Long Term Comparison of Alternative Range Livestock Management Strategies Across Extended Droughts and Cyclical Prices

By John P. Ritten, Christopher T. Bastian, Steven I. Paisley, and Michael A. Smith

Abstract

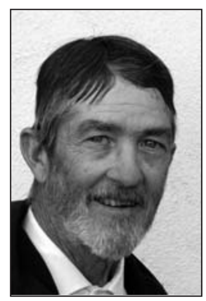
Variable precipitation, more importantly drought, impacts profitability for livestock management. Financial outcomes from management decisions related to forage shortages can be exacerbated by price variability. This research examines alternative management strategies to determine the potential profitability and riskiness over a long-term horizon and across various drought event scenarios. Results indicate that late calving can be a promising strategy, but it also can result in higher variability in profits as compared to some of the other strategies analyzed. Retaining ownership of steer calves over the winter, with the option to sell if forage supplies become scarce, outperforms both partial liquidation and summer feeding, and it results in less profit variability than late calving or early weaning.

Introduction

Variable precipitation, particularly drought, and fluctuating prices impact ranch profitability. Nagler, et al. (2007) found that drought lasting between 2000 and 2004 reduced grazing capacity, decreased calf weights, reduced irrigation supplies, and reduced owner equity for Wyoming ranchers. Bastian, et al. (2006) suggest that decisions to take advantage of income averaging after drought-induced sales of breeding livestock and decisions related to restocking after drought can be complicated by price cycle dynamics. The authors go on to suggest that producers would be better served if researchers addressed the potential effects of drought and price cycle dynamics when analyzing potential livestock management strategies.

Drought negatively affects forage production which can alter management decisions by forcing ranchers to carry smaller herds, increase costs associated with purchased feed, and increase short term debt. Moreover, management decisions associated with stocking rates and variable precipitation are made in a fluctuating price environment. Interestingly, relatively little research has addressed the financial consequences of livestock management alternatives that address variable precipitation, and/or drought, coupled with price cycle dynamics. Foran and Smith (1991) conclude that maintaining lower-than-average stocking rates was the most profitable for droughts lasting two or more years. Parsch, et al. (1997) indicate that fluctuating weather coupled with increased stocking rates increases the severity of income losses. Carande, et al. (1995) analyzed stocker operations in Colorado with differing rainfall and price scenarios.



John P. Ritten is the contact author and is an Assistant Professor in the Department of Agricultural and Applied Economics at University of Wyoming.

Christopher T. Bastian is an Assistant Professor in the Department of Agricultural and Applied Economics at University of Wyoming.

Steven I. Paisley is an Associate Professor in the Department of Animal Sciences at University of Wyoming.

Michael A. Smith is a Professor in the Department of Renewable Resources at University of Wyoming.

They concluded that high stocking rates are profitable when rainfall is favorable, but lower stocking rates needed to be utilized when rainfall is unfavorable. Holecheck (1994), in a drought study of New Mexico cattle producers, found that producers who respond to high prices without regard to poor forage production levels can overgraze pastures, a result that can require pastures be completely destocked for recovery, ultimately resulting in reduced income later. Bastian, et al. (2009) use a multi-period linear programming model based on a case ranch in Wyoming to analyze the financial consequences of herd liquidation and/or the use of purchased feed to address forage shortages from drought. The authors couple forage shortages from representative 3- or 4-year droughts with different price cycle scenarios (a 12-year peak-to-peak cycle or a 12-year trough-to-trough cycle) and evaluate those management strategies across the combinations of drought and price environments. The authors conclude that partial liquidation was more often profitable and less risky than purchasing hay to address forage shortages. Their results indicated that purchasing feed was only profitable when drought occurred as prices trended upward in the price cycle, but they conclude analyses of other alternatives over longer planning horizons could make a positive contribution to the research literature.

Overall, the above literature suggests partial liquidation or destocking may be a more profitable and/or less risky strategy than purchasing additional feed when faced with variable precipitation or drought. However, the stocking decision and purchasing supplemental feed represent a potentially small subset of relevant management strategies used by range livestock producers to address forage shortages resulting from deficit precipitation. Bastian, et al. (2006) and Nagler, et al. (2007) found Wyoming producers used a number of different strategies to address forage shortages associated with drought. These strategies included partial herd liquidation, purchasing additional feed, early weaning of calves to reduce feed needs, selling retained yearlings, and total herd liquidation.

