RightRisk™

How Much Risk Is Right For You?

Technical Guide **(September, 2016 #TG-16-09)**

Multi-Temporal Risk Analyzer

By:
Dr. Jay Parsons - University of Nebraska-Lincoln
John P. Hewlett – University of Wyoming

Assessing changes to your operation in the face of uncertainty

University of Wyoming Extension | Extension | RMA USDA

Multi-Temporal Risk Analyzer

List of Tables

List of Figures

Introduction

The Multi-Temporal Risk Analyzer (MTRA) Tool is designed to provide economic analysis of multi-year management strategies and decisions involving risk. Examples include investment decisions, changes in production practices, adding and subtracting enterprises, and other decisions that involve multiple years to come to fruition or a multi-year commitment in order to see a positive economic return.

The MTRA tool is unique in that it is specifically designed to analyze risk and uncertainty over a number of years. This is usually accomplished for these types of investment decisions or decisions involving significant management changes by adjusting the time value of money (i.e. interest rate) to include risk or by using conservative estimates for expected returns to account for uncertainty. However, in many cases, these are difficult tasks to accomplish with accuracy or appropriately given the true nature of the uncertainty.

The MTRA tool allows the user to input the decision or proposed change in a partial budget template, where expected positive inflows (increased returns and/or decreased costs) are netted-out against expected negative outflows (decreased returns and/or additional costs). These individual inflows and outflows can be turned on and off over the course of 20 years to reflect long term expectations.

Most importantly, the MTRA tool gives the user the ability to incorporate risk around any of the inflows or outflows by providing a modest amount of information regarding the possible value of the flow over the time period designated. The highest possible value and the lowest possible value are entered to provide a range of values the flow might vary between over time. The most likely value is entered to provide a central tendency. Armed with this information, the MTRA tool can produce a number of different graphical and numerical outputs to help the user analyze the possible returns from the proposed action, as well as evaluate the risk involved over a multiple year period.

This guide will present an overview of the tool and two case studies representing possible decisions that can be analyzed using the MTRA tool in the sections that follow. These cases were chosen to represent a range of examples the user can draw from in creating their own decision analysis. They do not reflect the full breadth of possibilities, nor do they represent any single producer's decision.

Users of the MTRA tool are encouraged to explore using the tool in a manner that best fits their situation. It is designed with flexibility in mind, so as not to limit those possibilities.

Multi-Temporal Risk Analyzer Tool Overview

The MTRA tool is a Microsoft Excel-based tool. It is available in both a 64-bit version and a 32-bit version. Users should download the appropriate version that matches with their version of Excel.

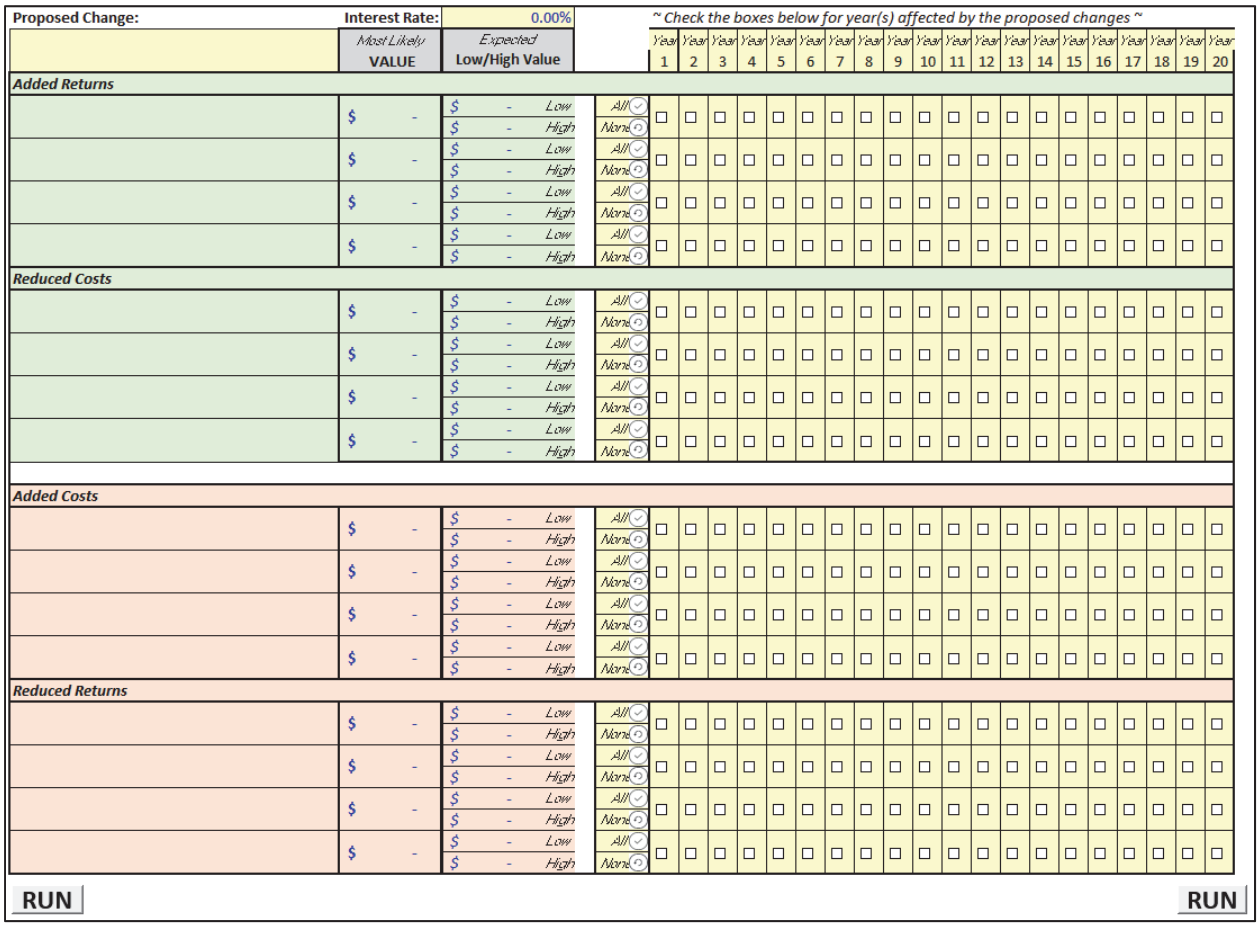
The MTRA tool was developed by members of the RightRisk team with funding support from the USDA-Risk Management Agency.

The MTRA software contain three worksheets: a Home page worksheet; an Input page worksheet; and, an Output page worksheet. The Input worksheet (Figure 1) has input space for the user to enter the model name, reflective of the proposed change they are analyzing at the top of the page. An entry blank to the right provides the input blank for the interest rate to be used across the analysis. This rate is used

in time value of money calculations and should represent a rate the user feels is an appropriate, long-term rate of return.

In the input blocks below, the entry form provides two green-colored blocks to describe the positive effects of added returns and reduced costs followed by two salmon-colored blocks to describe the negative effects of added costs and reduced returns.

Figure 1: Multi-Temporal Risk Analyzer Input Page



The second column of the input worksheet is used to enter the most likely value for each of the items listed in column 1. For each of the items listed in the green or salmon-colored boxes of column 1, an expected low value and an expected high value is entered into column 3 to give a range over which each of the uncertain variables is expected to vary.

If there is no expected uncertainty in value for an item listed in column 1, it is appropriate to list the most likely value from column 2 as both the expected low and the expected high in column 3.

The MTRA tool is designed to analyze proposed changes for up to 20 years. The columns in the yellow-colored section allow the user to check any or all of the next 20 years as being affected by the proposed change in each row.

