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RESEARCH ARTICLE

Economic Analysis of Calving Assistance on Western Canadian Cow-Calf Operations

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Abstract

The objective was to estimate the difference in cost, revenue, and profit between unassisted and assisted calvings on western Canadian cow-calf operations. Historical records of individual animal production measures from 2015 to 2020 and industry-described inputs were used in a modified decision tree model. The incidence of assisted calvings in heifers and cows was 4.6 and 2%, respectively. Assisted heifers and cows had an expected profit of −$227.43 and −$67.06 CAD per calving, respectively, while unassisted heifers and cows had an expected profit of −$76.11 and $120.12 CAD per calving, respectively. Calving assistance can impact the profitability of western Canadian cow-calf operations.

Keywords: Beef cattle; calving assistance; cost estimation; economic model

JEL classifications: Q00; Q01; Q12; Q19

Introduction

One of the most complicated events affecting cattle on cow-calf operations is a difficult calving (Dematawena and Berger, 1997; Drost, 2014). The overall incidence of difficult calvings in beef cattle was reported as 4.9% in western Canada, although heifers (i.e., primiparous dams) experienced a 13.5% risk of assistance and cows (i.e., multiparous dams) experienced a 3.2% risk of assistance (Pearson et al., 2019a). A difficult calving can have negative consequences for both the cow and the calf (Barrier et al., 2013; Gaafar et al., 2011; Mee, 2008). Calves assisted at birth may experience trauma, hypoxemia, and acidemia (Homerosky et al., 2017a; Pearson et al., 2019b). Consequently, these calves may be less vigorous than those with a normal, unassisted birth (Murray et al., 2016; Homerosky et al., 2017a). Less vigorous calves have a reduction in suckle reflex, which can affect the timely consumption of colostrum, thus contributing to inadequate transfer of passive immunity (Barrier et al., 2013; Sanderson and Dargatz, 2000; Murray et al., 2016; Homerosky et al., 2017b). Colostrum consumption provides maternal antibodies that give the calf the immunologic protection they need to survive the first months of life (Chase et al., 2008; Lopez and Heinrichs, 2022). Therefore, inadequate transfer of passive immunity can increase the risk of morbidity and mortality in calves during the perinatal period (Murray and Leslie, 2013; Murray et al., 2016; Norquay et al., 2020; Pearson et al., 2019b; Sanderson and Dargatz, 2000; Waldner and Rosengren, 2009). Cows that require an assisted calving have a higher risk of postpartum injuries, pain, uterine infections, and decreased milk production (Gaafar et al., 2011; Lombard et al., 2007; Proudfoot et al., 2009). These postpartum problems can lead to infertility in the cow, which can impact productivity (Waldner and García, 2013). Additionally, profit margins in beef cow-calf production are small (Alberta Agriculture and Forestry, 2018; Canfax, 2021c; Canfax, 2023a,b). Beef breeding females start calving at the age of 2 years and are expected to calve at the same time each year until the age of 10 or 12 years. Difficulty during calving can disrupt a cow's ability to resume estrus and rebreed which reduces profitability (Canfax, 2023a).

Any loss of production from morbidity and mortality of calves or decreased fertility in cows can represent a financial loss for the producer (Bellows et al., 2002; McGuirk et al., 2007). Previous studies of dairy cattle in the United States have estimated the average annual cost of assisted calvings at $28.53 for heifers and $10.00 for cows (Dematawena and Berger, 1997), while in cow-calf operations, the estimation was $5.50 per cow (Bellows et al., 2002). In Australia, the estimated cost of assisted calvings was $97.8M per annum (Shepard et al., 2022). However, these estimations all used published aggregated regional estimates for cattle diseases from literature or surveys and national-level incidences of calving assistance (Bellows et al., 2002; Dematawena and Berger, 1997; Shepard et al., 2022). These studies did not examine individual-level data that would be more accurate at the herd level. Additionally, these previous studies lack external validity for western Canadian cow-calf operations due to the differences in the incidence of calving assistance and mortality, and the input and output values used.

Therefore, the objective of this study was to estimate the difference in cost, revenue, and profit between unassisted and assisted calvings on western Canadian cow-calf operations using individual-level production data and locally relevant cost estimates.

