Measures of herd health and productivity in Ontario cow-calf herds

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Abstract

A cohort of cows and heifers in 180 separate breeding herds from 170 randomly sampled farms was followed from the 1986 breeding season through to the weaning of their calves in 1987. Data were collected from farm records, survey information collected during farm visits, and provincial government weaning-weight records.

"Kilograms of calf weaned per female-exposed-to-breeding" was calculated as a summary measure of herd productivity. The lowest 25% of cow-herds produced less than 160 kg of calf weaned per cow-exposed-to-breeding, while the highest 25% exceeded 205 kg.

Overall calf crop was 78.1% for cows and 78.5% for heifers. The 25th, 50th, 75th, and 90th percentile estimates for rates, which were components of calf crop (e.g. calving rate), were estimated. The component rates that most influenced calf crop were culling rate for cows and stillbirth rate for heifers.

Résumé

Détermination de l'état de santé et de la productivité de troupeaux vache-veau en Ontario

Un groupe de vaches et de génisses provenant de 180 troupeaux de reproduction répartis sur 170 fermes choisies au hasard a été évalué à partir du début de la saison de reproduction en 1986 jusqu'au sevrage de leur veau en 1987. Les données furent recueillies à partir des dossiers de la ferme, des informations obtenues lors de visites pour examen et des dossiers du gouvernement provincial sur le poids au sevrage. Le poids en kilogramme de veau sevré par vache soumise à la reproduction fut calculé comme un indice sommaire de la productivité du troupeau. Le dernier 25 % des vaches du troupeau a produit moins de 160 kg de veau sevré par vache soumise à la reproduction alors que le premier 25% a excédé 205 kg.

L'ensemble de la production de veaux a été de 78,1 % pour les vaches et de 78,5 % pour les génisses. Les 25^{e}, 50^{e}, 75^{e} et 90^{e} percentiles furent évalués pour le taux, lequel est un élément de la production des veaux (exemple : le taux de mise bas). Les éléments du taux qui ont le plus influencé la production de veaux ont été le taux de réforme pour les vaches et le taux de mort-nés pour les génisses.

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Introduction

Knowledge of the actual and optimal productivity levels and disease rates for cow-calf herds is an important prerequisite for highlighting overall industry losses and guiding research planning and extension efforts. Together with the goals of the farmer, this information also provides an objective basis for establishing targets of performance in individual herds.

Historically, the logistical difficulties of obtaining valid data from cow-calf producers has restricted efforts to estimate production levels and disease rates on producers' farms. Most estimates in the literature are based on data from research farms or from specific research projects [for example, studies by Bellows *et al* (1) and Wiltbank (2)] rather than appropriately sampled farm populations. However, some attempts have been made to estimate reproductive and disease rates for farm populations (3–5).

The main objective of this study, known as "Benchmark," was to estimate overall herd productivity and the component herd productivity measures and disease rates for Ontario cow-calf breeding herds.

Materials and methods

Herds

The population under study consisted of 180 separate breeding herds from 170 randomly selected farms. There were 10 more herds than farms because there were two separate breeding herds on each of 10 farms. In each case, the two herds were housed and managed separately, with one herd calving in the spring and the other herd calving in the fall. Data on the numbers of cows (breeding females which had calved previously), heifers (breeding females which had not calved), and their calves were collected for the period from the beginning of the 1986 breeding season until weaning of the calves in 1987. Additional details about this study population are described elsewhere (6).

The bulk of the data consisted of the number of cows and heifers which were bred, culled, sold-for-breeding, purchased, died, aborted, retained-open, calved, and the number of calves which were born alive, died, and/or were weaned. The source of the data was a combination of farmer-generated records and survey information collected during farm visits. If individual animal records were not available, farmers were asked, during the farm visit, to recall the number of animals in each category of interest. The number of cows and heifers calving, or the number of calves weaned, often served as a reference point in these herds. For each herd, the breeding and calving seasons were defined. Then each calving was assigned to a particular calving year (i.e. 1986, 1987, or 1988) based on defined season for that herd. In all herds, only the cohort of females exposed to breeding in the 1986 breeding season was included in productivity

Table 1. Definitions of productivity measures and disease rates used in an observational study of Ontario cow-calf herds

