Managing your ranch during drought:
Implications from long- and short-run analyses

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Executive Summary

We examine the economic consequences of the two most common drought management strategies utilized by Wyoming producers according to recent survey results – purchasing additional feed and partial herd liquidation.

We analyze different combinations of drought and price cycles to determine how these strategies will perform across differing situations. Specific attention is given to long-run and short-run outcomes and the important considerations for producers thinking about implementing these strategies. We investigate whether it is better to 1) liquidate animals and increase current revenues at the potential expense of having to increase herd sizes in the future, or 2) maintain larger herd sizes and increase current costs while decreasing the need for future expenses related to restocking by utilizing purchased feed to address forage shortages during periods of drought.

Our research results suggest there is potential for greater long-term profits if purchased feed is used to address forage shortages, but this can be a risky strategy to pursue as producers may incur increased borrowing and costs in the short run. A producer who does not want to accept additional risk would be better off foregoing the feeding strategy and culling deeper.

If a producer is willing to accept more risk, has some financing available, and expectations are for increasing prices over the next several years, purchasing feed may be a good management strategy. All of these decisions should be made with considerations regarding the long-term health of the range resource.

Cattle producers will likely have to manage their operations through drought multiple times during their lives. Recently, Wyoming, as well as other parts of the western U.S., has experienced one of the worst drought periods in more than 80 years (Piechota et al., 2004), and research suggests the dry summers often associated with drought years may become more common due to climate change (Hengeveld, 2000). Cattle producers are affected both by less available water and lower productivity on rangelands during drought. Even though drought is relatively common, few economic analyses have been conducted to compare possible drought management strategies for Wyoming cattle producers.

A survey of Wyoming cattle producers was conducted to determine the effects of, and strategies for coping with, the drought (Nagler et al., 2006). Producers tended to strongly agree with the following statement, "A drought contingency plan is important for beef producers in Wyoming." Although producers generally tended to agree having a drought management plan is important, their actual responses to drought varied. Bastian et al. (2006) point out the economic consequences of these strategies are not well understood.

Price cycles may also affect the economic consequences of drought management strategies. Prices were below their peak when many Wyoming producers liquidated their herds in response to the most recent drought. This created lower revenues for local producers than would have been the case during cyclically high prices. Moreover, as producers began to restock herds in the face of rising prices, they were doing so by either retaining calves that could have sold at higher prices or purchasing breeding stock at high prices. These high-cost animals are likely to have very low returns over their productive lives. Bastian et al. (2006) conclude there could be great value in developing research that can account for the potential cumulative effects of drought and price cycle dynamics when analyzing potential drought management strategies.

In this analysis, we examine the economic consequences of the two most common drought management strategies utilized by Wyoming producers according to survey results reported in Nagler et al. (2006) – purchasing additional feed and partial herd liquidation. We analyze different combinations of drought and price cycles to determine how these strategies will perform across differing situations. Specific attention is given to long-run and short-run outcomes and the important considerations for producers thinking about implementing these strategies. We hope to answer whether it is better to 1) liquidate animals and increase current revenues at the potential expense of increasing herd sizes in the future, or 2) maintain larger herd sizes and increase current costs while decreasing the need for future expenses related to restocking by utilizing purchased feed to address forage shortages during periods of drought.

How the Problem was Approached

A mathematical model of a representative case ranch in Fremont County, Wyoming, developed by Torrell et al. (2001) was used for our analyses. The representative ranch simulates a cow-calf ranch with forage resources capable of sustaining a herd of 600 cows. The model maximizes net present values (NPV) of discounted annual returns over a specified planning horizon. The model is specified to ensure seasonal forage availability from grazing leases and permits meet seasonal herd forage requirements. Feed, in the form of additional hay, can also be purchased, although may only be fed during the traditional winter-feeding season in the baseline model. The herd evolves over time, although livestock may be bought and sold on an annual basis. Likewise, excess cash is assumed to be saved to cover potential cash needs in future years. The model also allows for short-term debt to accrue if prior savings are not able to meet current cash flow needs.