Selling retained yearlings implies something different than the more common cow-calf operation. Feuz and Kearl (1987) have stated that cow-yearling operations in Wyoming proved to be more profitable than the traditional cow-calf operation. Cow-yearling operators typically retain ownership of steer calves over winter, and market them as yearlings the following fall. This type of operation could potentially allow the manager to adjust the number of yearlings in the spring to meet forage shortages, perhaps more quickly and with less disruption to the operation than liquidating breeding livestock. Another potential management strategy to address forage requirements could be to change calving dates to later spring or early summer to reduce purchased feed requirements for lactating cows. Although this strategy may not be thought of as a strategy directly used to address drought, May, et al. (1999) have suggested late calving as a potential approach to match herd requirements to forage supplies in Wyoming. Therefore, we also examine this approach in order to determine long run, as well as within-drought, profitability.

The objective of this research is to evaluate the long-term profitability of alternative management strategies for livestock operations when faced with variable precipitation and fluctuating prices. Specifically, we examine the profitability of late calving, early weaning, and retaining steers as compared to the more frequently used strategies of partial liquidation and/or purchasing additional feed (hay) to address forage shortages given fluctuating market prices.

Methodology

We accomplish our research objective by using a methodology similar to that reported by Bastian, et al. (2009). We adapt a multi-period linear programming model reported by Torell, et al. (2001) to analyze the alternative management strategies of interest. The model is estimated using GAMS (Generalized Algebraic Modeling Systems) software. The original model is based on a cow-calf operation with forage resources able to sustain an average herd size of 600 cows. The production technology, associated parameters, and resulting costs are representative of a range livestock operation in central Wyoming, specifically Fremont County, Wyoming based on data originally collected by Torell, et al. (2001). The standard practices of this representative ranch include spring calving, with marketing of all calves in the fall. Cattle graze in the summer months and are allowed hay as supplemental feed during the winter months. The model utilized allows for the herd size to fluctuate across years in response to changing forage and market conditions.

Bastian, et al. (2009) maximize net present values (NPV) of annual returns (revenues less costs) over a 12-year planning horizon subject to constraints on seasonal forage supplies as well as inter-year transfers. We develop a data series regarding precipitation and prices that allows us to examine net present values of annual returns over an 86-year planning horizon. The model adjusts seasonal forage supply resulting from variable spring precipitation. Producers are able to purchase feed and lease public land forage in the model. Off-ranch income is constrained to equal family living allowances. The model also allows for annual borrowing, which can be transferred across years, with accrued interest expenses. Although Bastian, et al. (2009) allowed for annual borrowing to extend past the planning horizon due to feasibility issues, we constrain the model to force all debt to be repaid by the end of the T-year planning horizon, consistent with the original model utilized by Torell, et al. (2001).

Incorporating Precipitation Variability into the Model

We utilize the entire precipitation data set available from Riverton, Wyoming to generate forage response over an 86-year horizon. We utilize research reported by Smith (2007) and Smith, Thurow, and Legg (2005), which reports range forage production as a function of spring precipitation. This forage production relationship is reported as a regression in Smith, Thurow, and Legg (2005). Variability in precipitation is used to predict forage, which in turn is used to alter the forage supply constraints in our model by scaling available forage as a percentage change from the mean production. The 86-year profile of precipitation indicates 45 years of below average growing season precipitation, but only 9 occurrences of consecutive years of drought.

Incorporating Price Fluctuations into the Model

Historical prices were utilized from actual Wyoming auction price data (Livestock Marketing Information Center, unpublished data). Using monthly data converted to 2006 dollars, we identify a 27-year span of prices across the relevant livestock classes that contains 2 complete price cycles. The price data included prices for steer calves, heifer calves, cull cows, bulls, heifer yearlings, steer yearlings, and bred cows from 1968 to 2006. Prices collected were for the weights and time of sales determined by the strategies analyzed.

