A Mail Survey of Factors Associated with Morbidity and Mortality in Feedlot Calves in Southwestern Ontario

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ABSTRACT

The design and results of a mail survey of a simple random sample of southwestern Ontario feedlot owners are presented. The survey provided general data about management of feedlot calves and the association between a number of factors and disease and/or death rates.

The number of calves purchased was related positively, in a linear manner, to mortality and morbidity rates. Increased levels of morbidity and mortality were noted when the ration was changed to corn silage from dry-hay within the first month after arrival. However, it was not clear whether the ration changes preceeded or followed increased rates of morbidity and mortality.

Prophylactic levels of antimicrobials in the water supply were associated with increased death losses. Shipping cattle by truck, rather than train, was associated with decreased rates of disease. Processing factors, including using vaccines against respiratory disease, were not associated significantly with mortality or morbidity.

It was concluded that reducing the number of calves, to approximately 100 per group, not changing the ration to silage within the first month and not using antibiotics in the water supply on arrival could significantly reduce disease and death losses.

Key Words: Survey, morbidity, mortality, feedlot calves, association.

RÉSUMÉ

Cet article présente la planification et les résultats d'une enquête postale adressée à un groupe de propriétaires de parcs d'engraissement du sud-ouest de l'Ontario, choisis au hasard. L'enquête procura des renseignements généraux, relatifs à la régie des veaux des parcs d'engraissement et à la relation entre un certain nombre de facteurs, les maladies et/ou le taux de mortalité.

Le nombre de veaux achetés afficha une relation positive et linéaire avec les taux de mortalité et de morbidité. On enregistra une hausse de ces taux, quand les veaux passèrent du régime au foin sec à celui de l'ensilage de maïs, au cours du mois qui suivit leur arrivée dans les parcs d'engraissement. Il s'avéra toutefois impossible de déterminer avec certitude si le changement de régime précéda ou suivit la hausse des taux de morbidité et de mortalité.

L'addition d'une quantité prophylactique d'antibiotiques à l'eau de boisson se traduisit par une hausse du taux de mortalité. Le transport des veaux, par camion plutôt que par train, s'accompagna d'une baisse du taux des maladies. Les facteurs de régie, y compris l'utilisation des vaccins contre les maladies respiratoires, n'affichèrent pas d'association appréciable avec la mortalité ou la morbidité.

Il semble par conséquent que la réduction du nombre de veaux à environ 100 par groupe, que le fait de ne pas passer du régime au foin sec à celui de l'ensilage de maïs, au cours du premier mois après l'arrivée des veaux dans les parcs d'engraissement, et que le fait de ne pas ajouter d'antibiotiques à l'eau de boisson, à l'arrivée des veaux dans les parcs d'engraissement, pourraient contribuer de façon appréciable à réduire la maladie et la mortalité.

Mots clés: enquête morbidité, mortalité, veaux de parcs d'engraissement, association.

INTRODUCTION

This mail-in survey was designed to provide data on factors associated with morbidity and mortality, at the farm level, in

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feedlot calves in southwestern Ontario. Questions about many of the factors investigated in the Bruce County Beef Project (2, 3, 7) such as management techniques, ration, prophylactic regimes, housing and transportation were included in this survey. Consistent findings in these two independent studies would increase the likelihood that the statistical associations reported in the Bruce County study (7) were, in fact, causal associations (2). This report summarizes and discusses the results of the mail-in survey.

MATERIALS AND METHODS

Six counties in Ontario, with the greatest number of slaughter steers and heifers over one year of age (9) (Table I) were selected and the Ontario Cattlemen's Association (CA) county representatives provided a list (sampling frame) of the feedlot owners from their membership. The names of members known, by the CA or Ontario Ministry of Agriculture and Food (OMAF) agricultural representative, not to be buying beef calves were removed from the list prior to sampling. The sizes of the random sample within a county were proportional to the number of slaughter steers and heifers over one year and a total of 500 members were contacted. The sample sizes within Bruce, Oxford and Middlesex counties were reduced by one-half because of design, insufficient membership size and time constraints respectively.

