The Professional Animal Scientist 21 (2005):164–173

Symposium Paper: Economic and Tax Implications for Managing Beef Replacement Heifers[1,2]

R. T. CLARK*,3, K. W. CREIGHTON†, H. H. PATTERSON‡, and T. N. BARRETT*

*Department of Agricultural Economics, University of Nebraska–Lincoln, Lincoln 68583; †CBR International Corp., Boulder, CO 80301; ‡Department of Animal and Range Sciences, South Dakota State University, Brookings 57007

Abstract

*Sustainable cowherds require replacement of cull cows either internally via raised heifers or externally with purchased females. Managing raised replacements begins with a weaned heifer calf and continues on through her second pregnancy and calving. Replacement costs were estimated from research conducted in Nebraska for spring-calving cowherds and included the opportunity cost of the heifer calf. The analysis, based on research data, showed that heifer development programs targeted to 50 to 55% of mature BW (**MBW**) at first breeding can be successful, challenging the traditional target of 65% of MBW at first breeding. The lower BW programs achieved first-calf pregnancy rates near 90% of heifers exposed and resulted in development costs that were $25 to $30 per head lower than the higher BW programs. Finishing or selling open first-calf heifers was shown to be an economically viable enterprise given development costs were not too large. Numbers of open first-calf heifers were shown not to greatly affect total development costs. The primiparous heifer can increase the overall heifer development costs if not managed properly. Research showed that strategic nutritional programs for primiparous heifers resulted in successful reproduction without large increases in costs (<$2 per head). Price cycles were shown to affect the overall heifer development costs through the opportunity cost of the heifer calf and the value of calves and culled heifers and cows. Income tax treatment of purchased vs raised replacement females differs; however, the overall magnitude of differences were shown to not likely be a major determinant of whether to raise or purchase replacements.*

(Key Words: Heifers, Economics, Prices, Taxes, Primiparous.)

Introduction

Beef-cow replacement is necessary to sustain an operation. The costs of managing the replacement female are influenced first by the development costs (or purchase price) of the yearling heifer. To understand the options related to managing the 2-yr old, it is necessary to understand her management as a weaned calf through breeding and calving. The replacement heifer can also be purchased as a pregnant, first-calf heifer.

Based on various research projects over a number of years, the concept that heifers should be at or near 65% of their expected mature BW (**MBW**) when exposed for breeding the first time has evolved (Patterson et al., 1991). The research has implied that the size is necessary for successful breeding and eventual delivery of the calf. Breed differences in success of breeding the first time have also been observed (Patterson et al., 1991). Recent research questions whether or not the 65% level is necessary (Creighton, 2004; Deutscher et al., 2001) for successful development of replacement females, especially when cost factors are considered.

Successful first breeding and calving of the heifer is only part of a successful replacement strategy. The challenge is to get the heifer pregnant with the second calf. Research related to reproductive performance of the primiparous (first parity experienced) heifer has shown that nutrition is one of the keys (Patterson et al., 2003). Proper nutrition has economic consequences.

This paper examines economic issues related to raising the heifer, in-

[1]A contribution of the University of Nebraska-Lincoln, Agricultural Research Division, Lincoln 68583. Jr. Series No. 14654.
[2]Presented at the Extension Symposium at the Midwest American Society of Animal Science sectional meetings in Des Moines, IA on March 16, 2004. The symposium was sponsored by NCR-87, Committee on Cow-Calf Nutrition and Management.
[3]To whom correspondence should be addressed: rtclark@unlnotes.unl.edu

cluding developing her to become pregnant with her second calf. In addition, we discuss differences in tax consequences of raising the heifer vs purchasing a pregnant heifer. We will look specifically at research conducted at the University of Nebraska's Gudmundsen Sandhills Laboratory near Whitman, Nebraska over the past several years. The costs of heifer development will be examined using the actual feed inputs of this research over a range of input prices and prices for the heifer calf.

Review and Discussion

Procedures of Reviewed Heifer Development Studies. A 3-yr (1998-2000) study (Experiment 1) of heifer development for spring-calving MARC II (¼ each of Angus, Hereford, Simmental, and Gelbvieh) cows at Gudmundsen Sandhills Laboratory was conducted (Deutscher et al., 2001; Funston and Deutscher, 2003). Each yr, 80 heifer calves were randomly allotted within age and BW to two treatment groups in mid December. (Calves had been weaned in late September.) The two treatments, low gain or high gain, were intended to achieve pre-breeding target BW of 299 kg (55% MBW) or 327 kg (60% of MBW), respectively, by May 15. Each year heifers were placed into dry-lot pens by treatment group for the winter feeding phase. The winter diet consisted of meadow hay fed for ad libitum intake. Supplements were based on wheat middlings and soybean hulls and contained 40% CP plus Rumensin® (Elanco Animal Health, Greenfield, IN). Cracked corn was fed as needed to achieve a balanced diet so that the two treatment groups would gain to achieve their target BW. The heifers were managed together during the breeding season, which began on May 20 and lasted 45 d. Heifers were exposed to four Angus bulls. The heifers were pregnancy tested about 60 d after the end of the breeding season.

