Economic value of characteristics in heifer development: Repro-Sim software[1]

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Abstract

Selection and management of replacement beef heifers involve decisions that affect the future productivity of an entire herd. This article evaluates the production and economic impacts of several heifer replacement strategies using a spreadsheet decision tool. Repro-Sim is a dynamic 8-yr simulation model that evaluates heifer development and replacement alternatives for cow/calf operations. Production and economic data used in the simulation are based on data from more than 16,000 heifers enrolled from 1997 to 1999 in the Show-Me Select Replacement Heifer Program. The objective of the software is to help producers evaluate the net combined production and economic impacts of various characteristics of a quality heifer development program and to evaluate the optimum cow replacement strategy under various price and efficiency scenarios. The results of the simulations in this model demonstrate the estimated impact of replacement decisions on long-term profits. Specifically, long-run returns for replacement heifer strategies are higher for management programs, in the scenarios studied, that increase the reproductive integrity of the herd through raising or out-sourcing higher-quality heifers with improved reproductive capabilities.

Key Words: Beef, Heifers, Reproduction, Economics

Introduction

The implementation or modification of farm strategies for the selection and management of replacement beef heifers involves decisions that affect future productivity of an entire herd. Research and programs associated with heifer development and replacement strategies have focused largely on factors that affect puberty (Sorensen et al., 1954; Ferrell, 1982; Melton, 1995). Considering a strategy that involves breeding heifers as yearlings requires additional consideration of the economics of production, reproductive status, and breed type or genetic make-up of the heifers (Byerley et al., 1987; DeRouen et al., 1989; Short et al., 1990). However, increasing a producer's ability to identify heifers with the reproductive potential that can help farm profitability before the breeding season should result in increased reproductive efficiency and profits (Anderson et al., 1991; Patterson et al., 1992, 1995). Nevertheless, replacement heifers are often chosen based on size and appearance (Brooks, 1985; Buttram et al., 1987). It is questionable whether these subjective and highly variable methods of selection have offered suitable focus on economically important reproductive traits.

Other factors in the production system influence profits. Because most calves are weaned at a particular time rather on a weight-constant or age-constant basis, calves born late in the normal calving season are usually lighter at sale than those born early. These and other factors contribute to total economic productivity and associated farm income (Lesmeister et al., 1973; Marshall et al., 1990). This article outlines a process for evaluating the economic impact of production assumptions on heifer replacement strategies as they affect overall farm profitability.

Materials and Methods

The development of a decision support tool used to analyze replacement strategies must have the following components to effectively capture the economic impact of the choice variables on the farm simulation:

1. Individual annual enterprise budgets integrated over the planning horizon. An enterprise budget is a complete financial description of all of the costs and income expected from a cow/calf business for each year of analysis. Budgets in a long-term model need to be dynamic in the sense that impacts from production, marketing, and prices from one year must carry into the next year's budget. For example, the budgets for yr 2 and beyond should reflect any income or expense changes that are expected from introducing a new replacement strategy in yr 1.
2. Sensitivity analysis. The model must demonstrate the impact of changes in model variables on model results. Results that show the benefits of a particular strategy need to be investigated for the sensitivity of the conclusion on small changes in the values of key assumptions. The tool should allow "what if" scenarios to be analyzed. For example:
   a. The impact of the cattle cycle on results
   b. How assumptions about input and output prices affect profits in budgeting
   c. Allow easy comparison between scenarios and help to incorporate the interaction between economic and production factors
3. Production efficiency. The model must clearly demonstrate assumptions about production efficiency, for example:

a. Heifer assessment (reproductive tract score [RTS], pelvic measurements, prebreeding weight) and productive capacity
b. Mature cow conception rates
c. Calving distribution
d. Calf differences in growth and performance over scenarios

A decision on replacements this fall will have an impact on the profitability of the cow herd for at least the next 8 to 10 yr. When one considers keeping offspring of current replacements for future replacements, then herd profitability will be affected even further into the future. Therefore, decisions on replacements should include a long-term overview of their impact. The low-cost producer of maternal herd reproductive capacity must evaluate long- and short-term effects of replacement choices and the combined sensitivity of those choices to market price and long-term reproductive integrity of the herd. Finally, decision systems that consider the long-term effect of female replacement strategies need to include:

1. Reproductive soundness of the replacement choices
2. Replacement rate
3. Comparative productive capacity between heifers and cows
4. Death and morbidity rates
5. Disease incidence
6. Conception rates
7. Comparative pregnancy distribution between heifers and cows
8. Calving interval effects on weaning weight and prices
9. Birth weight differences between heifer and cows

