Reproductive Efficiency and Calf Survival in Ontario Beef Cow-calf Herds: A Cross-sectional Mail Survey

R.W. Rogers, S.W. Martin and A.H. Meek*

ABSTRACT

A survey of the efficiency of production of Ontario beef cow-calf herds was conducted using a stratified systematic random sample of Ontario producers. In general, about 87% of females exposed to breeding produced a live calf and 6% of these died before reaching four weeks of age. The herd to herd variation in these rates was quite large, the coefficient of variation being about 17%. The stillbirth rate was 1.7% and the abortion rate 1.2%.

In general, herds in northern Ontario and herds whose owners kept breeding and calving records, had reduced livebirth rates, the latter probably reflecting accuracy of data. Herds with a restricted (less than three months) breeding season had increased livebirth rates. Herds using injectable vitamins ADE, and prophylactic antibiotics, had increased neonatal losses. Herds with a restricted calving season (≤3 months) and/or feeding free choice salt to cows had decreased neonatal losses. Herdsize and calf mortality rate were directly related, but this did not appear to be due to increased density of cows at calving time. In herds, where calving occurred during the spring, using scour vaccines in calves was associated with increased calf mortality.

Key words: Survey, cross-sectional, reproductive efficiency, calf survivorship, beef.

RÉSUMÉ

Cet article rapporte un relevé de l'efficacité de la production des troupeaux "vaches-veaux" de boucherie de l'Ontario, à l'aide d'un échantillonnage au hasard, systématique et stratifié, d'un certain nombre de producteurs. En général, environ 87% des vaches saillies donnèrent un veau vivant, mais 6% d'entre eux moururent avant d'atteindre l'âge de quatre semaines. La variation entre ces taux se révéla appréciable, d'un troupeau à l'autre, et son coefficient se situait aux environs de 17%. Le taux de mortinatalité atteignit 1,7% et celui de l'avortement, 1,2%.

En général, les troupeaux du nord de l'Ontario et ceux dont les propriétaires tenaient un registre des saillies et des vêlages, affichaient une plus faible proportion de veaux nés vivants, reflet vraisemblable de l'exactitude des données. Les troupeaux dont la saison d'accouplements s'échelonnait sur une période restreinte de moins de trois mois connurent une proportion élevée de veaux nés vivants. Les troupeaux où on utilisait l'injection des vitamines ADE, ainsi qu'une antibiothérapie prophylactique, présentaient une augmentation des pertes néonatales. Les troupeaux dont la saison d'accouplements s'échelonnait sur une période restreinte d'environ trois mois et où les vaches avaient ou non libre accès à du sel, connurent moins de pertes néonatales. L'importance du troupeau et le taux de mortalité des veaux affichèrent une relation directe qui ne sembla toutefois pas attribuable à une densité accrue des vaches, au moment du vêlage. Dans les troupeaux où le vêlage se produisit au printemps, la vaccination des veaux contre la diarrhée néonatale s'accompagna d'une mortalité plus élevée de ces derniers.

Mots clés: relevé en sections transversales, efficacité reproductrice, survie des veaux, boeuf de boucherie.

INTRODUCTION

The primary objective of beef cow-calf producers is to produce one calf per cow per year and the extent to which this goal is achieved, in a herd or population, can be assessed using the calf crop rate (1). An overall measure of performance such as calf crop rate, has components that relate to both the reproductive performance of the cow herd and the ability of calves to survive.

A review of the literature revealed that no formal studies have been done on Ontario beef cow-calf herds to determine the level of reproductive performance and neonatal mortality. Thus, the major purpose of this survey was to obtain estimates of live-birth calf crop rate (the percentage of bred females producing a live calf), neonatal mortality rates (the percentage of liveborn calves that die within one month of birth) and the calf crop rate (the percentage of bred females producing a calf that survived one month), in Ontario beef cow-calf herds. An additional purpose of the survey was to collect data on cow herd characteristics, preventive health regimes and management factors, in order to assess their relationship with calf crop and mortality rates.

MATERIALS AND METHODS

SAMPLING PROCEDURE

The owners of 225 herds were contacted and asked to collaborate in the

*Department of Veterinary Microbiology and Immunology, Ontario Veterinary College, University of Guelph, Guelph, Ontario N1G 2W1. Present address of senior author: Regional Office, Terminal Plaza Building — 5th Floor, 1222 Main Street, P.O. Box 6088, Moncton, New Brunswick E1C 8R2.