We looped this 27-year price data set in order to create a series of prices long enough to match with the 86 years of precipitation data. In order to evaluate how management decisions would compare across various precipitation and price combinations, the model was evaluated 27 times for each scenario, with each iteration starting at a different point in the 27-year price profile. The weather effects were modeled in a consistent manner for each iteration, resulting in 27 complete sets of financial returns to analyze. This allowed us to determine optimal responses across all potential combinations of price and weather fluctuations.

Consistent with Bastian, et al. (2009), hay prices were modeled to be constant across years. The authors find a low and positive correlation between spring precipitation and hay prices or lagged hay prices. They conclude this finding is a result of the majority of hay produced in the study area being produced under irrigation, and that current growing season precipitation is not likely to be highly correlated with storage of irrigation water.

Scenarios Analyzed

We extend the research reported by Bastian, et al. (2009) by modeling the alternative management strategies described earlier, including partial liquidation and purchasing feed, over a longer horizon across multiple weather and price combinations. This allows us to conduct comparisons across the scenarios as well as how each competes across various drought scenarios. The alternative scenarios analyzed are listed in Table 1.

The base scenario, which only allows partial herd liquidation as a drought mitigation strategy (labeled as *Base*), was modeled by allowing herd size to fluctuate as deemed optimal by the mathematical model. The option to purchase additional hay (*Summer Feeding*) removes the constraint that limits hay fed in summer months when most feed requirements are traditionally met through grazing for the model ranch. The option to wean calves early and take them to market earlier than normal in order to reduce forage needs in the summer (*Early Wean*) assumes the producer is free to wean as many calves as needed to bring herd requirements in line with available forage on August 1 (as opposed to October 15 in the base model). The animals are taken to market at lighter weights due to early weaning.

The strategy that utilizes later calving dates (*Late Calving*) pushes calving dates to June 1 (as opposed to April 15 in the base model), but maintains the October 15 weaning date and November 1 sale date. This strategy is expected to reduce the overall hay requirement of the herd as high feed requirements during lactation are largely met through grazing rather than supplemental feeding (May, et al., 1999; Kruse, et al. 2007). As expected, calves born later are modeled as being sold at lighter weights than traditionally born calves (e.g., steer calves were modeled at 390 lbs. for the late calving scenario versus 440 lbs. in the base model). Weights for late season calves are not assumed to be drastically different from earlier born calves however, as Younglove, et al. (1998) state that in Wyoming, later born calves usually experience heavier birth weights than early season calves. Kruse, et al. (2007) also reported lighter weaning weights for later calving seasons, however they mention reduced costs from late calving can increase overall profitability. Therefore, we model the late calving scenario in two ways. The base late calving scenario (*Late Calving*) only alters calving dates, weaning/sale weights, and the prices associated with lighter sale weights. The other late calving scenario analyzed (*Late Calving-Additional Benefits*) models additional benefits that may be realized, which include increased breed back (a reduction of open cows by 50% [Smith, personal communication, 2008]), reduction in calf death loss by 50% (May, et al. 1999), a reduction yearly in cow costs (due to less calving difficulties and labor costs [May, et al. 1999]), less supplementation needs, (Younglove, et al. 1998), and a reduction in yearly fixed costs representing cost savings associated with less required buildings for calving, given most calving would take place out of doors (May, et al. 1999). While not all of these additional benefits may be experienced by all producers (for example, it is unlikely an operation would eliminate existing barn space due to reduced calving inside), the model was run with all benefits to get an idea of the potential impact of a best case scenario associated with a conversion to late calving. It should be noted, however, that the model assumes the transition has already occurred, and none of the conversion costs (transition breeding stock, updating grazing strategies, etc.) have been included.

The final scenario analyzed was that of retaining all weaned steers (*Retain Steers*) over winter with the goal of selling yearling steers the following November. However, in order to accommodate the reduced forage supply associated with drought, this scenario gave producers the option to sell some short yearlings on May 1 in order to reduce herd forage requirements if needed. It should be noted here as well that the model assumes transition to a cow-yearling operation has already occurred, and neither the initial loss of revenues associated with a forgone steer calf crop nor any costs associated with the conversion are included in this analysis.

