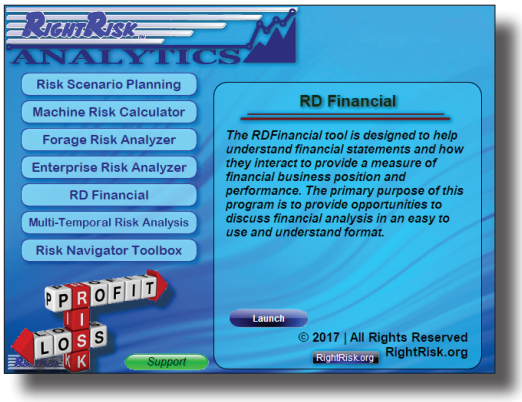
Applied Risk Analytics

Harnessing the Power of Partial Budgeting in Agriculture

Miles Smith* is starting his third year farming in Wyoming's Big Horn Basin, working a farm he purchased under contract from his uncle. Like many new and beginning producers, he has limited resources when it comes to purchasing machinery. Among the custom services he utilizes is spraying. The main disadvantage of this strategy is the challenge of making timely applications of certain herbicides. As he plans for the upcoming year, Miles notices a definite effect on yields, especially in his barley and sugar beet crops.



He views purchasing his own sprayer (leasing is not an option at this time) as the solution to his problem, however, he is unsure whether the costs will outweigh the benefits of ownership. Additionally, he believes there are further advantages to owning a sprayer, such as the potential to reduce tillage, which should also be taken into account. In this analysis, we explore Miles' potential purchase using partial budgeting and related tools from RightRisk.org.

Partial Budgeting Overview

Partial budgeting is often considered the first step in the budget-building process, helping to determine the potential effect on net income from a proposed change to a business or enterprise activity. These changes might include business expansion, a machinery or equipment purchase, a shift in marketing strategy, or deciding between custom hire and owning equipment. Partial budgeting also serves as a valuable risk analysis tool; it allows producers to break down how simple changes in their operations impact overall risk exposure and provides insight into managing that exposure, aiding in future risk management decisions.

RightRisk Analytics
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A partial budget breaks down a potential decision by classifying items into one of four categories: added revenues, reduced expenses, reduced revenues, and added expenses. The net effect of any potential change or decision can be

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J. Hewlett-University of Wyoming, J. Sedman-Sedman Economics, J.Tranel-Colorado State University, and J. Parsons-University of Nebraska-Lincoln.

estimated by the sum of the potential benefits (added revenue and reduced expenses) minus the potential costs (reduced revenues and added expenses), Figure 1.

It is crucial to include only the items that will change due to the potential decision when building a partial budget. Do not include costs that will remain constant, such as land payments or insurance costs. Items that will change, such as alternative seed, fertilizer, or tillage operations must be included. Considering all potential revenue and expense items is essential to ensure an accurate and realistic result. It is also important that all cost and revenue inputs are representative of current conditions, as this can significantly affect the outcome of the partial budget analysis.

Figure 1. Partial Budget Framework

Scenario Layout

Let's apply this approach to Miles' scenario. First, Miles outlines the potential purchase of a sprayer using a partial budget format. Under added returns, he anticipates that timely spraying will help reduce yield losses currently caused by weed pressure. He estimates that owning his own sprayer would allow him to increase yields by at least ten bushels per acre for his malt barley, equating to $80 per acre at $8.00 per bushel. Similarly, he expects to add 2 tons per acre for his sugar beets, translating to $90 per acre at $45 per ton, Figure 2.

Under added costs, Miles includes the sprayer purchase price of $25,000. With a 9.5% interest rate and five annual payments, his loan payment would be $6,511 per year, Table 1. Spread over 1,200 acres (300 acres sprayed 4 times), this results in an annual cost of $5.43 per acre. Notably, these five payments only capture the ownership cost of the sprayer. As such, this analysis is valid for a five-year planning horizon, assuming the sprayer has no residual value at the end of the period. Other critical ownership costs and potential benefits, such as depreciation, salvage value, and the impact on his borrowing capacity, are not included in this per-acre estimate.

Miles also estimates operating costs at $7.50 per acre, which includes his own labor for operating the sprayer, along with repairs and maintenance costs, estimated at $12.50 per acre. Additionally, if he owned his own sprayer, Miles anticipates making additional herbicide applications, valued at $60 per acre, to reduce tillage and transition to a reduced-till operation, Figure 3.