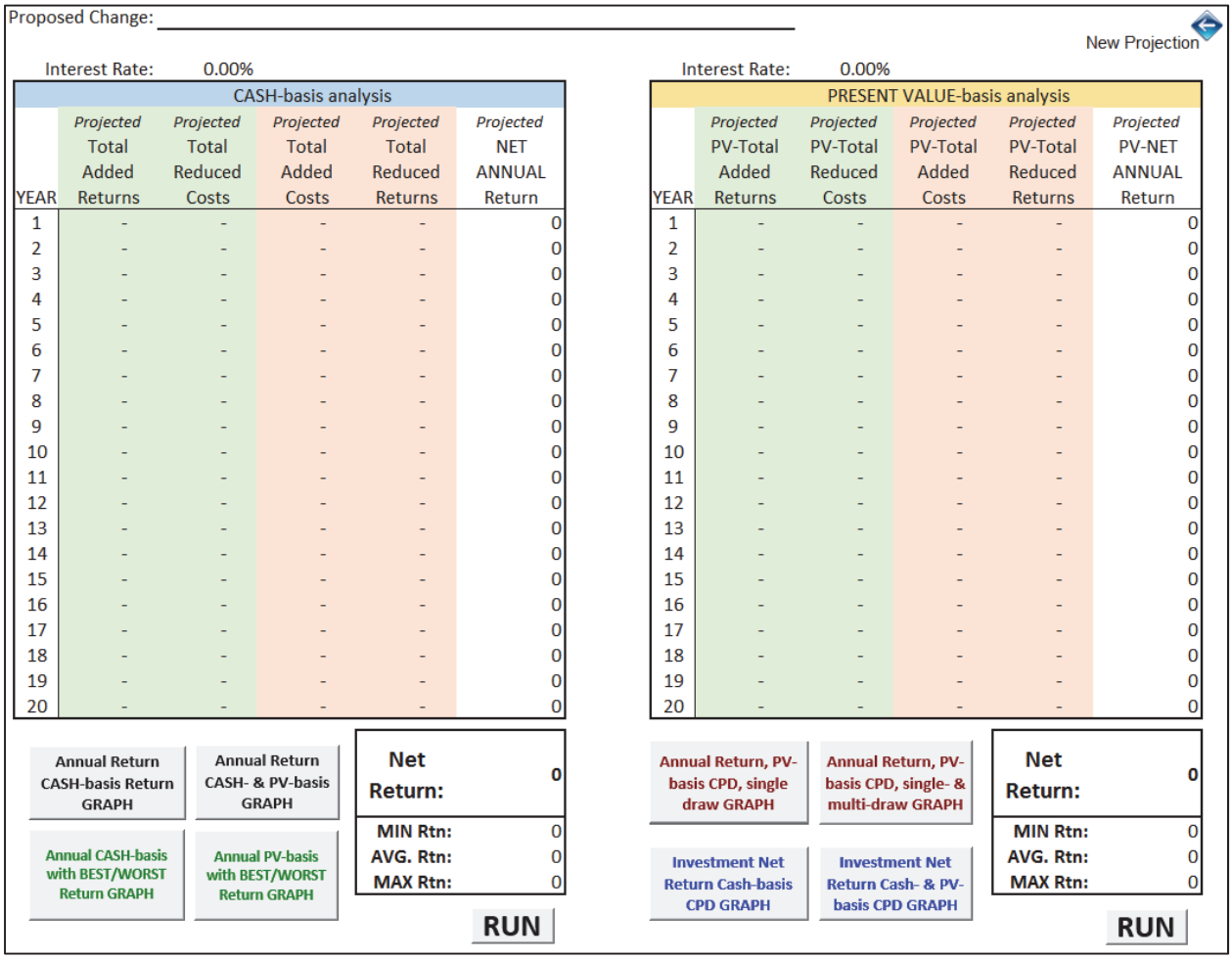
The check and refresh icons in column 4 are used to speed up this process by checking all 20 years (All) or unchecking all of them (None).

This check box feature may seem confusing at first, but it was adopted to provide the greatest flexibility to the user in terms of controlling when an item enters into the calculations over the time horizon, while not requiring the user to repeatedly renter the expected values.

The MTRA tool Output page (Figure 2) provides output in two different ways:

- The left half of the worksheet contains a cash-basis analysis in nominal dollars (current or actual dollars not adjusted for inflation).
- The right half of the worksheet contains a present value-basis analysis of the same proposed changed by adjusting for the time value of money using the interest rate provided at the top of column 3 of the input worksheet. These values represent the real purchasing power of the net return after adjusting for inflation. Note that the MTRA tool is designed to discount from the beginning of the year so Year 1 is not discounted.

Figure 2: Multi-Temporal Risk Analyzer Output Page



The total net return over the planning period along with the minimum annual return, average annual return, and maximum annual return over that period are reported at the bottom of each analysis table.

The buttons at the bottom of the Output worksheet allow the user to view the results in graphical form.

The annual returns can be viewed in several different graphs using the buttons below the cash-basis analysis:

- A graph of the cash-basis returns on an annual basis
- A graph with both the cash-basis and the present value basis returns displayed in the same graph on an annual basis
- A graph with the cash-basis returns on an annual basis bracketed by a best case and worst case range for each year on a cash-basis
- A graph with the present value-basis returns on an annual basis bracketed by a best case and worst case for each year on a present-value basis

The four buttons below the present value-basis analysis take the data and display cumulative probability distribution graphs for four different comparisons:

- Annual returns on a present value-basis from the output page are used to generate a cumulative probability distribution graph
- Annual returns on a present value-basis from the single draw over 20 years on the output page are compared to thousands of possible draws generated by the computer in two cumulative probability distribution graphs on the same page
- Investment return on a cash-basis is depicted in a cumulative probability distribution graph
- Investment return on a cash-basis is compared to investment return on a present-value basis in cumulative probability distribution graphs on the same page

The MTRA tool can be a powerful tool for analyzing a proposed change that has impacts extending over several years.

In some cases, the numbers displayed on the Output worksheet will provide a very clear answer because there is not a lot of uncertainty involved in the decision outcome. However, in most cases a considerable amount of uncertainty will be present in what the actual numbers will turn out to be moving forward over several years.

The MTRA tool can regenerate numbers for the Output worksheet via a click of the Run button to iteratively display some of the different outcomes that are possible or, more powerfully, it can display them in graphical form through a number of different comparisons.

The case studies that follow help display some of the powerful analysis available in the MTRA tool.

Case Study 1: Equipment Purchase Decision

John and Martha Hay own 300 acres of established hay meadow. They typically get three cuttings per year off of this meadow and, currently, they are paying a custom operator $15 per acre to windrow it each time they put up hay. John has considered purchasing a windrower for a number of years but never felt he could justify the cost of a new one and dreaded the thought of trying to keep an older machine in working order, given his limited time and mechanical skills.

However, recently he became aware of an almost new machine that he could purchase for about $100,000 with 5 percent financing for five years. It was a demo and a one-time rental machine from a local dealership that is in fantastic condition and all ready to go. John knows there is some uncertainty in the actual value this purchase could provide but he thinks it might actually make sense given their circumstances.

To further motivate John to analyze this decision, he is almost certain if he purchased this machine that a neighbor down the road would hire him to cut his hay, also giving John extra income and more acres over which to justify the purchase of the equipment. This neighbor has about 225 acres of hay meadow similar to John and Martha's meadow from which he normally gets three cuttings per year just like they do on theirs.

In consultation with the equipment dealer, John and Martha make several key estimates. Given the type of hay meadow they plan to use the windrower on, they estimate they can average about 10 acres per hour of operation and that the windrower will use about 5 gallons per hour in fuel, while windrowing hay. Given this information and the 525 acres they plan to cut three times per year, they arrive at an estimate of about 160 hours of operation per year to windrow approximately 1,575 acres.

In thinking about their ownership and operating costs, the Hays are told that with this level of use they could easily get $30,000 - $40,000 out of the machine after 10 years, should they choose to sell it or trade it in on a new one. They think this sounds about right for planning purposes in terms of how long they intend to own it. The equipment dealer tells them they should set aside an average of $2,000 per year for repairs and maintenance over the course of those ten years.

Paying themselves $18 per hour for labor cost would amount to $2,880 annually in operating labor expense. Estimating $2.60 per gallon for the price of fuel and adding an additional 15 percent for lubrication costs would amount to $2,392 annually. Adding repairs, maintenance, labor, fuel and lubrication together, they arrive at $7,272 in annual labor and operating costs. Roughly 60 percent of this would be on their own land and 40 percent would be custom work for the neighbor.

Lastly, they are told to figure about $1,000 per year to cover insurance, housing and property taxes associated with ownership of the machine.

Armed with this information, the Hays set about analyzing their windrower purchase decision using the MTRA tool with an eye toward including risk and uncertainty in the analysis picture. (See Figure 3.)

Added Returns: Equipment Purchase Decision

The Hays are confident but not certain that they can pick up the custom work for the neighbor on an

annual basis. If all goes according to plan, they could charge $15 per acre for 675 acres of cutting and add $10,125 to their bottom line. This would come with an additional $2,910 in operating expense. The net effect would be $7,215 in added returns for custom work.

The other added return would not occur until the end of the ten years as they capture the salvage value of the machine when they sell it or trade it in on a new one. Since the MTRA tool is designed to discount values from the beginning of the Year listed, the salvage value will be realized in Year 11 which is equivalent to the end of Year 10.