1) MEASURES OF PRODUCTION

KILOGRAMS OF CALF/FEMALE-EXPOSED-TO-BREEDING = (average weaning wt for herd × number of calves weaned)/(number of females-exposed-to-breeding)

ADJUSTED KILOGRAMS OF CALF/FEMALE-EXPOSED-TO-BREEDING = (average 200-day-adjusted weaning wt for herd × number of calves weaned)/(number of females-exposed-to-breeding)

CALF CROP = (number of calves weaned)/(number of females-exposed-to-breeding)

LIVEBORN-CALVING RATE = (number of calves alive at 24 h)/(number of females-exposed-to-breeding)

CALVING RATE = (number of females calving)/(number of females-exposed-to-breeding)
— an adjusted-calving rate excluding females sold-for-breeding sales was also calculated

PREGNANCY RATE = (number of females pregnant)/(number of females pregnancy-checked)

TWINNING RATE = (number of females with twins)/(number of females calved)

BREEDING-CALVING PERIOD CULLING RATE = (number of females culled between breeding and calving)/(number of females-exposed-to-breeding)

BREEDING-CALVING PERIOD SOLD-FOR-BREEDING RATE = (number of females-sold-for-breeding between breeding and calving)/(number of females-exposed-to-breeding)

RETAINED-OPEN RATE = (number of females retained-open)/(number of females-exposed-to-breeding)
— culling occurred when a cow or heifer was removed from the herd and sold for slaughter or to an auction market; breeding sales occurred when a cow or heifer was sold to another farmer as a breeding animal; a cow or heifer was considered to be retained-open if it failed to calve but was rebred in a subsequent breeding season

2) DISEASE RATES

ABORTION RATE = (number of females aborting)/(number of females-exposed-to-breeding)
— an abortion is a premature calving judged to be at least one month prior to full term

STILLBIRTH RATE = (number of calves stillborn)/(number of calves born alive and dead)
— a stillbirth is a full-term calf dead at birth or within 24 h of birth

DISEASE MORBIDITY RATES

BREEDING-CALVING PERIOD = (number of females recorded sick after breeding and prior to calving)/(number of females-exposed-to-breeding)

CALVING-BREEDING PERIOD = (number of females recorded sick at or after calving and prior to next breeding)/(number of females calving)
— specific rates associated with retained placenta, prolapsed uterus, prolapsed vagina, and other conditions

DYSTOCIA RATE = (number of females with dystocias)/(number of females calved)
— specific dystocia rates for easy pull, hard pull, malpresentation, and cesarean

MORTALITY RATES

BREEDING-CALVING PERIOD = (number of females dying after breeding and prior to calving)/(number of females-exposed-to-breeding)

CALVING-BREEDING PERIOD = (number of females dying at or after calving and prior to next breeding)/(number of females calving)

CALF MORTALITY RATE = (number of calves dying between 1 day of age and weaning)/(number of liveborn calves)

measure and disease rate calculations. This cohort consisted of 7671 cows in 180 study herds and 1253 heifers in 154 study herds. Cows and heifers purchased during the study period were excluded. The results obtained by using this simpler cohort approach were all within 0.1% of the results using the actual number at risk for the breeding, postbreeding, calving, and postcalving periods.

The other major source of productivity data was a provincial government-sponsored beef herd improvement program (BHIP) (7). This program provided incentive grants for the recording of calving data and weaning weights provided the calves were weighed at 120–250 days of age by an official weighperson.

Productivity measures

Productivity measures were summarized separately for cows and heifers. Actual and 200-day-adjusted "kilograms of calf weaned per female-exposed-to-breeding" were selected as the overall measures of herd productivity. These measures were calculated for each herd by multiplying the average weight of calves (actual or adjusted) at weaning by the calf crop (see below). The component rates of these overall measures were calculated as defined in Table 1 and covered the breeding-to-calving period, the periparturient period, and the calving-to-weaning period. Rates were calculated as proportions.