A questionnaire was prepared with questions pertaining to the variables listed in Table II. The total number of calves treated or dying, from any cause, in the first month after arrival was also requested. The survey was mailed with an explanatory letter to the selected feedlot owners. Reminder letters were sent two and four weeks after the initial mailing and another copy of the questionnaire was enclosed with the second letter. The deadline for replies was approximately seven weeks after the initial mailing.

TABLE I. The Distribution of Slaughter Steers and Heifers Compared to the Distribution of Completed Questionnaires from Six Counties of Southwestern Ontario, 1980-81

Counties	Slaughter Steers and Heifers[a]		% of survey contacts replying[b]	% of survey results analyzed[c]
	% of provincial total	% of six counties		
BRUCE	17.4	33.0	57.1	28.7
HURON	10.2	19.3	35.0	25.1
MIDDLESEX	7.2	13.7	45.1	11.8
GREY	7.0	13.3	23.7	11.8
SIMCOE	5.5	10.4	30.3	11.8
OXFORD	5.4	10.2	55.3	10.8

[a]Derived from OMAF statistics 1979 (7)
[b]Ratio of number of replies used in the analysis over number of members contacted
[c]Denominator is the 195 farms in the analysis

Farms on the Bruce County Beef Project were not excluded from the southwestern Ontario survey, and a total of 21 farms participated in both studies. In order to assess the validity of the mail survey data, values of variables which could be obtained from both studies were compared. Agreement, for each variable, between the two sources of data was tested using the Kappa statistic (1).

Initially, the mean mortality rate for each variable value was calculated using the average of $\log_{10}$ transformed mortality rates and differences were tested for significance using an F-test (SPSS program BREAKDOWN) (8). Stepwise regression analysis was performed using the dependent variable $\log_{10}$ (mortality rate (%) + 1) and all the independent variables listed in Table II. A maximum of six variables was allowed to enter the regression equation based on the magnitude of the F statistic. The association with mortality of the variables having significant F-values (5% level) at entry or at step six was investigated in more detail using relative risk and population attributable risk % statistics (2). A second stepwise regression analysis was performed using the morbidity rate (%) as the dependent variable. Since the morbidity data were approximately normally distributed, no transformation was used.

RESULTS

The overall response rate was about 90%. A total of 201 members replied that they had purchased calves between Sept. 1, 1980 and Jan. 1, 1981. Six farms that had purchased less than 30 calves were deleted leaving 195 farms for analysis. Two hundred and thirty eight members replied that they had not bought beef calves in the fall of 1980. Many of this group were cow-calf operators, some purchased yearling stockers only (over 275 kg) and a few had not purchased any cattle.

Summary information including morbidity and mortality rates for farms included in this study are given in Table III. Characteristics of feedlot calves on farms in southwestern Ontario are listed in Table IV. The frequency and time of processing and of ration changes on these farms are given in Table V. Note that approximately 60% of the farms did not use respiratory disease vaccines, 70% did not use anthelmintics, 50% did not treat for lice or grubs and 37% did not change the ration within one month of arrival.

The mean mortality rates at each level of variables which were, unconditionally, significantly (5% level) related to mortality are recorded in Table VI. Variables representing the number of calves purchased, changing the roughage or castrating some calves in the first 28 days were significant at the 1% level.

Results of the regression analysis using mortality rate as the dependent variable are given in Table VII. The variables CALFNO, ANTIMICROBIAL and RUFCHANGE

were significant in the regression equation at the 5% level. The slope coefficients were all positive indicating that the mortality rate tended to increase as the variable values increased.

The results using morbidity rate as a dependent variable are given in Table VIII. CALFNO and RUFDIFWHEN had significant positive slope coefficients, whereas SHIPTRUCK had a significant negative slope indicating a sparing effect on morbidity.

The variable ANTIMICROBIAL is further refined in Table IX, showing the type and frequency of antimicrobials added to water on arrival and the subsequent mortality rate (%).

The association between SALEEAST, SALEWEST and the mortality rate is shown in Table X. Farmers who purchased calves from both eastern and western salesyards experienced the highest mortality in their calves, whereas farmers who obtained calves directly from their original ranch or farm recorded the lowest rates of mortality.