Analysis of Results

Each of the above scenarios was modeled over each of the 27 iterations for the 86-year planning horizon, as described previously. GAMS output was used to determine the net discounted returns (revenues less costs) over each of the 27 iterations for each scenario. In addition to overall profitability, special attention was given to how each scenario performed within drought periods. To determine effectiveness at mitigating drought impacts, output was analyzed for three separate drought events. The first event was a short, two-year drought. A five-year window was also examined which consisted of two years of drought, followed by a year of normal precipitation, immediately followed by another two-year drought. Finally, an extended drought of 11 years was examined (this represented the longest drought in our data set). All of the drought comparisons are made across the sum of net returns over the window analyzed.

Results

Returns Over Entire Horizon

As seen in Table 2, the profitability over the 86-year horizon varied across the management scenarios analyzed. Consistent with Ritten (2008), allowing for summer feeding did improve overall average profitability over the long run when compared to just partial liquidation. However this alternative was the least profitable when compared to the remaining management options. If all of the additional benefits are included with the late calving option, this scenario outperformed all others over the planning horizon on average. However, if the only change is lighter calves at sales date ignoring all other potential benefits as stated by Smith (2008), the scenario that retained all steer calves over the winter with the option to sell in early summer or fall outperformed the late calving strategy. The option to wean calves early and send them to market when forage resources became scarce in mid-summer performed worse than either late calving or retaining steers, yet did outperform both summer feeding and only partial liquidation as management strategies.

Many producers are also concerned with risk when making management decisions. Summer feeding and retaining steers over the winter reduced the standard deviation of outcomes when compared to the base scenario of partial liquidation, while early weaning and late calving widened the distribution. Producers concerned with more constant returns may be motivated to consider retaining steers over the winter or feeding hay during the summer when forage resources become scarce rather than the riskier, yet potentially more rewarding, late calving option.

Short Drought Results

The weather data consisted of many drought years and many short drought events. Therefore, a two-year drought event was examined to determine effectiveness of each strategy to cope with a relatively short drought event with the results reported in Table 3. Over this drought event, the best performing strategy on average was again the late calving option when all other potential benefits are included. However, over this horizon, even without the additional benefits as suggest above, late calving performs better on average than the nonlate calving options. The main difference when including the additional potential benefits is slightly more variable outcomes, but better potential profits and lower potential maximum losses as compared to late calving only. Over this short drought, early weaning outperforms retaining steers. However, both late calving scenarios and early weaning experience much more variability in their respective outcomes. Moreover, retaining steers is the only scenario that did not result in a minimum that indicated negative returns. This suggests a risk adverse producer may want to examine retaining steers as a potential strategy. While all of these strategies offer improvements over the base scenario, the option of summer feeding actually lowers average profitability. While this may seem counter intuitive, Ritten (2008) describes this as an inventory effect, contributing the lower profitability in the drought years to the added costs of carrying larger herd numbers through the drought with purchased feed. Ritten (2008) went on to explain that this option performed well post-drought, allowing the producer to sell more animals immediately post-drought, while the base scenario required took longer to restore herd numbers to pre-drought levels and resulted in less sales as heifers were retained rather than sold.

Medium Drought Results

The medium drought consists of two years of drought followed by a year of average precipitation followed again by two years of drought. As seen in Table 4, the ranking of scenarios based on average profitability are largely consistent with the overall profitability trends of the entire 86-year horizon, except for the summer feeding scenario, which again was the worst performing scenario due to the increased costs of the inventory effect. Notably, over this five-year window, the option to retain steers was much more competitive with the late calving scenario with all potential benefits as compared to the total eighty-six-year horizon. While the late calving scenario with these benefits did have the best potential maximum pay-off, the option to retain steers was much less variable than either of the late calving scenarios or the early weaning option. The early weaning strategy provided a very high potential payoff (maximum), but it was also the riskier option with both a lower average and more variable profitability over this five-year horizon, as compared to either late calving or retaining steers.