Materials and methods

This study was approved by the University of Calgary Research Ethics Board (REB20-2240, REB21-0157). The study consisted of two parts: a labor survey and an economic analysis of historical production records from cow-calf operations. Recruitment of herds was through advertisements posted on a cow-calf record-keeping software systems (Animal Record Management by TELUS Agriculture and Consumer Goods, Alberta, Canada) website and distributed within the researchers' professional network. Herds that were interested in participating contacted the researchers directly to enroll. The two cow-calf operations that participated in the labor survey were also part of the economic analysis.

Population description

Seven cow-calf operations in western Canada were enrolled in this study. Six operations were located in the province of Alberta, and one operation was located in the province of Saskatchewan. One privately owned cow-calf operation and six institutional operations (i.e., belonging to a university or governmental institutions) were enrolled.

Labor survey

The survey consisted of 15 questions regarding human assistance with calving, colostrum consumption, and cow-calf bonding. First, it was sent out to ranch personnel to test the quality of the questions. After edits to clarify the questions were made, two cow-calf operations, one with more intensive management (Ranch 1) and one with more extensive management (Ranch 2), both in Alberta, were enrolled during the 2021 calving season as a convenience sample of herds. Ranch personnel were asked to complete a survey describing the methods used and time spent providing care to cows and calves during and after an assisted calving. The ranch personnel answered the survey each time they had to assist a cow with calving, mismothering behaviors, or to administer colostrum to a calf.

Data management

Historical records for dams and calves from 2015 to 2020 were obtained from a commercially available herd management software program (Animal Record Management by TELUS Agriculture and Consumer Goods, Alberta, Canada) or Microsoft Excel (Microsoft Corporation, Redmond, WA). The variables collected from dam records were: parity, calf identification number, calving ease category, date of calving, reasons for treatment for disease during the 30 days after calving, culling date and reason, mortality date, and suspected cause of death. The variables collected from the calf records were: dam identification number, calving ease category, preweaning treatments for disease, preweaning mortality, and body weight at weaning (i.e., weaning weight).

A programming software (Python programming language, Python Software Foundation, Netherlands) was used to extract and process data from individual herds. Data were then compiled into a single dataset in Microsoft Excel. Duplicate records and records without a calving ease category, dam identification, or with incomplete health information for the calf were removed from the dataset. After cleaning the dataset, records from 15,006 dams and 15,211 calves remained. Each calving was used as an independent event, so an individual dam could be represented up to 6 times within the 6-year dataset. This was due to lack of historic records for individual females.

The dam parity was classified into primiparous (heifers) and multiparous (cows). Calving ease category was divided into unassisted, cesarean section (c-section), and nonsurgical assistance (assisted). There were different levels of nonsurgical assistance (i.e., easy assist, hard assist), but due to the subjective nature of these classifications, these were categorized as one group of assisted calvings.

The cow treatment records were not available for all enrolled operations. As a consequence, cow treatments were not included in the analysis. The recorded causes for cow mortality during the 30 days postpartum included were the ones considered to be possibly associated with calving assistance. These were: c-section, calving complications, chronic disease, hypocalcemia, retained placenta, metritis, depression, unspecified sickness with fever, respiratory disease, musculoskeletal injury, prolapsed vagina, other, or unknown cause (Gaafar et al., 2011; Lombard et al., 2007; Proudfoot et al., 2009). For the calf treatment records, only the treatments for conditions that were deemed to potentially be related to an assisted calving or a c-section during the preweaning period were included (Lombard et al., 2007). The treatments for disease included were calving complications, lameness, musculoskeletal injury, umbilical disease, nervous disease, respiratory disease, diarrhea, unspecified sickness with fever, weakness, other, or unknown cause.

Descriptive statistics using STATA (Version 14; StataCorp LP, College Station, TX) were generated for the weaning weight of calves, because it was one of the primary outcomes of interest. A test for normality was performed on weaning weight, and it was found to be non-normally distributed. Therefore, a nonparametric, Kruskal–Wallis test was performed to evaluate the association of weaning weight with calving ease category, dam parity, and calf treatments to identify which variables would be considered in the decision tree model.