For a more detailed explanation of the representative ranch, see Torrell et al. (2001) or Taylor et al. (2004). Figure 1 (from Torrell et al., 2001, p. 5) shows a basic graphical depiction of the ranch model within a planning year. The model was utilized in two different ways to analyze the long-term and short-term implications of both partial liquidation and allowing additional purchased feed to mitigate the effects of drought on the representative ranch.

Long-term Analysis

When estimating how drought affects range forage supplies, Smith (2007) indicates spring precipitation is a good predictor of yearly forage production for the state. As the representative ranch is set in Fremont County, precipitation data from Riverton were coupled with estimated forage response functions from Smith et al. (2005) to estimate forage production for 1921 through 2006 (86 years). The estimated forage production over time was then utilized in the mathematical model to test the management strategies during times of drought.

Cattle prices were obtained for the Torrington cattle auction mainly from the Livestock Marketing Information Center (LMIC), (unpublished data supplied by Jim Robb, LMIC, Lakewood, CO, June 22, 2007); however, some

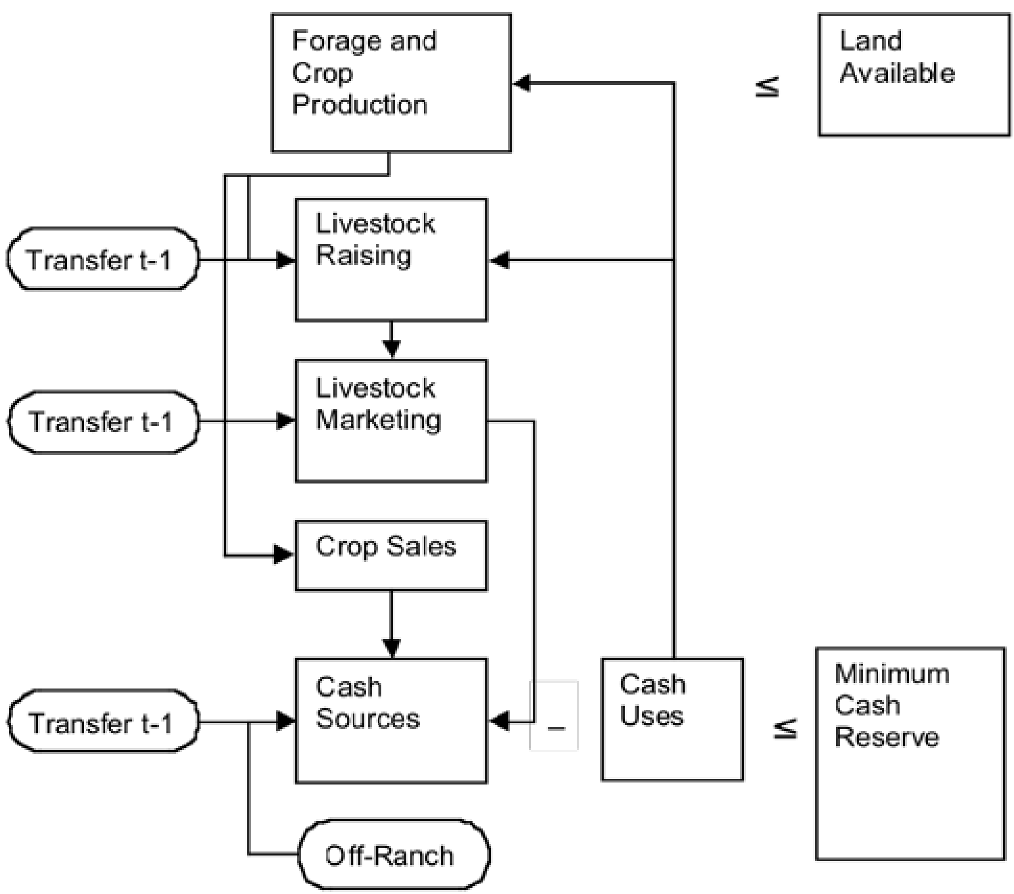

Figure 1. Graphical display of mathematical model (from Torrell et al., 2001, p. 5)

data were also obtained from Cattle-Fax (unpublished data from Cattle-Fax Inc., Centennial, CO, August 21, 2007). Any months with missing observations in both data sets were estimated based on existing data from the animal classes with complete data sets. The model assumes a sale date of November 1; therefore, prices in the model were based on average prices received October 1 through November 30. Price data were analyzed from 1968 through 2006, with two complete distinct price cycles being observed from 1980-2006. These 27 years of prices were replicated to create a cycle of prices 86 years – long enough to match the length of the series of estimated forage production previously described.