After breeding, heifers from both treatments grazed subirrigated meadow. During the winter, heifers were fed meadow hay, grazed dormant range, and received 0.68 kg/d of a 40% CP supplement. Calving began about March 1. After calving, the heifers were fed good quality meadow hay plus 0.68 kg/d of 40% CP supplement until mid May when they were moved to summer pasture. The heifers were exposed to MARC II bulls beginning June 5 of each year. Calves were weaned in early September of each year. After weaning, all pregnant 2-yr-old cows were placed and managed with the mature cowherd.

In the second study (Experiment 2), also conducted for 3 yr (2001–2003), 261 MARC II (1/4 each of Angus, Hereford, Simmental, and Gelbvieh)-Husker Red (¾ Red Angus, ¼ Gelbvieh) crossbred heifers were assigned randomly to one of two systems (Creighton, 2004). In the intense (**INT**) system, heifers were targeted to gain at a rate to achieve 55% of MBW prior to a 45-d breeding season. In the relaxed (**RLX**) system, the heifers were targeted to weigh 50% of expected MBW prior to a 60-d breeding season. The treatments were initiated in January in 2001 and December in 2002 and 2003. All heifers were combined for breeding, and the INT heifers were removed from the breeding pasture after 45 d. After the RLX heifers were finished with breeding, all heifers were combined for the remainder of the summer. Pregnancy was determined 60 d after the completion of the breeding season. During the winter growing period, heifers were separated by treatment on hay feeding grounds and fed diets balanced to achieve the projected rate of BW gain for the respective treatments. Rations consisted of meadow hay, a protein supplement, and whole corn, if necessary. The protein supplement was composed primarily of wheat middlings and either dried distillers grains (2001) or corn gluten feed (2002 and 2003). The supplements also contained soybean hulls and Rumensin®.

Economics Applied to Heifer Development Studies. Costs for developing a replacement heifer from spring-calving cows to pregnant-heifer status were estimated for each of 11 yr, 1992 to 2002, using data from Experiments 1 and 2. These 11 yr were chosen for two reasons: 1) USDA started reporting steer and heifer calf prices in 22.7-kg increments in 1992, and 2) the period from 1992 through 2002 covered a wide range in cattle and input prices, which were necessary to estimate effects over different types of markets. Development costs per head were estimated as follows:

$$HDC = OCH + FC + MC \quad (1)$$
$$ADC = HDC - VCS \quad (2)$$
$$CBH = ADC/[1 - (OR + CR)] \quad (3)$$

where HDC = heifer development costs, OCH = opportunity cost of heifer calf, FC = feed costs, MC = miscellaneous costs, ADC = adjusted development costs, VCS = value of cull sales (open and culled for other reasons), CBH = cost of pregnant heifer in fall, OR = open rate in fall, and CR = cull rate for reasons other than open.

Death loss was ignored in these estimates, as it was small and was not affected by any of the treatments. The development costs for all heifers were adjusted by the income from the sale of cull heifers. Equation 3 (for cost of a pregnant heifer in the fall) recognized that the costs for developing all heifers, not only those pregnant and retained, must be charged against those finally retained. The result was the estimated cost of one pregnant heifer in October of a given year. The growing costs reflected actual inputs used in the two experiments. The quantities of inputs were based on the average over the 3 yr that the two trials were conducted. Nominal prices for cattle and inputs (e.g., corn, supplement, hay, and grazing) were used for estimating costs for the 11 yr. Nominal prices were used, as they permit estimation of costs that reflect actual expenses *vs* real prices that have been adjusted for inflation. Adjusting prices for inflation would not be expected to change any of the results. The heifer calves and cull heifers (those open and culled for other reasons) were priced for the appropriate years. A major cost of development is the opportunity cost of the weaned heifer calf. The opportunity cost was used, as sale of the heifer calf at weaning is an obvious alternative to retaining and further developing her as a replacement. Miscellaneous costs included 6% interest/yr on the value of the heifer calf and 6 mo of feed costs plus cost of feeding harvested forage estimated at $9.10/tonne.

The year for which estimated costs are shown is tied to the year the replacement heifer would have been born and weaned over the 1992–2002 time period. For example, the estimated costs for developing a replacement for 1992 included the opportunity cost of the heifer calf in October 1992 and the feed (hay, supplement, and corn, if fed) priced at 1992 average yearly prices. Income from sale of cull heifers was based on October 1993 prices, when culling was assumed to occur. The charge for the summer grazing was based on 1993 prices, since the 1992-born heifer calf would be summer-grazed and inseminated in 1993. The cost estimate for 1993 was similar except each input was priced a year later than for the 1992 estimate (etc.). We did not estimate a cost for heifer development for 2003, as we would need prices occurring after preparation of these analyses to properly record the summer feed costs and cull income. The resulting costs for each trial are summarized by presenting the average over the 11 yr, the standard deviation, and the range from high to low.

Feed resources related to the heifer development trials were priced for the years 1992 through 2003 (Mark et al., 2003; Nebraska Agricultural Statistics Service, 2004). Wheat middlings were a primary ingredient in the protein supplements used in both trials. Lacking a comparable source of yearly prices for the supplement, the price per year was estimated by developing a price index based on the yearly price for hard red winter wheat received by Nebraska producers and multiplying that times the base price (cost in 2003) for the supplement. Although this is not a perfect reflection of how that supplement's price might have varied over the years from 1992 to 2003, it does introduce variability consistent with the wheat market. Heifer calves at BW relevant to the two studies were priced over the same years, 1992 through 2002 (J. Robb, 2003, Livestock Marketing Information Center, 655 Parfet Street, Suite E310, Lakewood, CO 80227, personal communication).