Reduced costs for Miles' potential sprayer purchase include eliminating the $8.00 per acre cost for custom spraying. Additionally, owning his own sprayer would allow him to reduce tillage and move toward a reduced-tillage system, saving a primary tillage pass with the disk before planting barley, which costs $40.00 per acre. He would also eliminate the need for a cultivator on his sugar beets, saving $15.00 per acre. Further savings would come from reduced repairs and maintenance on tillage equipment, estimated at $10.00 per acre, Figure 4. In total, the reduced costs are estimated at $73.00 per acre. There are no reduced returns expected in this scenario.

Table 1. Sprayer Payment Schedule

Initial Cost:	$25,000
Interest Rate:	9.50%
Number of Payments:	5
Estimated Payment:	$6,510.91

The next step is to determine the total net benefit of this potential strategy. The added returns ($170.00 per acre) and reduced costs ($73.00 per acre) together amount to $243.00 per acre. The additional costs total $85.43 per acre. Subtracting these costs from the total benefits results in a net benefit of $157.57 per acre, Figure 5. Based on these specific cost and revenue assumptions, it would be advisable for Miles to purchase the sprayer.

Figure 2. Added Returns

Added Returns		
Yield Increase, Barley (10 bushels/ac, $8/bu)	$	80.00
Yeild Increase, Sugarbeets (2 tons/ac, $45/ton)	$	90.00

Figure 3. Added Costs

Added Costs		
Initial Purchase Cost (loan payment per acre)	$	5.43
Sprayer operation (tractor included)	$	7.50
Repairs and maintenace (tractor and sprayer)	$	12.50
Add. herbicide applications (herbicide cost)	$	60.00

Figure 4. Reduced Costs

Reduced Costs		
Custom Spraying	$	8.00
Tillage pass (disking before barley)	$	40.00
Secondary tillage pass (cultivate beets)	$	15.00
Tillage repair cost	$	10.00

Risk, Variability, and the Risk Scenario Planning Tool

The partial budgeting process should be an essential financial planning step for any farm or ranch. However, the challenge arises in how to manage risk and uncertainty within this process. One of the main pitfalls of standard partial budgeting is relying on figures (such as potential prices or yields) that are essentially best guesses of how we expect things to go. This reliance can become problematic if major decisions are made without properly accounting for the inherent uncertainty in these numbers.

In Miles' case, consider the impact on the overall decision if the yield increases are not as high as expected. In addition, think about how changes in commodity prices for sugar beets

Figure 5. Total Net Benefit of Sprayer Purchase

Total Positive Effects			Total Negative Effects		
(Added Returns + Reduced Costs)	$	243.00	(Added Costs + Reduced Returns)	$	85.43
			Net Benefit of: Smith Sprayer Purchase	$	157.57

and barley might affect the final decision and potential outcomes. From a different perspective, what is the probability of this decision being profitable when these uncertain variables are factored into the analysis?

The *Risk Scenario Planning* tool (RSP) is designed to help agricultural producers consider a range of values when making budget projections or production decisions. The RSP tool allows producers to quantify the risk associated with a particular decision or change in their operation and reduce uncertainty by assigning a range of probable outcomes for specific variables. Since the RSP tool is already structured in a partial budget format, Miles can easily input his data for added returns, reduced costs, and added costs.

A unique feature of the RSP tool, compared to a standard partial budget, is its ability to incorporate up to two uncertain variables in the analysis to better account for risk. The tool evaluates a wide range of scenarios based on the data entered for these variables, which are input as a range (minimum, maximum, and most likely values). In this analysis, the two main variables most likely to influence the potential outcome are the expected crop yield increase and the crop prices.

For the first run using the RSP tool, Miles selects both the barley price (per bushel) and the sugar beet price (per ton) as the uncertain variables. He enters a range of prices for each, Figure 6. For barley, he forecasts that the price will vary by $3.00 per bushel from the expected $8.00 per bushel, giving $5.00 as the minimum and $11.00 as the maximum. For sugar beets, the price might be expected to vary by $10 per ton from the estimated $45 per ton, resulting in a minimum of $35 and a maximum of $55. After clicking "RUN," the RSP tool evaluates at least 1,000 alternative scenarios and generates a probability curve for the expected outcomes, Figure 7. Allowing output prices to vary, Miles can expect a 50/50 probability (most likely) of achieving a net benefit of $157.90 per acre using a purchased sprayer; this net benefit could range anywhere from $122 per acre to $191 per acre.