Uncertainty around these two projected, added returns are summarized by Martha Hay as follows, “While we expect to net $7,215 per year in custom work for the neighbor each year, it could be as low as zero or much as 20 percent higher ($8,658 per year) depending upon actual acres cut, operating costs, and the actual rate we are able to charge. We expect the salvage value of the windrower to be $30,000 but it may be as low as $20,000 or as high as $40,000 when that time rolls around.”

Figure 3: Multi-Temporal Risk Analyzer Entries for Equipment Purchase Decision

Proposed Change: Windrower Purchase — Interest Rate: 5.00%

~ Check the boxes below for year(s) affected by the proposed changes ~

Proposed Change	Most Likely VALUE	Expected Low	Expected High	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Added Returns																							
Custom work	$ 7,215	$ -	$ 8,658	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
Salvage value	$ 30,000	$ 20,000	$ 40,000											✓									
	$ -	$ -	$ -																				
	$ -	$ -	$ -																				
Reduced Costs																							
Custom windrowing expense	$ 13,500	$ 13,500	$ 13,500	✓	✓																		
Custom windrowing expense	$ 14,850	$ 13,500	$ 16,335			✓	✓	✓	✓														
Custom windrowing expense	$ 16,335	$ 13,500	$ 18,000							✓	✓	✓	✓										
	$ -	$ -	$ -																				
Added Costs																							
Loan payments	$ 23,097	$ 23,097	$ 23,097	✓	✓	✓	✓	✓															
Operating costs (labor, fuel & repairs)	$ 4,362	$ 4,362	$ 4,362	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
Taxes, housing, and insurance	$ 1,000	$ 1,000	$ 1,000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
	$ -	$ -	$ -																				
Reduced Returns																							
	$ -	$ -	$ -																				
	$ -	$ -	$ -																				
	$ -	$ -	$ -																				
	$ -	$ -	$ -																				

RUN RUN

Reduced Costs: Equipment Purchase Decision

Since the proposed change would result in the Hays no longer needing to hire their hay to be custom windrowed, they can safely bet that they will save $13,500 per year in custom windrowing charges. However, given historical experience, they think there is a good chance this could increase in the coming years.

The MTRA tool allows them to input these expectations into the analysis by entering a range of values and associating them with specific years by checking the appropriate boxes in the planning horizon.

They enter an expectation for $14,850 as custom rate charges for year 3 through year 6, with a possible range for these charges from $13,500 to $16,335. They also enter an expectation for custom rate charges from year 7 through year 10 as $16,335, with a possible range from $13,500 to $18,000.

Added Costs: Equipment Purchase Decision

If the Hays finance the entire $100,000 purchase price for five years at 5 percent annual interest, their annual payments would be $23,097.48 for each of the first five years of their planning horizon. They would also have an additional $4,362 in associated operating costs for windrowing their own 300 acres three times per year and an additional $1,000 per year to cover insurance, property and housing.

Reduced Returns: Equipment Purchase Decision

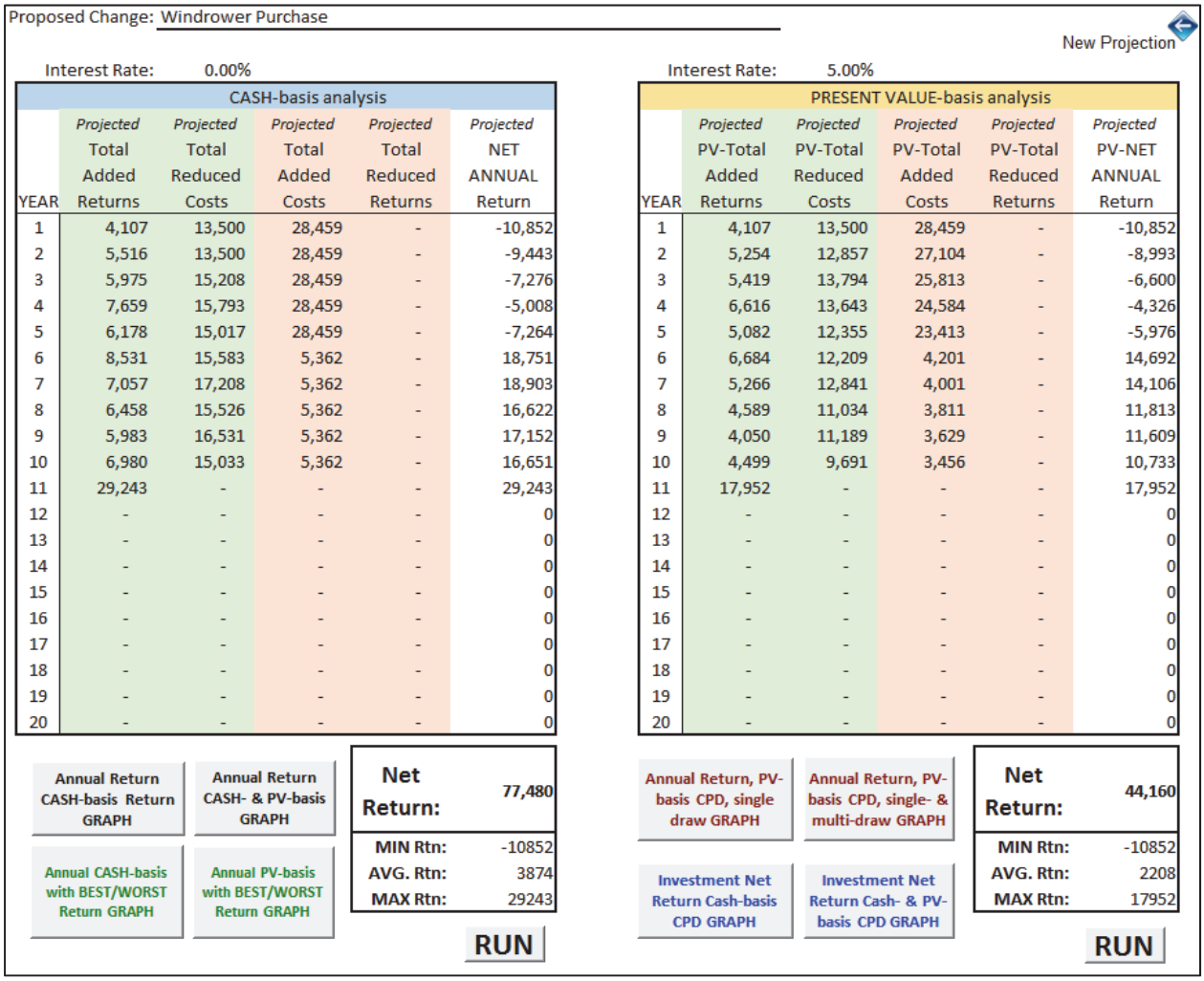
The Hays do not anticipate any reduced returns associated with this decision.

Results and Graphs for Equipment Purchase Decision Analysis

The MTRA tool produces a number of different output screens for analyzing multi-temporal decisions with risk. By clicking the Run button, the user initiates thousands of random draws representing possible outcomes of the windrower purchase decision over the course of the 10 years of ownership.

The Output worksheet for the equipment purchase decision for the Hays potential purchase of the windrower is shown in Figure 4.