Cull rate was based on one minus pregnancy rate (percentage open) plus 4% as an arbitrary estimate of the percentage that would be culled for reasons other than being open. The cull rate then was multiplied times the actual BW of the heifers at pregnancy test time and that result was taken times the price for October of the corresponding year for the relevant BW class. The data series used (J. Robb, 2003, Livestock Marketing Information Center, personal communication) did not contain prices for 23-kg increments for heifers exceeding 363 kg but did have incremental data for steers. The relationship between the BW classes for establishing the slide between the 340- to 363-kg, the 363- to 386-kg, and 386- to 408-kg BW classes for heifers was estimated from that for steers for the same market and dates.

Results of Heifer Development Studies.

Experiment 1. The average pregnancy rate for the low-BW gain heifers was 92% over the 3-yr study; the high-gain heifers had an average pregnancy rate of 88% (P>0.05). Calf loss, calving to weaning, was identical. The results of the cost analysis are shown in Table 1. Results are shown for actual and pooled (across treatment and years) pregnancy rates. Changing the pregnancy rates to the pooled value (90%) made little difference in the final costs of both treatments. On average, the low-gain treatment resulted in approximately $27 less cost per head compared with the high-gain treatment.

Sensitivity analysis of the development costs to various pregnancy rates for these two treatments over this set of years was conducted. As pregnancy rates were lowered (and the greater the number of culls going to market as yearlings), the development costs for heifers in the low-gain treatment was reduced. The variation between years, however, increased. For example, assuming a 50% pregnancy rate resulted in an average development cost of $590 and a standard deviation of approximately $127, which is about 90% greater than when pregnancy rates near those actually achieved were used. With the high-gain treatment, an assumed 50% pregnancy rate resulted in no change in the average costs but a significant increase in variability with a standard deviation of $132, or 100% greater than when pregnancy rates near those actually achieved were used. Annual variation in this analysis is all due to prices of cattle and inputs. An interpretation of the results is that in the low-gain system, selling open yearling heifers was a paying proposition, although it was about at breakeven for the high-gain heifers. This analysis showed that, in some years, it was more profitable to sell yearling, open heifers vs developing heifers for replacements. Over the years used in this analysis, the implication is that the low-gain development system provided a better opportunity for that option.

After the first parturition, the reproductive performance of these heifers was followed through the next 3 yr (Funston and Deutscher, 2003). There were no differences in pregnancy rates for any of those 3 yr. Pregnancy rates were 91, 94, and 96% for the succeeding 3 yr for the low-gain treatment. The pregnancy rates were 91, 92, and 96% for the succeeding years for the high-gain treatments. The heifers were not treated differently after delivering the first calf.

Experiment 2. Results from the second set of studies were similar to

TABLE 1. Total development costs for 1992–2002 prices from weaning to pregnancy for heifers fed to achieve 55% (low) and 60% (high) of mature BW by time of first bull exposure. PR = pregnancy rate.

Item	BW at breeding, kg (% mature)	Average cost[a], $	Least cost[b], $ (yr)	Highest cost[c], $ (yr)	SD
Low (actual PR, 92%)	289 (53)	608	483 (1996)	682 (2001)	67
High (actual PR, 88%)	313 (57)	635	510 (1996)	708 (2001)	66
Low (pooled[d] PR, 90%)	289 (53)	608	481 (1996)	683 (2001)	68
High (pooled[d] PR, 90%)	313 (57)	635	512 (1996)	707 (2001)	65

[a]Average cost of a developing heifer over 11 yr of prices for cattle and inputs; quantities of feed and other inputs were held constant at average over 3 yr of the experiment.

[b]Least cost (and year of occurrence) for developing heifers over the 11 yr of prices, 1992–2002.

[c]Highest cost (and year of occurrence) for developing heifers over 11 yr of prices, 1992–2002.

[d]Pooled across years and treatments.

those of the first. Pregnancy rates over the 3 yr were not significantly different between treatments (87.2 and 89.8% for RLX and INT, respectively; Creighton, 2004). Results for both the pooled (across treatment and years) pregnancy rate (88.5%) and actual pregnancy rates are shown in Table 2. The RLX heifers were developed on average for about $20 less than their more intensively fed counterparts. Sensitivity of the costs to pregnancy rates was similar to Experiment 1. As assumed pregnancy rates decreased, the costs of developing the individual heifers also decreased for both the RLX and INT systems. As this average cost receded, the standard deviation increased. For example, at an assumed pregnancy rate of 50%, the average development cost of the first-calf heifer declined to $540 and $571 for the RLX and INT systems, respectively. The standard deviation increased to $129 and $135 for the RLX and INT, respectively, or a 79 and 98% increase in standard deviation for the RLX and INT systems, respectively. Recall that the only variation was introduced through the prices of the inputs and the cattle. These results primarily reflect the relationship between calf and yearling prices for heifers. The analysis showed that for the development costs of either treatment, selling yearling heifers was a paying proposition. When we arbitrarily increased the development cost (before culling for opens and others), this relationship changed. With lesser pregnancy rates and greater development costs (about $41 greater was the changing point for the RLX system), the cost of the replacement also increased when pregnancy rates were lessened. This result only emphasizes the fact that for the costs faced by these systems and the

TABLE 2. Total development costs for 1992–2002 prices from weaning to pregnancy for heifers fed to achieve 50% (relaxed; RLX) and 55% (intense; INT) of mature BW by time of first bull exposure. PR = pregnancy rate.