We might also examine the effects of varying the potential yield increase Miles estimated for each crop using a purchased sprayer. When estimating a reasonable minimum increase, let's assume Miles is overly optimistic and enter zero. As an estimate for the maximum increase, let's be conservative, estimating a 15-bushel increase for barley and a 1-ton increase for sugar beets, Figure 8.

Figure 6. RSP Tool Risk Inputs, Barley and Sugar Beet Prices

Risk Scenarios					
Uncertain Value 1		☑ Include	**Uncertain Value 2**		☑ Include
Description	**Cell**		**Description**	**Cell**	
Barley price	D7		*Sugar Beet price*	D8	
Current Value (Most Likely)	8		Current Value (Most Likely)	45	
Minimum Value	5		Minimum Value	35	
Maximum Value	11		Maximum Value	55	

Figure 7. RSP Tool Probability Curve with Variable Barley and Sugar Beet Prices

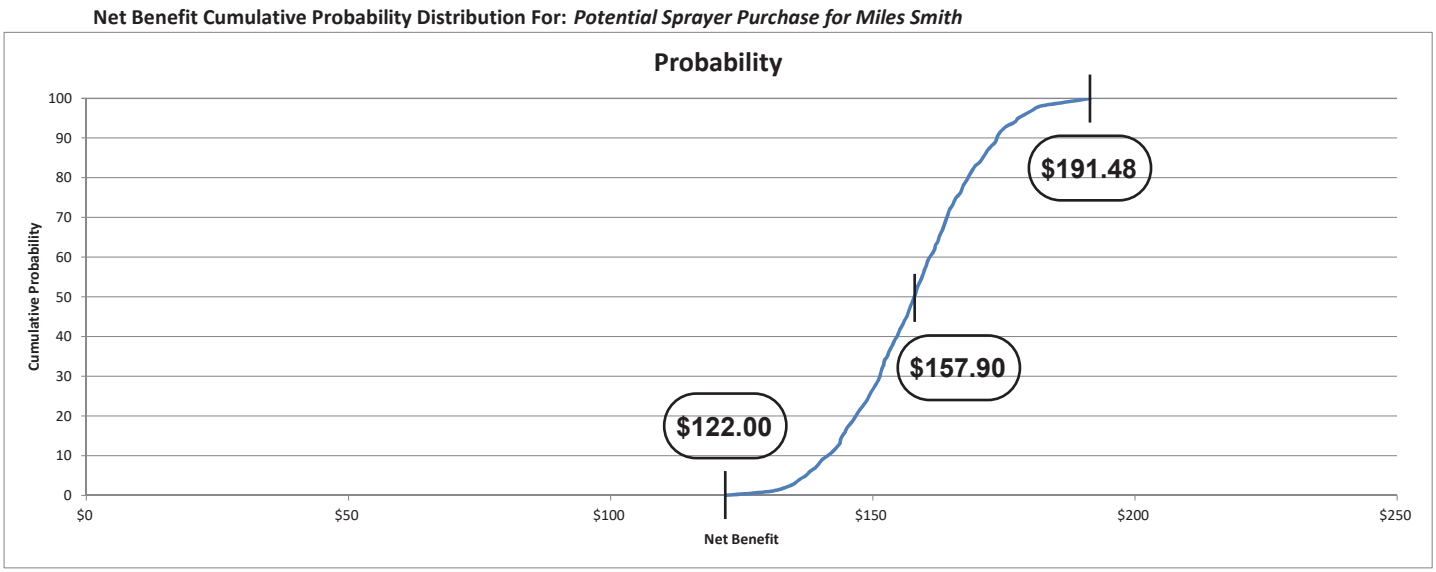
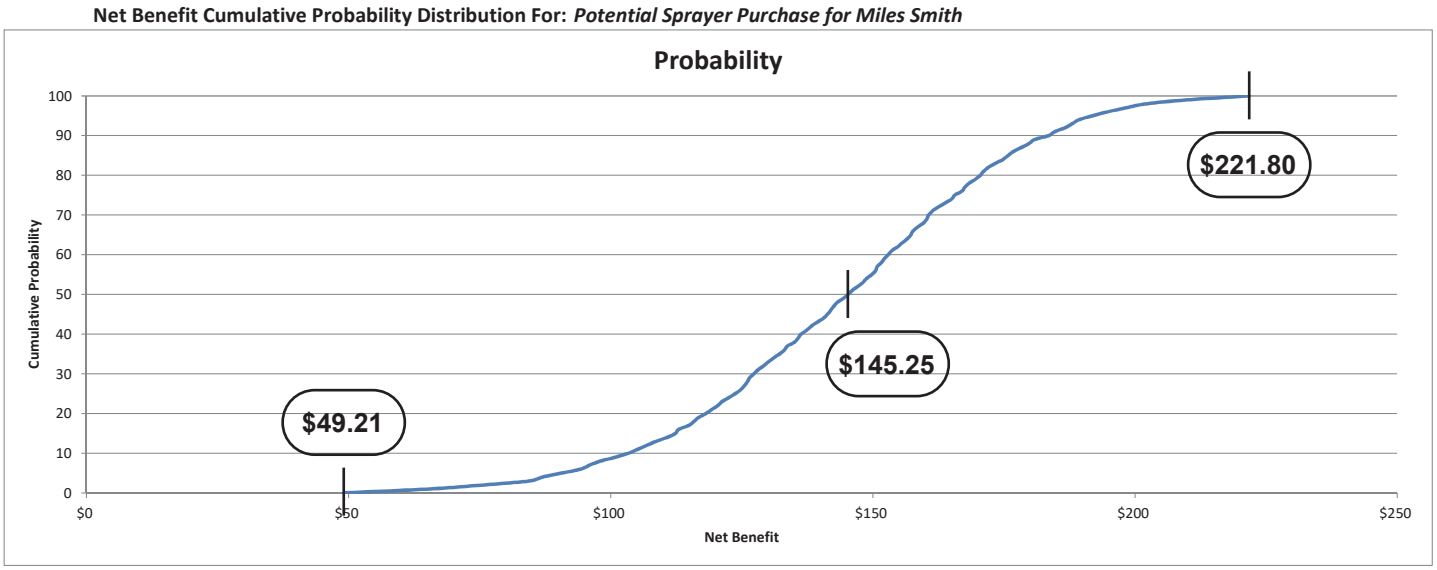