The effects and importance of the three significant variables in the regression analysis with mortality rate as the dependent variable are summarized in Table XI. The population attributable risk % takes into account both the prevalence of a factor grouping and the increase in rate of mortality when that factor grouping was present (relative risk). For example, 23.7% of all deaths in the population was attributable to purchasing a large number of calves and changing the roughage within 28 days of arrival (assuming these factors are direct or indirect causes of mortality). These results are portrayed graphically in Fig. 1.

Data on 24 variables from the Bruce County Beef Project and the southwestern Ontario survey, were compared as demonstrated in Table XII. The 19 variables with significant agreement at the 5% level between the two data sources are listed in Table XIII. Data on variables ANTISTAR and INJANTIBIOT agreed on 19 and 20 of the 21 farms respectively, but could not be tested statistically.

The data on the variables CASTRATE and DEHORN, which were coded as to whether or not some calves were castrated or dehorned within 28 days of arrival,

TABLE II. The Definition of Variables used in a Study of Factors Related to Sickness and Death in Feedlot Calves

Variable	Definition[a]
CALFNO	The number of calves which came to the feedlot between Sept. 1, 1980 and Jan. 1, 1981
MIXGRP	Were calves from different sources or calves arriving on different days mixed in the same pen within three weeks of arrival?
FEMSEX	Were any heifer calves purchased?
MALESEX	Were any steers or bulls purchased?
RAISWEST	Was the majority of the calves raised in the west?
RAISEAST	Was the majority of the calves raised in the east?
ANTIMICROBIAL	Were antimicrobials added to the water on and/or shortly after arrival?
BANKBARN	Was an open-fronted bank or pole barn provided for shelter?
CLOSBARN	Was a closed barn provided for shelter?
SALEWEST	Were the calves shipped directly to your farm via a dealer/salesyard in the west?
SALEEAST	Were the calves shipped directly to your farm via a dealer/salesyard in Ontario? (Off loaded and/or purchased there)
DIRECTSHIP	Were the calves shipped directly to your farm from their original ranch or farm?
SHIPRAIL	Was the majority of your calves shipped by rail from the western source? (ranch/farm/salesyard)
SHIPTRUCK	Was the majority of your calves shipped by truck from the western source?
PROCESS	Was the majority of the calves processed? (Processing refers to one or more of the next eight variables)
WORMED	Was an anthelmintic given?
INJVITADE	Were the calves injected with vitamin ADE?
INJANTIBIO	Were the calves injected with antibiotics?
DELICED	Were the calves treated for external parasites?
CASTRATE	What percent of the calves were castrated?
DEHORN	What percent of the calves were dehorned?
IBR:NASAL	Were the calves given IBR intranasal vaccine?
IBR:MUSC	Were the calves given IBR intramuscular vaccine?
HAYAR	Was dry hay a major source of roughage within two days of arrival?
HAYSILAGEAR	As per HAYAR for hay silage
CORNSILAGEAR	As per HAYAR for corn silage
RUFCHANGE	Was the type of roughage changed?
RUFDIFWHEN	How many days after arrival do you begin to change the type of roughage?
HAYSILAGEDIF	Was the major source of roughage changed to haysilage?
CORNSILAGEDIF	Was the major source of roughage changed to corn silage?
CORNCONCAR	Was corn a major component of the concentrate fed on arrival?
BARLEYOATAR	Was barley and/or oats a major component of the concentrate fed on arrival?
CONCCHANGE	Was the type of concentrate fed changed?
CONCDIFWHEN	How many days after arrival do you begin to change the major concentrate component?
CORNCONCDIF	Was the major component of the concentrate changed to corn?
BARLEYOATDIF	Was the major component of the concentrate changed to barley and/or oats?
STARTER	Was a commercial starter ration fed?
ANTISTAR	Were antimicrobials incorporated into the starter ration?

