 0 to slaughter (0-Slaugh); and processing to slaughter (P-Slaugh).

The DDMI was calculated for the periods 0–27, 28–55, 56–83, 84–111, 112–139, 140-Slaugh, and 0-Slaugh for each pen, using the corresponding feed consumption, orts, and days on feed data for each period. The feed consumption data were adjusted for any animals which died during trial. All feed consumption data were based on 100% dry matter content. The DM:G for each pen was calculated for the same periods by dividing the DDMI by the ADG.

From processing until day 0 of the trial (allocation day), all of the S and W calves were commingled in the same pen. Consequently, separate feed consumption data for the S or W calves were not available, and the actual DM:G ratio from P-Slaugh could not be calculated.

Table 2. Daily dry matter intake (DDMI) summary by experimental group for the defined time intervals

	Group S Mean ± S.D.	Group W Mean ± S.D.
DDMI (kg feed/day)[a]		
Interval (days)		
0–27	6.31[b] ± 0.42	6.64[c] ± 0.44
28–55	8.28 ± 0.23	8.41 ± 0.27
56–83	8.53 ± 0.29	8.65 ± 0.36
84–111	8.89 ± 0.28	9.01 ± 0.53
112–139	10.33 ± 0.50	10.30 ± 0.44
140-Slaughter	10.44 ± 0.41	10.40 ± 0.62
0-Slaughter	9.10 ± 0.30	9.20 ± 0.54

[a]Least square means adjusted for processing group
[b,c]Means in the same row with different superscripts are significantly different ($p<0.05$)

The DM:G from P-Slaugh was estimated by three methods. Method 1 (DM:G, P-Slaugh, M1) involved dividing the actual dry matter intake from 0-Slaugh by the gain from P-Slaugh for each pen. Methods 2 and 3 (DM:G, P-Slaugh, M2 and DM:G, P-Slaugh, M3) involved estimating the feed consumption from P-0. This was estimated on a pen basis by utilizing the actual DDMI from 0–27. In method 2, the feed consumption for both the S and W pens was calculated in an identical manner. In method 3, the feed consumption of the W pens was the same as for method 2, but the feed consumption of the S pens was considered to be zero.

Carcass characteristics were obtained from the Agriculture Canada Blue Tag Program. The Blue Tag Program provides data on carcass weight, average fat cover, grade fat, rib eye area, marbling, and cutability estimate. In addition, the grade of each carcass was recorded.

The individual animal health data were summarized on a pen basis from the written treatment records for use in the economic analysis.

Statistical analysis

The performance parameters and the carcass characteristics were compared on a pen basis between the S and W groups using least squares analysis of variance and covariance (11). The data were stratified by processing group, and an analysis of covariance, was used to correct ADG for differences in initial weight between pens. A multivariate analysis of variance was used to compare either the overall feedlot performance or the overall carcass characteristics between the S and W calves (12). The variable "grade" was compared between the S and W groups at the individual animal level using a chi-square test of independence for rectangular contingency tables (13).

Economic analysis

The economic returns of S versus W calves were compared using the following parameters: feed costs; value of the animal at slaughter; and costs associated with morbidity and mortality. Feeding costs are affected by ADG, DDMI, and DM:G; value of the slaughter animal by carcass weight and carcass grade; morbidity by the therapeutic cost of treating sick animals; and mortality by the number of animals dying in each experimental group. The carcass characteristics, namely, average fat, grade fat, rib eye area, marbling, and cutability estimate, were excluded from the economic analysis, because they did not influence the price paid for the animal (i.e., cattle were sold on the "rail" and payment was made strictly on carcass weight and grade).

Least squares analysis of variance was used to assess the overall economic impact of respiratory disease in this trial using the outcome variable net profit per pen (NPP). Net profit per pen was defined as follows: NPP=(A-B-C-D-E), where A=(slaughter weight × slaughter price), B=(pen processing weight × purchase price), C=(total pen feed cost), D=(pen therapeutic costs (labor and pharmaceuticals)), and E=(feed costs for dead animals).

The average purchase price of the calves on the trial was $2.29 CDN per kg BW, the average slaughter price was $1.85 CDN per kg BW, and the average feed cost was $13.23 CDN per 100 kg dry matter. The cost of tilmicosin therapy, including labor, was $11.00 CDN per treatment.

Results

Eleven hundred and twenty-four calves representing four processing groups were required to obtain the 512 trial animals.

The S calves were significantly ($p<0.05$) heavier than the W calves at processing; however, there was no significant ($p\geq0.05$) difference in weight at slaughter between the S and W calves (Table 1).