Reprint requests to Dr. S.W. Martin.

This project was completed by the senior author as part of the requirements for an MSc degree in epidemiology.

Submitted October 15, 1983.

study. [Estimates of the required sample size were based on simple random sampling. It was desired that the estimate be within 2% of the actual population mean 95% of the time and the population standard deviation for the between herd mean calf crop rate was assumed to be 15%. Thus $n=(4x15^2)/2^2 = 225$, where 4 is approximately $Z_{0.975} = 1.96^2$.]

The sample was drawn using stratified systematic random sampling techniques. In order to accomplish this, a 1982 listing (sampling frame) of beef herds with at least ten females of breeding age was obtained and was divided into five major areas: northern, southern, western, central and eastern Ontario. The number of herds selected within each area was proportional to the total number of herds in the sampling frame in each area. Herds in each area were identified by consecutive integers and selected systematically following a random start.

QUESTIONNAIRE DESIGN

The initial questionnaire was revised following scrutiny by two beef cattle specialists and two veterinary clinicians at the University of Guelph. Following this, the questionnaire was mailed, with a personalized explanatory letter and a stamped self-addressed return envelope to the selected producers. This was followed by a personalized reminder letter two weeks later. A final personalized reminder letter, which included another questionnaire, was sent four weeks after the initial mailing to non-respondents. The deadline for replies was approximately seven weeks after the initial mailing. Collaborators who returned incomplete questionnaires, or forms with apparently discrepant answers were interviewed by telephone. After coding of returned questionnaires and editing for errors, the data were entered into computer files.

Twenty-five validation visits were made to farms in selected counties in the southern, western and central areas. (This restriction was due to time constraints, cost and convenience.) Fifteen of these farms were randomly selected from the survey respondents, while ten were nonrespondents, chosen by proximity to survey contacts.

The survey requested owners to record the number of heifers and cows (including females purchased since July 31, 1982) that were exposed to a bull, or artificially inseminated, between August 1, 1981 and July 31, 1982. Herdsize (HERDSIZE), in this survey, refers to the total number of bred females minus any bred animals reported sold for breeding purposes before they had calved. Owners also reported the number of bred animals that were culled or died before they had calved, the number that had stillbirths or abortions, the total number of calves born alive between May 1, 1982 and April 30, 1983 from these animals and the number of these calves that died before four weeks of age.

Data were collected on cow herd characteristics and management factors. These included predominant breed, method of breeding, calendar time and length of breeding season (LENGTH), rations fed (during the breeding season and last month of pregnancy) and types of housing for the cow herd (during the breeding season and in the last month of pregnancy).

Data also were obtained on preventive medicine regimes. For bred animals, owners were asked if breeding and calving records (RECORDS) were kept, if pregnancy checks were done, if vaccines against infectious bovine rhinotracheitis, bovine virus diarrhea, leptospirosis, or any calf scour vaccines (COWSCOUR) were used, if injectable ADE vitamins were given (COWADE) and if parasite (warble fly, lice, worms) treatments were performed. As well, owners were asked if a breeding soundness examination, a semen evaluation or scrotal circumference measurement were performed on their bulls prior to the breeding season.

With respect to neonatal (up to four weeks old) calves, information was collected on the use of: preventive antibiotic injections (ANTIBIOTIC), vitamin E injections, vitamin ADE injections (ADE), use of calf scour vaccines (SCOUR) and if calves were assisted in an attempt to ensure adequate colostrum intake. Owners were also asked to state the major health problem in their calves.

ESTIMATION AND STATISTICAL ANALYSIS

Live-birth calf crop rates were calculated separately for heifers and cows and for the herd as a whole. The denominator for these rates was the number of bred animals (heifers, cows or total) minus any animals sold before calving and the numerator was the number of calves born alive to the appropriate animals. The neonatal calf mortality rate was calculated for each herd with the denominator being the total number of calves born alive and the numerator, the number of these calves that died within four weeks of birth. Calf crop rates for each of the herds were calculated with HERDSIZE as the denominator and the number of calves alive at four weeks of age as the numerator.