[a]Unless otherwise specified, the appropriate time period after arrival for the above variables is four weeks

TABLE III. A Summary of Mortality and Morbidity Rates for Feeder Calves in Southwestern Ontario 1980-81

No. of Farms in Study	195[a]
No. of Calves	43,065
No. of Deaths	643
No. Sick	14,605
% Mortality —	
Mean of Log_{10} Rate	0.944 ± .805[b]
Median Rate	0.91
% Morbidity —	
Arithmetic Mean Rate	21.13 ± 18.30[b]
Median Rate	16.7

[a]Initially 201 replies received but six farms with less than 30 calves were deleted from the analysis
[b]Standard deviation of value

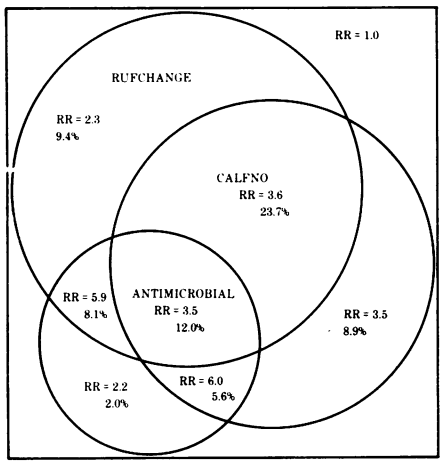

Fig. 1. The association between CALFNO, ANTIMICROBIAL and RUFCHANGE and the risk of excess mortality in feedlot calves in southwestern Ontario, 1980-1981. The area of the circles represents the proportion of farms experiencing that factor. The relative risk and percentage of deaths attributable to each factor grouping is shown (see Table XI). In all, approximately 69.7% of all deaths were attributable to these three factors. CALFNO was dichotomized as per Table VI.

did not show significant agreement between the two sources. Six of the 21 farms involved stated that they had purchased additional calves the preceding fall which were not included in the Bruce County study. This along with some variation about the 28 day postarrival time limit, which affected whether or not these procedures were recorded, tended to reduce the agreement.

Information on the variable DIRECTSHIP agreed on 17 farms but disagreed on four farms. The definition of the variable was different in the two sources of data, varying from "some" of the calves on the farm in the mail survey to the "majority" of the calves in a group in the Bruce County study. This and the possible inclusion of additional calves in the southwestern Ontario survey could have affected agreement.

One reply was received from a Bruce County participant stating

TABLE IV. The Characteristics of Feedlot Calves on Farms in Southwestern Ontario, 1980-81

Variable	Percent Positive	Variable	Percent Positive
MIXGRP	49.2	HAYAR	97.9
FEMSEX	42.8	HAYSILAGEAR	0.5
MALESEX	74.8	CORNSILAGEAR	2.6
RAISWEST	92.3	RUFCHANGE	62.6
RAISEAST	5.1	HAYSILAGEDIF	18.5
ANTIMICROBIAL	25.6	CORNSILAGEDIF	49.7
BANKBARN	64.6	CORNCONCAR	8.2
CLOSBARN	29.2	BARLEYOATAR	27.2
SALEWEST	51.8	CONCCHANGE	33.3
SALEEAST	45.6	CORNCONCDIF	16.4
DIRECTSHIP	13.8	BARLEYOATDIF	17.9
SHIPRAIL	35.4	STARTER	12.3
SHIPTRUCK	45.1	ANTISTAR	10.8
PROCESS	64.6	CASTRATE	24.6
		DEHORN	31.3

TABLE V. The Frequency (%) and Time of Processing and of Ration Changes in Feedlot Calves in Southwestern Ontario, 1980-81

	Days Postarrival				
Variables	1	2-7	8-14	15-28	Not in 28
INJVITADE	17.4	10.8	5.1	6.7	60.0
INJANTIBIOT	3.1	1.5	2.1	0.5	92.8
IBR:NASAL	8.7	4.1	1.0	3.1	83.1
IBR:MUSC	7.7	6.2	2.1	5.1	79.0
WORMED	5.6	8.2	3.1	11.8	71.2
DELICED	16.9	9.7	5.1	19.0	49.2
	2-7	8-14	15-21	22-28	Not in 28
RUFDIFWHEN	12.3	21.0	19.0	10.3	37.4
CONCDIFWHEN	8.2	10.8	10.8	3.6	66.7

TABLE VI. Mortality Rate (%)[a] in Feedlot Calves in Southwestern Ontario for Variables with Significant Differences between Values ($p \leq 0.05$)

Variable	Value = 0 % Mortality	Value = 1 % Mortality	Significance (p value)
CALFNO[b]	0.664	1.254	0.0003
RUFCHANGE	0.684	1.119	0.0082
CASTRATE[c]	0.826	1.355	0.0093
CORNSILAGEDIF	0.755	1.157	0.0143
ANTIMICROBIAL	0.832	1.312	0.0159
CLOSBARN	1.068	0.675	0.0231
SALEWEST	0.775	1.115	0.0380
SHIPRAIL	0.824	1.186	0.0400