The data for the performance parameters ADG, DDMI, DM:G are presented in Tables 1, 2, and 3, respectively. The ADG of the S group was significantly ($p<0.05$) lower from (P-(−1)) than the W group. Note that the S group actually lost weight during this period. The ADG of the S group was significantly ($p<0.05$) higher from 0–27 than the W group. There were no significant ($p\geq0.05$) differences in ADG between the S and W group from 28–55, 56–83, 84–111, 112–139, 140-Slaugh, 0-Slaugh, or P-Slaugh (Table 1).

The DDMI of the S group was significantly ($p<0.05$) lower from 0–27 than the W group. There were no sig-

Table 3. Dry matter intake to gain ratio (DM:G) summary by experimental group for the defined time intervals

	Group S Mean ± S.D.	Group W Mean ± S.D.
DD:G (kg feed/kg gain)[a]		
Interval (days)		
0–27	4.07[b] ± 0.52	4.72[c] ± 0.49
28–55	6.06 ± 0.88	6.30 ± 1.29
56–83	5.97 ± 0.99	5.91 ± 1.30
84–111	5.31[b] ± 0.39	5.61[c] ± 0.35
112–139	6.30 ± 1.16	6.53 ± 1.11
140-Slaugh	6.84 ± 0.65	6.86 ± 0.65
0-Slaugh	5.83[b] ± 0.20	6.02[c] ± 0.17
P-Slaugh M1	6.10 ± 0.19	6.09 ± 0.23
P-Slaugh M2	6.10 ± 0.19	6.09 ± 0.23
P-Slaugh M3	6.10 ± 0.19	6.09 ± 0.23

[a]Least square means adjusted for processing group
[b,c]Means in the same row with different superscripts are significantly different ($p<0.05$)
P = processing
Slaugh = slaughter

Table 4. Carcass characteristic summary by experimental group

	Group S Mean[a] ± S.D.	Group W Mean[a] ± S.D.
Carcass weight (kg)	311.0 ± 13.8	309.6 ± 12.8
Average fat (mm)	9.4 ± 1.1	9.4 ± 1.0
Grade fat (mm)	8.4 ± 1.0	8.5 ± 1.0
Rib eye area (mm^2)	77.0 ± 5.3	76.8 ± 3.5
Marble score	7.3 ± 0.4	7.4 ± 0.4
Cutability estimate (%)	57.3 ± 2.4	57.2 ± 2.1

[a]Least square means adjusted for processing group

nificant ($p\geq0.05$) differences in DDMI between the S and W groups from 28–55, 56–83, 84–111, 112–139, 140-Slaugh, or 0-Slaugh (Table 2).

The DM:G of the S group was significantly ($p<0.05$) lower than the W group from 0–27, 84–111, and 0-Slaugh. There were no significant ($p\geq0.05$) differences in DM:G between the S and W groups from 28–55, 56–83, or 112–139. Also, there were no significant ($p\geq0.05$) differences between the S and W groups from P-Slaugh regardless of estimation method used (Table 3).

There was no significant ($p\geq0.05$) difference in overall feedlot performance between the S and W groups when a multivariate analysis of variance, including ADG, DDMI, and DM:G parameters, was used.

A summary of the carcass characteristic data is presented in Table 4. There were no significant ($p\geq0.05$) differences between the S and W groups for carcass weight, average fat, grade fat, rib eye area, marbling score, or cutability estimate. In addition, there was no significant ($p\geq0.05$) difference between the S and W groups with respect to overall carcass characteristics when a multivariate analysis of variance was used.

There were no significant ($p\geq0.05$) differences in carcass grading between the S and W groups.

Following allocation, the BRD treatment rates in the S group and the W group were 6.6% and 4.7%, respectively. Also, the mortality rates in the S group and the W group were 0.78% and 0.39%, respectively. There were no deaths attributable to BRD in either group.

In the economic model, the least squares mean of NPP was $2910.00 CDN for the S group compared to $2980.00 CDN for the W group. This difference was not significant ($p\geq0.05$), as the standard deviations of NPP for the S and W groups were $530.00 and $510.00 CDN, respectively.

Discussion

It seems logical to assume that sickness from BRD would reduce feedlot performance, because the febrile response is known to accelerate protein and energy metabolism (14). Further to this contention, Loew (6) states that "...calculations could be made of the protein or caloric cost of fever, regardless of cause, in animal production situations which are less profound than death, thereby providing an additional estimate of production loss resulting from fever." Paradoxically, in this trial, DM:G is significantly lower in the S group for the intervals 0–27, 84–111 and 0-Slaugh. These contradictory observations can be rationalized if one con-

siders the fact that ADG of the W group was significantly higher in the period (P-(−1)). That is, the S cattle were losing weight from processing to allocation day. Conversely, the W cattle were gaining weight, so that, on allocation day, the W cattle were 5.3 kg heavier than the S cattle, despite being 5.4 kg lighter at processing. Thus, it appears that the DM:G differences between the S and W groups is caused by variation in "gut fill".