Repro-Sim Decision Tool

A dynamic 8-yr simulation model has been constructed that incorporates the considerations outlined above in evaluating potential female development and replacement alternatives for a cow/calf operation. The objective of the software is to help producers evaluate the net combined production and economic impacts of various characteristics of a quality heifer development program for a specific farm and to evaluate the optimum cow replacement strategy under various price and efficiency scenarios. Production and economic data used in the simulation are based on data from more than 16,000 heifers enrolled from 1997 to 1999 in the Show-Me Select Replacement Heifer Program. Long-run price projections were included based on forecasts from the University of Missouri Department of Agricultural Economics and FAPRI (99). Enterprise budgets include estimates for costs of raising replacement heifers. The major assumptions about the production system used in this deterministic model are:

1. Farm includes a mature cow herd of 100 maintained over the model horizon
2. A 15% cow replacement rate is assumed to simulate an average cow turnover rate and can be modified by the user in the model. A cull rate of 14% is assumed with a 1% death loss
3. Potential raised replacements were held back at a rate 1.5 × replacement rate
4. Replacement heifers evaluated at 6 wk before scheduled breeding have a 50% cyclicity rate, with 47% noncycling and the remaining 3% infertile
5. A 6.5-mo suckling phase before selling calves in November of each year
6. The breeding period was evaluated at several levels of concentration from three to five estrous cycles
7. Conception rates were varied based on management practices and assumptions on purchased replacements

Four scenarios are evaluated for the sample herd. The scenarios are differentiated according to the reproductive profile of the replacement heifers.

Profile 1. Purchased select (conception: 100%; calving distribution: 80:20%). This profile assumes that all replacements are purchased from a known source that guarantees pregnancy. In addition, calves are assumed to have a calving season that extends over two 21-d intervals in which 80% of the purchased replacements calve in the first cycle projected and 20% of the purchased replacements calve in the second cycle. It is assumed that a projected calving season start date is also provided along with the heifer.

Profile 2. Purchased average (conception: 100% ; distribution: 30:20:20:20:10%). This profile assumes all replacements are purchased with a guaranteed pregnancy. The heifers are assumed to calve over a range of five 21-d calving cycles with 30% calving in the first cycle, 20% in the second, third, and fourth cycles, and 10% in the fifth cycle.

Profile 3. Raised select (conception: 95%; distribution: 70:15:10%). This profile assumes that all herd replacements are raised by the producer in a program that increases the likelihood of pregnancy and a condensed calving season. However, because the owner in this case assumes the management risk associated with raising replacements, only 95% of the heifers retained for breeding become pregnant. The heifers are assumed to calve over a range of three 21-d calving cycles with 70% calving in the first cycle, 15% in the second, and 10% in the third cycle.

Profile 4. Raised average (conception: 85%; distribution: 30:20:20:10:5%). This profile assumes that all herd replacements are raised. Because the owner assumes management risk associated with raising replacements, only 85% of the heifers retained for breeding become pregnant. The heifers are assumed to calve over a range of five 21-d calving cycles with 30% calving in the first cycle, 20% in the second and third cycles, 10% in the fourth cycle, and 5% in the fifth cycle.

Each scenario assumes a base cow herd calving distribution similar to the replacement strategy profile 4. Changes in the female calving profile of the entire herd occur only in the

replacement heifers in their year of introduction into the herd and subsequently as they enter the mature herd.

Results and Discussion

The effects of each of the profiles were determined for the sample herd described above. In the first comparison reported below, long-run effects were compared for a female replacement strategy comparing profile 1 to profile 4. Considering the hypothesis concerning the long-run impact of heifer quality, we would expect this comparison to show the greatest impact between any two profiles of heifer replacements. Table 1 shows the impact of using purchased select heifers compared to raising average heifers. For example, in 1998 a producer using the purchased select replacement strategy would have had $1,083 available to pay for each heifer matching the requirements of profile 1. Over the 8-yr period, a producer would have had an average of $1,210 available to buy heifers. Should a producer be able to source heifers each year for less than this amount the balance would go toward profits.

In the second comparison, long-run effects were evaluated for a female replacement strategy comparing profile 3 to profile 4. Table 2 shows the impact of raising select heifers compared to raising average heifers. This may compare to a producer that has been raising average heifers and is considering a move to a quality raised replacement heifer program. For example, in 1998 a producer using a raised select heifer strategy would add $285 to the economic value of each heifer matching the requirements of profile 3. Over the 8-yr period, the producer would have an average of $315 increase in the value of each heifer to the herd.

In the third comparison, long-run effects were evaluated for a female replacement strategy comparing profile 1 to profile 3. Table 3 shows the impact of purchasing select heifers compared to raising select heifers. This may compare to a producer that has been raising select heifers and is considering buying heifers of roughly the same quality. For example, in 1998 a producer using the purchase select heifer strategy would have had $798 available to pay for each heifer matching the requirements of profile 1. Over the 8-yr period, the producer would have had an average of $894 available to buy heifers. Should the farmer be able to source heifers each year for less than this amount the balance would go toward profits.