[a] Derived from average of $\log_{10}$ transformed rate
[b] Dichotomized on median value ($0 \leq 155$, $1 > 155$) of number of calves purchased
[c] Dichotomized with value = 1 assigned to "some castrated"

TABLE VII. Entry Sequence, F-values and Standardized Regression Coefficients (Beta) of Variables[a] Entering Regression Equation in First Six Steps

Step no.	Variables	Beta	F-Value at entry	F-Value at step 6
1	CALFNO	0.154	10.508[c]	4.569[c]
2	ANTIMICROBIAL	0.121	4.438[c]	3.103
3	RUFCHANGE	0.144	3.409	4.175[c]
4	SALEWEST	0.130	3.405	3.554
5	WORMED[b]	-0.128	3.452	3.510
6	CLOSBARN	-0.113	2.706	2.706

[a] Dependent variable was $\log_{10}$ (mortality % +1)
[b] Processing variables were dichotomized with value = 1 assigned to procedure done within two weeks of arrival
[c] Significant at $p \leq 0.05$

TABLE VIII. Entry Sequence, F-values and Standardized Regression Coefficients (Beta) of Variables[a] Entering Regression Equation in First Six Steps

Step no.	Variables	Beta	F-Value at entry	F-Value at step 6
1	CALFNO	0.204	7.956[b]	7.878[b]
2	SHIPTRUCK	-0.166	4.438[b]	5.707[b]
3	RUFDIFWHEN	0.325	3.783	6.149[b]
4	FEMSEX	-0.123	2.722	3.222
5	CLOSBARN	-0.117	2.700	2.827
6	RUFCHANGE	0.206	2.546	2.546

[a]Dependent variable was morbidity %
[b]Significant at $p \leq 0.05$

that no calves under seven months of age had been purchased the preceding fall. The majority of the calves that were recorded as purchased by this individual in the Bruce County study averaged 236 kg in weight so it was possible that many of these calves did exceed this age limit.

TABLE IX. The Type and Frequency (%) of Antimicrobials Added to Water on Arrival and Subsequent Mortality Rate[a]

Definition	Frequency	Mortality %
No antimicrobials were added	74.4	0.832
Sulfa products only	15.9	1.069
Tetracycline products only	4.7	1.582
Multiple products added	5.1	1.768

[a]Derived from average of $\log_{10}$ transformed rate

DISCUSSION

The unit of concern in this survey was the farm, whereas it was the group, within a farm, in the Bruce County study. The latter is a difficult unit to identify in a mail-in survey such as this and differences in the unit of concern caused some problems in comparing results between these two studies. Although farmers tend to have general management styles and purchasing habits that apply to all groups, between group differences are possible. Using the average number of calves per farm (220) in this survey and the average number per group (142) in the Bruce County study (7) it appears that the average number of groups of calves per farm was 1.5 (assuming group sizes of 142 calves).

The analysis of data collected on 21 farms that participated in both the Bruce County Beef Project and the southwestern Ontario survey indicated significant agreement in the results of 21 of the 24 variables compared. This high proportion of agreement indicates that the data submitted in the southwestern Ontario mail survey in the spring of 1981 were very similar to the data collected by personal interviews and examination of on-farm records completed for the Bruce County Beef Project in the fall of 1980. This agreement supports the validity of using a mail survey to collect data on the factors consi-

TABLE X. Mean Mortality Rate (%)[a] in Feedlot Calves in Southwestern Ontario at Different Levels of SALEEAST and SALEWEST

Variables and Values	Mortality Rate (%)	No. of Farms
SALEEAST = 1, SALEWEST = 1	1.408	12
SALEEAST = 0, SALEWEST = 1	1.079	89
SALEEAST = 1, SALEWEST = 0	0.815	77
SALEEAST = 0, SALEWEST = 0[b]	0.609	17

[a]Derived from $\log_{10}$ transformed mortality rate
[b]Calves were shipped directly from source ranch or farm