In this trial, the phenomenon that calves, classified as suffering from BRD, lose weight from processing is a major finding that substantially affects data interpretation. As a result, the relevant intervals are those calculated from processing. The intervals calculated from day 0 are biased due to significant ($p<0.05$) differences in ADG from (P-(−1)) and as such, could lead to erroneous conclusions regarding the effect of BRD on performance.

For the interval P-Slaugh, the ADG of the W group was greater ($p\geq0.05$) than the S group (1.51 versus 1.49 kg/d). These data are similar to the findings of Cole *et al* (12) and Andrews (13) who reported that, although BRD treatment did not significantly ($p\geq0.05$) affect ADG, the numerical trend indicated that untreated cattle had a higher ADG than cattle treated for BRD. Moreover, for the interval P-Slaugh, DM:G of the W group was slightly less than the S group (6.09 versus 6.10), which is supportive of the concept that fever will reduce feed efficiency.

In this trial, the severity of the BRD challenge was considerably less than anticipated. For example, in a previous study, calves derived from auction markets had BRD treatment rates of 47–56% and overall mortality rates of 4.1–5.1%, despite treatment with antibiotics on arrival (15). Subsequent to allocation, the low incidence of BRD reduced the power of this trial to detect performance differences between the experimental groups. Quite simply, it is difficult to measure the impact of a disease if the disease does not occur.

In a feedlot herd health program, veterinarians often make the fundamental assumption that improving animal health will increase performance. It is extremely ironic that the evidence to support the latter hypothesis is merely anecdotal, as this concept is often used to justify vaccination protocols, management strategies, and therapeutic regimes. The refereed literature does not validate the concept that BRD treatment *per se* in feedlot cattle reduces ADG and increases DM:G. Consequently, feedlot veterinarians who serve as production consultants should be skeptical of products that are purported as cost-effective because they reduce "subclinical" disease.

In conclusion, we feel that our experimental design and economic model were valid with respect to determining the total impact of BRD in feedlot cattle; however, this study did not produce definitive results because a sufficient disease challenge did not occur. Moreover, this trial should expedite further investigations which attempt to quantify the effect of BRD on feedlot performance parameters as appropriate changes to the experimental protocol can be made to accommodate the observation that sick calves tend to lose weight following processing. Finally, consideration should be given to developing a more rigorous case definition for BRD, so that cattle with moderate disease, as opposed to those with a "fever", could be allocated to a study.

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References

1. Yates WDG. A review of infectious bovine rhinotracheitis, shipping fever pneumonia and viral-bacterial synergism in respiratory disease of cattle. Can J Comp Med 1982; 46: 225–263.
2. Church TL, Radostits OM. A retrospective survey of diseases of feedlot cattle in Alberta. Can Vet J 1981; 22: 27–30.
3. Martin SW, Meek AH, Davis DG, *et al*. Factors associated with mortality in feedlot cattle: The Bruce County beef cattle project. Can J Comp Med 1980; 44: 1–10.
4. Frank GH. *Pasteurella haemolytica* and respiratory disease in cattle. Proc Annu Meet US Anim Health Assoc 1979; 83: 153–160.
5. Jensen R, Pierson RE, Braddy PM, *et al*. Shipping fever pneumonia in yearling feedlot cattle. J Am Vet Med Assoc 1976; 169: 500–506.
6. Loew FM. A theoretical effect of fever on feed efficiency in livestock. Can Vet J 1974; 15: 298–299.
7. Cole NA, McLaren JB, Irwin MR. Influence of pretransit feeding regimen and posttransit B-vitamin supplementation on stressed feeder steers. J Anim Sci 1979; 49: 310–317.
8. Andrews AH. Some factors influencing respiratory disease in growing bulls and the effect of treatment on liveweight. Vet Rec 1976; 98: 146–149.
9. Thomas LH, Wood PDP, Longland JM. The influence of disease on the performance of beef cattle. Br Vet J 1978; 134: 152–161.
10. National Research Council. Nutrient Requirements of Beef Cattle. Washington, DC. National Academy of Sciences. Sixth Revised Edition. National Academy Press, 1984.
11. SAS Institute Inc. SAS/STAT User's Guide, Release 6.03 edition. Cary, North Carolina: SAS Institute Inc., 1988. 1028 pp.
12. Pendergast J, Littel R. Repeated Measures Analysis with SAS^R System. 13th SAS^R Users Group International Proceedings, 1988: 1205–1211.
13. Steel RGD, Torrie JH. Principles and Procedures of Statistics. A Biometrical Approach. 2nd ed. New York: McGraw Hill, 1980: 496–502.
14. Howard LM. Three key dilemmas in international health. Am J Public Health 1972; 62: 73–76.
15. Harland RJ, Jim GK, Guichon PT, Townsend HGG, Janzen ED. Efficacy of parenteral antibiotics for disease prophylaxis in feedlot calves. Can Vet J 1991; 32: 163–168.