Evaluating Fertilizer Application Decisions

Northern Wyoming ranchers Adam and Jill Tomzak* are considering their fertilizer needs for the coming year, specifically for their irrigated grass hay crop. They know they need to apply at least some fertilizer for growth/maintenance. The Tomzaks are concerned, however, about the high prices for nitrogen. They are worried that if they apply nitrogen at the normal rate, their yield response may not be sufficient to cover the cost of the fertilizer. Their analysis takes a closer look at what the optimum rate of fertilizer might be and the risk management implications of their decision.

Online Fertilizer Analysis Tools

RightRisk offers Risk Analytics to help producers evaluate their fertilizer inputs. The first tool helps determine how much fertilizer to apply. The tool uses the concept of diminishing marginal returns: the benefits, in the form of additional yield, decline as the quantity of applied fertilizer increases.

The tool can help producers discover the most economical level of fertilizer to apply for a variety of example crops, based on previous research. Producers enter the estimated fertilizer price, as well as crop harvest costs and sale prices. The tool allows the user to adjust yield increments for fertilizer applied, based on their own yield data as well.

RightRisk Analytics
Tools and guides are available at no cost at the website https://RightRisk.org

The Tomzaks begin by selecting Improved Grass Hay from the list of crops supplied on the left side of the screen. The tool generates a preloaded example showing nitrogen fertilizer applied in 40-pound increments on a per acre basis, the associated yield increases, the fertilizer cost per pound, crop harvest cost per pound, and the crop sale price. They assume the yield increments already entered stay the same for this example.

Entering in the fertilizer cost requires a bit of calculation. Assume the Tomzaks are applying 160 pounds of 46-0-0 (nitrogen) fertilizer per acre,

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which would be 73.6 pounds of nitrogen (46 percent of 160 pounds). For this tool, we enter the fertilizer cost on a per pound of available nutrient applied basis. If we assume the price of the 46-0-0 fertilizer is $900/ton; the fertilizer yields 920 pounds per ton (0.46 times 2000). We then we divide $900 by 920. This yields a cost per pound of $0.9783 per pound of available nitrogen applied. This times 73.6 pounds (when applying 160 total pounds) results in a cost of $72.00 per acre. For this hay crop we will assume $50/ton for harvesting cost (cutting, raking, baling, and stacking), and a sale price of $200 per ton, Table 1. It is important to remember to include all harvesting costs to make the results as accurate as possible.

Table 1. How Much Fertilizer Can You Afford to Apply Input Screen.

Improved Grass Hay

	First Increment	Second Increment	Third Increment	Fourth Increment	Fifth Increment	Sixth Increment	Seventh Increment
Fertilizer Applied per Acre	0	40	80	120	160	0.0	0.0
Yield per Acre	1.11	1.69	2.15	2.50	2.74	00.0	00.0
Fertilizer Cost	$ .9783	**per Pound** (If you don't know the cost per pound, click here to use the Fertilizer Formulation Analysis software.)					
Crop Harvest Cost	$ 50	**per** Ton/Acre	**Crop Units per Acre**				
Crop Sale Price	$ 200	**per Unit**					

Table 2. How Much Fertilizer Can You Afford to Apply Output Screen.

Fertilizer Calculator Results Generated for:

~ Improved Grass Hay ~

Fertilizer per Acre	Yield Ton/Acre	Added Yield Ton/Acre	- - - Added Costs - - - Fertilizer [$0.98/Pound]	Harvest [$50.00/Ton]	Added Return [$200.00/Ton]	Added Return Less Added Costs
0	**1.11**	- - -	- - -	- - -	- - -	- - -
40.0	**1.7**	**0.6**	**$39.13**	**$29.00**	**$116.00**	**$47.87**
80.0	**2.1**	**0.5**	**$39.13**	**$23.00**	**$92.00**	**$29.87**
120.0	**2.5**	**0.4**	**$39.13**	**$17.50**	**$70.00**	**$13.37**
160.0	2.7	0.2	$39.13	$12.00	$48.00	$-3.13

By clicking CALCULATE, the tool generates a set of results showing the optimal fertilizer at 120 pounds applied, with added returns minus added costs equal to $13.30 per acre, Table 2. Note that even with high prices for the hay crop, the yield benefit of the added fertilizer at the 160 pound level is overshadowed by its high cost; added returns are lower than added costs.

