Reproductive Failure Impacts on Retained Beef Heifer Profitability

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Adapted from: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

Introduction

The lifeblood of most cow-calf operations is the females that make up the herd. Cow-calf producers make culling and retention decisions on a regular basis that influence profitability. The decision to cull a cow, or to add a female to the herd, is largely based on the animal's structural integrity (i.e., feet, udder), disposition, expected reproductive success, and expected profitability. Thus, there is a certain risk related to cattle prices, cow reproductive efficiency, and calf performance.

Cow-calf producers have several alternatives when it comes to replacing a culled cow, including purchasing open heifers, bred heifers or mature cows. However, the most common option is retaining female calves for replacement heifers (U.S. Department of Agriculture [USDA], 2009). Retaining calves from one's own operation is common because the producer has the advantage of knowing the heifers' genetics, reducing herd exposure to disease from off-farm animals, and no cash expense for the purchase of external heifers. Despite reducing certain risks by retaining one's own animals, retaining and developing heifers to place back in the breeding herd is still a large and risky investment that will impact long-term profitability of the operation (Mathews and Short, 2001).

Many cattle producers recognize that open/late calving cows impact profitability (USDA, 2009). To be more specific, open cows due to failed pregnancy, abortions and calf death contribute to costs but do not generate revenue. Deciding to cull or retain a female that failed to produce a calf impacts long-run profits. The research objective of this study was to determine how reproductive failure impacts the profitability of raising replacement beef heifers in Tennessee in a spring and fall calving season. Results in this report could benefit producers by showing the economic implications of selecting replacement heifers based on fertility and ability to contribute to the herd.

Measuring Heifer Profitability

One method of estimating the profitability of raising a heifer to replace a culled cow is net present value (NPV). NPV is a way of considering all the costs and revenues over the animal's lifetime and converting them into a single value. Heifer development cost might begin when the cow that produced the heifer is bred. The development cost would include cow maintenance cost during pregnancy, nursing and weaning. After weaning, the cost of production would include forage, land, animal health, labor and feed until that heifer is bred. These costs would vary by calving season due to different feed requirements. The developed heifer generates revenue when she produces a marketable calf and revenue as a culled cow when she is sold. To calculate NPV, we assumed an 11-year useful life for the raised replacement female and that she would produce her first calf at 2 years of age. A positive value would indicate a profit over the heifer's lifetime, whereas a negative value would indicate a loss.

The payback period was also calculated. The payback period is the number of years it takes to pay off the initial investment in the heifer. In other words, how many years does it take for annual profits to exceed the development costs of the heifer? Shorter payback periods are preferred.

Data

Data originated from spring- and fall-calving cattle herds located at the Ames Plantation AgResearch and Education Center near Grand Junction, Tennessee, spanning from 1990 to 2008. Cattle were either purebred Angus or Angus with Hereford and Simmental influence. The spring calving season was from January through mid-April, and the fall calving season was from early September through mid-November.

Cattle primarily grazed endophyte-infected tall fescue and were supplemented with free choice mineral and corn silage as needed. Reasons for culling included failure to breed, poor calf performance (i.e., below average weaning weights), and age. Over the 19-year span, the spring-calving herd included 478 individual cows producing 1,534 calves, while the fall-calving herd included 474 cows producing 1,727 calves.

Calf data included date of birth, sex, sire, number of calves the cow calved, average daily gain, birth weight and weaning weight. Weaning weight summary statistics for the spring- and fall-calving herd as a function of dam age during the associated breeding cycle is shown in Table 1. Cow data included calving herd, sire, dam and date of birth. Information was not recorded for cows that did not calve, resulting in no information on calving rate and replacement rate. Thus, a calving rate of 85 percent and replacement rate of 15 percent were assumed (Henry et al. 2016).