The calf crop (the percentage of females-exposed-to-breeding which produced a weaned calf) was a rate calculated over the entire breeding-to-weaning period. The rates contributing to calf crop, namely, calving rate, liveborn-calving rate, twinning rate, and the stillbirth rate, were also calculated. Likewise, the components of calving rate, covering the breeding-to-calving period, were calculated including culling, sold-for-breeding, death, retained-open, and abortion rates. Adjusted calving rates were also calculated, for those

Table 2. Outcomes from birth to weaning for a cohort of beef females-exposed-to-breeding in Ontario, 1986

	Cows		Heifers	
Outcome[a]	Number	Rates (%)	Number	Rates (%)
Bred	7671		1253	
Culled	876	11.4	43	3.4
Sold-for-breeding	263	3.4	52	4.2
Aborted	55	0.7	1	0.1
Died	39	0.5	4	0.3
Retained-open	227	3.0	54	4.3
Calved	6211	81.0	1099	87.7
Liveborn calves	6154	80.2	1017	81.2
Weaned calves	5994[b]	78.1	983[b]	78.5
Twin births	118	1.9	5	0.5
Stillbirths	175	2.8	87	7.9
Calf deaths (1 day to weaning)	160	2.6	34	3.3

[a]Terms are defined in Table 1
[b]Weaned calves include 26 calves sold with cows and 1 calf sold with a heifer

herds selling breeding females, by subtracting the number of females sold-for-breeding from the initial denominator. No adjustments were made for culls or deaths.

Pregnancy rates were estimated using data from the 54 heifer-herds and 52 cow-herds in which pregnancy diagnosis was performed.

Disease rates

All diseases were based on farmer-recorded diagnoses and were restricted to the most common conditions in beef cows including dystocia, retained placenta, prolapsed vagina, prolapsed uterus, mastitis, and lameness. Based on the recommendations of Philipsson *et al.* (8), dystocia was classified into four categories: 1) easy assistance — calving requiring the manual help of one person; 2) hard assistance — calving requiring an additional person or mechanical assistance; 3) calving requiring cesarean; and 4) malpresentations. To calculate rates for conditions associated with calving, such as dystocia, retained placenta, mastitis, and prolapsed uterus, the number of cows or heifers calving was used as the denominator. To calculate rates for other diseases occurring from the start of the 1986 breeding season up to the 1987 calving season, we used the number of cows- or heifers-exposed-to-breeding as the denominator.

Distribution of productivity measures and disease rates

For the herd productivity measures and disease rates of interest, the 25th, 50th (median), 75th, and 90th percentiles were chosen as summary statistics to describe the actual distribution of these rates and to demarcate useful targets for producers and veterinarians. The standard deviations of these percentiles were calculated using a distribution-free method (9). Average rates were also calculated for the cohort of 7671 cows and 1253 heifers.

Results

Breeding-to-calving-period

Overall rates for culling, sales for breeding, deaths between breeding and calving, abortions, retained-open for rebreeding in 1987, and calving, are defined in Table 1 and presented in Table 2. Estimates of the 25th, 50th, 75th, and 90th percentiles with their 95% confidence intervals for herd-level rates are presented in Table 3 for cows and in Table 4 for heifers.

No heifers were culled in 127 herds (82.5%) versus only 26 herds (14.4%) in which no cows were culled. Sales for breeding differences between heifer-herds and cow-herds were less marked, with the majority of herds not selling any bred cows (82.2%) or bred heifers (92.2%). In only a few herds (5.5% for cows and 5.8% for heifers) did breeding-sale rates exceed 20%. The majority of herds (60.0% for cows and 80.5% for heifers) had no nonpregnant females retained for subsequent rebreeding. However, in a few herds (2.8% for cows and 8.4% for heifers), over 20% of females exposed to breeding were subsequently found open and were retained.

Eighty-six percent of herds had no cow deaths and only 2.8% of herds had death losses in cows of 5.0% or greater during the period from breeding up to calving. A total of four heifers in four different herds died during this period. Most (78.3%) herds experienced no abortions in cows. The maximum abortion rate for a cow-herd was 16.2% (6/37), while the second highest rate was 7.1%. Only one abortion from a heifer was reported.

Pregnancy diagnoses were performed in 52 cow-herds and 54 heifer-herds. For cow-herds, the range of pregnancy rates was 62.8% to 100% with a median of 92.7%. For heifer-herds the range of pregnancy rates was 0% to 100% with a median of 100%. Forty-seven (87.0%) heifer-herds had a pregnancy rate greater than 80% and in 32 herds all heifers examined were pregnant.