As this model was designed to determine long-term implications of management strategies, the data streams were further manipulated to replicate many potential combinations of weather and price outcomes. Precipitation data were looped and analyzed. Three series of forage production having an 86-year stream of data starting in either a relatively dry, normal, or wet pattern were created. The impact of both drought and prices on ranch decisions and financial outcomes were of interest, so, for each of the three weather patterns, the model was solved using each of the 27 years of the price cycle as the beginning year of prices. This results in 81 individual model applications, or 6,966 yearly observations. The model was solved initially for a scenario that did not include the effects of drought on forage production (Base), a drought scenario that allowed liquidation as the only way to mitigate drought (Drought), and a scenario that allowed feeding of purchased hay in summer months in addition to liquidation (Feed). See Ritten (2008) for more specific details.

Short-term Analysis

The model was modified again for the short-term analysis. Specific attention was given to how producers would respond in the short-term without regard to long-term implications. Again, spring precipitation (Smith, 2007) is used as the primary factor impacting range productivity. Also, actual precipitation received was analyzed, but, instead of replicating actual forage production, representative patterns of drought were determined. From 1946 to 2006, the majority of multiple-year droughts in the area lasted either three or four years; therefore, representative droughts of both three- and four-years were created based on the historical precipitation data. As in the long-term analysis, price impacts on ranch outcomes were of interest; however, in this case the focus was to determine the effect of how the cycle itself affected management decisions and outcomes. Using previously collected price data (Freeburn & Bastian, 2005; Taulealea & Bastian, 2003; Bastian, 1997; Bastian, 1992; Kearl, 1987), a representative cattle cycle observed between the years of 1979 to 1996 was identified. The resulting price cycle included a 12-year peak-to-peak cycle from 1979 to 1990 and a trough-to-trough cycle from 1985 to 1996. These data were then used to estimate smoothed prices for each class of livestock for each of the two price cycles. The model was then solved for two smoothed price cycle possibilities (peak-to-peak and trough-to-trough) for a 12-year planning horizon for weather scenarios including stable precipitation and variable precipitation with either a three- or four-year drought initiated in the second year of the planning horizon. The following specifically analyzed were:

1. Base: Stable Precipitation;
2. Three-year drought (allows model to choose optimal herd size each year);
3. Four-year drought (allows model to choose optimal herd size each year);
4. Three-year drought – Purchase feed option (allows model to choose optimal herd size and feed purchased alfalfa year round);
5. Four-year drought – Purchase feed option (allows model to choose optimal herd size and feed purchased alfalfa year-round);
6. Variable Precipitation – No long-term drought (allows model to choose optimal herd size each year).

See Ponnameneni (2007) for more specific details.

Results

Results from our analyses have some interesting implications for cattle producers. In the long-term model, with a substantially longer planning horizon, results suggest it is better to respond more to precipitation when making decisions than price indicators; however, in the short-term model, the type of price cycle the drought occurs in dominates the outcomes. This can have major impacts on decisions made by cattle producers. Table 1 displays the mean, range, and standard deviation of net discounted yearly returns over the 27 different price cycles for a scenario with constant forage production (Base), a scenario with weather impacts where the only strategy allowed is liquidation (Drought), and a scenario that also allows the ability to feed during summer months in addition to partial liquidation (Feed). The results also show that including variable precipitation in the model greatly affects the results; however, the ability to feed during drought can improve producers' profitability over the long run. This is especially true in comparison to liquidation as a strategy to mitigate for poor forage production in dry years. In the long run, maintaining larger herd sizes (not necessarily maximum herd sizes) through purchasing additional feed resulted in a higher profit over the 86-year planning horizon.

