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RISK SCENARIO PLANNING

United States farm policy enacted since 1996 has created a need for agricultural producers to better understand and manage risk. However, risk is a difficult concept to address because the ideas are challenging and the breadth of solutions is wide. Even where the concept is well understood, few have mastery of the tools and skills needed to properly evaluate alternatives.

RightRisk has been involved in developing teaching simulations, online courses, and risk decision tools since 2001. The team's recently completed Risk Scenario Planning (RSP) tool provides farm and ranch managers much-needed assistance in evaluating risk management alternatives. RSP utilizes a partial budgeting framework to evaluate proposed changes, including: added returns; reduced costs; added costs; or reduced returns. From these, the net financial benefit of making a change may be calculated.

While partial budgeting provides a useful approach for evaluating changes, it is not especially helpful in evaluating the impact of any risks that may be involved. The RSP tool offers users a chance to evaluate risk scenarios by varying up to two factors. The RSP tool describes possible outcomes using a cumulative distribution graph that indicates the probability of earning a net return at or below a given value.

Risk Analytics, Decision Analysis, Farm Management

Introduction

When a farm or ranch manager contemplates making changes to their business operations, they often do so with some intuition for the future. In other words, the change is based on a forecast for what the future holds. Uncertainty is almost always present when these decisions are taken and with it comes anxiety.

Partial budgets are one approach for organizing financial information that many find useful when contemplating a change to an operation, particularly if the change is relatively simple. For example, a manager might ask, “Do I retain and breed back more heifers in order to take advantage of a good market for replacements?” This is a question that can be analyzed fairly easily with a partial budget approach. However, in order to develop the budget, the manager must make estimates for prices, yields, and costs. What happens if those numbers are surrounded by uncertainty? What happens if the go/no-go answer to the question is dependent upon some key uncertain number?

There are a number of ways to handle this dilemma but what most managers appear to do is make a “best guess” for the uncertain numbers and enter them into the budget. The “best guess” can be an estimate of the most likely outcome or it may be an average of all of the possible outcomes. Either way, it serves as an estimate for the uncertain number. However, the proxy nature of this value is often forgotten as the decision-making process unfolds. What began as an estimate often evolves into a certain value when deciding if the management change is worth pursuing.

A better way to handle the uncertainty when estimating uncertain values is to think in terms of distributions. Instead of making a “best guess” to estimate an uncertain number, managers should take the time to think of the range of possible values the number may take in the future. In a simplistic sense, this is playing a “what if” game. In a slightly more sophisticated sense this might be called scenario planning or scenario risk analysis. The idea is to, rather than attempt to estimate the uncertain number as a single “certain” value for decision-making, embrace the uncertainty and bring it into the decision-making process to create a more robust answer to the question at hand.

Risk Scenario Planning Tool

Computers can be a tremendous asset when it comes to analyzing several alternative scenarios in the presence of uncertainty. The Risk Scenario Planning tool was developed to help managers play the “what if” game, when analyzing proposed changes to their business. The tool is based on the standard framework used to create a partial budget.

A partial budget is a simple framework used to analyze changes to a portion of a business. It is based on the fact that changes to business operations can generally be assessed by their four different effects on the bottom line. Any particular management change under consideration can: (1) add returns; (2) reduce costs; (3) add costs; or (4) reduce returns. The effects of (1) and (2) will increase profits while the effects of (3) and (4) will decrease profits. The net financial benefit of making the change can be calculated as $(1) + (2) - (3) - (4)$.

The Risk Scenario Planning tool provides a template for the decision-maker to enter the financial effects of making a proposed change. It then adds the ability to further refine estimates by defining up to two input values as uncertain numbers. Based on user input, estimates for minimum, most likely, and maximum values are used to fit beta distributions describing each of the two uncertain numbers. The RSP tool then uses a bootstrap approach to create probability estimates of the net financial benefit of making the change. This produces a more robust analysis of the proposed change and a more thorough understanding of the possible outcomes if the change is implemented.

It is easiest to understand the usefulness of this tool by seeing it applied to analyze a proposed change in an example. We have prepared an example using a proposed change for a cattle operation with uncertain prices included in the mix.

Replacement Heifer Management Change

Consider a cow/calf ranch operation that runs 350 head of cows in central Wyoming. Each year the operator would expect to replace 15 percent of the mother cows or about 52 head. As a result, the manager would normally keep 52 heifers back from the current year calf crop to feed over the winter and later breed as replacement animals.