Estimates of the population means and standard errors on a per animal basis were calculated according to the method of Cochrane (2). Estimation on a per herd basis were obtained using the arithmetic means of herd rates (3).

The live-birth calf crop rate (LBCCR) and the neonatal calf mortality rate (NMR) were transformed prior to detailed analysis using Log_{10} (rate (%) + 1) and will be referred to hereafter as Log LBCCR and Log NMR respectively. Initial analyses examined unconditional associations between categorical variables that potentially were biologically or environmentally related to each of these rates. The significance level was set at five percent (i.e. $p < 0.05$). Subsequently, those categorical variables that were statistically associated with these rates and represented at least 5% of the sample herds and other continuous variables that potentially were biologically related to live-birth calf crop or neonatal calf mortality rates, were used in regression analyses. Variables relating to geographic area and RECORDS were forced into all regression equations. Stepwise selection was done on the remaining variables with the entry level set at five percent.

Similar regression analyses were done on two subsets of the sample. One subset was restricted to herds in which the breeding season was only in the summer months (June, July, August). The other subset selected was herds that had a breeding season of less than three months (QUARTER) and which used a bull only for breeding.

RESULTS

The number of herds by geographic area in the sample, sampling frame and census report are displayed in Table I. The total number of herds in the sampling frame with at least ten females of breeding age per herd was 77.4% of the census' total herds, which included all herds with at least eight females of breeding age. The proportions of the target population by area in the sampling frame were compared to the census report to ensure that the distribution of herds in the sampling frame was representative and this appeared to be the case.

The overall response rate to the survey was 58.7% (132/225). Thirteen of the 225 farms initially contacted no longer had beef cow-calf herds. Approximately 48%, 35% and 17% of the replies were received after the first, second and third mailings respectively.

Prior to the fifteen validation visits being made to respondents, their returned questionnaires were reviewed. The format of the interview was not standardized and each questionnaire was evaluated independently. Consequently, the determination of the sensitivity or specificity of particular questions was not possible. However, these visits did reveal that the main reasons for the unexplained losses (see Table III) were due to animals that were repeat breeders after the time frame specified, as well as heifers that did not conceive but were being carried over for another breeding season. Results of the visits made to nonrespondents to determine why the questionnaires were not returned were as follows: 70% said they were too busy, 10% said the questionnaire was too long, 10% said they don't fill out questionnaires and 10% said they would not divulge the type of information requested.

Herdsize in the sample ranged from seven to two hundred animals, representing a total of 3,729 females of breeding age, for an average herdsize of 29 animals. A summary of the major rates obtained from the survey is shown in Table II. A total of 3,252 calves were reported born alive from the 3,729 females exposed to breeding, hence the population estimate of the live-birth calf crop rate was 87.2%. The estimate of the population mean of the heifer live-birth calf crop rate was 9.8% lower than the cow rate. Prior to four weeks of age, 186 calves were reported to have died and thus the estimate of the neonatal calf mortality rate in the population was 5.7%. The mean calf crop rate (up to the time calves were four weeks old), in Ontario beef cow-calf herds was 82.2%.

The averages of the herd rates, are similar to the above rates. Although the estimates of the population means are moderately precise (i.e. small standard errors of $SD/(129)^{1\ 2}$), there was a large farm to farm variability in all rates, as indicated by the standard deviations. The initial "guesstimate" of the between farm variability of the mean calf crop rate (15%) was quite close to the observed standard deviation of 14.7%.

The mean total culling and death losses among breeding females was 12.1%. The components of the heifer, cow and herd live-birth calf crop rates that resulted in reduced live-birth calf crop rates are displayed in Table III. Heifers had greater losses than cows in

TABLE I. The Number of Herds by Area in the Sample, Sampling Frame and Census Report, in a Survey of Ontario Beef Cow-calf Producers, 1983

Area	Total No. Farms With > 8 Cows In Census[a]	Total No. Farms With > 10 Cows in Sampling Frame	No. of Survey Contacts by Area	No. of Survey Contacts Replying by Area	% Survey Contacts Replying by Area
Northern	1,333	1,064	18	8	44.4
Southern	2,125	1,409	23	17	73.9
Western	5,998	5,025	84	48	57.1
Central	3,933	2,806	47	23	70.2
Eastern	4,067	3,207	53	26	49.1
Ontario	17,456	13,511	225	132	58.7