Item	BW at breeding, kg (% mature)	Average cost[a], $	Least cost[b], $ (yr)	Highest cost[c], $ (yr)	SD
RLX (actual PR, 87.2%)	277 (50.9)	580	449 (1996)	655 (2001)	72
INT (actual PR, 89.8%)	308 (56.5)	603	478 (1996)	675 (1993)	68
RLX (pooled[d] PR, 88.5%)	277 (50.9)	581	451 (1996)	655 (2001)	71
INT (pooled[d] PR, 88.5%)	308 (56.5)	602	477 (1996)	676 (1993)	68

[a]Average cost of a developing heifer over 11 yr of prices for cattle and inputs; quantities of feed and other inputs were held constant at average over 3 yr of the experiment.

[b]Least cost (and year of occurrence) for developing heifers over the 11 yr of prices, 1992–2002.

[c]Highest cost (and year of occurrence) for developing heifers over 11 yr of prices, 1992–2002.

[d]Pooled across years and treatments.

TABLE 3. Simulated development costs for heifer calves born from 1992 through 2001 from weaning to second pregnancy developed to achieve 50% (relaxed; RLX) of mature BW by time of first bull exposure. PR = pregnancy rate.

Item	Cow BW at weaning, kg	Calf BW at weaning, kg	Average cost[a], $	Least cost[b], $ (yr)	Highest cost[c], $ (yr)	SD
RLX						
Actual (PR = 91.7%)	415	190	564	397 (1998)	731 (1993)	107
Simulated[d] (PR = 75%)	415	190	611	411 (1998)	815 (1993)	129

[a]Average cost of a developing heifer over 11 yr of prices for cattle and inputs; quantities of feed and other inputs were held constant at average over 3 yr of the experiment.

[b]Least cost (and year of occurrence) for developing heifers over the 11 yr of prices, 1992–2002.

[c]Highest cost (and year of occurrence) for developing heifers over 11 yr of prices, 1992–2002.

[d]Arbitrary lessening of PR, assuming the same feed and other inputs as actual.

prices for cull heifers that existed between 1992 and 2002, selling open yearling heifers was a paying proposition.

Rebreeding the First-Calf Heifer. After the first calf heifer has weaned her calf, successful rebreeding becomes the challenge. As discussed previously, the successful first breeding of the heifer may not be as critical in terms of costs if development costs make the yearling heifer operation profitable. However, the primiparous heifer that is open is likely to bring cull cow price or a price at least between the cull cow and an open yearling. Therefore, the cull primiparous heifer is not likely to bring enough to offset the added costs of her second year of development.

For Experiment 2, we examined the second year costs of developing the heifer (Table 3). We reported only the costs for the RLX system, as second year costs and pregnancy rates were similar. The estimated costs were reduced by the value of the first calf. The calf value was based on the actual weaning BW of the calf (calves from the INT system averaged about 7 kg more at weaning compared with those from the RLX system) and the weaning rate based on exposed yearling heifers. The costs also reflected the sale of cull heifers based on actual numbers open after the second breeding plus culling 2.5% for reasons other than being open. Again, death loss was ignored. The average cost to obtain a cow pregnant with her second calf actually declined from the cost of her development in the first year. The reason for the reduced cost was that the return from the sale of the first calf and the culls generally offset the second year development costs. The heifers in this experiment had a 2-yr-old pregnancy (second calf) rate of 91.4% averaged over the 3 yr of the trial. Note that the low and high cost data shown for each year represent the full development costs for heifers born in that year. The feed costs, replacement values, and values of the calves were all based on the appropriate year for a calf born in the given year. For example, the least cost was for a 1998-born heifer calf. The cull heifer prices used were for 1999, the cull cow for 2000, and the calf price for the first calf was for 2000. Costs were similarly adjusted to reflect the appropriate year. The variation in development costs increased between the first- and second-calf heifers as reflected in a greater standard deviation and a greater difference between the high and low years.

When we simulated the impacts of a lesser pregnancy rate for the second breeding, the average development cost and cost variability of a cow pregnant the second time increased (Table 3). Recall that when we simulated a lesser pregnancy rate for the first calf, the average cost actually declined, even though the variability increased. The results, however, were sensitive to the prices assumed for sales of the culled 2-yr old. If we used the average of the prices received for cull cows and yearlings in determining the costs of getting the heifer pregnant with her first calf, then reduced pregnancy rates did not alter the average total costs, but they did increase variability. When we used the yearling price for the price of the cull 2-yr olds, the lesser pregnancy rate decreased the average cost of getting the heifer pregnant the first time and increased variability. These results, which were the same for the INT treatment, imply that getting the first-calf heifer pregnant the second time is a place to concentrate management attention. Another implication is that strategic marketing of culled 2-yr-old heifers could have a major impact on overall cost of developing her pregnant counter part.