Long Drought Results

As seen in Table 5, over the long drought horizon, the top performing strategy was again late calving with all potential benefits. Even without the included benefits, late calving still outperformed retaining steers over winter. Retaining steers offered the next best average returns after either late calving scenario. Early weaning did have a higher potential maximum payoff when compared to retaining steers, but it had the most variability in returns over this 11-year horizon compared to the other alternatives. As with the other drought events, summer feeding decreased average profitability when compared to the base scenario due to the inventory effect.

Conclusions

Bastian, et al. (2009) point out that relatively little research has been published examining the potential financial outcomes of alternative livestock strategies given variable precipitation, particularly drought events, and fluctuating market prices. As livestock producers are likely to continue to face periods of drought, some insight as to the performance of alternative management strategies was evaluated. This research utilized a multi-period mathematical programming model to examine long-term profitability as well as financial outcomes during specific periods of drought for partial liquidation, summer feeding, late calving, early weaning, and retaining of steers over winter. Over a long planning horizon, based on our assumptions, if additional benefits of late calving, which included lower calf death loss, increased breed back, and reduction in both fixed and variable per-cow expenses were realized, late-calving offered the best returns on average. However, if these additional benefits are not realized, retaining steers over winter with the option to sell short yearlings early in the grazing season if forage becomes scarce, performs the best on average. Another benefit of the retaining steers option is that profit variability is reduced as compared to either late calving or early weaning. The strategy of summer feeding during periods of drought outperforms the base scenario of partial liquidation only over the entire horizon, but during drought events performs worse due to increased costs associated with higher herd numbers. This option performs better immediately post-drought as compared to partial liquidation because producers are able to sell more calves than producers that culled more deeply during drought as they retain additional animals to restore herd size to pre-drought levels.

During drought events, the top performer on average continued to be late calving if the additional benefits were realized. Without the potential additional benefits of late calving, the option to retain steers performed better on average than any other option in medium droughts, and very similar to late calving in a very long drought. During a short drought, late calving outperformed all others on average, but returns were more variable and had a similar maximum payoff as early weaning. The option to wean and sell calves early as a way to conserve forage in poor forage years never performed best on average. However high potential payoffs (maximums) were possible in short and medium length drought events. A major drawback of this option is riskiness as measured by variability in returns. This alternative resulted in the most variable outcomes of any scenario analyzed for medium and long length drought events.

As stated previously, the option to feed in the summer to mitigate reduced grazing forage production during drought years lowered average profitability in all drought events analyzed as compared to the base scenario that only utilized partial liquidation during the drought impacted years. Previous research by Ritten (2008) indicates this is due to an inventory effect, namely that producers that feed to offset poor forage production are able to carry larger herds resulting in higher variable costs during drought impacted years as compared to producers that rely solely on herd liquidation. This scenario performs better than partial liquidation in the long run as these producers are in a better position immediately post-drought to generate more revenues from calf sales compared to producers that must retain heifer calves to restore herd numbers. The fact that this option decreases profitability in drought years should be acknowledged, and producers considering this alternative should evaluate whether their operation is in a financial position to absorb these lower profits in drought years.

Producers concerned with risk management may want to consider the option to retain steer calves over winter, and sell short yearlings if forage resources are unable to support existing herd numbers. Although this was never the best possible performer, it did perform well on average, and had lower variability than most other strategies over most of the drought events analyzed. This result is consistent with previous work by Feuz and Kearl (1987) that indicated cow-yearling operations were more profitable than cow-calf operations in Wyoming.

Given our results indicate late calving may be a promising strategy, some caution must be exercised used when considering this alternative. There are some potential disadvantages of this option that were not incorporated into our analysis. May, et al. (1999) point out that one drawback is the potential for conflicting labor demands when calving is delayed into irrigating schedules. Another potential drawback as stated by May, et al. (1999) is that many producers in this region rely on public grazing during summer months, and moving newborn calves to these grazing lands can be stressful to both the calves and the dams. Additionally, producers utilizing common grazing allotments can lead to problems if others turn out bulls when grazing these public lands. Late calving would require isolation of cows from other herds in the area to eliminate the potential for early conception. While our analysis ignored these potential drawbacks, they should be evaluated before adopting this strategy.