Figure 4: Multi-Temporal Risk Analyzer Output for Equipment Purchase Decision



Proposed Change: Windrower Purchase

New Projection

Interest Rate: 0.00%

CASH-basis analysis

YEAR	Projected Total Added Returns	Projected Total Reduced Costs	Projected Total Added Costs	Projected Total Reduced Returns	Projected NET ANNUAL Return
1	4,107	13,500	28,459	-	-10,852
2	5,516	13,500	28,459	-	-9,443
3	5,975	15,208	28,459	-	-7,276
4	7,659	15,793	28,459	-	-5,008
5	6,178	15,017	28,459	-	-7,264
6	8,531	15,583	5,362	-	18,751
7	7,057	17,208	5,362	-	18,903
8	6,458	15,526	5,362	-	16,622
9	5,983	16,531	5,362	-	17,152
10	6,980	15,033	5,362	-	16,651
11	29,243	-	-	-	29,243
12	-	-	-	-	0
13	-	-	-	-	0
14	-	-	-	-	0
15	-	-	-	-	0
16	-	-	-	-	0
17	-	-	-	-	0
18	-	-	-	-	0
19	-	-	-	-	0
20	-	-	-	-	0

Annual Return CASH-basis Return GRAPH

Annual Return CASH- & PV-basis GRAPH

Annual CASH-basis with BEST/WORST Return GRAPH

Annual PV-basis with BEST/WORST Return GRAPH

Net Return:	77,480
MIN Rtn:	-10852
AVG. Rtn:	3874
MAX Rtn:	29243

RUN

Interest Rate: 5.00%

PRESENT VALUE-basis analysis

YEAR	Projected PV-Total Added Returns	Projected PV-Total Reduced Costs	Projected PV-Total Added Costs	Projected PV-Total Reduced Returns	Projected PV-NET ANNUAL Return
1	4,107	13,500	28,459	-	-10,852
2	5,254	12,857	27,104	-	-8,993
3	5,419	13,794	25,813	-	-6,600
4	6,616	13,643	24,584	-	-4,326
5	5,082	12,355	23,413	-	-5,976
6	6,684	12,209	4,201	-	14,692
7	5,266	12,841	4,001	-	14,106
8	4,589	11,034	3,811	-	11,813
9	4,050	11,189	3,629	-	11,609
10	4,499	9,691	3,456	-	10,733
11	17,952	-	-	-	17,952
12	-	-	-	-	0
13	-	-	-	-	0
14	-	-	-	-	0
15	-	-	-	-	0
16	-	-	-	-	0
17	-	-	-	-	0
18	-	-	-	-	0
19	-	-	-	-	0
20	-	-	-	-	0

Annual Return, PV-basis CPD, single draw GRAPH

Annual Return, PV-basis CPD, single- & multi-draw GRAPH

Investment Net Return Cash-basis CPD GRAPH

Investment Net Return Cash- & PV-basis CPD GRAPH

Net Return:	44,160
MIN Rtn:	-10852
AVG. Rtn:	2208
MAX Rtn:	17952

RUN

The left side of the Output worksheet provides a snapshot view for a single draw of a set of potential annual net returns on a cash-basis. This one random draw of the ten years produces a total net return of $77,840.

The lowest annual return of -$10,852 occurs in Year 1, when savings from custom windrowing expenses are lowest. The highest annual return of $29,243 occurs in Year 11, when the salvage value is realized. The average annual return is $3,874, but this is not reflective of any one year where the return for the first five years is lower than -$5,000 due to the loan payments. Once the loan is paid off, the annual returns are all greater than $16,000.

The right side of the output provides a snapshot view for a single draw of this same set of potential annual net returns on a discounted, net present value (NPV) basis using the 5 percent interest rate as the discount factor for the time value of money.

In particular, the upfront, added cost of paying off the loan and the wait until the end to realize the salvage value has a tremendous effect on the bottom line when the time value of money is taken into consideration. The total net return on a NPV-basis is only $44,160.

Annual Return Graphs: Equipment Purchase Decision

The expected annual returns on a cash basis can be graphed on their own over time, in comparison with possible best and worst case scenarios (see Figure 5), or in comparison to the present value of expected annual returns (see Figure 6).

The expected value for the net present value annual returns can also be graphed in comparison to best and worst case scenarios (see Figure 7).

The user will note by viewing these graphs that there is quite a bit of uncertainty surrounding these results, especially to the downside. In Figure 5, the worst case scenario for Year 1 through Year 10 lies quite a bit below the cash return realized in Figure 4, which is graphed using a solid blue line in Figure 5. In Figure 6, a similar situation is depicted for the discounted annual returns.

Figure 7 shows a graphical comparison between the cash returns and the discounted returns on a year-by-year basis. Notice how the gap between the two widens as you move from left to right in the graph, where discounting has more of an effect on the present value of the cash inflows and outflows.

Though the returns are negative until the loan is paid off, the decision looks like a positive change to make overall. Even when evaluated on a NPV basis, the returns look very positive at the end of the ten years.

However, the MTRA tool adds real power to this analysis by taking uncertainty into account by producing a cumulative range of possible annual results. Figure 8 contains one of these graphical results comparing the range of NPV annual returns to one sample draw.

The green curve in Figure 8 represents all of the possibilities for any annual NPV return given thousands of possible random draws (multi-draw analysis). The worst case scenario is -$12,743 and the best case scenario is +$21,721 on a NPV basis for any one year.

The brown curve in Figure 8 represents possible annual NPV returns for each year of a single draw (single draw analysis).

Recalculating the MTRA spreadsheet by clicking the Run button, will produce a new brown curve based on a new single draw. Since the green curve represents all possible draws, the brown curve will always be bounded on the left and the right by the end points of the green curve. In addition, the green curve will not change with a new Run, unless the user modifies one or more of the underlying parameters.

Figure 5: Expected Cash Annual Returns versus Best and Worst Case Scenarios for the Equipment Purchase Decision

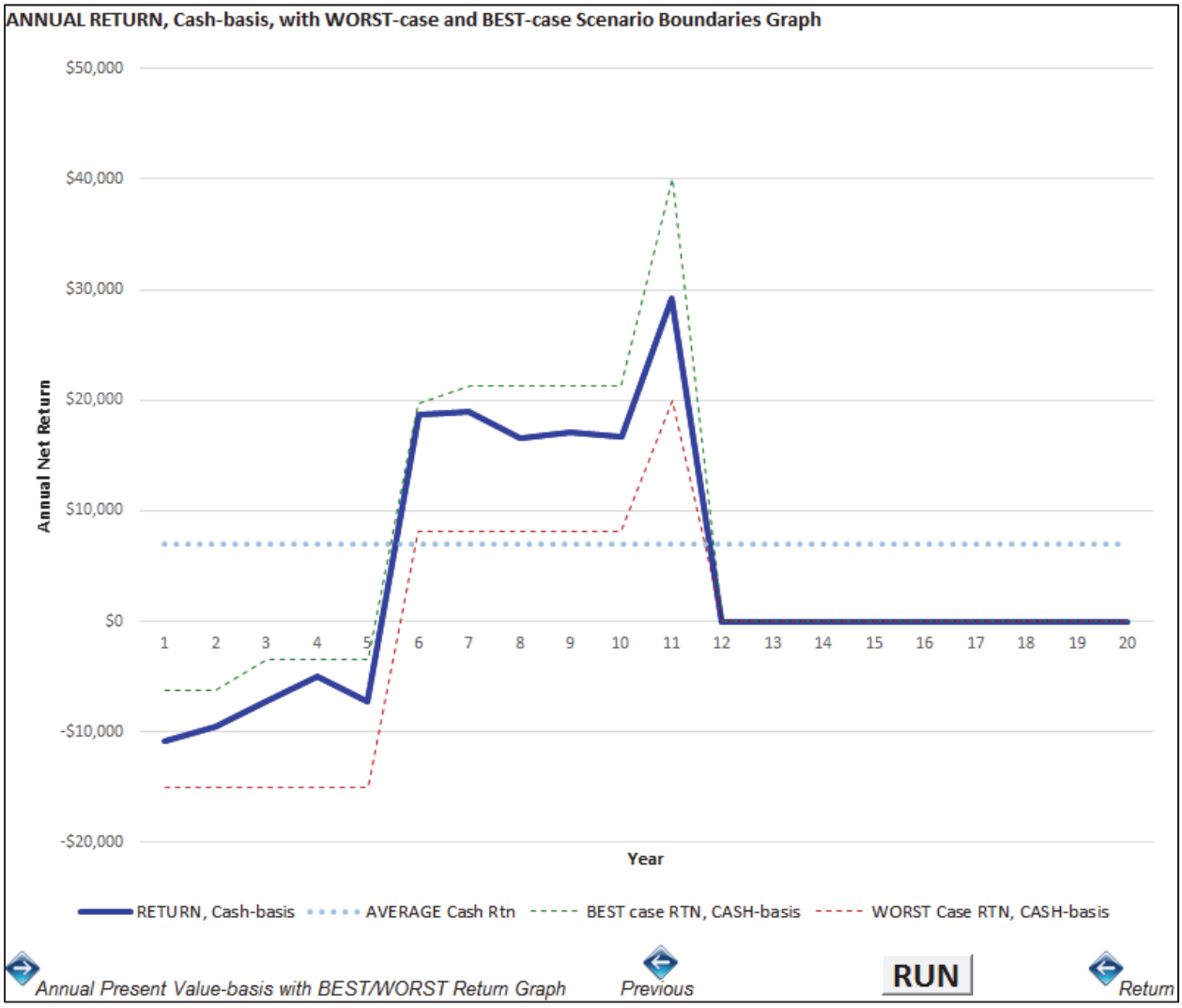


Figure 6: Expected NPV Annual Returns versus Best and Worst Case Scenarios for the Equipment Purchase Decision