Other research showed that obtaining acceptable 2-yr-old pregnancy rates (second calf) was not necessarily expensive. Patterson et al. (2003) found that pregnancy rates for primiparous heifers grazing winter range after weaning were improved by formulating a supplement to meet metabolizable protein requirements (**MPR**) compared with CP requirements (**CPR**). The supplement used for MPR contained feather meal to meet undegradable intake protein requirements. The studies were conducted on over 1000 head of pregnant heifers/yr for a 2-yr period on a commercial ranch in the Nebraska Sandhills. These heifers were exposed for the first time at about 53% of their expected MBW. Two-year olds on the MPR treatment had greater (91%) pregnancy rates than those in the CPR group (86%) (*P*=0.001). The added cost for this 5% increase in pregnancy rate averaged $1.80 per cow over the 2-yr period (Patterson, 2000). Capital budgeting techniques and the actual cow costs as experienced by the ranch were used to estimate net present value (**NPV**) of the heifers. The only differences between the NPV estimates for the MPR and CPR were the costs of the supplements and the pregnancy rates as 2-yr olds. Under this scenario, MPR heifers averaged $13.64 greater NPV than CPR heifers. Although this is not huge, it demonstrates that proper nutrition can have a positive impact on the 2-yr old without a large cost.

A similar 2-yr (2000–2002) study was conducted using heifers from the same commercial ranch (Loy, 2003; Loy et al., 2003). Pregnant heifers were rotated on native range pastures during the dormant season. A supplement, formulated to meet MPR, was fed to control heifers. The supplement was high in undegradable intake protein supplied primarily by feather meal. Hay feeding of the control heifers began in December and gradually increased as the winter progressed. As hay increased, the availability of ungrazed forage decreased. Treatment heifers had access to unlimited amounts of ungrazed forage prior to calving and were fed a different supplement. The supplement for the treatment heifers also was formulated to meet MPR and was based on dry corn gluten feed. The treatment heifers received increasing amounts of supplement as they neared parturition, and they were not fed hay. (The supplement was fed at a rate to supply similar energy as the combination of hay and supplement in the control group, while supplying adequate metabolizable protein.) Each treatment went from October 1 to March 1, the beginning of calving. The heifers were managed together after calving. Pregnancy rates (second calf) were not different (96.1 and 96.4% for control and treatment, respectively). The treatment system was least costly primarily because of the absence of hay and the associated cost of the feeding of hay. Grazing and supplement costs were highest for the treatment system. Neither system had a high cost. Total feed and labor costs averaged $83.67 and $76.76 for the control and treatment systems, respectively. These costs represented the treatment part of the trial only and did not include the costs acquired after calving began. If hay and grazing were valued differently, then the relationship between the costs of these two systems could easily change.

Role of Price Cycle in Development Cost and Expected Income. Development costs were impacted by the historic price cycle as reflected in the cost variability and extremes (Tables 1 through 3). An even longer time series would probably suggest much the same. But how does one time the cycle? A heifer born in 1998 had the least development cost (Table 3), but 1998 was not the least priced year for heifer calves. It was followed by several years of high prices for calves, so that cull income and income from that first calf were strong. By contrast, the greater cost year for development was 1993, a year of relatively high prices for calves (but not the greatest), which was followed by declining prices for the next 3 yr. These prices were among the least of the 11-yr period. It appears that during down price cycle for calves, greater development costs for replacements occurred.

What about expected income from the heifer born in a given year and then developed? We estimated gross income from a heifer born in a given year from the next 5 yr of calves (Figure 1). We assumed a 100% calf crop just to examine the impact year of birth had on expected income. The first calf was assumed to weigh the average of the calves from Experiment 2 (193 kg) and was priced by the October price for that BW group in the following year. We assumed that the following four calves would weigh 238 kg at sale time, again in October. Because we used 5 yr of price history (moving forward), we were able to only make those estimates for 6 yr (heifer calves born in 1992 through 1997). We also estimated gross sales from heifers calving in a given year (Figure 1), so we were then able to estimate future income for 2 additional yr (those calving in 1998 and 1999).

Gross income from heifers born in 1992 grew steadily through those born in 1997 (Figure 1). The reason for that growth is that the first calf available for sale would have been in 1994, which was followed by 4 yr of low to moderate prices. A heifer born in 1993 would have had a calf available in 1995, and prices started gradually improving over the next 5 yr. The projected gross income from heifers that started calving in a given year generally increased as well (Figure 1); however, there was a small decrease in 1994 because of the lesser prices that occurred in the mid 1990s. The implication is that if a heifer begins calving at the start of a downturn in the cattle price cycle, the amount of income she can generate will be less than from a heifer that begins to calve at the low point of the cycle. Of course the outcome depends on the length of the price cycle. Discounting the expected returns to a present value that coincides with the year the heifer was born (first series discussed) did not change the relationship except at very high discount rates (>34%).