We believe this research makes an important contribution to the literature in terms of analyzing alternative management strategies as potential drought mitigation strategies, but we must also recognize some limitations. First, as with Bastian et al. (2009), we assumed our range to consist primarily of cool season grasses, which allows us the ability to predict annual forage production with spring precipitation. The ability to predict shortages in forage production is likely to be more problematic for ranges with different forage composition. We also assumed linear production relationships in our model. Animal weights may very well not behave linearly. While we did analyze a relatively long window including various combinations of precipitation and cattle prices, we ignored any specific correlations between the two, focusing instead on distributions of potential outcomes. It is expected that cattle prices may be influenced by national drought events that impact cattle management, although we expect less of an impact on specific localized drought events.

References

Bastian, C. T., S. Mooney, A. M. Nagler, J. P. Hewlett, S. I. Paisley, M. A. Smith, W. M. Frasier, and W. J. Umberger. 2006. "Cattle Ranchers Diverse in Their Drought Management Strategies." *Western Economics Forum* 5,2:1-8.

Bastian, C. T., P. Ponnamanneni, S. Mooney, J. P. Ritten, W. M. Frasier, S. I. Paisley, M. A. Smith, and W. J. Umberger. 2009. "Range Livestock Strategies Given Extended Drought and Different Price Cycles" *Journal of the American Society of Farm Managers and Rural Appraisers* 72,1: 153-163.

Carande, V. G., E. T. Bartlett, and P. H. Gutierrez. 1995. "Optimization of Rangeland Management Strategies under Rainfall and Price Risks." *Journal of Range Management* 48:68-72.

Feuz, D. M. and W. G. Kearl. 1987. "An Economic Analysis of Enterprise Combinations on Mountain Valley Cattle Ranches." Department of Agricultural and Applied Economics and Agricultural Experiment Station, University of Wyoming. RJ-207. April.

Foran, B. D., and D. M. Stafford Smith. 1991. "Risk, Biology and Drought Management Strategies for Cattle Stations in Central Australia." *Journal of Environmental Management* 33: 17-33.

Holecheck, J. L. 1994. "Financial Returns from Grazing Different Management Systems in New Mexico." *Rangelands* 16:237-240.

Kruse, R. E., M. W. Tess, and R. K. Heitschidt. 2007. "Livestock Management During Drought in the Northern Great Plains. II. Evaluation of Alternative Strategies for Cow-Calf Enterprise." *The Professional Animal Scientist* 23: 234-345.

Livestock Marketing Information Center (LMIC), unpublished data. June 2007.

May, G. J., L. W. Van Tassell, M. A. Smith, and J. W. Waggoner. 1999. "Delayed Calving in Wyoming." *Rangelands* 21,3: 8-12.

Nagler, A., C. T. Bastian, J. P. Hewlett, S. Mooney, S. I. Paisley, M. A. Smith, M. Frasier, W. Umberger, and P. Ponnameneni. 2007. "Multiple Impacts – Multiple Strategies: How Wyoming Cattle Producers Are Surviving in Prolonged Drought." Bulletin B-1178. Cooperative Extension Service, College of Agriculture, University of Wyoming, Laramie. April.

Parsch, L. D., M. P. Popp, and O. J. Loewer. 1997. "Stocking Rate Risk for Pasture-Fed Steers Under Weather Uncertainty." *Journal of Range Management* 50:541-549.

Ritten, J. 2008. "Bioeconomic Modeling of Livestock Production, Rangeland Management and Forage Systems in a Dynamic Context." Unpublished Doctoral Dissertation. Department of Agricultural and Resource Economics. Colorado State University. Fort Collins, CO.

Smith, M. A. 2008. Personal Communication.

Smith, M. A. 2007. "Recognizing and Responding to Drought on Rangelands." *Wyo Range Facts*, University of Wyoming, CES Publication, MP-111.09, April, (available at: http://ces.uwyo.edu/PUBS/MP111-09.PDF).

Smith, M. A., T. L. Thurow, and D. L. Legg. 2005. "Report for 2002WY7B: Drought prediction model development and dissemination in Wyoming." (Available at: http://water.usgs.gov/wrri/04grants/Progress%20Completion%20Reports/2002WY7B.pdf).