Table 2 shows outcomes for a five-year drought occurring in the 11th year of the "normal start" long-term scenario. This drought was chosen for analysis as it occurred early in the planning horizon and was preceded by relatively normal forage production. This allowed us to better determine the effects of a major drought on an operation after a relatively normal period. Annual net discounted returns, number of cows, and cash transfers (the model was able to deposit enough money from prior years to make short-term borrowing from the bank unnecessary) for each of the five years of drought as well as the two years immediately following the drought are listed in Table 2.[1] A major finding in the long-term model is that average net discounted returns during the five-year drought are almost identical for the drought and feed scenarios, with the returns accruing to the feed scenario being slightly more variable. This may seem counterintuitive, as this strategy was hypothesized to mitigate impacts from the drought in Table 1; however, upon further analysis, the similarity in returns is due to the fact the feed scenario is able to carry a few more cows through the drought, resulting in fewer culling activities. This has two impacts. The drought scenario will increase revenues during the drought by selling culled animals while the feed scenario will have increased costs associated with feeding and carrying a slightly larger herd as well as increased revenues associated with larger calf crops. The feed scenario relied more heavily on withdrawals to fund this strategy. So, why would this strategy be used by producers to mitigate drought impacts? The answer seems to follow immediately post-drought. In the second set of columns in Table 2, the same variables are reported for a two-year period immediately following the drought. Here we can see the feed scenario outperforms the base drought scenario in terms of returns, has much less variability in herd size, and is able to save more money ($57,298 versus $46,262).

When looking at the short-term scenarios, we analyzed the liquidation and feed strategies for both a three- and four-year drought against stable precipitation and variable precipitation without a long-term drought. An important difference in this scenario is the planning horizon is only 12 years long, and the drought is imposed before any money can be saved, resulting in higher borrowing needs. Both drought scenarios impose the beginning of the drought in year two; however, the three-year drought begins with very poor forage production that improves as the drought continues while the four-year drought has lesser impacts in the first year with more severe impacts occurring later in the drought scenario. As with the long-term scenario, imposing variable precipitation results in lower returns for producers as compared to stable precipitation in all years. Regardless of the scenario, returns tend to follow price fluctuations.

Table 3 shows that the peak-to-peak price cycles with the option to purchase feed results in low, extremely variable returns. For the trough-to-trough cycles, again purchasing feed results in lower average returns. The fact that the most severe drought impacts on forage production occur at different times over the planning horizon is the reason producers tend to perform better in a four-year drought as compared to a three-year drought.

Table 4, which ranks the scenarios by mean returns, also displays averages of other variables of interest. As stated above, the four-year drought tends to outperform the three-year drought in terms of average returns per year. In the peak-to-peak cycle without the option to feed, the better performance of the four-year drought scenario is due to the fact that, on average, the herd size for the four-year scenario averages higher than for the three-year drought scenario, yet requiring only slightly more feed and less overall borrowing. When feeding is allowed as an option to deal with drought, the three-year drought scenario sees higher mean herd sizes as compared to the four-year drought, but the increased costs associated with higher feed and borrowing costs outweigh the benefit of higher herd sizes when compared to the four-year drought scenario. In the trough-to-trough cycle, regardless of whether feeding is allowed as a drought mitigation strategy, the four-year drought scenario has much higher herd numbers, no borrowing, and only slightly more feed as compared to the three-year drought scenarios.

The option to purchase feed does not outperform liquidation only in a short-term planning horizon without the ability to rebound. This seems to suggest purchasing feed may not be a preferred way to mitigate decreased forage production associated with drought conditions. Purchasing feed results in more variable returns (except possibly in the trough-to-trough cycle) and an increase in borrowing needs, implying this strategy could be risky for a producer who is not able to bear these burdens when planning for the long-term. Regardless of risk-bearing ability, timing of drought and price cycles will generally affect the success of purchasing feed as a drought mitigation strategy.

1 It should be noted the model assumed sufficient off-ranch income to offset a family allowance. This allows all ranch income to be used for business purposes. This was done to evaluate the effectiveness of the management strategies described.