Now consider that the manager is thinking of making a change that would involve keeping back an additional 40 heifers to put through the replacement program. The idea is that people will need replacement heifers as they rebuild their own herds following a recent drought; the genetics for this herd are strong for this area; and management feels they have a comparative advantage at raising replacement heifers and getting them bred at a lower cost than other operators.

The Risk Scenario Planning tool will allow users to analyze the expected profitability of this proposed change using a partial budget approach, while including the uncertainty around future market prices. Figure 1 depicts the completed partial budget analysis as entered into the RSP tool.

Figure 1. Completed partial budget analysis for raising 40 extra replacement heifers.

Positive Effects				Negative Effects			
Added Returns		Quantity	Value	Added Costs		Quantity	Value
Bred Heifers	34	\$ 1,200.00	\$ 40,800.00	Private Grazing (40 hd. X 6 AUMs)	240	\$ 20.00	\$ 4,800.00
6 Feeder Heifers (408 kilos)	2448	\$ 2.97	\$ 7,270.56	Hay (40 hd. X 1,587 kilos)	63480	\$ 0.21	\$ 13,330.80
Cull Bulls (kilos/year)	272	\$ 1.87	\$ 508.64	Vet & Medicine	40	\$ 10.00	\$ 400.00
			\$ -	Hired Labor (hours)	275	\$ 12.00	\$ 3,300.00
			\$ -	Interest - Operating Capital	27300.8	\$ 0.08	\$ 2,184.06
			\$ -	Bull Opportunity Cost	2	\$ 34.56	\$ 69.12
			\$ -	Annual Bull Depreciation	2	\$ 333.33	\$ 666.66
			\$ -	Fuel, Supplies, Repairs, Maintenance, etc.	40	\$ 29.81	\$ 1,192.40
			\$ -				\$ -
			\$ -				\$ -
Total Added Returns			\$ 48,579.20	Total Added Costs			\$ 25,943.04
Reduced Costs		Quantity	Value	Reduced Returns		Quantity	Value
			\$ -	40 Heifer Calves @ 227 kilos	9040	\$ 3.02	\$ 27,300.80
			\$ -				\$ -
			\$ -				\$ -
			\$ -				\$ -
Total Reduced Costs			\$ -	Total Reduced Returns			\$ 27,300.80
Total Positive Effects				Total Negative Effects			
(Added Returns + Reduced Costs)			\$ 48,579.20	(Added Costs + Reduced Returns)			\$ 53,243.84
Net Benefit of: Raise Bred Heifers to Sell							\$ (4,664.64)

Positive Effects of the Management Change

The positive side of the partial budget ledger includes (1) added returns and (2) reduced costs. Management does not expect any reduced costs due to the proposed change. Added returns include several points: the manager expects 34 of the 40 extra replacement heifers to be bred and ready to sell as replacement females each fall. Price expectations suggest that these replacements should sell for around \$1,200 per head or \$40,800 in total. The 6 heifers that are not successfully bred can be sold as yearling feeder animals. The manager expects they should weigh about 408 kilos (900 pounds) each and bring about \$2.97 per kilo (\$134.50 per hundred weight [cwt]). This will result in another \$7,271 in additional revenue. Finally, the extra replacement heifers will require an estimated 2 additional bulls to cover the larger herd. The manager estimates that this change will result in about 273 more kilos (600 pounds) of cull bull sales each year at around \$1.87 per kilo (\$85 per cwt) or \$509 total. The positive effects expected from making this management change total \$48,579.20 in added returns.

Negative Effects of the Management Change

The negative side of the partial budget includes (3) added costs and (4) reduced returns. Saving an additional 40 replacement heifers implies that the ranch will have 40 fewer weaned heifers calves to sell each fall. The manager estimates that the weaned heifers weigh about 226 kilos (500 pounds) each and that the market price would be about \$3.02 per kilo (\$137 per cwt). This results in \$27,301 in total reduced returns.

The more complicated aspect of the proposed management change is calculating the total additional costs expected. We begin with an estimate of the additional feed cost, including the need for at least 6 additional animal unit months (AUMs) of grazing per head at \$20 per AUM that adds an additional expense of \$4,800 per year. The winter feed requirement includes an estimated 1,587 kilos (1.75 tons) of hay per head at a price of \$0.21 per kilo (\$190 per ton) for an added hay expense of \$13,331 per year.