Torell, L. A., J. A. Tanaka, N. Rimbey, T. Darden, L. Van Tassell, and A. Harp. *Ranch-Level Impacts of Changing Grazing Policies on BLM Land to Protect the Greater Sage-Grouse: Evidence from Idaho, Nevada and Oregon*. Caldwell, ID: Policy Analysis Center for Western Public Lands, PACWPL Policy Paper SG-01-02, 2001.

Younglove, G. A., T. M. Youngberg, J. W. Waggoner, R. H. Hart, and M. A. Smith. 1998. "Sustainable Rangeland Based Beef Cattle Production Systems." *Reflections*, University of Wyoming Cooperative Extension, 1998: 15-17.

Table 1. Comparison of alternative herd management strategies

	Base	Summer Feeding	Late Calving	Late Calving - Additional Benefits	Early Wean[1]	Retain Steers[2]
Calving Date	Apr. 15	Apr. 15	June 1	June 1	Apr. 15	Apr. 15
Weaning Date	Oct. 1	Oct. 1	Oct. 1	Oct. 1	Aug. 1 / Oct. 1	Oct. 1
Allowed to Feed Hay in Summer Months	No	Yes	No	No	No	No
Yearling Sale Date	N/A	N/A	N/A	N/A	N/A	May 1 / Nov. 1
Reduction in Calving Costs Compared to Base	No	No	No	Yes	No	No

[1] Standard weaning date is October 1, however calves can be weaned or sold August 1 if forage resources are lacking due to drought. [2] Standard yearling sales date is November 1, however yearlings can be sold May 1 if forage resources are lacking due to drought.

Table 2. Range and distribution of net discounted returns over entire 86-year horizon

	Late Calving	Late Calving Additional Benefits	Early Wean	Retain Steers	Summer Feeding	Base
Minimum	$1,382,708	$1,556,828	$1,241,704	$1,440,733	$977,329	$885,562
Average	$1,532,248	$1,712,451	$1,415,089	$1,591,260	$1,105,798	$1,034,335
Maximum	$1,640,996	$1,826,303	$1,542,872	$1,683,501	$1,189,350	$1,121,476
Standard Deviation	$80,402	$83,309	$81,951	$65,694	$62,143	$66,743

Table 3. Range of distribution of net discounted returns over 2-year drought

	Late Calving	Late Calving - Additional Benefits	Early Wean	Retain Steers	Summer Feeding	Base
Minimum	-\$16,294	-\$6,889	-\$15,548	\$7,578	-\$28,174	-\$25,279
Average	\$98,675	\$100,825	\$94,616	\$80,749	\$45,947	\$60,483
Maximum	\$185,480	\$205,785	\$185,130	\$161,074	\$110,670	\$125,238
Standard Deviation	\$63,145	\$65,661	\$60,536	\$39,409	\$40,341	\$49,679

Table 4. Range and distribution of net distribution returns over 5-year drought

	Late Calving	Late Calving - Additional Benefits	Early Wean	Retain Steers	Summer Feeding	Base
Minimum	\$48,911	\$68,465	\$31,713	\$90,100	\$24,580	\$18,248
Average	\$167,625	\$190,960	\$153,680	\$187,490	\$106,344	\$106,764
Maximum	\$275,338	\$302,349	\$301,088	\$287,245	\$184,798	\$192,630
Standard Deviation	\$68,032	\$71,640	\$71,592	\$51,200	\$48,130	\$51,247

Table 5. Range of distribution of net discounted returns over 11-year drought

	Late Calving	Late Calving - Additional Benefits	Early Wean	Retain Steers	Summer Feeding	Base
Minimum	\$65,198	\$75,889	\$53,682	\$63,759	\$36,892	\$38,331
Average	\$74,378	\$84,035	\$68,218	\$73,536	\$46,010	\$47,717
Maximum	\$85,757	\$93,347	\$79,838	\$79,115	\$52,351	\$54,760
Standard Deviation	\$5,386	\$5,184	\$6,347	\$4,077	\$4,421	\$4,345