Economic inputs for the model

The model inputs used to estimate the expected cost, in Canadian dollars, related to calves were the labor cost (i.e., cost of human labor for assisting delivery of the calf) and the treatment cost (i.e., cost of medicines given when treatment was required due to illness), when applicable. The amount of labor hours associated with an assisted calving on cow-calf operations was not available in published sources. Therefore, the results from the labor survey from the two cow-calf operations were used. The average amount of time (in hours) ranch personnel spent assisting a cow during calving was multiplied by $21.16, the 6-year average hourly wage rate for agriculture laborers in Alberta (Statistics Canada, 2023). The treatment cost for the calves was estimated from the historical records of the product cost, which was available for some operations, and the quantity and type of product, which were available for all the operations. A micro-costing analysis was performed to obtain the unit cost of the treatment for each calf by multiplying the cost of the product by the amount used. For the treatment cost, the calf treatments were classified using three age cutoffs: from the date of birth to one month of life, from one month to three months, and from three months to weaning.

The inputs to estimate the expected costs related to the cow were cost of production, replacement cost (i.e., the cost of buying a replacement animal), and c-section cost, when applicable. The cost of production was estimated using data from the Department of Agriculture, Forestry, and Rural Economic Development (Oginskyy and Boyda, 2020, 2022). This data was from a multi-year business performance analysis of Alberta cow-calf producers that participated in the AgriProfit$ Business Analysis Program. The 6-year (2015–2020) average annual cost of production for cows used in the model was $968.09 CAD ($/cow wintered) (Oginskyy and Boyda, 2020, 2022). The estimation of this cost of production included winter feed, pasture, veterinary services, breeding, breeding fees, bull rental, trucking and marketing charges, fuel, machines repairs, corrals and buildings, utilities and miscellaneous expenses, custom work and specialized labor, operating interest paid, paid labor and benefits, unpaid labor, taxes, water rates, insurance, equipment and building depreciation, lease payments, and paid capital interest. The cost of a replacement animal if the dam died or was sold was $1,422 CAD, the 6-year (2015–2020) average low price for bred heifers in Alberta (Canfax, 2021a). The cost of a c-section used was $540.83 CAD, as estimated from the Canadian Veterinary Medical Association fee guide (The Canadian Veterinary Medical Association, 2015-2021).

The input to estimate the expected revenue for a weaned calf was determined by multiplying the estimated price per kilogram of calf weaned ($4.61/kg CAD), obtained from 6 years of data from AgriProfit$ (2015–2020) (Oginskyy and Boyda, 2020, 2022), by the median weaning weight of the calves from the historical records. Calf weaning weight averages were stratified by cow parity, calving ease category, and whether the calf was treated or not prior to weaning.

The model input to estimate the expected revenue for the dams was based on the expected value of her sale for meat if she was recorded as being culled. If the dam was sold as a heifer, the input was $995.39 CAD, assuming a weight of 1100 lb, and if sold as a cow, the revenue value was $1,221.13 CAD, assuming a weight of 1350 lb (Canfax, 2021a).

Model building

A modified decision tree model was used for this study. A normal decision tree model is usually used in a cost-benefit analysis to evaluate the cost of a decision regarding different interventions that can lead to different outcomes and measured at a specific time point (Rautenberg et al., 2020). In a decision tree model, the probability of an event happening is multiplied by the corresponding inputs, and a comparison between interventions is made (Rautenberg et al., 2020). Due to the data available, a decision tree economic model was adapted to estimate the expected cost, revenue, and profit of assisted and unassisted calvings. However, in this case each node was not a decision but was a probability of an event occurring.

A visual depiction of the model is shown in Figure 1. Microsoft Excel (Microsoft Corporation, Redmond, WA) was used to develop a modified decision tree model to estimate the cost of an assisted calving. In this type of model, a decision node is represented by a circle. Each node leads to different branches that demonstrate each of the possible outcomes after calving and represent the probability of that event occurring in the model. Probabilities for each event must sum to one.