In addition, *Repro-Sim* allows for the evaluation of sensitivity of production and economic variables on net returns and break-even in comparing the various scenarios. Application of sensitivity analysis and the resulting economic assessments are provided for each of the following:

1. Breakeven purchase price of profile 1 heifers over profile 4 heifers is $1,210 for the base 100-cow farm. Increasing the farm size to 200 cows increases the amount that a producer could pay for profile 1 heifers to $1,224. The additional value of heifers for the larger farm is attributed to the economic cost of holding more heifers back as potential replacements.
2. The baseline comparison between profile 1 heifers and profile 4 heifers provided for a $1,210 break-even purchase price for replacement heifers that meet the specifications of profile 1. Calves in the baseline analysis under profiles 1 and 4 were assumed to grow at a rate of 0.91 kg/d from birth to weaning. As a result of increased management control, increased guidance from veterinarians, and better genetics from profile 1 type production plans the gain from the animals in profile 1 might be expected to increase. The model shows that for an increase in average daily gain for the profile 1 system to 0.95 kg/d, a producer could afford to pay an additional $126 for replacement heifers and the accompanying services for a total of $1,336 per heifer.
3. Producer decisions regarding marketing of the weaned cattle have an influence on net income regardless of the production system. *Repro-Sim* accumulates the combined economic and production impacts of extended growth periods. Under profile 1, producers could expect an increase of $14 per cow in income over variable costs in extending the suckling phase by 14 d over the cattle cycle analyzed.
4. The overall value of the cow herd is affected by the replacement heifer program influencing that herd's productive and economic capacity. In addition, the purchase price of replacement heifers that meet the guidelines of profile 1 influence net income. A producer moving to profile 1 type production systems, paying $800 for replacements, could add $447 to the net present value of each cow in the herd due to a change in the replacement strategy of heifers over the planning horizon of the model.
5. Cyclicity of potential replacements at the time of breeding influences conception rates and long-term economic value of a heifer. Assuming a cycling rate of 50% of replacement candidates 4 to 6 wk before the start of the breeding season allows for synchronization to have substantial impact on conception rates. Producers who are developing their own replacements under profile 3 and have a cyclicity rate of 50% at the prebreeding examination can expect to increase the economic value of that heifer to the herd by $315 per replacement heifer when compared to profile 4 type heifers. Increasing the cyclicity rate to 60% raises that value by $31 to $346 per heifer. A 70% cyclicity rate increases the value to $370. Combined an increase of 1% in the cyclicity rate increases the value of that replacement heifer by $2.75.
6. The extent of concentration of breeding during the calving season under any profile will influence many factors of production and reproduction in the herd. *Repro-Sim* accumulates the production and economic impact of more concentrated calving seasons under each profile. The economic value, measured in dollars of income over variable cost per cow, from concentrating the calving season and thus reducing it by one estrous cycle is 6.71, 2.35, 5.64, and $7.95, respectively, for profiles 1 through 4.

Implications

Cow-calf producers choosing replacement strategies for their operations are making decisions on one of the most important and long-term indicators of profitability for their farms. The results of this model show that variables that affect reproductive efficiency and economic performance can be modeled to help producers forecast the potential impact of that decision or sensitivity of the variables influencing that decision on profits.

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Notes

1. The author expresses gratitude to Drs. David Patterson and Richard Randle for their helpful assistance in the preparation of this manuscript and in the description of scenarios evaluated. This effort builds on previous joint work.

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Table 1. Value of purchased select bred heifer over raising average heifer

	Available for purchase of replacements per heifer	Descriptive statistics over 8-yr analysis
1998	$1,083.11	
1999	$1,150.83	
2000	$1,194.53	Average available for heifer purchase
2001	$1,238.43	
2002	$1282.56	$1,210
2003	$1,278.47	
2004	$1,250.39	
2005	$1198.33	

Table 2. Value of raised select heifer over raising average heifer

	Additional value of replacements per heifer	Descriptive statistics over 8-yr analysis
1998	$284.65	
1999	$303.11	
2000	$314.18	Average available for heifer purchase
2001	$325.25	
2002	$336.33	$315
2003	$332.63	
2004	$321.56	
2005	$303.11	

Table 3. Value of purchased select bred heifer over raising select heifer

	Available for purchase of replacements per heifer	Descriptive statistics over 8-yr analysis
1998	$798.46	
1999	$847.72	
2000	$880.35	Average available for heifer purchase
2001	$913.18	
2002	$946.23	$894
2003	$945.83	
2004	$928.83	
2005	$895.23	