The reported morbidity rate was only 1.8% for cows and only 0.7% for heifers. There were no reported diseases in 95% of heifer-herds and in 68.9% of cow-herds. Of herds which reported cow disease events, 14.4% had crude morbidity rates greater than 5%.

Table 3. Distribution of herd productivity measures and disease rates for cows, 1986 breeding to 1987 weaning, in 180 Ontario cow-calf herds

Outcome[a]	25th percentile	Median	75th percentile	90th percentile
Culling rate (breeding-calving)	4.5[b] (3.3,5.9)[c]	10.7 (7.8,12.1)	16.0 (14.6,18.5)	24.1 (21.1,27.9)
Sold-for-breeding rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	8.1 (3.8,20.8)
Mortality rate (breeding-calving)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	2.0 (0.0,2.8)
Abortion rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,1.9)	3.1 (2.5,4.0)
Retained-open rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	3.6 (2.8,5.1)	7.9 (6.2,13.0)
Calving rate	74.4 (69.6,78.8)	84.0 (81.5,86.2)	90.9 (89.3,93.1)	96.8 (94.9,100)
Adjusted-calving rate	78.6 (74.5,80.8)	85.7 (83.9,87.5)	92.1 (90.2,94.1)	97.1 (95.5,100)
Twin rate	0.0 (0.0,0.0)	0.0 (0.0,1.3)	3.2 (2.6,4.2)	5.9 (4.5,7.4)
Stillbirth rate	0.0 (0.0,0.0)	1.9 (0.0,2.4)	4.5 (3.3,5.7)	7.4 (6.2,10.0)
Liveborn-calving rate	72.7 (69.5,76.7)	83.9 (81.1,86.7)	90.9 (88.0,92.9)	96.6 (94.4,100)
Calf crop	70.0 (67.8,75.0)	80.8 (78.8,83.7)	87.8 (86.2,90.9)	95.3 (93.0,100)
Kg calf/cow-exposed-to-breeding	157.0 (149,165)	183.3 (176,188)	202.6 (196,215)	225.7 (219,248)
Adj kg calf/cow-exposed-to-breeding	169.3 (155,183)	199.0 (192,202)	216.2 (216,228)	248.6 (228,277)

[a]Terms are defined in Table 1
[b]e.g. 25% of cow-herds had a culling rate of 4.5% or less
[c]Confidence intervals calculated using the method in David (9) p. 16

Periparturient period

Bred heifers were more likely to calve than bred cows, but heifers suffered more losses at calving (Tables 3 and 4). Stillbirth rates were approximately three times greater in calves born to heifers (7.9%) than in calves born to cows (2.8%). Cows produced more twins: 1.9% versus 0.5% for heifers. Thus, the overall liveborn-calving rate for cows (80.2%) was close to that for heifers (81.2%).

Overall dystocia rates and the rates for each of the four levels of calving assistance are compiled in Table 5 for both cows and heifers. Table 5 also includes the distribution of herd dystocia rates for cows and heifers.

The majority of diseases reported were associated with the periparturient period. Morbidity rates for calving-associated diseases, other than dystocias, were 4.2% for cows and 4.4% for heifers. Specific disease rates were: retained placenta — 1.9% for cows and 2.4% for heifers; prolapsed uterus — 0.5% for cows and 1.5% for heifers; and prolapsed vagina — 0.5% for cows and 0% for heifers. Other diseases, mainly mastitis, accounted for the remaining 1.3% and 0.5% of calving-associated diseases, other than dystocias, reported for cows and heifers, respectively.

Calving-to-weaning period

The distribution of herd calf mortality rates and the overall and age-specific calf mortality rates are shown in Table 6.

Overall breeding-to-weaning period

The calf crop was 78.1% for cows and 78.5% for heifers. For both cows and heifers the 25% of herds with the lowest calf crop rates had lower rates, in practical terms, than the 25% of herds with the highest calf crop rates (Table 3 for cows and Table 4 for heifers).