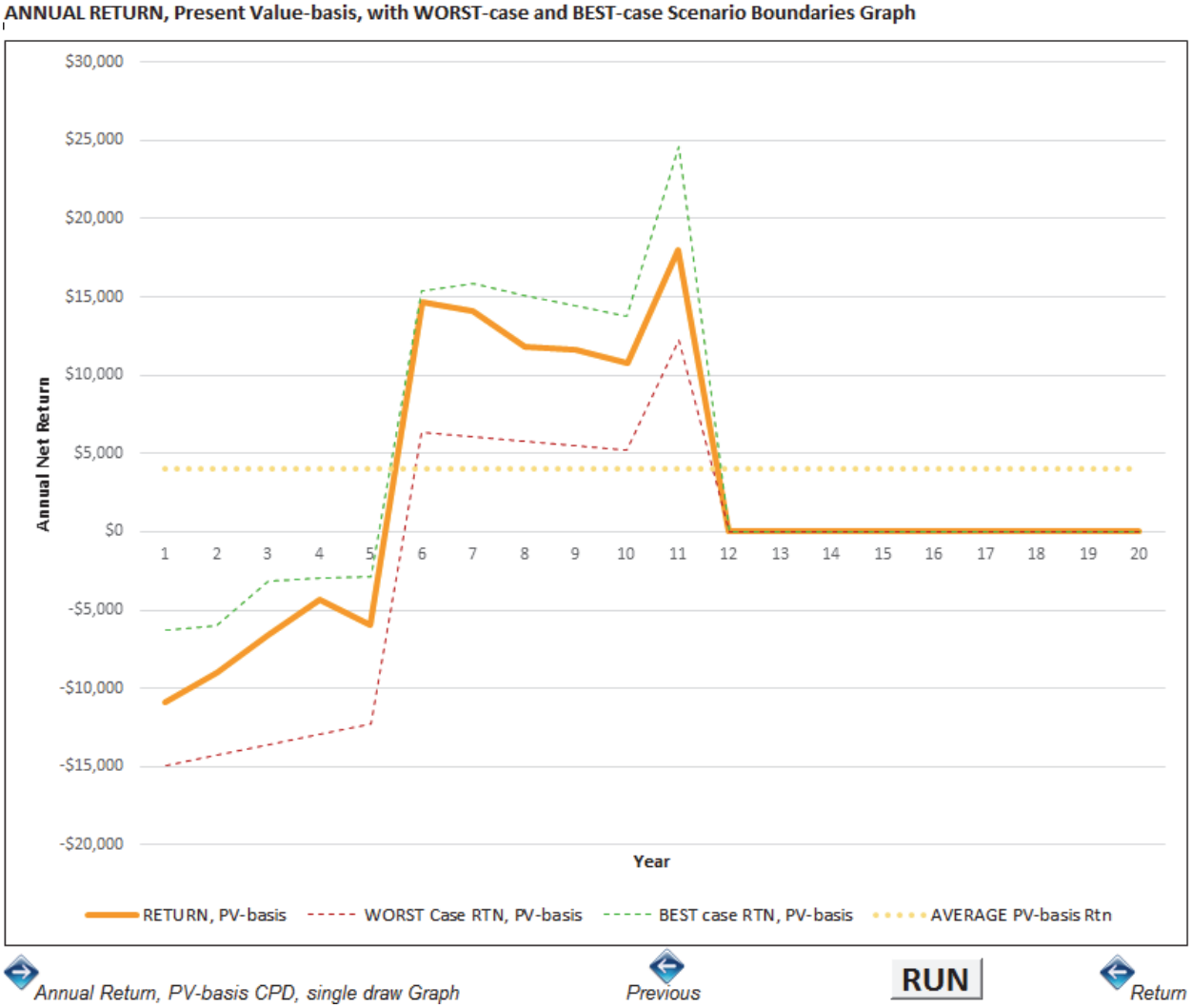


Figure 7: Expected Annual Returns Cash versus Present Value Scenario for the Equipment Purchase Decision

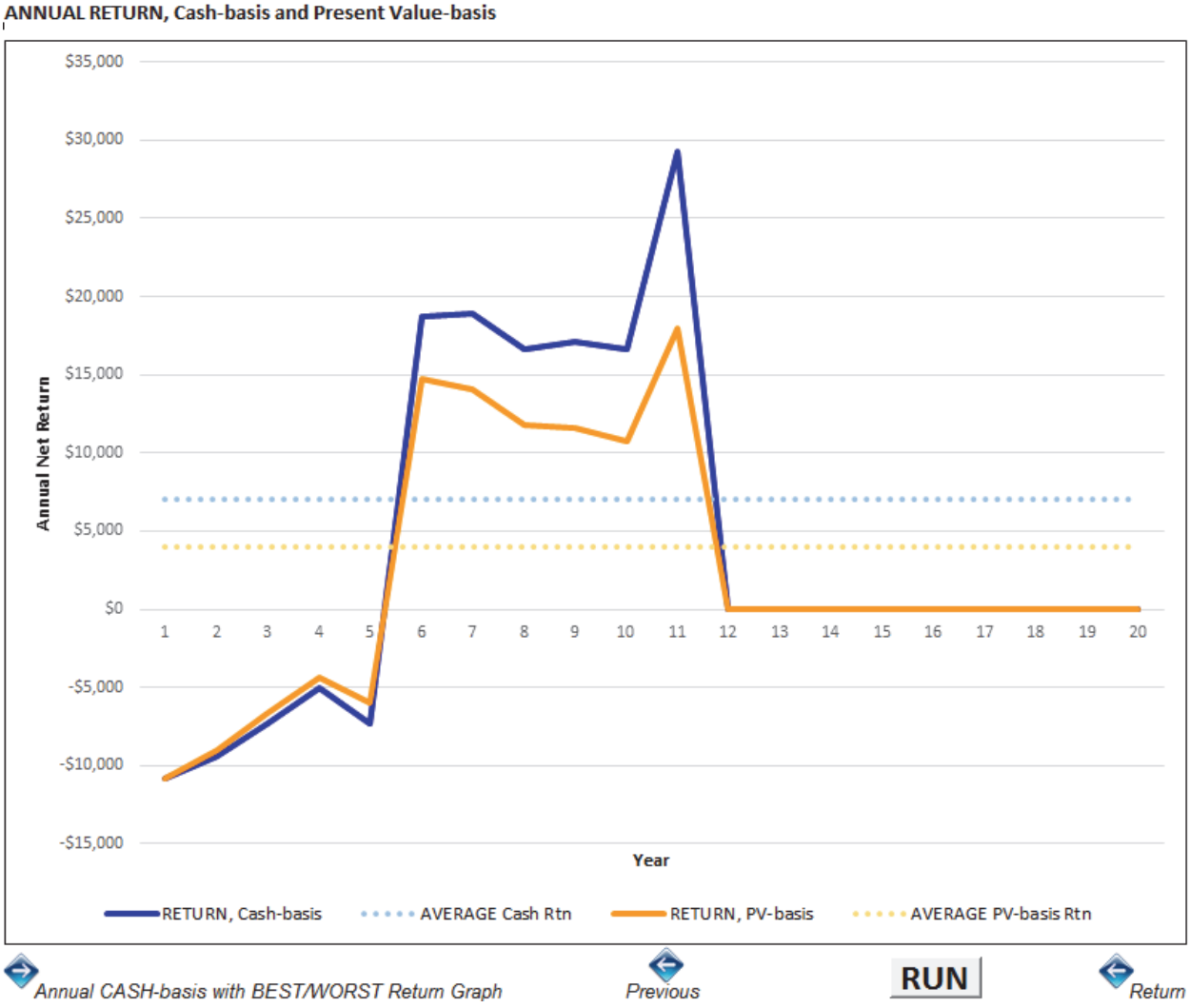
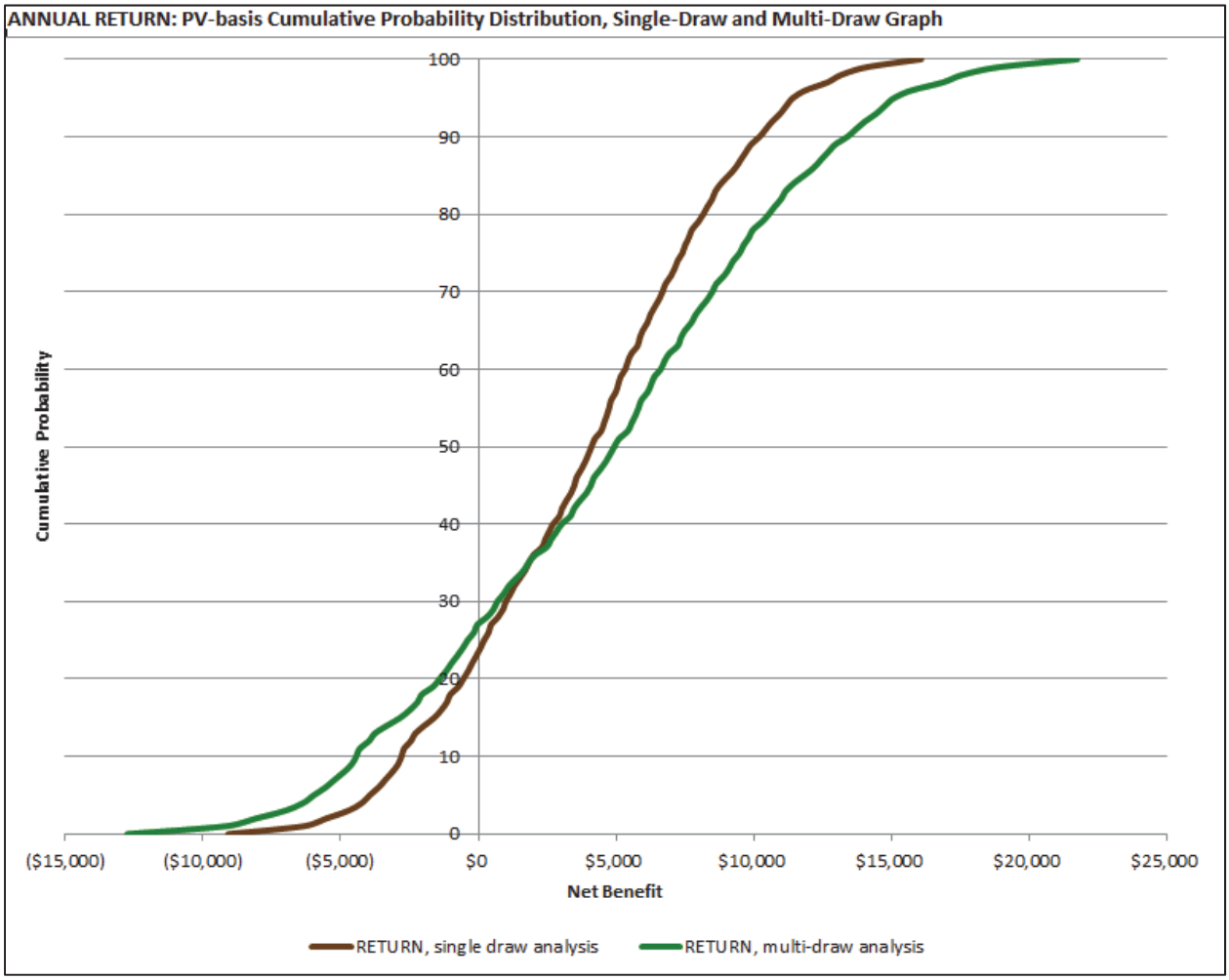