If you don't know either the cost per pound or the quantity of nutrients applied in your fertilizer, a second tool, the *Fertilizer Formulation Analysis* tool can help estimate these costs, as well as the cost for combinations of more than one fertilizer formulation on a per pound of available nutrient applied, cost per pound, cost per acre, cost for each nutrient applied, and more.

Risk Scenario Planning

The Tomzaks now understand that applying 120 pounds of fertilizer is beneficial on a marginal cost basis. The point that remains unclear is how to take risk or the variability in prices into account in their analysis? In otherwords, how sensitive is the marginal cost analysis to changes in the hay price or yield response? This is where the Risk Scenario Planning (RSP) tool can help.

The RSP tool helps evaluate the inherent risk involved in the budgeting process. The tool is set up like most partial budgets, with four categories (added returns, reduced costs, added costs, and reduced returns) resulting in an estimated net revenue for the proposed change. Instead of choosing one value for the factors included, such as prices in this analysis, the RSP tool allows the user to examine a range of values (maximum, minimum, and most likely) for up to two factors, and their subsequent effect on the budget.

Problems arise when using values in the budgeting process that do not account for variability or risk. If you make an assumption about a commodity price, that assumption becomes the basis of further analysis without accounting for risk. In our example, Jill and Adam Tomzak assume they will produce hay worth $200 per ton, but what if the price drops to $150 or even $100 per ton? The RSP tool develops probability outcomes showing how a range of values, not just a single value, can affect the budgeting decision and better account for the uncertainty.

To get started, the Tomzaks need to take a closer look at the last 40-pound increment of

Table 3. Risk Scenario Planning Input Screen, Last 40-pound Increment.

RightRisk™ **Partial Budget For:** *Fertilizer application decision*

Positive Effects				Negative Effects			
Added Returns	**Quantity**	**Value**	**Total**	**Added Costs**	**Quantity**	**Value**	
Increased hay yield (tons/acre)	0.4	$ 200.00	$ 80.00	*Fertilizer application cost (last 40 lbs.)*	40	$ 0.98	$ 39.13
			$ -	*Harvest cost (added 40 lbs/ac)*	0.4	$ 50.00	$ 20.00
			$ -				$ -
			$ -				$ -
Total Added Returns			$ 80.00	**Total Added Costs**			$ 59.13
Reduced Costs	**Quantity**	**Value**		**Reduced Returns**	**Quantity**	**Value**	
			$ -				$ -

Total Positive Effects
(Added Returns + Reduced Costs) $ 80.00

Total Negative Effects
(Added Costs + Reduced Returns) $ 59.13

Net Benefit of: Fertilizer application decision $ 20.87

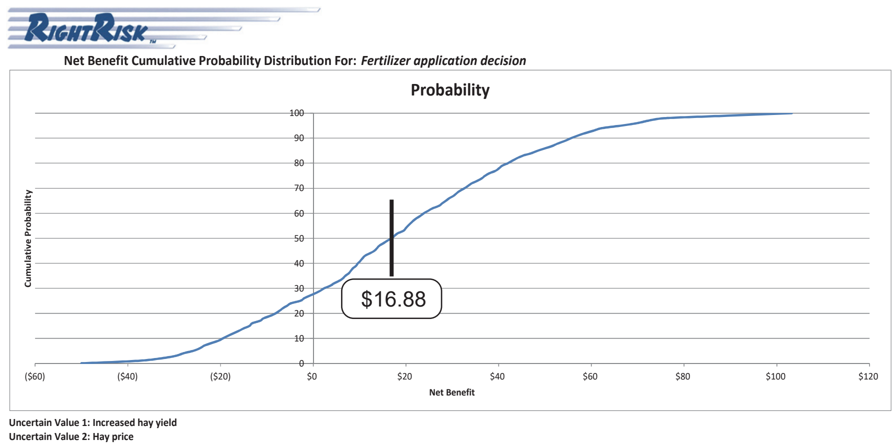
Risk Scenarios

Uncertain Value 1		**Uncertain Value 2**	
☑ Include		☑ Include	
Description	**Cell**	**Description**	**Cell**
Increased hay yield	C7	*Hay price*	D7
Current Value (Most Likely)	0.4	Current Value (Most Likely)	200
Minimum Value	0	Minimum Value	100
Maximum Value	0.8	Maximum Value	250