The manager also estimates that \$10 per head or an additional \$400 for veterinary and medicine expenses will be needed. Finally, additional labor expenses are more difficult to estimate but the manager's experience suggests that 275 additional hours will be needed to check, move, handle, and feed the added replacement heifers with the balance of the herd. At \$12 per hour, this totals to \$3,300 in added labor costs.

The \$27,301 in reduced returns from not selling the 40 heifers as weaned calves is money not currently in the bank and it will be a full year before the ranch will receive the returns from selling the heifers as replacements. At 8 percent interest, this adds \$2,184 in interest costs where the capital is borrowed. Having 2 additional bulls in the herd also generates additional opportunity costs (\$69.15) and depreciation expense (\$666.66) each year. Finally, the manager estimates that a portion of the annual fuel, supplies, repairs, and maintenance costs are expected to increase with additional animals and calculates a total cost per animal at \$29.81 per year. Applying this to the 40 additional replacement heifers results in \$1,192.40 in added costs. The total comes to \$25,943.04 in added costs resulting from making the proposed management change to the operation.

The total added costs and total reduced returns result in a total negative effect of \$53,243.84 as a result of making the change to retain additional replacement heifers. After

including the \$48,579.20 in expected added returns the overall net benefit is a loss of \$4,664.64.

At this stage, it does not seem like a good idea to pursue the additional replacement heifer strategy. However, upon further reflection, the manager feels that some of the estimates have been rather conservative. Specifically, the estimate for receiving \$1,200 per head for the replacement heifers might be as high as \$1,500 per head given the herd genetics and general health. It is also felt that the estimate of \$0.21 per kilo (\$190 per ton) for hay seems high for long term planning, but recent prices have been quite variable.

Risk Analysis of the Management Change

The Risk Scenario Planning tool allows the user to designate up to two values in the partial budget analysis as uncertain and analyze the range of possible results. Figure 2 depicts the interface for entering possible risk scenarios into the RSP tool.

The first step is to identify which value(s) the user wants to make uncertain and which cell it resides in. Given the management strategy for retaining additional replacement heifers, assume that the manager wants to make the sale value for the bred heifers uncertain. The current value of \$1,200 (Figure 1) is entered in cell D6 of the RSP tool. Therefore, the user would enter “Bred Heifer Value” as the description and “D6” as the cell under Uncertain Value 1 in the Risk Scenarios section of the RSP tool (Figure 2). Furthermore, the user could enter 1200 as the current value, 1100 as a possible minimum value, and 1500 as a possible maximum value. This creates a distribution of possible bred heifer values to use in analyzing the scenario.

Figure 2. Sample risk scenarios evaluating the decision to retain and raise 40 more replacement heifers for sale as bred cows.

Risk Scenarios					
Uncertain Value 1		<input checked="" type="checkbox"/> Include	Uncertain Value 2		<input checked="" type="checkbox"/> Include
Description	Cell		Description	Cell	
Bred Heifer Value	D6		Hay Price	H7	
Current Value (Most Likely)	1200		Current Value (Most Likely)	0.21	
Minimum Value	1100		Minimum Value	0.14	
Maximum Value	1500		Maximum Value	0.28	

Assume that the manager also wanted to make hay price an uncertain value. The current hay price of \$0.21 per kilo (\$190 per ton) (Figure 1) is contained in cell H7 of the RSP tool. Therefore, the user would enter “Hay Price” as the description and “H7” as the cell under Uncertain Value 2. Enter “0.21” per kilo as the current value, but also enter