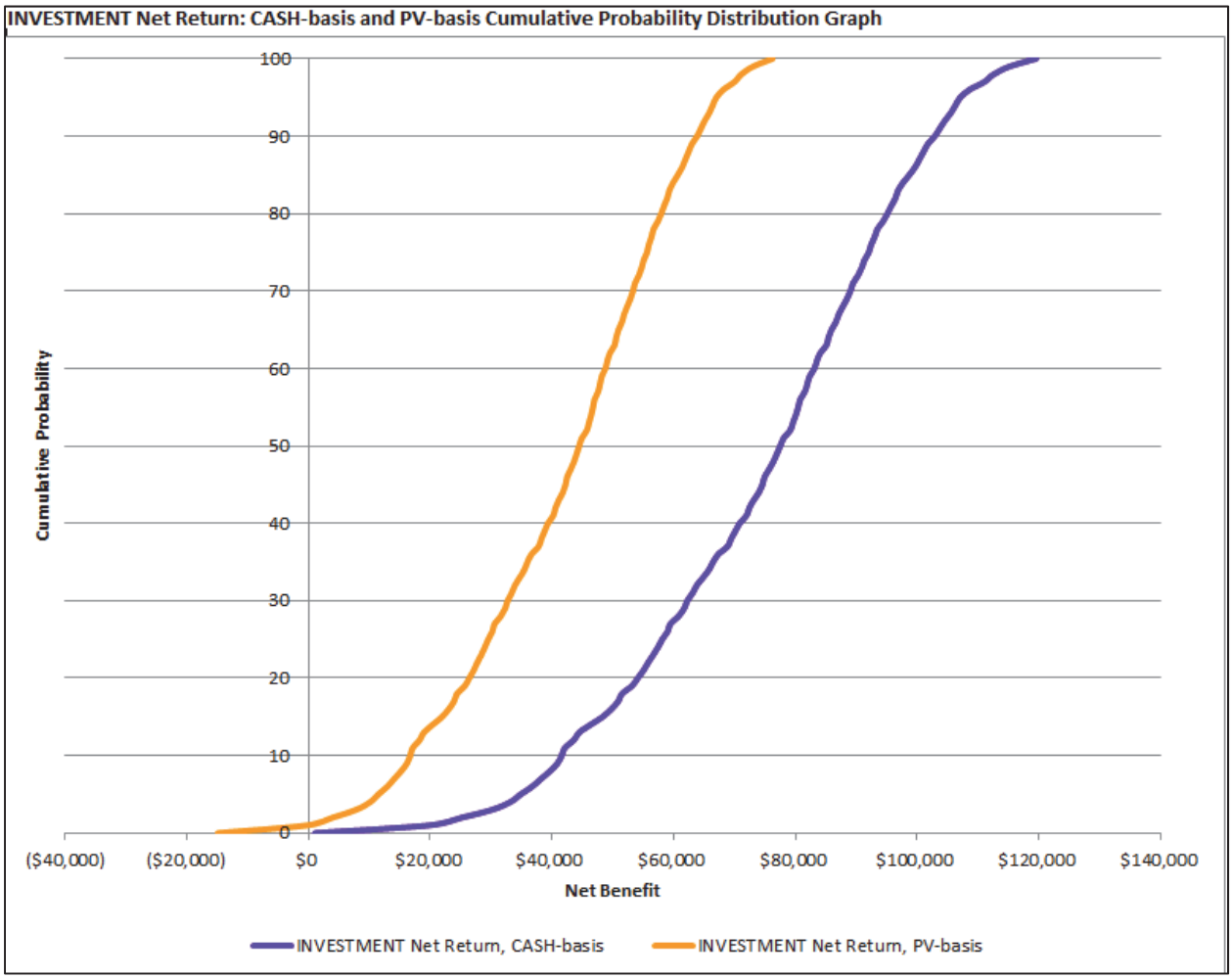
Figure 8: Distribution of the NPV of Annual Returns for the Equipment Purchase Decision



Investment Analysis: Equipment Purchase Decision

Finally, the MTRA tool can produce a cumulative probability distribution for the investment analysis on a cash basis and NPV basis (see Figure 9).

Figure 9: Investment Analysis of the Equipment Purchase Decision



On a cash-basis the investment analysis looks really good, where the salvage value at the end of the ten years is treated as if it were received today. As depicted in Figure 9, the cumulative net return on a cash basis for this windrower purchase decision could be as high as $119,531 or as low as -$142.

When the time value of money is taken into account, the picture is not quite so positive. The investment net return over ten years on a PV-basis could be as low as -$14,870 or as high as $76,219. On a NPV basis, there is a 50 percent chance that the net returns from the decision could be above $44,462 and a 50 percent chance it could be below $44,462.

Overall, it looks like a good decision would be to purchase the windrower.

Case Study 2: Pasture Improvement Decision

Rex and Sara Timber currently manage a 1280-acre pasture as a single unit. The pasture has a water source at the north end and is fenced around the perimeter. Their normal practice is to graze 400 yearling steers in the pasture for a period of 2.5 months from June 15 to August 31 each year. The starting weight for the steers is around 550 pounds and the ending weight is usually about 660 pounds.

The Timbers are considering making some improvements to the pasture infrastructure in order to increase the carrying capacity. Specifically, they are considering cross fencing the pasture into four equal quadrants and extending a water line from an adjacent pasture into the new sub-divided pasture with a tank in each of the four pastures. The improvements would involve the following:

(1) The installation of four miles of buried water line and four water tanks; and,
(2) The construction of three miles of 4-wire cross fencing.