Cow-calf herd productivity, as summarized by actual and 200-day-adjusted "kilograms of calf weaned per female-exposed-to-breeding", varied widely between herds (Table 3 for cows and Table 4 for heifers). For cow-herds, the actual "kilograms of calf weaned per cow-exposed-to-breeding" ranged from 72.4 to 318.8 kg and the 200-day-adjusted-values from 89.5 to 316.1 kg. The lowest 25% of study herds produced less than 157 kg of weaned calf (170 kg–200 day adjusted-weight) per cow-exposed-to-breeding while the top 25% produced at least 205 kg (216 kg adjusted-weight). Compared to cows, the median actual "kilograms of calf weaned per heifer-exposed-to-breeding" was approximately 10% lower. However, the 200-day-adjusted "kilograms of calf per female-

Table 4. Distribution of herd productivity measures and disease rates for heifers, 1986 breeding to 1987 weaning, in 154 Ontario cow-calf herds

Outcome[a]	25th percentile	Median	75th percentile	90th percentile
Culling rate (breeding-calving)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,2.0)	15.4[b] (7.7,25.0)[c]
Sold-for-breeding rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,25.0)
(Mortality rate (breeding-calving)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)
Abortion rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)
Retained-open rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,10.0)	20.0 (11.5,25.0)
Calving rate	80.0 (73.3,87.5)	100.0 (95.8,100)	100.0 (100,100)	100.0 (100,100)
Adjusted-calving rate	84.4 (77.8,90.0)	100.0 (100,100)	100.0 (100,100)	100.0 (100,100)
Twin rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)	0.0 (0.0,0.0)
Stillbirth rate	0.0 (0.0,0.0)	0.0 (0.0,0.0)	12.5 (7.9,16.7)	33.3 (16.7,50.0)
Liveborn-calving rate	70.0 (62.5,75.0)	88.9 (80.0,94.4)	100.0 (100,100)	100.0 (100,100)
Calf crop	66.7 (60.0,73.3)	83.3 (78.6,88.9)	100.0 (100,100)	100.0 (100,100)
Kg calf/heifer-exposed-to-breeding	126.1 (110,139)	165.7 (151,179)	197.7 (192,210)	228.5 (215,251)
Adj kg calf/heifer-exposed-to-breeding	158.1 (144,170)	201.9 (188,212)	239.5 (223,248)	265.4 (251,288)

[a]Terms are defined in Table 1
[b]e.g. 90% of heifer-herds had a culling rate of 15.4% or less
[c]Confidence intervals calculated using the method in David (9) p. 16

exposed-to-breeding" was the same for both cows and heifers.

Discussion

The study design, as well as the productivity measures and disease rates estimated in this study, was largely shaped by the perceived needs and nature of the cow-calf industry in Ontario. A desire to get both precise and unbiased estimates of herd-level production measures and disease rates for the population of Ontario cow-calf herds dictated the large number of herds and random sampling strategy employed (10). The availability of calf weaning weight data from the provincial government sponsored BHIP (7), supplemented by the census and survey data collected in each herd, allowed a unique opportunity to estimate a broad measure of herd productivity, namely, "kilograms of calf per cow-exposed-to-breeding". This measure contains components of herd reproductive efficiency, disease losses, and calf growth. However, collecting data from a large number of herds precluded estimation of some production measures, such as pregnancy rate for individual sires, and prevented rigorous definitions of some specific diseases and health problems of interest.

Data on the numbers of cows and heifers bred, culled, sold-for-breeding, dying, aborting (although early abortions may be missed), retained-open, calving, and the number of calves dying in specified periods from birth-to-weaning can be collected on almost all cow-calf farms. The resulting productivity measures — calving rate, liveborn-calving rate, calf-crop, and "kilograms of calf weaned per female-exposed-to-breeding" — are obvious and practical measures of a cow-calf unit's productivity. Such measures are of direct value and also provide a useful framework within which certain production measures, which can only feasibly be calculated in a more restricted experimental station population, might be extrapolated.

One advantage of collecting data from representative herds is that farmers, veterinarians, and agricultural extension personnel can then compare a specific herd's health and productivity to productivity measures and disease rates of other herds kept under the same conditions. Since the herd is the unit of interest for most cow-calf management decisions, the production measure or disease rate achieved by a chosen proportion of herds, rather than the average herd rate, seems a more relevant benchmark. Therefore, a range of percentiles for each measure has been provided. (Percentile estimates stratified by breed type or region of Ontario are available on request.)