Figure 8. RSP Tool Risk Inputs, Barley and Sugar Beet Yields

Risk Scenarios					
Uncertain Value 1		☑ Include	**Uncertain Value 2**		☑ Include
Description	**Cell**		**Description**	**Cell**	
Barley yield increase	C7		*Sugar Beet yield increase*	C8	
Current Value (Most Likely)	10		Current Value (Most Likely)	2	
Minimum Value	0		Minimum Value	0	
Maximum Value	15		Maximum Value	3	

Figure 9. RSP Tool Probability Curve with Variable Barley and Sugar Beet Yields



After clicking "RUN," the RSP tool evaluates at least 1,000 alternative scenarios and generates a probability curve, revealing that yield variability has a greater potential to negatively impact overall net benefit compared to price variability. The most likely outcome (50/50 probability) drops slightly to $145.25 per acre, with the potential net benefit ranging from as low as $49 to as high as $222 per acre, Figure 9. The expected reduction in tillage operations and related repairs helps keep the potential net benefit above zero, even in the worst-case scenario of no yield increases.

Results and Potential Further Analysis

After conducting the partial budget analysis and accounting for potential variability in his assumptions, Miles Smith expects a positive net benefit from purchasing his own sprayer to eliminate custom hire costs in his operation. At a minimum, he anticipates generating a net benefit of at least $49 per acre. Miles could consider further analysis of the long-term effects of this decision using the *Multi-Temporal Risk Analyzer* (MTRA) tool. This tool allows users to extend the partial budgeting analysis to include multiple years and providing a cumulative probability of net benefit over the period.

The *Risk Scenario Planning* tool and the *Multi-Temporal Risk Analyzer* are two of several risk analytics tools available from RightRisk.org. These are available with accompanying user guides, examples, and more for download at no cost. See RightRisk.org and select the Resources tab to access the RightRisk Analytics toolbox to get started.

** The Smith operation is a case study example created to demonstrate RightRisk tools and their applications. No identification with actual persons living or deceased, places, or agricultural operation is intended nor should be inferred.*