[a]Refers to 1981 Canada Agriculture Census Statistics Report, reference 4

TABLE II. Beef Calf Crop and Mortality Rates Obtained From 1983 Mail Survey of Ontario Beef Cow-calf Herds

Rate	Population Estimate (%) ± SE[a]	Average of Herd Rates (%) ± SD (extreme values)
Heifer live-birth calf crop	78.9 ± 3.5	81.2 ± 29.0 (0 to 100)
Cow live-birth calf crop	88.7 ± 6.0	89.8 ± 12.8 (33.3 to 111.8)
Herd live-birth calf crop	87.2 ± 6.3	88.2 ± 13.4 (33.3 to 111.8)
Neonatal calf mortality	5.7 ± 0.8	4.7 ± 6.5 (0 to 28.1)
Calf crop	82.2 ± 8.1	84.2 ± 14.7 (33.3 to 111.8)

[a]Calculations by method of Cochrane, 1977

TABLE III. Average Herd Rates of Overt Losses Resulting in Reduced Live-birth Calf Crop Rates in Ontario Beef Cow-calf Herds (1983 Mail Survey)

Reason for Loss	Heifers	Cows	Herd
Culled before calving	5.7 ± 15.8	4.9 ± 8.9	5.3 ± 8.92
Died on farm before calving	0.4 ± 3.0	0.7 ± 2.4	0.7 ± 2.36
Stillbirths	3.4 ± 9.1	1.6 ± 3.7	1.7 ± 3.52
Abortions	2.7 ± 12.4	1.0 ± 4.7	1.2 ± 6.06
Unexplained	6.4 ± 20.9	2.6 ± 6.9	3.2 ± 7.9
Total	18.5 ± 29.0	10.7 ± 12.2	12.1 ± 13.0

Rates shown are herd arithmetic mean percentages ± SD. Twenty-six herds reported no heifers expected to calve

all categories except "died on the farm before calving". Note that the 3.22% unexplained losses represents less than one cow in the average sized herd.

DESCRIPTION OF FARMS

Twenty-two percent of the herds had a pureline breed of cows, 58% a crossbred type and 20% were mixed breed. Grouped by bloodlines, 54% of the herds had predominantly British breeds, 26% exotic breeds and the remaining herds were of mixed breeds.

Sixty-nine percent of the herds had a breeding season less than or equal to three months duration, 14% between three and six months and 17% had a season longer than six months. (The categorical variable name used for these three groupings was LENGTH). The majority of herds (55%) breed only in the summer months (June, July, August). Methods of servicing females were: bulls only in 84% of the herds, artificial insemination only in 7% and 9% used both methods. Ten percent of the owners using a bull indicated that a breeding soundness examination was done before usage; 5% took a scrotal circumference measurement and 2% did a semen evaluation. The number of cows and heifers per bull (RATIO), in the 109 herds using only natural service, was 24.1 ± 10.9 (SD), and ranged from 5 to 61 animals. Pregnancy checks were done in 12% of the herds. Breeding and calving records (RECORDS) were kept in 30% of the herds.

Frequencies of selected preventive health regimes for bred animals and neonatal calves are shown in Table IV. Note that 28% of the herds reported the use of preventive antibiotic injections in their neonatal calves.

A confined breeding site (in this survey this included all housing types except pastures and pastures with woodlots) was used in 32% of the herds and a confined calving site in 73% of the herds. Ten percent of females were housed in tie-stalls during breeding season, 23% were kept in tie-stalls during the last month of pregnancy and 18% calved in tie-stalls.

The types of ration fed to cow herds where animals were bred in the summer months only are shown in Table V. Sixteen percent of all herds did not feed salt free choice during the breeding season or during the last month of pregnancy and only 37% supplemented their cow herd rations with commercially mixed grains, home grown grains or protein supplements during these periods. None of the twenty herds that did not feed salt free choice fed their cow herd commercially mixed grains; seven fed mineral free choice.