The average prices for pregnant heifers in October as recorded by Cattle Fax Inc. (Denver, CO) are given in Figure 1. The prices are lagged a year to be comparable with a heifer calf born in a given year, as our costs for a pregnant heifer represent the year born. In other words, the Cattle Fax Inc. value from the fall of 1993 is for

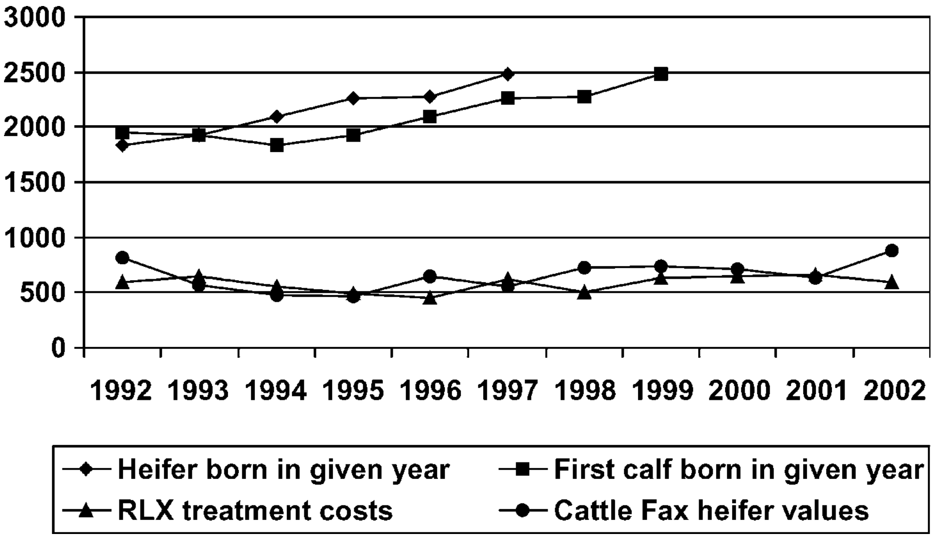

Figure 1. Expected gross value of calves from heifers calving for each of the 5 following yr and value and cost of heifers born in October of a given year. RLX = relaxed. Cattle Fax values were obtained from Cattle Fax Inc. (Denver, CO).

a heifer born in 1992 and is shown in Figure 1 as the 1992 value. Note that values trend downward through 1994 and 1995 and then increase again. The values follow our estimated costs for the RLX system heifers very closely (Figure 1). One implication of the comparison between these two series is that the development cost and purchase price would have been similar over these years. One should recognize that our estimated development costs were for one type of system, and costs for other systems may be quite different.

We do not specifically address the buy vs purchase decision for replacement females. That decision needs to consider other factors in addition to the costs we have discussed for these specific heifer development programs. For example, can females be purchased that match the genetic lines and quality of the producer's cowherd or the direction the producer wants to take that cowherd? The answer to that question will vary by producer, possibly even more than the costs of heifer development.

Tax Implications. Whether a producer raises or purchases the replacement female does affect federal income tax and self-employment tax (social security payments) differently. Most producers report taxes for cash basis accounting rather than accrual. This discussion will pertain only to the cash basis taxpayer. In the following discussion, the impacts of death loss for raised and purchased replacements are also ignored.

The costs of a raised replacement are, in essence, expensed out during the year in which such expenses occurred. The costs of raising the heifer calf to weaning age are embedded in the costs associated with feeding and caring for the heifer's mother (cow) including breeding expense, veterinary costs, etc. during the year leading up to the birth and weaning of that heifer calf. In our analysis, we assumed a calendar year, fiscal year for reporting of income and expense. In addition, the costs expended to sustain the raised heifer calf until she becomes a pregnant heifer the following year also are expenses that can be deducted on schedule F. For comparative purposes, we only considered the costs of developing the first-calf heifer to the stage of becoming a pregnant heifer in the fall. The comparison was with a pregnant heifer purchased in the same fall. One of the problems of estimating the tax consequences of a raised replacement is that producers seldom keep records where heifer development is a separate enterprise. We have utilized budgeted costs and made some assumptions about the proportion that would be cash expenses and, therefore, deductible.

If the replacement is purchased, taxes can be treated by two methods (Dep. Treasury, 2004). Method 1 uses Section 179 of the Internal Revenue Service code that permits producers to fully claim the expense for a capital item in the year of purchase if the producer so chooses. The total dollar value that can be claimed under Section 179 is limited to $100,000. For comparison purposes, we chose to ignore the upper limit on total claims, but it could be important for taxpayers purchasing many replacements and/or those with other capital items they wish to expense out in that year. Method 2 utilizes the regular depreciation schedule for a purchased female and takes 6 yr for the entire purchase price to be claimed as an expense (Dep. Treasury, 2004).

As shown in Table 4, total expenses that can be deducted for the purchased replacement are the same (except for rounding error) for each strategy. The only difference is in the distribution of those expenses by year. Which strategy should be followed depends on the individual producer and their tax planning needs.