Table 1. Summary Statistics for Weaning Weights (lb) for each Calving Season and Age of Cow

Cow Age Years	Number of Observations	Minimum	Median	Maximum	Mean
Spring-Calving Herd					
2	321	171	447	669	443
3	293	254	495	685	497
4	231	338	528	735	525
5	175	262	556	720	552
6	133	386	562	722	560
7	96	415	564	763	570
8	74	421	566	707	557
9	62	382	559	670	556
10	38	392	555	708	543
11	18	356	555	629	541
Fall-Calving Herd					
2	355	257	452	766	457
3	284	248	501	788	495
4	229	310	523	819	527
5	183	369	546	730	547
6	168	289	547	692	542
7	145	284	544	716	539
8	114	291	546	690	544
9	91	372	514	694	521
10	53	400	542	692	537
11	23	390	570	702	560

Source: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

Annual variable production costs for spring- and fall-calving herds were $590 and $595 per head, respectively. Replacement heifer development costs were $889 per head and $894 per head for the spring- and fall-calving herds, respectively. Monthly Tennessee prices for steers, heifers and culled cows were collected from 2000 to 2017 (USDA Agricultural Marketing Service, 2017). Calves born in the spring were assumed to be sold at weaning during September, October and November. Calves born in the fall were assumed to be sold at weaning during March, April and May. Price summary statistics for 500-600 lb steers, 500-600 lb heifers and slaughter cows are shown in Table 2. Cull cow revenue was found by multiplying slaughter cow price by a cull cow weight of 1,300 pounds.

Table 2. Summary Statistics of Cattle Prices ($/lb) in Tennessee from 2000-2017 in 2017 Dollars by Calving Season

Commodity	Mean	Standard Deviation	Minimum	Maximum
Spring-Calving Herd				
Steer Price	1.44	0.36	1.04	2.41
Heifer Price	1.31	0.34	0.96	2.23
Culled Cow Price	0.67	0.17	0.46	1.11
Fall-Calving Herd				
Steer Price	1.50	0.38	1.13	2.62
Heifer Price	1.34	0.34	0.99	2.35
Culled Cow Price	0.70	0.17	0.52	1.12

Source: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

Results

Weaning Weight

Results indicate weaning weights increased at a decreasing rate as a dam got older until the weaning weight-maximizing age, at which time weaning weights decreased as dam age increased. The weaning weight-maximizing age for a dam for both herds was 7 years old (Table 3). Steer calves weighed on average 33 lb per head more than heifer calves born in the spring, while steer calves born in the fall weighed on average 25 lb per head heavier than heifer calves.

Table 3. Parameter Estimates for Weaning Weight (lb/head) Response to Dam Age for Spring- and Fall-Calving

Parameter Estimates	Spring-Calving Season	Fall-Calving Season
Intercept	353.48***	402.25***
AGE	65.529***	41.7593***
AGE^2	-4.5218***	-2.9116***
S	32.723***	25.4834***
Weaning Weight Maximizing Dam Age	7 years old	7 years old

Note: Single, double, and triple asterisks (*, **, ***) represent significance at the 10 percent, 5 percent and 1 percent level.

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Net Present Value and Payback Period

Table 4 presents the expected NPV and payback period for the spring- and fall-calving herds. Dams calving and marketing a calf every year over an 11-year useful life have an expected NPV of $671 per head for the spring-calving herd and $683 per head for the fall-calving herd. Missing one calf over the 11-year useful life decreases profitability by $472 per head ($671-$199) for the spring-calving dams and $483 per head ($683-$200) for the fall-calving dams. This equates to an annual average profit of $20 per head for the spring and fall herds compared to an annual average profit of $67 and $68 per head for the spring and fall herds, respectively, when no reproductive failure occurs. Cows that failed to wean and market a calf twice over the 11-year useful life resulted in a negative NPV.

Table 4. Summary Statistics of the Net Present Value ($/head) and Payback Period (years) by Calving Season

Measurement	Zero Missed Calves	One Missed Calf	Two Missed Calves
Spring-Calving Herd			
Net Present Value	$671 (1,029)	$199 (932)	-$279 (833)
Payback Period [a]	6.03 (2.45)	8.21 (2.37)	9.77 (1.84)
Fall-Calving Herd			
Net Present Value	$683 (1,035)	$200 (935)	-$278 (837)
Payback Period [a]	6.14 (2.88)	8.18 (2.54)	9.61 (1.91)

NPV mean values are shown. Standard Deviations are noted in parentheses.

[a] The payback period reports the number of calves the cow would need to produce to pay off the investment of retaining the heifer.

Source: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

Figure 1 shows the probability of the NPV being below zero (red), between zero and $500 per head (yellow), and above $500 per head (green) for the spring-calving herd. There is a 77 percent chance that a raised replacement heifer producing a calf each year over an 11-year productive life will produce a positive NPV and a 23 percent chance of a negative NPV. This demonstrates that even a perfect reproductive history can potentially result in a negative return to the investment. Missing one calf increased the likelihood of NPV being negative to 48 percent and decreased the probability of NPV being greater than $500 per head to 19 percent. Missing two calves had an 81 percent probability of a negative expected NPV.