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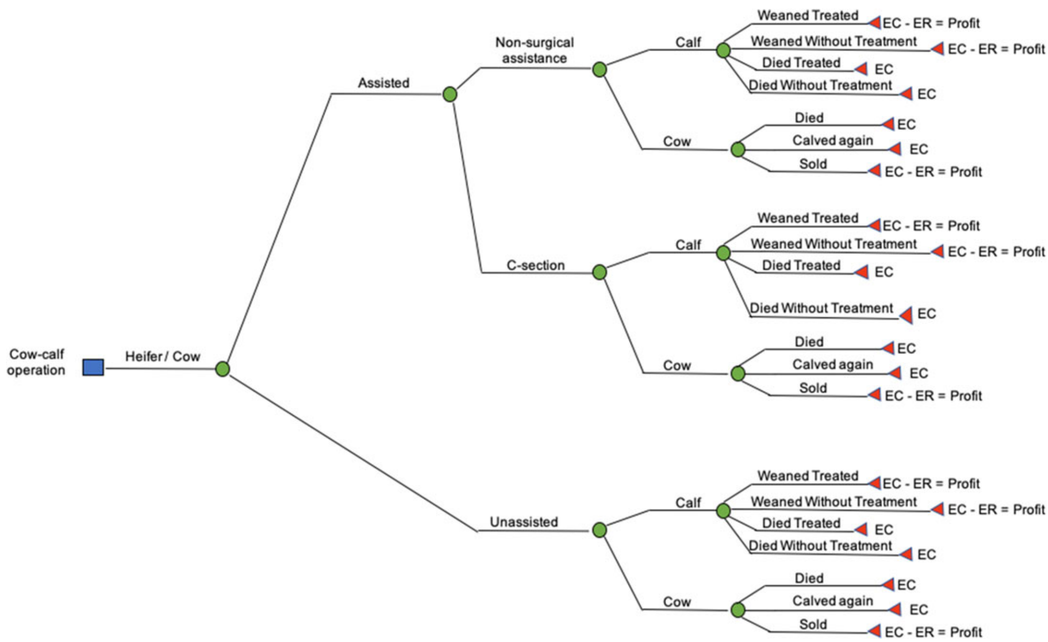

Figure 1. Diagram of a modified decision tree model for the estimation of costs, revenues, and profits of calvings from seven cow-calf operations in western Canada. The decision node is represented by a circle, and each node leads to different branches that are the possible outcomes after calving. The terminal nodes represented by a triangle represent the overall outcome with the expected cost, expected revenue, and profit.

The terminal nodes, represented by a triangle, report the overall outcome for the expected cost, revenue, and profit. The expected cost, revenue, and profit were obtained by multiplying the probability of each branch with the corresponding model inputs (described in Data Management section).

For this study, the data was first categorized by dam parity and then subsequently divided by calving ease category (i.e., unassisted, assisted). Assisted calvings were then divided into assisted and c-section categories. Then, the model was designed based on the different outcomes that a calf or dam could have after calving. The outcomes evaluated for the calf were: not being treated for disease prior to being weaned, being treated for disease and weaned, being treated for disease and dying before weaning, or not being treated for disease and dying before weaning. The outcomes for the cow were being sold (i.e., culled), dying, or calving again.

Probabilistic sensitivity analysis

To evaluate the uncertainties of the model, a probabilistic sensitivity analysis (PSA) was performed with 1,000 replications (Hatswell et al, 2018). A PSA feeds the model with specific parameters, and the values of these parameters are randomly selected from the distribution of the data (Limwattananon, 2008). The distribution used for costs and revenues was a gamma distribution, and for probabilities, it was a beta distribution (Limwattananon, 2008). Therefore, in each replication, some inputs and probabilities for calves and cows were modified randomly according to these distributions. The cost parameters that varied were the annual cost of production and c-section cost. The revenue parameters that varied were revenue of weaned calves and revenue from culled dams. The probability parameters for cows that varied were being sold, dying, or calving again. The probability parameters for calves that varied were being weaned with or without treatment and dying with or without treatment.

Results

Study population

Six cow-calf operations were enrolled from Alberta, representing 13,612 (89.5%) of the total individual animal herd records, and one from Saskatchewan, representing 1,599 (10.5%) individual records. The amount of data from calves obtained from 6 years of historical records per cow-calf operation were: Ranch 1 consisted of 3,426 crossbred calves (22.5% of the population), Ranch 2 consisted of 5,475 Angus calves (36.9%), Ranch 3 consisted of 1,598 crossbred calves (10.9%), Ranch 4 consisted of 1,204 Angus calves (7.9%), Ranch 5 consisted of 812 Charolais calves (5.3%), Ranch 6 consisted of 1,296 crossbred calves (8.5%), and Ranch 7 consisted of 1,332 crossbred calves (8.7%). Ranch 1 had 9% incidence of assisted calving among heifers and 7% incidence of assisted calving in cows. Ranch 2 had 3% incidence of assistance in heifers and 0.3% incidence of assistance in cows. Ranch 3 had 4% incidence of assistance in heifers and 1% incidence of assistance in cows. Ranch 4 had 2% incidence of assistance in heifers and 0.2% incidence of assistance in cows. Ranch 5 had 5% incidence of assistance in heifers and 0.8% incidence of assistance in cows. Ranch 6 had 5% incidence of assistance in heifers and 0% incidence of assistance in cows. Ranch 7 had 2% incidence of assistance in heifers and 0.3% incidence of assistance in cows.