So, Should Cattle Producers Feed During a Drought?

The answer is, as it always seems to be with economists, it depends. A producer unable to accept more risk would be better off foregoing the feeding strategy and culling deeper. Likewise, a producer who either has little cash reserves or little ability to acquire additional financing would do better with liquidation. Also, if a producer is unable to plan beyond just a few years, feeding is probably not a viable option. If, on the other hand, a producer is able to plan for the long-term (greater than a 10-year planning horizon) and is able to accept some short-term risk and costs, feeding may be an option worth considering. For this type of producer, expectations about the price cycle should guide the decision of whether feeding is a strategy that should be considered. The feeding strategy will make the most sense if price expectations call for increasing prices over the feeding horizon. If, on the other hand, prices are expected to drop over the potential feeding horizon, a producer would be better off to cull deeper, as the feeding strategy would reduce sales at high points in the cycle and create higher-cost animals that will begin to produce calves when prices are dropping.

Management Implications

When faced with drought, length of the drought and outlook for cattle prices affect the outcomes associated with management decisions related to liquidation and/or purchasing additional feed. These management decisions are made with uncertainty about what the future holds regarding precipitation and prices. So, what do these results suggest for a ranch manager facing such a decision? Essentially, the producer has three questions to ask.

First, the manager needs to assess where his or her operation is financially. Is the ranch in a good equity position? Does the ranch have additional borrowing capacity, and can it withstand several years of losses without putting the operation at risk? If the answer to these questions is yes, the operation has the ability to withstand more risk. If the answer is no, then the operation has little ability to withstand more risk.

Second, the manager needs to gather market expectations about future prices. Do market predictions from experts suggest a period of falling or rising prices in the near future?

Third, the manager needs to assess his current range conditions. What do you think your range can actually support without damaging its long-term health?

The above results suggest that, if the operation has the ability to withstand several years of added costs, purchasing feed can improve potential profits in the long run. This is a less-risky strategy if the outlook is for stable-to-increasing prices. Moreover, the manager must assess how this strategy can be managed so the long-term health of the range resource is not damaged.

If, however, the operation has little willingness to accept more risk, little ability to borrow additional capital, and the outlook for prices is uncertain to declining, partial liquidation is likely a safer strategy. How many head to cull should be based on the manager's assessment of what the range resource can safely support. Smith et al. (2005) suggest precipitation in April and May are good indicators of that year's forage supplies. Hoping for more precipitation later in the year will likely lead to stocking decisions that may result in running out of forage and forced liquidation as well as putting the range resource at risk. Thus, culling decisions should be made as early as possible in the summer to reduce risk.

Tools Available to Producers to Help with Management Decisions

When making the decision how to cope with drought, it is important for the producer to fully account for changes in both costs and revenues associated with the management plan chosen. While our results give some insight as to how these strategies perform over a wide range of economic situations, our assumptions may not be accurate for all operations in the state; therefore, it is important for producers to evaluate the potential impacts of these strategies on their operations. Wyoag.net has useful tools available to help make these sorts of decisions. There is a link to an enterprise analysis tool within the Master Cattleman section on the livestock page at wyoag.net. This tool has both a partial budget tool as well as a net present value (NPV) calculator to help producers calculate how the different management plans may affect their yearly returns. The partial budgeting tool can help show the net impacts due to changes in both cost and revenues, and the NPV calculator can demonstrate the net impact of changes over multiple years. The Cattle Producer's Library (www.csubeef.com) also has some useful discussions related to both partial budgeting and net present value calculations in the finance section.