Figure 2 shows the probability of the NPV being below zero (red), between $0 and $500 (yellow), and above $500 per head (green) for the fall-calving herd. A dam in the fall-calving herd that never fails to wean and market a calf over an 11-year useful life has a 75 percent probability of a positive NPV and a 48 percent probability that the NPV will exceed $500 per head. The probability of a positive NPV declines to 50 percent when missing one calf and to 24 percent when missing two calves over an 11-year useful life.

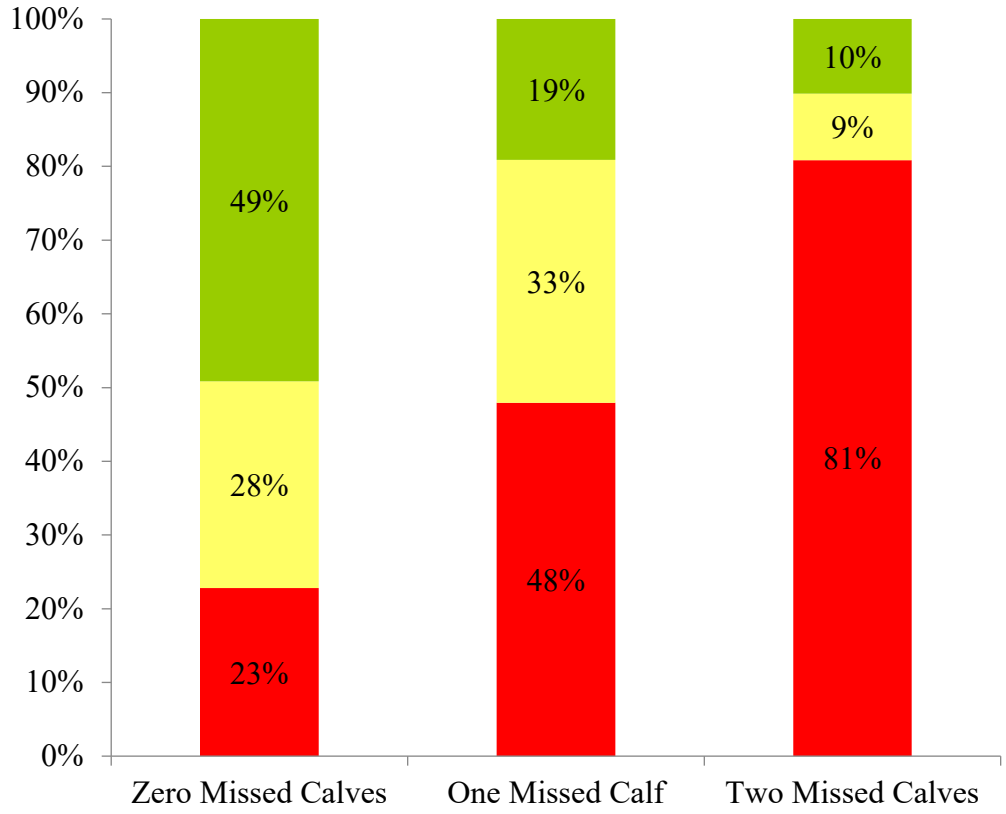

Figure 1. Probability of net present value being less than zero (red), between zero and $500 per head (yellow), and greater than $500 per head (green) for the spring-calving herd