The Timbers estimate that the water development and cross fencing will allow them to increase the carrying capacity to about 460 head of steers over the same grazing period while maintaining the same average ending weight of around 660 pounds.

Cross fencing would require a bit more labor and management of the steers (0.3 hours/steer instead of 0.2 hours/steer) as they would need to be rotated periodically. With the new water development and cross fencing, the Timbers can abandon the current water source that has required about $175 per year in maintenance.

The Timbers compiled a table of facts to help them analyze the situation (Table 1):

Table 1: Information for the Pasture Improvement Decision

Item	Value
Annual perimeter fence and water maintenance	$ 400
Annual depreciation of perimeter fence	$ 325
Annual labor hours per steer w/out cross fencing	0.2
Average land value per acre (current)	$ 700
Annual property taxes per acre (current)	$ 3.40
Cross fencing materials and installation per mile	$ 8,550
Cross fence annual repairs and maintenance	$ 225
Cross fence useful live	35 years
Waterline installation	$ 27,750
Water tanks ($/tank)	$ 3,000
Tank & waterline annual repairs and maintenance	$ 100
Tank & waterline useful life	20 years
Annual labor hours per steer with cross fencing	0.3
Annual property taxes per acre with proposed improvements	$ 3.65
Wage rate per hour	$ 20
Interest rate on investments	8%

Added Returns: Pasture Improvement Decision

The added returns from implementing this decision would come from an increased carrying capacity or number of head the Timbers will be able to put into the pasture for the 2.5 month grazing season. With current prices, the Timbers are adding about $235 in value per head over the grazing period. With the pasture improvement implemented, the extra 60 head of steers represent an additional $14,100 in net return from buying and selling steer calves on an annual basis.

The Timbers feel there will be considerable uncertainty in price and some uncertainty in weight gain on an annual basis. To account for this uncertainty, they think it would be a good idea to consider a worst case scenario where the prices and weight gain are such that the calves don't gain any value over the 2.5 month grazing period. In order to counter balance this, they feel it is also possible that their net returns could be as much as 30 percent higher than the $14,100 figure in a really good year.

The MTRA tool allows the Timbers to include these fluctuations by entering an expected low value of $0 and an expected high value of $18,330 for the additional returns attributed to increased production and sales (Figure 10).

Reduced Costs: Pasture Improvement Decision

The only reduced cost the Timbers will realize from implementing the pasture improvements is the $175 per year maintenance cost on their current water source in the north part of the unimproved pasture. If they implement the improvements, they plan to abandon this source in favor of the new waterline and 4-pasture tank system so they would no longer have this $175 annual expense.

Added Costs: Pasture Improvement Decision

Most of the added costs the Timbers would incur would be in the form of capital improvement expenses occurring in year 1. At $8,550 per mile for three miles, the interior cross fences will cost $25,650 to construct. At $3,000 each for the four water tanks, the tanks will cost them an additional $12,000. Finally, installing the waterline is expected to cost $27,750.

These three improvements total $65,400 in additional capital expenses occurring in year 1. The Timbers feel this estimate is pretty solid and do not wish to analyze any uncertainty around this figure. However, they have been talking to their banker who has suggested that they can add the total improvement cost to their operating line of credit. Therefore, they feel it is most appropriate to spread the added cost of this investment out evenly over the span of its 20 year useful life in the form of depreciation. This amounts to 65,400/20 = $3,270 per year.

Adding the cost of the capital improvements to their operating note will have an additional interest cost attached to it. If they use the average value of the improvements over their 20 year useful life, this equates to paying interest on an additional 65,400/2 = $32,700 per year. At 8 percent interest, this equates to an additional $2,616 in interest expense each year.

In addition, they will be purchasing an addition 60 head of steers each year. They will need to pay interest on this increased investment over the 2.5 month growing period. If the average purchase price is approximately $900 per head, this equates to $900 x 60 x 0.08 x 2.5/12 = $900 per year.

The Timbers decide they had better budget for an additional $3,516 per year in interest expense. With possible fluctuations in interest rates and purchase price for the incoming steers, they decide to use an expected low value of $2,800 and an expected high value of $4,395 to account for this uncertainty.

Figure 10: Multi-Temporal Risk Analyzer Entries for the Pasture Improvement Decision

Proposed Change: Interest Rate: 5.00% ~ Check the boxes below for year(s) affected by the proposed changes ~

Pasture Improvement	Most Likely VALUE	Expected Low/High Value		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Added Returns																							
60 additional head of steers	$ 14,100	$ - Low $ 18,330 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Reduced Costs																							
Current water source maintenance cost	$ 175	$ 175 Low $ 175 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Added Costs																							
Capital Improvements (fence & water) dep.	$ 3,270	$ 3,270 Low $ 3,270 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Interest	$ 3,516	$ 2,800 Low $ 4,395 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Annual labor, repairs & maintenance	$ 1,485	$ 1,053 Low $ 1,992 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Property taxes	$ 320	$ 320 Low $ 320 High	All None	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Reduced Returns																							
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	$ -	$ - Low $ - High	All None	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

RUN RUN

Other added annual costs the Timbers expect to incur with the pasture improvements include additional annual repairs and maintenance on the cross fence, waterlines, and tanks. They feel $325 is a good number to use for these expenses on an annual basis (see Table 1). Further, they believe these expenses could turn out to be as low as $125 or range as high as $600 in any given year, so they enter these values in as the expected low value and expected high value, respectively, to account for uncertainty.

In addition, the Timbers expect additional labor will be needed. Without cross fencing, they were consistently spending about 80 hours per year on this enterprise, which is equal to 0.2 hours per steer for 400 steers. With the cross fencing improvements, they will need to move the animals on a regular

basis to take advantage of the rotational grazing system.

They will also have increased infrastructure to care for with the new water and fencing improvements. They estimate their labor will now total 0.3 hours per steer or 138 hours per year. At $20 per hour, this will be an expected net increase of $1,160 per year. To account for annual variations, they decide to use $928 for an expected low value and $1,392 for an expected high value, in order to build in a range reflecting possible 20 percent swings above and below expectations.

The Timbers also feel it is appropriate to expect changes in property taxes to result from these pasture improvements. They expect their property taxes to increase $0.25 per acre as a result of adding the cross fencing, waterlines, and tanks to the property. This equates to $320 per year for the 1280-acre pasture. They decide not to put any uncertainty around this figure because, relatively speaking, they don't expect it to vary up and down much once it is set. It will likely just trend upward with the value of the property as a whole and they don't feel uncertainty with this item to be a big deal in terms of analyzing the decision.