The number of heifers included in the compiled dataset was 2,265 (95.4%) with an unassisted calving, 102 (4.5%) with an assisted calving, and 6 (0.3%) requiring a c-section. The number of cows was 12,389 (98.1%) with an unassisted calving, 239 (1.9%) with an assisted calving, and 5 (0.04%) requiring a c-sections. The numbers of dams and calves were not equal because of the inclusion of twins. The number of calves born to heifers was 2,407 (15.8%), of which 2,297 (95.4%) were unassisted at birth, 104 (4.3%) were assisted at birth, and 6 (0.3%) were delivered by c-section. The number of calves born to cows was 12,804 (84.2%), of which 12,547 (98%) were unassisted at birth, 252 (1.9%) were assisted at birth, and 5 (0.04%) were delivered by c-sections.

Labor survey

Ninety-one cow-calf pairs required management assistance after calving from the 2 cow-calf operations that were enrolled in the labor survey. Ranch 1 assisted with post-calving management in 33 animals in total, 22 cows were assisted during calving, 3 cows needed bonding assistance, and 6 calves were assisted with colostrum consumption. Ranch 2 assisted with post-calving management in 58 animals in total, 14 cows were assisted during calving, 30 cows were assisted with bonding, and 31 calves were assisted with colostrum consumption. The median amount of time spent by ranch personnel assisting a calving was 15 minutes (Interquartile range (IQR): 15–45), while for c-sections, (performed by a veterinarian but needed assistance from the ranch personel), it was 2 hours (IQR: 2–2). The median of each type of calving assistance was multiplied by the hourly wage rate for agriculture laborers (Statistics Canada, 2023), resulting in an estimated labor cost of ranch personnel for a nonsurgical assistance of $5.29 and for a c-section $42.32 CAD.

The mean amount of time spent by ranch personnel on bonding assistance was 92.8 minutes (SD: 56.3), and the median amount of time for colostrum assistance was 37.5 minutes (IQR: 15–60). However, this information could not be used in the model due to a lack of data on these topics within the individual animal records.

Model probabilities and outputs

The calves' probabilities of being weaned or dying with or without treatment and cows' probabilities of being sold, dying, or calving again are shown in Table 1. These probabilities were used in the model with the inputs previously listed.

Table 1. Descriptive data from seven cow-calf operations in western Canada used in a modified decision tree model estimating the costs, revenues, and profits of calving for dams and calves, stratified by dam parity and calving ease category

Animal	Dam Parity	Calving Ease Category	Overall Probability	Calved Again	Sold	Died
Dams	Heifer	Assisted	4.6% (108)	67.6% (73)	31.5% (34)	0.9% (1)
		Unassisted	95.4% (2,265)	82.9% (1,878)	16.2% (366)	0.9% (21)
	Cow	Assisted	1.9% (244)	72.9% (178)	23.4% (57)	3.7% (9)
		Unassisted	98.1% (12,389)	78.8% (9,762)	19.6% (2,424)	1.6% (203)

Animal	Dam Parity	Calving Ease Category	Overall Probability	Weaned Having Been Treated	Weaned Without Being Treated	Died Having Been Treated	Died Without Being Treated
Calves	Heifer	Assisted	4.6% (110)	14.5% (16)	66.4% (73)	0.9% (1)	18.2% (20)
		Unassisted	95.4% (2,297)	9.2% (212)	84.9% (1,950)	0.6% (15)	5.3% (121)
	Cow	Assisted	2% (257)	9.7% (25)	65.8% (169)	1.6% (4)	22.9% (59)
		Unassisted	98% (12,547)	7.6% (950)	88.6% (11,119)	0.4% (50)	3.4% (428)

Table 2. Expected revenue from weaned calves who were or were not treated for disease prior to weaning, stratified by calving ease category and dam parity[1,2] in Canadian dollars