fertilizer applied. Under added returns we enter the increase in hay yield, or 0.4 tons, valued at $200/ton, Table 3. Under added costs, we add the fertilizer application of 40 pounds at $0.98 per pound ($39.20 total), and the harvest cost for the last yield increase of $20 ($50 per ton multiplied by 0.4 tons/acre). There would be no reduced returns or reduced costs in this example.

The next step is to select the values where risk or variability plays a role in making the decision. In this example, the Tomzaks focus on changes in the hay yield and sale price. Under Uncertain Value 1, Table 4, they enter the hay yield increase, with an expected value of 0.4 tons per acre taken from the fertilizer tool and a maximum yield of 0.8 and a minimum yield of 0. For Uncertain Value 2, they enter the price for the hay as $200/ton, with a maximum of $250/ton and a minimum of $100/ton. They also check each box to include the variability for the two uncertain values in the analysis.

Figure 1. Estimated Net Return Distribution for the Fertilizer Application Decision on the Last 40-pound Increment.



Clicking RUN generates the probability analysis, in the form of a graph, Figure 1. The most likely outcome, one with roughly a 50/50 chance of occurring, is estimated as $16.88 net return per acre. In addition, we can see from the results that they should expect the net return to be no lower than -$50.03 per acre and no higher than $103.22 per acre. In other words, there is a 50 percent chance the fertilizer application will result in an increase in their net return of $16.88/acre for that last 40 pounds of fertilizer.

Overall Fertilizer Application

We can also use the RSP tool to evaluate the overall fertilizer application decision, not just the last 40 pounds applied. To take a look at the overall decision, the Tomzaks enter 1.39 tons of additional hay (2.5 tons yield with fertilizer minus the 1.11 tons without fertilizer), valued at $200/ton under the added returns section, Table 4. On the added cost side, they enter 120 pounds of fertilizer at $0.9783 per pound and the harvest cost of the increased hay yield (1.39 tons/acre) valued at $50/ton.

Total added returns are calculated at $278/acre and total added costs are $186.90/acre. For the probability analysis, the Tomzaks use the same range of values for hay price (most likely $200/ton, minimum of $150/ton, maximum of $250/ton), and for hay yield they set the most likely at 1.39/tons/acre, 0 tons/acre for the minimum and 2 tons/acre for the maximum yield gain. Clicking RUN generates a curve similar to the analysis for the last 40-pounds of fertilizer, with a 50/50 chance of an increased net return of $67.98/acre for the overall fertilizer application, Figure 2. They can expect that net returns might fall as low as -$144.31/acre or range as high as $245.97 net return per acre.

The Tomzaks can expect a positive return on their fertilizer investment based on the results of this analysis. However, there are a number of factors that could cause the results to turn out differently; drought or other extreme weather, insect pressure, or other factors could make the expected yield turn out lower than the forecast. Conversely, above average precipitation could increase the potential yield increase. These events could also have an effect on hay prices, if they extend to a large enough area.

The RSP analysis offers the Tomzaks insight into the effects of risk in the form of varying hay prices and yield responses that might be expected following the fertilizer application.

Digging further into the analysis, one of the

Table 4. Risk Scenario Planning Input Screen, Total Application.

RightRisk — Partial Budget For: *Fertilizer application decision, TOTAL APPLICATION*

Positive Effects				Negative Effects			
Added Returns	Quantity	Value	Total	Added Costs	Quantity	Value	
Increased hay yield (tons/acre)	1.39	$ 200.00	$ 278.00	*Fertilizer application cost*	120	$ 0.98	$ 117.40
			$ -	*Harvest cost*	1.39	$ 50.00	$ 69.50
			$ -				$ -
			$ -				$ -
Total Added Returns			$ 278.00	Total Added Costs			$ 186.90
Reduced Costs	Quantity	Value		Reduced Returns	Quantity	Value	
			$ -				$ -