Owners were asked to state the major health problems in their calves. Of the one hundred and twelve that provided an answer, 50% cited scours, 16% white muscle disease, 4% pneumonia and 4% listed other diseases such as pinkeye and coccidiosis. Twenty six percent said they had no specific health problems in their calves.

FACTORS RELATED TO CALF CROP AND/OR MORTALITY RATES

Herds where RECORDS were kept had a lower herd mean Log LBCCR. No other categorical variable was unconditionally associated with Log LBCCR at the 5% level.

The results of stepwise regression analysis using Log LBCCR as the dependent variable are shown in Table VI. Two of the variables forced into the equation (RECORDS and NORTH) were significant as was QUARTER (herds with a breeding season of less than or equal to three months). The variables NORTH and RECORDS had negative regression coefficients indicating lower live-birth calf crop rates of approximately 13.5% and 6.3% respectively. QUARTER had a positive regression coefficient indicating a significant increase in live-birth calf crop rate of 6.3%.

The multiple regression analysis based on herds (n=78) using natural service alone in conjunction with an intensive breeding season (QUARTER) found no significant difference ($p=0.11$) in the live-birth calf crop rate

TABLE IV. Frequencies of Selected Preventive Herd Health Regimes Used for Bred Animals and Neonatal Calves, Ontario 1983

Bred Animals	% of Herds Replying Yes	Calves	% of Herds Replying Yes
IBR vaccination	11	Assist calves to ensure adequate colostrum intake	67
BVD vaccination	2		
Leptospirosis vaccination	6	Antibiotic given as a prevention	28
Scour vaccine given	9		
Injectable ADE vitamins	29	Scour vaccine given	12
Treated for lice	80	Vitamin E/ Selenium injection given	33
Dewormed	20	Injectable ADE vitamins given	33

TABLE V. Ration Contents in Ontario Cow Herds using a Summer (June, July, August) Breeding Season, 1983 Mail Survey

Ration Type	Fed During The Breeding Season (% Herds Positive)	Fed During The Last Month Of Pregnancy (% Herds Positive)
Haylage	3	4
Cornsilage	20	24
Hay	49	96
Pasture	90	31
Corn stover or straw	11	17
Protein supplement and/or grain	28	42
Salt (free choice)	89	86
Minerals (free choice)	79	80
Vitamins (free choice)	18	18

as the number of heifers and cows exposed to breeding per bull increased.

Results of the regression analysis with Log LBCCR as the dependent variable using only those herds when the breeding season was in the summer months (n=70) resulted in no variables being selected by the stepwise procedure.

Three categorical variables, LENGTH, ADE (injectable ADE vitamins given to neonatal calves) and PSALT (salt fed free choice during the last month of pregnancy) were significantly unconditionally related to Log NMR. Although not significant unconditionally, herds that did not feed salt free choice in the last month of pregnancy (n=20) but fed mineral free choice had lower neonatal calf mortality rates (mean rate=3.9%) compared to herds that fed neither (mean rate=7.0%).

The results of the regression analysis using Log NMR as the dependent variable are shown in Table VI. None of the variables forced into the equation were significant. ADE, PSALT, HERDSIZE and QUARTER were significantly related to NMR. HERDSIZE and ADE had positive regression coefficients indicating an increase in the herd neonatal calf mortality rates as the values of these variables increased. PSALT and QUARTER had negative regression coefficients indicating a significant decrease in herd neonatal calf mortality rates when salt was fed free choice and the calving season was less than or equal to three months.

In herds where the breeding season was during the summer months, two variables ADE and SCOUR were significantly related to Log NMR. Both of these variables had positive regression coefficients indicating an increase in the neonatal calf mortality rates in these herds when ADE or SCOUR were positive.