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Table 1. Long-Term Analysis – Descriptive Statistics of Net Discounted Returns over 86-Year Planning Horizon by Initial Weather Conditions and Management Scenario

		Mean	Minimum	Maximum	Standard Deviation
Base: Stable Precipitation		$1,061,164	$909,826	$1,139,373	$61,527
	Dry Start	$860,280	$621,477	$931,913	$69,153
Drought	Average Start	$958,874	$798,180	$1,045,134	$67,612
	Wet Start	$995,182	$817,484	$1,077,905	$65,121
	Dry Start	$882,405	$616,215	$963,002	$76,974
Feed	Average Start	$1,033,516	$906,845	$1,115,948	$60,806
	Wet Start	$1,082,845	$942,620	$1,158,082	$56,800

Table 2. Long-Term Analysis – Summary of Means of Net Discounted Annual Returns, Number of Cows, and Cash Transfers During and After a Five-Year Drought by Management Scenario

	During Drought				Post-Drought			
	Mean	Minimum	Maximum	Standard Deviation	Mean	Minimum	Maximum	Standard Deviation
Net discounted Returns								
Drought	$19,309	-$21,411	$56,440	$17,578	$26,537	-$9,636	$54,608	$15,741
Feed	$19,365	-$22,412	$55,838	$18,022	$30,093	-$3,753	$56,052	$15,523
Number of Cows								
Drought	445	383	512	37	528	376	600	48
Feed	447	395	518	24	514	410	585	42
Cash Transfers								
Drought	$9,301	-$82,418	$98,662	$42,447	$46,262	-$67,445	$123,862	$48,937
Feed	$9,582	-$87,213	$97,212	$43,265	$57,298	-$49,206	$139,707	$47,844

Table 3. Short-Term Analysis – Descriptive Statistics of Annual Net Discounted Returns – By Price, Precipitation, and Management Scenario.

	Price Cycle: Peak to Peak			
Scenario	Mean	Minimum	Maximum	Standard Deviation
Base: Stable Precipitation	$34,092	$9,449	$95,221	$26,699
Variable Precipitation	$14,757	-$16,507	$115,680	$37,093
Three-Year Drought	$8,622	-$23,989	$113,925	$36,138
Four-Year Drought	$15,933	-$13,101	$110,528	$33,851
Three-Year Drought – Purchase Feed Option	-$12,244	-$63,434	$108,584	$47,203
Four-Year Drought – Purchase Feed Option	-$3,922	-$52,069	$107,768	$44,990
	Price Cycle: Trough to Trough			
Base: Stable Precipitation	$40,819	$5,310	$70,589	$18,462
Variable Precipitation	$27,277	$1,162	$42,725	$12,827
Three-Year Drought	$23,560	$1,162	$39,147	$95,95
Four-Year Drought	$30,869	$1,162	$48,600	$12,588
Three-Year Drought – Purchase Feed Option	$19,088	-$2,757	$36,656	$10,919
Four-Year Drought – Purchase Feed Option	$25,966	-$1,100	$35,611	$9,661

Table 4. Short-Term Analysis – Summary of Means of Net Discounted Returns (arranged in descending order), Herd Size, Amount of Raised Meadow Hay, Amount of Purchased Alfalfa, and Amount of Short-Term Borrowing By Precipitation, Management, and Price Cycle Scenario.

Precipitation and Management Scenario: Price Cycle	Mean of Net Discounted Returns	Mean of Herd Size (AU)	Mean of Raised Meadow Hay Used	Mean of Purchased Alfalfa	Mean of Short-Term Borrowing
Base - Stable Precipitation: trough to trough	$40,819	$673	$893	$72	$238
Base - Stable Precipitation: peak to peak	$34,092	$692	$917	$77	$0
Four-Year Drought: trough to trough	$30,869	$486	$646	$52	$0
Variable Precipitation: trough to trough	$27,277	$420	$558	$44	$0
Four-Year Drought - Purchased Feed Option: trough to trough	$25,966	$501	$668	$107	$427
Three-Year Drought: trough to trough	$23,560	$426	$569	$37	$1,663
Three-Year Drought - Purchased Feed Option: trough to trough	$19,088	$428	$572	$77	$8,415
Four-Year Drought: peak to peak	$15,933	$495	$659	$48	$17,708
Variable Precipitation: peak to peak	$14,757	$451	$599	$50	$20,456
Three-Year Drought: peak to peak	$8,622	$445	$591	$44	$31,419
Four-Year Drought - Purchased Feed Option: peak to peak	-$3,922	$455	$604	$109	$55,926
Three-Year Drought – Purchased Feed Option: peak to peak	-$12,244	$495	$657	$131	$69,397