Source: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

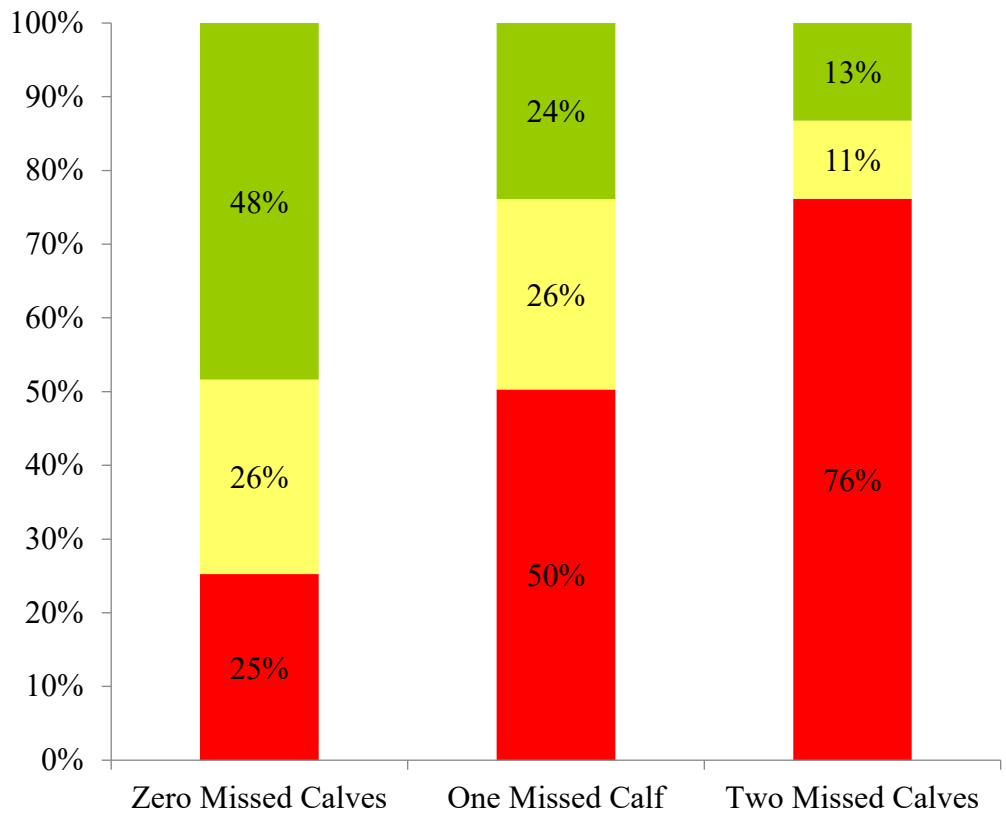

Figure 2. Probability of net present value being less than zero (red), between zero and $500 per head (yellow), and greater than $500 per head (green) for the fall-calving herd

Source: Boyer, C.N., A.P. Griffith, and K.L. DeLong. In press. Reproductive Failure and Long-Term Profitability of Spring and Fall Calving Beef Cows. *Journal of Agricultural and Resource Economics*.

Results suggest that a raised replacement heifer that misses one calf over an 11-year useful life is likely to have a positive NPV, but missing two calves would most likely result in a negative NPV. Giving a raised replacement heifer another chance at calving after missing a calf is risky and would likely result in a negative NPV for the dam even if there are no more missed calves. This would imply that selling an open dam after failing to breed would likely be a better management decision than keeping the open dam in the herd for another year. Selecting replacement heifers based on fertility and maintaining environmental conditions for heifer/cows to reproduce are vital for maintaining a profitable cow-calf operation.

Table 4 shows the payback period for raised replacement heifers in a spring- and fall-calving herd. If the dam produced a calf each year over her productive life, she would need to produce six calves before the returns to the investment were greater than the cost of development for both calving herds. The sixth calf would come at age 7 for the dam, which is the weaning-maximizing dam age for both calving herds. If one calf is missed, the ninth calf weaned pays off the development costs, which means the cow is 10 years old. Two missed calves results in the payback period occurring after the 10th calf was weaned.

These results illustrate the value of selecting heifers based on fertility and the importance of managing cows to annually wean a calf. In summary, managing for reproductive success is vital to long-term profitability, which means it is imperative to manage a cattle herd to minimize the likelihood of reproductive failure.

Conclusions

Culling cows and selecting replacement heifers is a complex decision that impacts profitability. The goal of this study and publication was to determine how reproductive failure impacts the NPV and payback period of raising replacement heifers in Tennessee and to convey this information to producers. Results show the implications of selecting replacement heifers based on fertility and on the profitability of the investment.

For both calving seasons analyzed, weaning weights of calves increased until the dam was 7 years old and then began to decrease. The NPV for dams that did not miss a calf and that missed one calf was expected to be positive, but NPV was negative if the dam missed two calves. While the expected NPV is positive for a raised replacement heifer that misses one calf, the probability of the dam being profitable over the 11-year production life was approximately 50 percent for both calving herds. The payback period was six calves if no calves were missed, nine calves if one calf was missed, and 10 calves if two calves were missed. Giving the dam another chance at calving after missing a calf would likely result in a negative NPV, even if there were no additional missed calves over the useful life. This implies a producer is likely better off selling an open dam than risking another reproductive failure.

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