TABLE VI. Results of Stepwise Multiple Regression Analyses

Dependent Variable	Log LBCCR			
Independent Variables	Regression Coefficient	Standardized Regression Coefficient	Effect[a]	Significance Level
RECORDS	-0.032	-0.184	-6.3%	0.04
NORTH	-0.073	-0.222	-13.5%	0.02
QUARTER	0.032	0.187	6.3%	0.03
Dependent Variable	**Log NMR**			
Independent Variables	Regression Coefficient	Standardized Regression Coefficient	Effect	Significance Level
ADE	0.23	0.217	1.7%	0.02
PSALT	-0.35	-0.249	-2.2%	0.004
HERDSIZE	0.007	0.223	0.1%	0.01
QUARTER	-0.185	-0.171	-1.4%	0.04

[a] The effect is the arithmetic difference in the LBCCR or NMR when the factor is present versus when it is absent, or when the value of the variable is increased by one unit, all other variables in the equation being set to their mean value

DISCUSSION

Based on the results of this cross-sectional mail-in survey, the calf crop rate (up to the time calves were four weeks old) in Ontario beef cow-calf herds is 82.2%. This is very similar to the 84% calf crop rate at 30 days of age reported for beef herds in Alberta and Saskatchewan (5) (Actually Dr. Acres reported a calf crop rate of 88% in cows expected to calve, which is 84% of females originally exposed to breeding; see reference (5) Table 3.6.). The LBCCR and NMR in Ontario appear to be 87% and 6% respectively, extremely close to the 88% and 4.2-5.6% reported for beef herds in Alberta and Saskatchewan (5). Beef cow-calf operators are presently guided in evaluating their potential profit margins based on an average weaned calf crop rate. Profit margin is a complicated computation, which the majority of owners cannot determine for themselves, so simplified results based on a 90% weaned calf crop rate are used (6). Since the calves in this study were only followed to four weeks of age, not to weaning, the actual calf crop rate is at least 7.8% below this arbitrary value and the impact of this on beef cow-calf profit margins should be evaluated.

In addition to the low overall calf crop rate there was a wide variation in the herd calf crop rates as indicated by the standard deviation of 14.7%. This suggests that many herds with very low calf crop rates might benefit from herd health programs. Recently it was reported that veterinary practitioners in Ontario spend an average of only 1.9% of their practice time delivering health management programs to beef cow-calf operations (7). In the present survey the frequency of use of some preventive health regimes were noted, but the survey did not ascertain if these prophylactic measures were performed by, or were otherwise dependent on, veterinarians. Certainly the overall percentages of veterinary involvement were low for recommended basic herd health procedures (1). For instance, only 12% of the herds had pregnancy checks done, only 10% did a breeding soundness examination of the bull(s) and only 5% took a scrotal circumference measurement. The latter technique is a good predictor of a bulls breeding potential although it is recommended that this is not to be the sole method of bull evaluation, since bull libido is not highly correlated to it (8,9).

Twenty-eight percent of the owners used prophylactic antibiotic injections in their neonatal calves. Although this variable was not significant at the 5% level, it was associated with elevated neonatal calf mortality rates. The authors do not know if there was a disease problem in the calves and thus antibiotics were being used prophylactically, or vice versa. Certainly this procedure is not totally effective in reducing the mortality rate. This uncertainty of temporal relationship is one of the major limitations of a cross-sectional study. Because of this, one is unable to conclude if there is a causal association between ANTIBIOTIC and the neonatal calf mortality rate, since a major criterion for causation is that the cause must precede its effect(s) (10). Statistical evaluation does not

solve this problem; it only indicates that chance was an unlikely reason for the association.

The calf crop rate is a composite of two rates, the live-birth calf crop rate, which is a measure of reproductive efficiency and the neonatal calf mortality rate, which is a measure of calf survivorship. Independent assessments were done on these latter two rates because the factors that influence these two rates probably differ. The herd was the unit of concern and factors operating at the herd level were examined for associations with these rates.

By design, the province was divided into five areas and herds were selected using stratified systematic random sampling (each area being a stratum) in a manner to help ensure that they were representative of the herds in the province. Since the survey was not designed to provide answers about environmental factors specific to each of the five geographic areas that were associated with differences in calf crop rates, variables denoting these areas were forced into all the multiple regression analyses to mathematically control for their effects (remove differences in rates among areas) before looking at potentially important herd factors. Similarly RECORDS was forced into all the multiple regression analyses to prevent suppression or distortion of associations between the rates and other variables. Whether or not a herd owner maintained breeding and calving records on individual animals was used to compare the accuracy of data between herds where RECORDS were kept, versus herds with no RECORDS. One might also make inferences about differential management between herds with and without RECORDS (i.e. herd owners who kept records managed their herds differently from those who didn't keep records). In either event, herds where RECORDS were kept had lower (by approximately 6.3%) live-birth calf crop rates compared to those in herds without RECORDS.