		Calves weaned with prior treatment		Calves weaned without prior treatment	
Calving ease Category	Dam Parity	Median Weaning Weight[3] (kg)	Expected Revenue[3] ($)	Median Weaning Weight[3] (kg)	Expected Revenue[3] ($)
Assisted	Heifer	241 (204-250)	$1,106.4 ($940.44-$1,152.5)	247 (211-272)	$1,138.67 ($972.71-$1,253.92)
	Cow	280 (240-315)	$1,290.8 ($1,106.4-$1,452.15)	293 (256-319)	$1,350.73 ($1,180.16-$1,470.59)
Unassisted	Heifer	218 (187-239)	$1,004.98 ($862.07-$1,101.79)	224 (200-249)	$1,032.64 ($922-$1,147.89)
	Cow	264 (225-285)	$1,217.04 ($1,037.25-$1,313.85)	248 (220-277)	$1,143.28 ($1,014.2-$1,276.97)
C-section	Heifer	239 (204-274)	$1,101.79 ($940.44-$1,263.14)	243 (224-326)	$1,120.23 ($1,032.64-$1,502.86)
	Cow	313	$1,442.93	276 (269-283)	$1,272.36 ($1,240.09-$1,304.63)

[1]Median weaning weight was multiplied by $4.61/kg weaned calf (Oginskyy and Boyda, 2020, 2022) to obtain the expected revenue for selling a weaned calf within that stratum.
[2]All values are in $CAD.
[3]Median and interquartile range (25th quartile–75th quartile).

The median weaning weights and calf expected revenue are shown in Table 2. The median weaning weights were significantly different among groups depending on the dam parity ($P < 0.0001$), calving ease category ($P = 0.0001$), and preweaning treatment ($P = 0.01$). The expected cost, revenue, and profit for unassisted and assisted heifers and cows as determined by the decision tree model are in Table 3. Assisted calvings for both heifers and cows had higher expected costs and lower profits compared to unassisted calvings (Table 3).

Table 3. Results from a modified decision tree model estimating the cost, revenue, and profit of calving in Canadian dollars, stratified by dam parity and calving ease category[1]

Dam Parity	Calving Ease Category	(%)	Expected Cost[2]	Expected Revenue[2]	Expected Profit[2]
Heifer	Assisted	4.6%	$1,463.34	$1,235.91	-$277.43
	Unassisted	95.4%	$1,212.35	$1,136.25	-$76.11
	Difference		$250.99	$99.67	-$151.32
Cow	Assisted	2%	$1,374.11	$1,307.04	-$67.06
	Unassisted	98%	$1,270.66	$1,390.78	$120.12
	Difference		$103.44	-$83.74	-$187.18

[1]Each cow and calf probability were multiplied by the inputs (i.e., production cost, treatment cost, sales revenues, weaned revenues) to obtain an expected cost, revenue, and profit.
[2]All values are in $CAD.

Probabilistic sensitivity analysis

The results from the PSA are described in Table 4. In the 1,000 repetitions of the model, the profit was always higher for the unassisted animals than the assisted ones. On average across iterations, assisted pairs had higher costs and less revenue than unassisted pairs.

Discussion

This is the first study to estimate the cost, revenue, and profit of assisted and unassisted calvings by using a modified decision tree model with individual herd-level data from western Canadian cow-calf operations and published data from the Canadian industry as inputs. Additionally, on-farm labor cost for calving assistance and time spent assisting cows and calves with calving, bonding, and colostrum consumption were reported. This study provides important, updated information that can be used by producers and researchers to better understand the negative impacts of calving assistance on the economics of cow-calf operations.

The incidence of assisted calving within this population was 2% for cows and 4% for heifers. This is similar to what has been reported in previous literature. A study in western Canadian cow-calf operations found that the average incidence of assistance at calving was 8.9% and severe dystocia was 3.7% (Waldner and García Guerra, 2013). Additionally, a more recent benchmarking study performed in the same region found an overall incidence of 4.9%, 13.5% for heifers and 3.2% for cows (Pearson et al., 2019a). Overall, the incidence of calving assistance is generally low but occurs on the majority of cow-calf operations at least once every year (Pearson et al., 2019a).

In this study, assisted heifers and cows with their calves had a higher cost of production and less profit than unassisted pairs. Similar to the findings from this study, previous studies have found that assisted cows at calving had higher costs than unassisted cows (Bellows et al., 2002; Dematawena and Berger, 1997; Shepard et al., 2022; USDA, 2007). While these studies have estimated the cost of assisted calving, they used aggregated data, which can have disadvantages because it may be inaccurate at the individual- or herd-level.