Table 5. Distribution of herd dystocia rates and proportion of dystocias reported by level of assistance in 180 Ontario cow-calf herds, during the 1987 calving season

Distribution of herd dystocia rates

	25th percentile	median	75th percentile	90th percentile
180 herds with cows calving	0.0	2.9	8.0	16.7
151 herds with heifers calving	0.0	18.8	37.5	66.7

Proportion of dystocias by levels of assistance

	Cows		Heifers	
	Number	Relative percentage	Number	Relative percentage
All dystocias	355	100.0	262	100.0
Easy pulls	199	56.1	134	51.1
Hard pulls	95	26.8	95	36.3
Cesareans	9	2.5	15	5.7
Malpresentations	52	14.6	18	6.9

A difficulty in standardizing beef herd health and production indices is the large range of breeding and calving season lengths (3–9 months) encountered in the field situation. Our approach was to define specifed breeding and calving seasons for each herd for each year. Each calving was classified into a given calving season and the cow could not calve again until the next year. All herds had at least a three month interval between calving seasons, and calves were weaned and weighed in two or at most three batches. In practice, this simple method of classifying events by season proved to be relatively robust, since the summary measures of interest were averaged over the herd and even for herds with extended breeding seasons the bulk of the cows tended to calve in a three month span. However, in subsequent analyses (unpublished observations) and for more detailed comparisons between herds, herds of similar breeding season length were compared.

Overall, productivity varied widely among herds. The maximum "kilograms of calf per cow-exposed-to-breeding" for the lowest 25% of herds was 45 kg less than the minimum level achieved by the highest 25% of herds. Although some of this variability may be due to breed differences, for the lower herds there is probably considerable room for improvement. It should be pointed out that smaller herds were more likely to have health and productivity rates at the high or low extremes of the distributions described. This was more of a problem in heifer-herds than in cow-herds, and was reflected in the greater variability of heifer-herd productivity. However, while the smaller number of heifers per herd was important, the biological variability among heifer-herds, particularly with respect to heifer-calving problems, was probably also important.

Judged by calving rate, the majority of herds, particularly heifer-herds, had a successful breeding-to-calving period. If an 80% calving rate is considered a reasonable target, approximately 75% of heifer-herds and 63.9% of cow-herds achieved this goal. The lower proportion of cow-herds achieving this goal reflects the higher cow-culling rates for most herds (11).

Differential herd rates for both culling and sales for breeding create difficulties in using calving rate as a summary measure of breeding season success on all farms (given that only 30% of herds were pregnancy-checked). Based on standard definitions for calculating rates (12), both sales and culls would be treated as "losses" from the initial population at risk of calving. Such calculations assume that "losses" are independent of pregnancy status. Clearly this is not the case. Since selling-for-breeding is a desirable event, we corrected for different herd selling rates by excluding females sold-for-breeding (these females were expected to be breeding successes rather than breeding problems). However, correcting for differences in herd culling rate is a more complicated situation. Culling rates may reflect either real breeding season failures in the herd, or herd management differences such as a more intense genetic selection policy. It is important to distinguish these differences. A practical approach is to interpret a herd's calving rate, conditional on the culling goals of the farmer.

On average, farmers were more likely to retain bred heifers than bred cows. For the cohort of cows and heifers bred in 1986, 11.4% of bred cows were culled versus 3.7% of bred heifers.

In addition to culling rate differences between cows and heifers, culling patterns also differed. For example, differences existed in the patterns of culling non-pregnant cows and heifers. The retained-open rate (females bred in 1986, not calving in 1987, and rebred in 1987) for the 2589 cows which were pregnancy-checked was almost identical to the rate for the 5082 cows which were not pregnancy-checked (2.94% versus 2.96%). On the other hand, the retained-open rate of 2.8% for the 609 heifers in pregnancy-checked herds was lower than the retained-open rate of 5.7% for the

Table 6. Distribution of herd calf mortality rates and proportion of calf mortality occurring in specific age intervals in 180 Ontario cow-calf herds, during the 1987 calving season

Distribution of herd rates

	25th percentile	median	75th percentile	90th percentile
180 herds with live calves from cows	0.0	0.0	4.3	5.9
150 herds[a] with live calves from heifers	0.0	0.0	0.0	14.3

Proportion of calf mortality in specific age intervals

	Cows		Heifers	
	Number	% of live calves[b]	Number	% of live calves[b]
Overall calf mortality	160	2.6	34	3.3
1 day–7 days	63	1.0	13	1.3
8 days–1 month	42	0.7	13	1.4
1 month-weaning	55	0.9	8	0.9

[a]In one herd all the calves born to heifers were stillborn
[b]Denominator is the number of calves alive at the beginning of the risk period

644 heifers in nonpregnancy-checked herds. Perhaps nonpregnant heifers were perceived to have a smaller chance of subsequent pregnancy than nonpregnant cows.