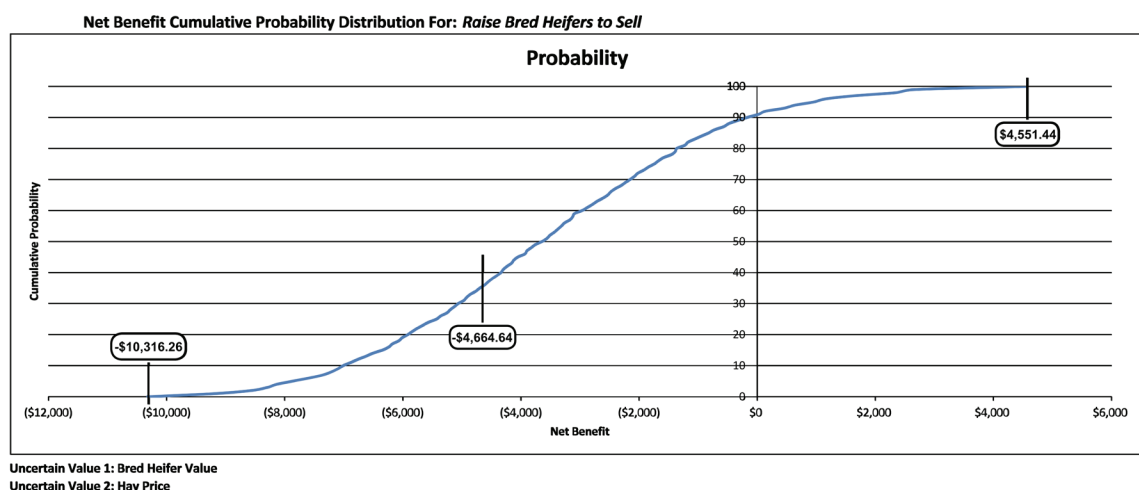
“0.14” per kilo (\$130 per ton) as a possible minimum value, and “0.28” per kilo (\$250 per ton) as a possible maximum value for hay price. Notice in Figure 2 that the user can choose to include (check) or not include (uncheck) either one or both of the uncertain values in the analysis by using the checkbox in the upper right area next to each input section. This allows the user to quickly evaluate each of the uncertain scenarios separately or together.

Results of the Risk Analysis

Clicking the “Run” button causes the RSP tool to begin calculating the risk analysis using either one or both of the two uncertain values to introduce uncertainty into the discrete results depicted in Figure 1. The Risk Scenario Planning tool executes repeated random draws from the distributions of each of the uncertain values as described in Figure 2. The result is a distribution of possible results as shown in Figure 3. The results are displayed as a cumulative distribution graph.

A cumulative distribution graph describes the probability of earning a net return at or below any value presented on the curve. For example, in Figure 3, the lowest point on the graph is at -\$10,316.26. This means that the manager would have a 0 percent probability of the net benefit falling below a net loss of \$10,316. The -\$10,316 serves as a lower bound on the possible outcomes.

Figure 3: Distribution of results from uncertainty introduced into the decision to retain and raise 40 more replacement heifers for sale as bred cows.



In a similar way, the highest point on the graph is at \$4,551.44. This means that a positive net return of \$4,551 is the upper bound on possible outcomes. In between these

two extremes, two other points are of immediate interest. In Figure 1, a net benefit loss of \$4,664.64 was estimated as the most likely outcome from retaining the additional replacement heifers. In Figure 3 the cumulative probability of 35 percent indicates that there is roughly a 35 percent chance that the actual outcome will be at or below this value and, conversely, a 65 percent probability that the actual outcome will be higher than this value. This reflects the relatively pessimistic estimates used for bred heifer value and hay price in the partial budget analysis described in Figure 1.

Finally, note the point where the graph crosses the \$0 net benefit axis (Figure 3). This point is at approximately 91 percent. This indicates that the manager has a 91 percent probability of the change resulting in net benefit at or below a \$0 return and, consequently, only a 9 percent probability of a net return greater than \$0.

When coupled with the results of the discrete analysis showing a net loss of \$4,664, the overall analysis would seem to indicate that making the proposed management change is not likely to result in an economic gain. Though the initial partial budget analysis presented in Figure 1 was pessimistic, the uncertainty introduced with risk scenarios does not provide much additional optimism for success. The chances of doing better than the estimated loss of \$4,664 are good, estimated at 65 percent, but the chances of doing well enough to achieve a positive net return are not.

Conclusion

The Risk Scenario Planning tool can be useful for analyzing simple changes to business operations in the presence of uncertainty. In this paper, one case example was presented using the RSP tool to evaluate a potential change to an existing cow/calf ranch operation. The RSP tool represents a better way to address the presence of uncertainty by describing results in terms of distributions, rather than using a “best guess” single estimate for an uncertain number. In this way, the concept embraces the uncertainty involved and brings it into the decision-making process to create a more robust approach to evaluating proposed management changes. The result should be a more informed decision-making process and better risk management decisions in the future.

RightRisk is a multi-state team of risk management educators that has designed and posted a series of online risk analytics tools, self-study courses, and associated facilitator

materials over the past several years. For more information or to access the online risk analytics, risk management courses, newsletters and more, visit the RightRisk web site at <http://RightRisk.org>.