Total Positive Effects (Added Returns + Reduced Costs)	$ 278.00	**Total Negative Effects** (Added Costs + Reduced Returns)	$ 186.90

Net Benefit of: Fertilizer application decision, TOTAL APPLICATION $ 91.10

Risk Scenarios

Uncertain Value 1	☑ Include	Uncertain Value 2	☑ Include
Description	Cell	Description	Cell
Increased hay yield	C7	*Hay price*	D7
Current Value (Most Likely)	1.39	Current Value (Most Likely)	200
Minimum Value	0	Minimum Value	150
Maximum Value	2	Maximum Value	250

drivers of the variability in net return is hay price. When we eliminate hay price from the analysis by unchecking the box for Uncertain Value 2, the estimate of the most likely net return increases to $72.96/acre, an increase of $4.98 in expected total net return per acre, compared to the returns when a variable price of hay was used, Figure 3.

Additional Considerations

In general, the overall results show that the Tomzaks could expect a positive return from their fertilizer investment. The analysis shows that some type of risk management strategy for hay price would be prudent, given its influence on the potential net return. This strategy might include some form of crop insurance, such as coverage offered by Forage Insurance or Pasture, Rangeland, Forage-Rainfall Index (RI-PRF) polices or forward pricing or forward contracting that could reduce some or all of the potential downside price risk.

Figure 2. Estimated Net Return Distribution for the Fertilizer Application Decision on the Total Fertilizer Application.

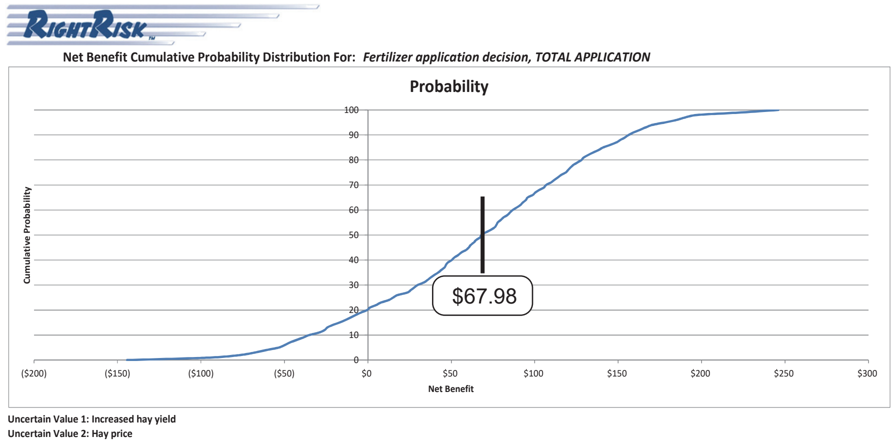
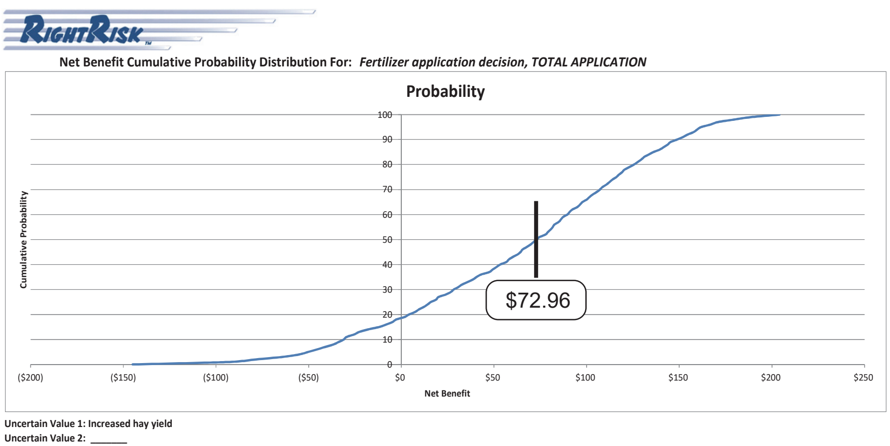


Figure 3. Estimated Net Return Distribution for the Fertilizer Application Decision on the Total Fertilizer Application, Without Hay Price Risk.



** The Adam and Jill Tomzak 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.*

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