Higher live-birth calf crop rates were significantly associated with a breeding interval of less than or equal to three months (QUARTER). QUARTER herds represented 69% of the total sample. Although there was a significant correlation between QUARTER and SUMMER, when the effects of the calendar time were controlled there was still a significant difference in the mean herd live-birth calf crop rates. Hence the authors conclude that a short breeding season, no matter what calendar time is involved, resulted in higher live-birth calf crop rates. This may reflect management factors such as heat detection or maintaining closer observation of the cow herd during the calving period, however the questionnaire was not refined sufficiently to provide these answers. A significant reduction in live-birth calf crop was found in herds from northern Ontario.

With regard to breeding policy, although not significant at the five percent level, as the number of females per bull increased in herds that used bulls alone in conjunction with an intensive breeding season, the live-birth calf crop rates decreased. Theriogenologists recommend that one bull (regardless of age) per twenty-five females of breeding age be used in herds where a bull evaluation has not been done (11). It is recognized that bulls with superior breeding ability can service fifty females in an intensive breeding season. Since the average HERDSIZE in Ontario is low, it seems particularly important to ensure breeding soundness when only one or two bulls are used.

Herds in which salt was not fed free choice to the cow herd during the last month of pregnancy had significantly higher neonatal calf mortality rates. A tenet of nutrition is that cattle should never be without salt and it should be supplied on a free choice basis (12). Salt deficiency can result in a decline of body weight and milk production in cattle. Either of these changes may be related to elevated calf mortality. Some of these herds provided mineral free choice and some mineral formulations contain 20% salt. In herds, not supplying salt free choice the calf mortality rates in the seven herds that supplied mineral was 4% compared to 7% in the 13 herds that fed neither.

A linear increase in the neonatal calf mortality rate was observed as herdsize increased. This may reflect the inability of farmers to adequately manage larger herds or it may reflect the increased spread of infections often observed in populations when large numbers of susceptible animals are housed together (10). There were no differences in calf mortality rates between herds that had confined calving sites and those that didn't, regardless of whether HERDSIZE was taken into account or not. Thus, density of animals does not appear to be an explanation of this association.

Herds in which the calving season was long (greater than three months) had elevated neonatal calf mortality rates. However, herds in which calving occurred during the winter months December to May inclusive, tended to have lower losses as compared to those that calved from June to November inclusive. Thus, it may be that the apparent beneficial effects of a short calving season on calf survival may partly reflect calendar time. Since the calendar time period covered in this study may include only a good or a bad year, climatic factors could also be involved in this relationship.

Herds in which injectable ADE vitamins were given to neonatal calves as a preventive measure experienced increased mortality rates. As mentioned earlier answers to questions for variables such as ADE do not allow for a clear interpretation of a time sequence in this type of study. The authors do not know if vitamins were given in response to a mortality problem in herds.

Herds in which breeding occurred only in the summer months and hence, calving in the spring months (March through May), had elevated calf losses when using ADE as well as SCOUR. Again the authors cannot infer causation with respect to the use of vitamins ADE or scour vaccines in calves. Although HERDSIZE in this analysis was not significant ($p=0.06$), mortality rates tended to increase as the HERDSIZE increased.

In conclusion, this survey has provided some factual information on the components of beef calf production in Ontario beef cow-calf herds. Mean losses in the beef calf production cycle (from the time when animals were exposed to breeding through to the time calves were four weeks old) were at least 17.8%. To a large extent the economic impact of these losses would depend on when open cows are detected and whether or not culling the

open cows prevents the herd owner from culling on more positive production oriented criteria (e.g. weaning weight of calf). Severe economic pressures are placed on producers and the optimization of their calf crop rates would help alleviate some of this stress. Utilization of current health management programs is low. In order to promote their adoption, it is mandatory that the components of proposed herd health programs be evaluated for their efficacy as well as to quantitate economic returns when programs are installed. This will validate profit motivated management decisions by owners and can be used as guidelines by veterinary practitioners on workable, realistic goals for herd calf crop rates.

ACKNOWLEDGMENTS

This project was supported by the Ontario Ministry of Agriculture and Food. The senior author is an employee of Agriculture Canada.

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