TABLE XI. A Summary of the Effects and Importance of CALFNO, ANTIMICROBIAL and RUFCHANGE on Mortality Rates in Feedlot Calves

Factor(s)						
CALFNO	ANTIMICROBIAL	RUFCHANGE	P(F$_i$)[b]	Mortality Rate (5)	Relative[c] Risk (RR)	PAR%i[d]
+	+	+	0.133	1.185	3.5	12.0%
+	+	-	0.031	2.039	6.0	5.6%
+	-	+	0.251	1.230	3.6	23.7%
-	+	+	0.046	1.990	5.9	8.1%
+	-	-	0.097	1.198	3.5	8.9%
-	+	-	0.046	0.751	2.2	2.0%
-	-	+	0.195	0.791	2.3	9.4%
-	-	-	0.200	0.330	1.0	0.0%

[a]Mortality rates derived from the mean of $\log_{10}$ transformed rates
[b]Proportion of farms treated in this manner
[c]Mean mortality rates in each grouping divided by the rate of mortality in "small farm, no antimicrobial added to water on arrival and major roughage source not changed within four weeks" group. The relative risk of the latter group is arbitrarily set to "1".
[d]Population attributable risk % describes the percentage of all deaths that is attributable to each of the CALFNO-ANTIMICROBIAL-RUFCHANGE groups. This is calculated by the formula:

$$\frac{100p(F_i) = [p(D+/F_i) - p(D+/F_o)]}{p(D+)}$$

Where p(D+) is the overall mortality rate and p(D+/F$_i$) is the mortality rate in a specific grouping of factors
CALFNO was dichotomized as per Table VI

dered in this beef calf health study. There were a few instances of disagreement, for example only 50% of those saying they used antimicrobials in the water on arrival, actually (according to Bruce County data) did use antimicrobials. These disagreements usually occurred when a feedlot owner purchased more than one group of calves and the calves receiving the antimicrobials were not included in the Bruce County study.

Initial unconditional analyses were conducted followed by regression analyses. The latter mathematically controls for the effects of multiple factors. Variables that were singificant unconditionally but not in the conditional analysis were deemed less important than variables retaining a significant effect. In most cases their unconditional significance was due to their association with the more important (conditionally significant) variables. Although, the dependent variables in this survey were crude measures of disease occurrence, it is quite likely that the shipping fever complex accounted for most treatments and deaths. Fibrinous pneumonia was probably the predominant disease, based on its high relative frequency in a number of studies. (7).

The variable most consistently and significantly associated with both morbidity and mortality was the total number of calves purchased. The linear increase in both morbidity and mortality rates in the larger farms may reflect the increased spread of infections commonly observed in populations when large numbers of susceptible people or animals are housed together (2), or it may reflect the inability of farmers to adequately manage large numbers of calves. The number of calves per group was an important predictor of death and/or disease in the Bruce study (7). The association between numbers of calves and extent of health problems followed a linear dose-response pattern and no critical size, below which the association disappeared was noted. Nonetheless, group sizes of 100 calves or less are probably preferable to larger groups.

Changing the roughage source in the first 28 days increased the risk of mortality. This association was also observed in the Bruce County Beef Project (3, 4, 5, 7) and in that study, early dietary changes, especially in the first week postarrival, were associated with elevated death losses and health costs. In this survey, the positive relationship between "delaying the time of ration change" and increased morbidity suggests that farmers delayed ration changes because of disease occurrence, not that increased disease occurrence was a result of ration changes. Both relationships make biological sense. That is, early ration changes could precipitate health problems whereas, in other groups of cattle experiencing increased levels of disease, farmers would delay ration changes. It is possible that "ration change" is a proxy measure of other unknown factors more directly related to morbidity and mortality.

Although no differences in outcome between train shipped or truck shipped cattle were noted in the Bruce County project (7) truck shipped cattle, in this study, had significantly reduced morbidity rates. This may reflect a greater difficulty in transporting cattle by train to the more southern counties in this survey.