In the current model, the principal reason for a lower profit in assisted animals was the high mortality in calves and cows. High mortality and morbidity after a difficult calving has been reported in other literature (Barrier et al., 2013; Murray et al., 2016). This is similar to production losses reported by Bellows and colleagues where dystocias experienced by cows and calves often resulted in mortality (Bellows et al., 2002). Furthermore, the results from the current study align with what has been identified in previous analysis of markets and trends in the North American

Table 4. Base case and probabilistic sensitivity analysis (PSA) results of a modified decision tree model estimating the cost, revenue, and profit of calving in Canadian dollars, stratified by dam parity and calving ease score[1,2]

	Cost		Revenue		Profit	
Model	Unassisted	Assisted	Unassisted	Assisted	Unassisted	Assisted
Heifer base case	$1,212.35	$1,463.34	$1,136.25	$1,235.91	-$76.11	-$227.43
Heifer PSA[3]	$1,238.54 ($1,088.91-$1,403.52)	$1,520.37 ($1,094.09-$1,931.08)	$1,149.24 ($1,092.15-$1,212.54)	$1,259.86 ($986.23-$1,533.58)	-$89.30 (-$240.97-$48.62)	-$260.52 (-$620.72-$95.90)
Cow base case	$1,270.66	$1,374.11	$1,390.78	$1,307.04	$120.12	-$67.06
Cow PSA[3]	$1,262.93 ($1,233.78-$1,291.25)	$1,415.09 ($1,173.34-$1,765.07)	$1,376.01 ($1,349.40-$1,395.29)	$1,294.71 ($1,133.73-$1,494.21)	$113.08 ($90.34-$135.26)	-$120.38 (-$416.12-$109.63)

[1]The probabilities were modified with beta distribution, and a gamma distribution was used for production cost and revenue of a weaned calf. To obtain the average for expected cost, revenue, and profit, the model was run 1000 times.
[2]All values are in $CAD.
[3]The PSA results from the average of 1000 iterations with maximum and minimum values are in parentheses.

beef industry as the main profit from a cow-calf operation, the number and weight of weaned calves' and the dams' reproductive ability (Canfax, 2017). This means that if the calf does not survive to weaning and cannot be sold, the cow-calf operation will not have a revenue from that pair. Although cows that were culled following dystocia generate income to the operation, it is more valuable to the cow-calf operation that cows do not have dystocia and wean a calf every year from age 2 to 12 years (Feuz and Umberger, 2003; Yorgason and Furniss, 1968).

Another important finding within the model was the differences in weaning weights by calving ease category (i.e., assisted, c-section, unassisted), treatment for disease, and dam parity. Previous literature has found similar factors affecting the weaning weights of calves (Gaafar et al., 2011; Lombard et al., 2007; Proudfoot et al., 2009). This may indicate that calves' weaning weights are affected by different factors and should be considered for an economic estimation. This was an important parameter that other studies did not include due to lack of individual-level data (Bellows et al., 2002; Dematawena and Berger, 1997; Shepard et al., 2022; USDA, 2007). In this study, calves born from an assisted calving weighed more at weaning than unassisted calves, and this could be associated with the birth weight. The risk of assistance at calving increases for calves that have a greater birth weight, and therefore are more likely to weigh more at weaning (Johanson and Berger, 2003). Fetal–maternal size mismatch is the most common cause of a difficult calving and is more common in heifers than mature cows (Berger et al., 1992; Meijering, 1984). However, despite assisted calves having greater weaning weights than unassisted calves, the increased risk of labor costs and mortality for assisted calves exceeds the additional revenue from a heavier calf and results in a loss for the cow-calf operation with potentially greater financial effects than selecting for larger birthweights.

The production cost used for this study was reported by AgriProfit$, and this estimate included variable costs and fixed costs with market values. The data for those estimates was obtained from approximately 35 to 50 cow-calf operations from Alberta that participate in the multi-year benchmarking report (Oginskyy and Boyda, 2020, 2022). The production costs may differ for each cow-calf operation, but using this estimate provided an approximation of the values for the industry on a yearly basis (Canfax, 2021b) and was locally relevant. The average hourly wage rate for agriculture laborers in Alberta used to calculate the labor cost of assistance was similar to the labor cost reported in Agriprofit$ and the 2021 Canadian Cow-calf Cost of Production Network (COP Network) (Canfax, 2021d; Oginskyy and Boyda, 2020; Oginskyy and Boyda, 2022), so the estimates for labor costs based on ranch personnel time and labor wages were also likely more relevant than other reports.