In addition to differences in how and when expenses are claimed from raised or purchased replacements, differences occur on the sales side of the ledger. As shown in Table 5, one of the first differences relates to the sale of all heifer calves that otherwise would have been retained as potential replacements. We have assumed that 20 calves will be retained to end up with 16 replacements. As a consequence, each replacement purchased releases the equivalent of 1.25 heifer calves for sale. The deductible expenses to raise each calf in that taxable year were assumed to be $245,

TABLE 4. Consequences of federal income and self employment (SE) tax options for purchased or raised replacement heifers assuming purchase cost of pregnant 2-yr old is $650.

	Purchased female tax options				Option for raised female	
	Section 179		Regular			
Year	Expense	Tax[a]	Expense	Tax	Expense	Tax
0	NA[b]	NA	NA	NA	$306[c]	($89)
1	$650	($189)	$ 98	($29)	204[d]	($59)
2	0	0	166	(49)	0	0
3	0	0	116	(34)	0	0
4	0	0	108	(32)	0	0
5	0	0	108	(32)	0	0
6	0	0	54	(16)	0	0
Total	$650	($189)	$650	($192)	$510	($148)

[a]Tax at marginal rate of 15% plus SE tax rate of 15.3% assumed for all years. The SE tax is on 93.35% of total, as allowed to reduce gross amount subject to SE by amount employer would normally pay (7.65%).

[b]NA = not applicable.

[c]Cost associated with feeding the cow during year of birth of heifer calf plus cost from weaning to end of calendar year. Because the owner must raise 1.25 heifer calves per retained heifer, costs per head have been adjusted accordingly.

[d]Expenses per retained female from January 1 of year after weaning to October. Expenses are assessed for 1.25 head per footnote c.

and the calves were assumed to sell for $400 per head. The total taxable gain then is $400 – $245 = $155, which is then multiplied by the 1.25 calves per purchased replacement. The sale of the cull cow, which created the need for the replacement, is handled differently. We assumed the cull had been in the herd for 5 yr. If that cull had been purchased and depreciated under the regular depreciation schedule (another assumption), then there would have been a remaining basis of $54 in that cow (assuming initial purchase cost of $650). The difference between the sale value ($300) and basis, then, is taxable as "recaptured depreciation." In other words, in prior years we had claimed all of the purchase value of this cow except for the last year ($54). That gain must be "recaptured" so that we are not receiving a deduction for something we did not earn. Note that the tax on the sale of this purchased cull cow is not subject to capital gains tax; so, the difference between the sale value and basis is taxed at our assumed rate of 15%. The raised cull cow, which sold for $300, had zero basis and was eligible to be taxed at the capital gains rate of 5% (if in the 15% overall tax bracket, producer is eligible for 5% capital gains rate). Proceeds from the sale of the cull cow, whether raised or pur-

TABLE 5. Tax treatment of sales of culls and calves for purchased and raised replacements.

	Purchased		Raised	
Revenue from sale:	Value	Tax	Value	Tax
Heifer calves, yr 0	$500–$306[a]	$57	NA[b]	NA
Cull cow, yr 1	$300	$37[c]	$300	$15[d]
Cull yearling heifers, yr 1	NA	NA	($648 × 0.25) = $162[e]	$47
Total tax		$94		$62

[a]Heifer calf sells for $400 per head but one must have 1.25 head per heifer otherwise retained, as we hold back 20 head to achieve 16 replacements. Tax deductible expenses are $245 per calf × 1.25 calves; income and self-employment tax.

[b]NA = not applicable.

[c]Regular tax rate (not eligible for capital gains tax) at 15% × sale value – the basis: ($300 – $54) × 0.15. Income from sale is taxed, as it is recaptured depreciation from prior years. Not subject to self-employment tax, because it is a capital item.

[d]Capital gains tax of 5% sale value (basis is 0) and not subject to self-employment tax.

[e]Assumed cull heifer sells for $648 per head. For 16 heifers retained, 4 culls would be sold (ignore death loss) so that 0.25 heifers are sold per heifer retained.

chased, is not subject to self employment tax, as this is a capital sale.

By combining the estimates in Tables 4 and 5, the net effect for a given year can be determined. For example, in yr 1, the net tax effect of a purchased heifer following the regular depreciation schedule would be a tax of \$8 per head (\$37 – \$29) for the replacement. Following the same tax strategy results in additional taxes of \$57 per head in yr 0, as there are no expenses for the purchased replacement (purchased the following year) to offset the gain from selling the heifer calves. If the producer chooses the full Section 179 depreciation in the year of purchase (yr 1), then the net effect for yr 1 is a reduction in tax of \$152 per head (\$189 – \$37). The net result in yr 1 for the raised replacement is an increased tax of only \$3 (\$62 – \$59). There are zero tax impacts for the purchased heifer following yr 1 under the full 179 scenario. The full tax effects from raising a heifer calf to a pregnant heifer in the fall are captured in yr 0 and 1, i.e., within 2 yr of birth of that replacement. The net effect of either purchased or raised is reduced taxes because of the expense of the replacement (under our assumptions) of –\$86 (–\$148 + \$62) for the raised and –\$96 (–\$190 + \$94) for the purchased. The difference is primarily due to the lesser tax deductible costs of the raised heifer, which depend on each producer's costs. Will the tax effects help determine whether or not one should raise or purchase replacements? The answer is that it might be a short run factor but in total not a very important one. We recommend that a tax advisor be consulted before decisions are made, because tax rules frequently change.