Although not significant at $p = 0.05$ in the regression analysis, purchasing some calves at a western salesyard was unconditionally associated with an increased mortality rate (Table IX). Feedlot owners who purchased some calves from both eastern and western salesyards experienced the highest mortality rate in their calves. Feedlots with calves purchased only at western salesyards tended to have higher mortality than those containing calves purchased only at eastern salesyards. Calves purchased in Ontario salesyards would be comprised of mainly western calves, and the differen-

TABLE XII. Example of Crosstabulation of Bruce County Beef Project Data with Southwestern Ontario Data[a] for Variables RUFCHANGE and ANTIMICROBIAL

Reported Value		No. of Farms	
Bruce Study	Mail Survey	RUFCHANGE	ANTIMICROBIAL
1	1	13	3
1	0	1	1
0	1	2	2
0	0	5	15

[a]A total of twenty-one farms participated in both studies in 1980-81

TABLE XIII. Kappa[a] Values of Variables with Significant Agreement (5% level) Between Data Collected as Part of the Bruce County Beef Project and Data from the Southwestern Ontario Survey, 1980-81

Variable	Kappa	Variable	Kappa
FEMSEX	0.90	RUFCHANGE	0.67
MALESEX	1.00	RUFDIFWHEN	0.61
PROCESS	0.79	HAYLAGEDIF	0.58
INJECTVITADE	0.64	CORNSILAGEDIF	0.60
IBR:NASAL	1.00	CONCDIFWHEN	0.24
IBR:MUSC	0.35	CORNCONCFED[b]	0.44
WORMED	0.33	BARLEYOATFED[b]	0.51
DELICED	0.60	STARTER	0.77
ANTIMICROBIAL	0.58	SALEEAST	0.70
		SALEWEST	0.79

[a]The statistic Kappa measures the amount of agreement that exists beyond that expected by chance alone. The scale ranges from -1 to +1 indicating a range of complete disagreement to complete agreement

[b]These variables were recoded as concentrate fed in the first 28 days postarrival. Ration information in the Bruce County study was recorded on specific days postarrival and the type of ration fed within two days of arrival could not be exactly determined if day 0 values differed from day 7 values

tial in health problems may reflect the purchasers' ability to exclude calves, suspected of having disease, when making a purchase in Ontario. Owners that only purchased calves directly from the source ranch or farm had the lowest mortality rate in their calves (Table XI). Since, the variable MIXGRP, which measured all mixing (including different groups of calves from the same general source) after arrival at the feedlot, was not significantly associated with mortality, we conclude that mixing of cattle groups is more harmful, the greater the difference in source and/or experience of calves. The variable equivalent to MIXGRP in the Bruce County Study was positively associated with disease problems (7).

The addition of antimicrobials to the water on arrival was significantly associated with mortality in this and the Bruce County study (7). It is possible that the addition of sulfa and tetracycline products to the water will reduce water intake by reducing palatibility and contribute to increased incidence of disease. Low levels of antimicrobials could also contribute to the selection of more virulent pathogens by inhibiting normal flora. A separate study on the effects of antimicrobials in the water, would be beneficial.

A number of processing variables were examined because they were important in the Bruce County study. In that study, most variables measuring processing were apparently harmful if performed within two weeks of arrival. Other workers have suggested that processing should be done on arrival or prior to shipment to reduce the impact of the procedures on weight gain over the first two months postarrival (3). Although not significant, the results of this study suggest that, processing on the day of arrival increased the risk of mortality. Also, feedlots that used infectious bovine rhinotracheitis (IBR) intranasal vaccine experienced a lower average mortality rate (not significant at $p \leqslant 0.05$) than those that used IBR intramuscular vaccine. No differences between intranasal and intramuscular vaccines were observed in the Bruce County study (7), both appearing to be harmful in the two weeks postarrival period.

Finally, although not significant in the regression analysis, providing a closed barn for shelter with or without yard access was negatively associated with mortality and morbidity when compared to cattle housed in bank or pole barns. This association may be a result of the positive correlation between closed barns and hay feeding or it may be a direct effect of housing per se. Barn type was not considered important in the Bruce County study (7).

In general, the results of this study support those of the Bruce County study. More studies are required however, and the timing and etiology of disease and death, together with measures of productivity as well as economic return should be included if possible. In the meantime, farmers and their veterinarians should strive to reduce the number of animals per group to 100 or less, reduce unnecessary mixing of cattle groups, restrict ration changes during the first month after arrival and refrain from using prophylactic antimicrobials in the water of calves on arrival at the feedlot.

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