Due to the large number of farms under study, practical considerations dictated that we rely on farmers to diagnose and record disease events. Thus, diseases were classified into specific conditions known to farmers (e.g. prolapsed uterus) or broad-based manifestational categories (e.g. lameness) rather than on more rigorous clinical criteria. While this approach lacks diagnostic sophistication and standardization, Leech (13) argued that, "on average", important diseases are highlighted, and not just those diseases brought to the attention of veterinarians.

Diseases of bred cows and heifers during the breeding-to-calving period were not commonly reported. Both the intensity of animal observation and (probably) the recording of diseases (6) varied between farms and between different seasons on the same farm. Due to less intense observation of bred females during the breeding-to-calving period, disease underreporting, particularly for less serious diseases, was probably significant. In contrast, diseases associated with calving, particularly prolapsed uterus but also prolapsed vagina and retained placenta, were less likely to be underreported.

At calving, heifers had more difficulties than cows. The extent of increased calving difficulties for heifers may partially explain why the managers of 26 (14.4%) herds chose not to breed any heifers in 1986. Stillbirth rates were three times higher for heifers than for cows. Some heifer-herds had particular problems, with 14.5% of herds having stillbirth rates in excess of 20%.

Heifers also required increased assistance at calving. Approximately 21% of heifers calving were assisted by the farmer, compared to 5.7% of cows. The effects of nonstandard definitions of stillbirth and dystocia on the variability of stillbirth and dystocia rates between herds is unknown. Arguably, dystocia rates may vary between herds due to either actual differences in the level of calving difficulties encountered or differences in a farmer's tendency to intervene. Thus, the percentile estimates for the herd rates presented in Table 5 should be interpreted with caution, although the tendency for increased calving assistance in heifer-herds seems obvious. Likewise, the specific rates for the four levels of calving assistance in Table 5 demonstrate a trend towards relatively more hard pulls and cesareans for heifers, and more malpresentations for cows.

Calf losses from birth-to-weaning were not excessive. For cows, losses due to calf mortality and stillbirths were similar. Calf mortality rates for calves born to heifers were slightly higher (3.3 versus 2.6%) than for calves born to cows. As reflected by these low overall rates, calf mortality was not a serious problem in the majority of herds. Calf mortality rates of greater than 5% occurred in only 16% of cow-herds and 14% of heifer-herds.

The data in this study were reworked to estimate herd averages that could be compared to herd averages obtained in a 1983 mail survey of Ontario cow-calf producers (3). The statistics from both these surveys corresponded well except on two points, both of which reflect potential difficulties in cow-calf recording schemes. In the current survey, the culling rate for cows (11.6%) was more than twice the 1983

estimate (4.9%), presumably due to the ability to uncover data on problem cows during repeated farm visits in the current study. The differences in the calving rate and liveborn-calving rate estimates for cows between the two surveys disappeared when both the percentage of cows sold and the increased proportion of culls detected in 1986 were subtracted from the 1983 estimates. The second discrepancy was in the estimates of heifer stillbirth and abortion rates. Most of the heifers classified as aborting in the 1983 mail survey would have been classified as stillbirths in this study. The sum of stillbirth and abortion rates for heifers in this study was approximately 50% higher than for the 1983 survey.

While calving rate, liveborn-calving rate, calf crop, and "kilograms of calf per cow-exposed-to-breeding" provide useful summaries of a cow-calf herd's performance, the complex combination of managerial, genetic, environmental, nutritional, and disease factors which influence these rates are not easily modelled. To investigate potential causal factors, these more global outcome rates should be subdivided into their component rates, for example, pregnancy rate or stillbirth rate, the determinants of which are better understood biologically and/or more easily summarized statistically. These will be the subject of subsequent studies.

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