The revenue from selling weaned calves and cull cows was based in part on the average price per kilogram of body weight over a 6-year period as reported by Agriprofit$ and Canfax (Canfax, 2021a; Oginskyy and Boyda, 2020; Oginskyy and Boyda, 2022). Cattle prices fluctuates drastically between years. This means the expected revenue for cow-calf operations is highly variable. These numbers are driven by other factors, such as supply and demand (Norton, 2005). For example, in the period from 2011 to 2016 the Canadian beef industry experienced a high demand of cattle principally from the United States; therefore, in 2015 the cattle prices reached a high record, due to the high demand and the low supply (Statistics Canada, 2017). Hence, the results from the expected revenue from cows and calves might vary from what other cow-calf operations have. A limitation to this estimate would be the varying prices for calves in association with their weaning weights. Therefore, heavier calves may be undervalued in this estimate. However, it is hypothesized by the authors that the variation in yearly prices and scale of price by calf weaning weight would be represented in the 6-year average and that the dataset would incorporate a representative number from western Canadian cow-calf operations.

There were some limitations of this study. One important limitation was data quality. For example, the treatment records were obtained from the historical records of each farm, and a complete description of the reason for using a treatment was not always available. In addition, the cost of the treatment was not available for all herds. However, to mitigate this, the cost of treatment that was available for some herds in the study population was extrapolated to all the operations. In addition, for the revenue associated with culled dams, individual weights of the dams were not able to be extracted from the data; therefore, an estimate of weight based on a cull weight of 1350 lb for cows and 1100 lb for heifers (Canfax, 2021a) was used. Similarly, individual weaning weights for all calves were not available. Therefore, the median weaning weight was used to estimate the calves' revenue. Lastly, data about the actual market prices received for weaned calves and cull dams was not available, so the 6-year average price from Agriprofit$ and Canfax, respectively, was used (Canfax, 2021a; Oginskyy and Boyda, 2020; Oginskyy and Boyda, 2022). Another potential limitation to the study was that the inputs used for this study were from Canadian published data and was an estimation of the economics of commercial cow-calf operations and not the ranch specific inputs (Oginskyy and Boyda, 2020; The Canadian Veterinary Medical Association, 2015-2020; Canfax, 2021a, Oginskyy and Boyda, 2022b; Statistics Canada, 2023). However, by using these estimation numbers, it increased the model inputs' external validity. The majority of herds enrolled were institutional herds that may affect the external validity of the study. However, because of the use of estimated inputs from the industry, this may be minimal. To mitigate the data limitations and estimate potential variance, a PSA was performed. Regardless of the variations of key values in the model, the assisted cows and calves always had a lower profit and a higher cost than unassisted pairs. The economic model was built on a number of uncertainties; however, it used as much of the currently available information as possible and despite the limitations of a modified decision tree model, it was possible to estimate the cost, revenue, and profit of unassisted and assisted calvings.

Medium-term profit margins average $309 per cow wintered for Alberta typical farms in the 2022 Canadian Cow-Calf Cost of Production results (Canfax, 2023b), over the long-term profitability is a loss of $21 per cow wintered. Low and negative net returns have persisted for decades in the cow-calf enterprise (Alberta Agriculture and Forestry, 2018). Calves are the primary source of revenue for cow-calf producers and ensuring females calve annually for at least 5 to 7 years is a way to minimize herd depreciation (Berger, 2014; Canfax, 2023a). The findings from this study illustrate that calving difficulty needs to be avoided as it results in losses for individual females, thereby reducing overall herd profitability.

Conclusion

This study provides novel information for producers, veterinarians, and researchers by using individual-level data from western Canadian cow-calf operations. The results from this model can be used to make economic and management decisions with the objective to increase the health, welfare, and profitability of beef cattle.

With this information, producers, veterinarians, and researchers can investigate the implementation of prevention strategies, such as genetic selection to decrease the risk of a difficult calving and pain mitigation strategies after a difficult calving to decrease the impact on health that the pairs may suffer.

Data available statement. Data availability is not applicable to this article as no new data were created or analyzed in this study.

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