Conclusions. The results of the research cited for development of replacement females are similar to those reported by Meek et al. (1999). They suggest that it may be advantageous to finish developing the replacement in the second year rather than to overdevelop yearling heifers. We conclude that the producer need not be greatly concerned about first calf pregnancy rates if enough yearling heifers are exposed to provide adequate, pregnant first-calf heifers. It is better to fail to achieve conception with the yearling than to fail with the second calf heifer. This conclusion may need to be modified for those producers who have large costs in their development program and those who have increased value because of rapid genetic change. We also conclude that successful breeding of the 2-yr old can be achieved without huge investments in feeds. Supplements for successful development must be formulated to meet the proper nutritional needs of the primiparous heifer.

The primary cost of developing a replacement female is the opportunity cost of the weaned heifer calf (or the financial costs invested in that calf through the cow costs to achieve a weaned calf). Revenue from the sales of cull heifers as yearlings, open or culled 2-yr olds, and the heifer's first calf can also be important determinants of the overall cost of the 2-yr-old beef heifer. Thus, price cycles for calves and replacements become important determinants of that final cost. Highest costs tend to be associated with heifers developed at the start of a down price cycle for cattle, as the cost recovered from sale of cull heifers and the heifer's first calf are reduced.

Income tax treatment of the costs related to either purchasing or raising the replacement female differs. These differences, in total, are not large enough to likely influence the decision as to whether to raise or purchase. The differences, however, for individual years, are large enough to impact the tax bill for that year. For example, if the full Section 179 depreciation is taken in the first year of purchase, all of the impact on reducing taxes occurs in that first year. If that year happens to be one that is to be high income for that producer, that strategy may make sense.

Implications

Previously published recommendations on the appropriate level of heifer development were based on production and not economic parameters. An evaluation of the economics of heifer development revealed that the pregnancy rate for yearling heifers may not be as important as the pregnancy rate of the 2-yr old. In fact, adding lesser inputs to the heifer development program can reduce 2-yr-old development costs. It is important to consider development costs, the price cycle, and tax implications associated with heifer development. Scientists and producers should challenge the previous recommendations that heifers need to be developed to 65% of mature weight.

Literature Cited

Creighton, K. W. 2004. Heifer development systems for March-born heifers and improving pregnancy rates in June-calving cows. Ph.D. Diss., Dep. Anim. Sci., Univ. Nebraska–Lincoln.

Dep. of the Treasury, Internal Revenue Service. 2004. Depreciation, depletion and amortization. In Farmer's Tax Guide. Publication 225, ch 8, p 36. Internal Revenue Service, Washington, DC.

Deutscher, G., B. Plugge, A. Applegarth, and R. Davis. 2001. Replacement heifer development for spring and summer calving herds. In 2002 Beef Cattle Report. MP 79-A, p 4. ARD, Univ. Nebraska-Lincoln.

Funston, R., and G. Deutscher. 2003. Developing replacement heifers: Recent research findings on target weights and fat supplementation. In Proceedings of The Range Beef Cow Symposium XVIII, p 148. Coop. Ext. and Anim. Sci. Dep., Univ. Nebraska, South Dakota State Univ., Colorado State Univ, and Univ. Wyoming.

Loy, T. W. 2003. Utilization of grain milling byproducts in high-forage diets. Ph.D. dissertation, Dep. Anim. Sci., Univ. Nebraksa-Lincoln.

Loy, T. W., D. C. Adams, T. J. Klopfenstein, D. M. Feuz, J. A. Musgrave, and B. Teichert. 2003. A system for wintering spring-calving bred heifers without feeding hay. In 2004 Beef Cattle Rep., MP 80-A, p 7. Dep. Anim. Sci., Univ. Nebraska-Lincoln.

Mark, D., D. Feuz, R. Selley, and T. Barrett. 2003. Crop and livestock prices for Nebraska producers. Coop. Extension EC-03-883-C. Univ. Nebraska-Lincoln.

Meek, M. S., J. C. Whittier, and N. L. Dalsted. 1999. Estimation of net present value of beef females of various ages and the economic sensitivity of net present value to changes in production. Prof. Anim. Sci. 15:46.

Nebraska Agricultural Statistics Service. 2004. Nebraska-Agri-Facts for 2003. Available http://www.nass.usda.gov/ne/agrifact.htm. Accessed Feb. 17, 2004.

Patterson, H. H. 2000. Protein supplementation to pregnant heifers and grazing management effects on cow diet quality. Ph.D. Diss., Dep. Anim. Sci., Univ. Nebraska–Lincoln.

Patterson, H. H., D. C. Adams, T. J. Klopfenstein, R. T. Clark, and B. Teichert. 2003. Supplementation to meet metabolizable protein requirements of primiparous beef heifers: II Pregnancy and economics. J. Anim. Sci. 81:563.

Patterson, D. J., L. R. Corah, J. R. Brethour, M. F. Spire, J. J. Higgins, G. H. Kiracofe, J. S. Stevenson, and D. D. Simms. 1991. Evaluation of reproductive traits in *Bos taurus* and *Bos indicus* crossbred heifers: Effects of postweaning energy manipulation. J. Anim. Sci. 69:2349.