Reduced Returns: Pasture Improvement Decision

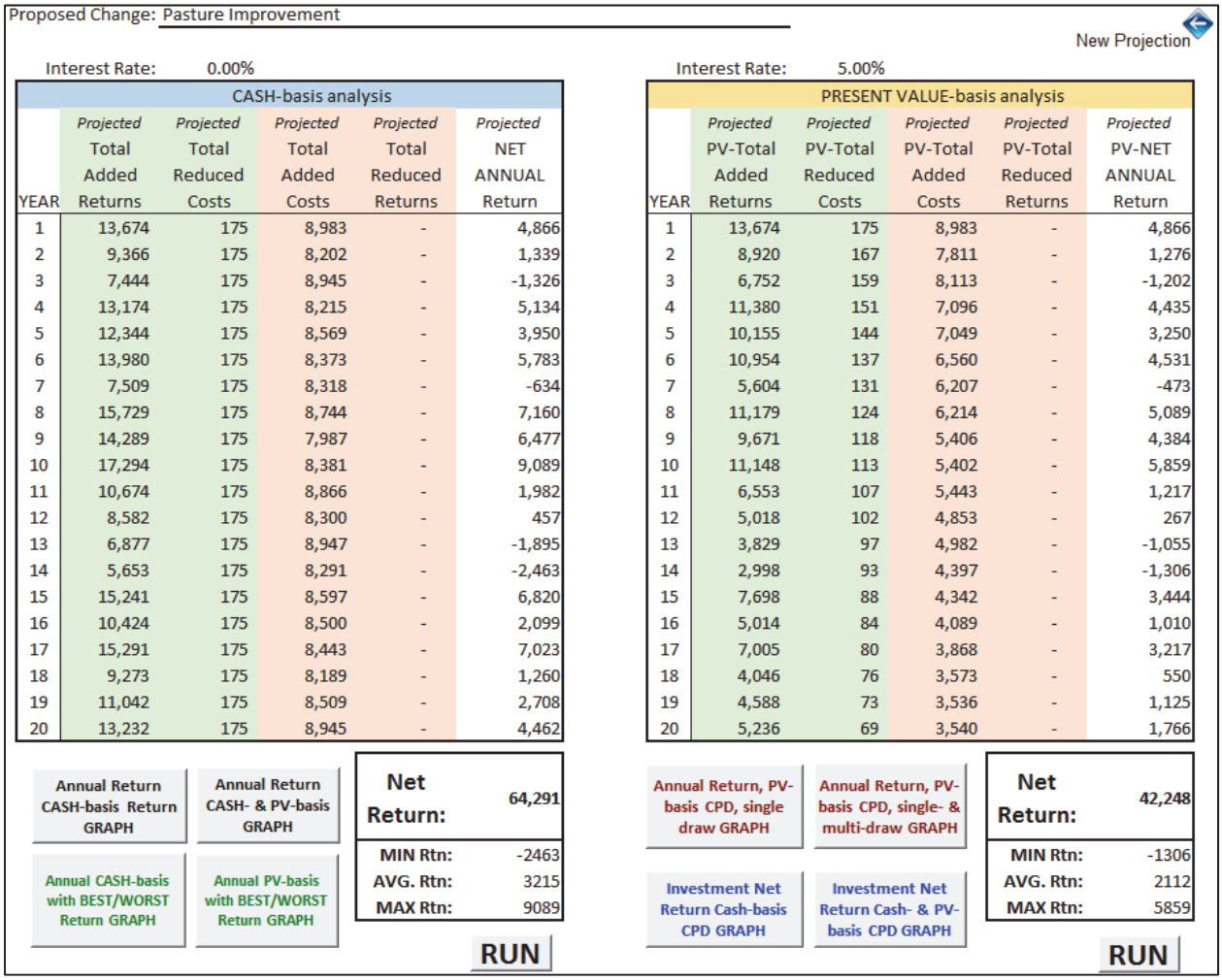
The Timbers do not anticipated any reduced returns associated with this decision.

Results and Graphs for the Pasture Improvement Decision Analysis

The MTRA tool produces a number of different output screens for analyzing multi-temporal decisions with risk. By clicking the Run button, the user initiates thousands of random draws representing possible outcomes of this pasture improvement decision over the course of the 20 year planning horizon.

The Output worksheet for the Timbers' pasture improvement decision is shown in Figure 11.

Figure 11: Multi-Temporal Risk Analyzer Output for the Pasture Improvement Decision



Proposed Change: Pasture Improvement

New Projection

Interest Rate: 0.00%

CASH-basis analysis

YEAR	Projected Total Added Returns	Projected Total Reduced Costs	Projected Total Added Costs	Projected Total Reduced Returns	Projected NET ANNUAL Return
1	13,674	175	8,983	-	4,866
2	9,366	175	8,202	-	1,339
3	7,444	175	8,945	-	-1,326
4	13,174	175	8,215	-	5,134
5	12,344	175	8,569	-	3,950
6	13,980	175	8,373	-	5,783
7	7,509	175	8,318	-	-634
8	15,729	175	8,744	-	7,160
9	14,289	175	7,987	-	6,477
10	17,294	175	8,381	-	9,089
11	10,674	175	8,866	-	1,982
12	8,582	175	8,300	-	457
13	6,877	175	8,947	-	-1,895
14	5,653	175	8,291	-	-2,463
15	15,241	175	8,597	-	6,820
16	10,424	175	8,500	-	2,099
17	15,291	175	8,443	-	7,023
18	9,273	175	8,189	-	1,260
19	11,042	175	8,509	-	2,708
20	13,232	175	8,945	-	4,462

Annual Return CASH-basis Return GRAPH

Annual Return CASH- & PV-basis GRAPH

Annual CASH-basis with BEST/WORST Return GRAPH

Annual PV-basis with BEST/WORST Return GRAPH

Net Return:	64,291
MIN Rtn:	-2463
AVG. Rtn:	3215
MAX Rtn:	9089

RUN

Interest Rate: 5.00%

PRESENT VALUE-basis analysis

YEAR	Projected PV-Total Added Returns	Projected PV-Total Reduced Costs	Projected PV-Total Added Costs	Projected PV-Total Reduced Returns	Projected PV-NET ANNUAL Return
1	13,674	175	8,983	-	4,866
2	8,920	167	7,811	-	1,276
3	6,752	159	8,113	-	-1,202
4	11,380	151	7,096	-	4,435
5	10,155	144	7,049	-	3,250
6	10,954	137	6,560	-	4,531
7	5,604	131	6,207	-	-473
8	11,179	124	6,214	-	5,089
9	9,671	118	5,406	-	4,384
10	11,148	113	5,402	-	5,859
11	6,553	107	5,443	-	1,217
12	5,018	102	4,853	-	267
13	3,829	97	4,982	-	-1,055
14	2,998	93	4,397	-	-1,306
15	7,698	88	4,342	-	3,444
16	5,014	84	4,089	-	1,010
17	7,005	80	3,868	-	3,217
18	4,046	76	3,573	-	550
19	4,588	73	3,536	-	1,125
20	5,236	69	3,540	-	1,766

Annual Return, PV-basis CPD, single draw GRAPH

Annual Return, PV-basis CPD, single- & multi-draw GRAPH

Investment Net Return Cash-basis CPD GRAPH

Investment Net Return Cash- & PV-basis CPD GRAPH

Net Return:	42,248
MIN Rtn:	-1306
AVG. Rtn:	2112
MAX Rtn:	5859

RUN

The left side of the Output worksheet provides a snapshot view for a single draw of a set of potential annual net returns on a cash-basis. This one random draw of the twenty years produces a total net return of $64,291.

The lowest annual return of -$2,463 occurs in Year 14, when the calves didn't increase much in value. The highest annual return of $9,089 occurs in Year 10, when the increase in calf value was three times what it was in Year 14. The average annual return is $3,215, but we also see that 4 out of the 20 years resulted in a negative net return with the implementation of the pasture improvement.

The right side of the output provides a snapshot view for a single draw of this same set of potential annual net returns on a discounted, net present value (NPV) basis using a 5 percent interest rate as the discount factor for the time value of money. The total net return on a NPV-basis is only $42,248.

Annual Return Graphs: Pasture Improvement Decision

The expected annual returns on a cash basis can be graphed on their own over time, in comparison with possible best and worst case scenarios (see Figure 12), or in comparison to the present value of expected annual returns (see Figure 13).

The expected value for the net present value of annual returns can also be graphed in comparison to best and worst case scenarios (see Figure 14).

In Figure 12, the worst case scenario for each year is -$9,802 if everything turns out poorly (lowest added returns and highest added costs). The best case scenario for each year is $11,062 if everything turns out as good as possible (highest added returns and lowest added costs). The average over 20 years is $3,215 per year. We see the fluctuations in results over the course of 20 years by following the solid blue line across the graph. As mentioned above, 4 out of the 20 years result in negative returns and no more than three years in a row are strung together with consecutive returns above or below the average.

In Figure 13, a similar situation is depicted for the discounted annual returns. In this case, we see the curved lines for the best and worst case scenarios that result from discounting future values. The best case scenario becomes less positive in present value terms as it moves further out into the future. Likewise, the worst case scenario becomes less negative in present value terms as it moves further out into the future.

The average return of $2,112 is also lower than the non-discounted average return of $3,215 but it is not as simple as just discounting a constant average return. The timing and magnitude of the inflows and outflows make a difference. For example, the negative net returns in year 13 and year 14 are discounted much more and move closer to zero than the positive net return in year 1 that is not discounted at all. While the patterns are similar, the dampening effect of discounting will always cause more of an impact on the later years than it will on the early years, demonstration that the timing of the flows does matter.

Figure 14 shows a graphical comparison between the cash returns and the discounted returns. Notice how the gap between the two widens as you move from left to right in the graph and how the discounted value is always closer to zero in a given year.

Overall, the decision looks like the pasture improvement would be a positive change to make, even considering that there are times when the returns are negative in a given year. Even on a NPV basis the returns look very positive at the end of the twenty years.

The MTRA tool adds real power to this analysis by taking uncertainty into account and producing a cumulative range of possible annual results. Figure 15 contains one of these graphical results comparing the range of NPV annual returns to one sample draw.

The green curve in Figure 15 represents all of the possibilities for any annual NPV return given thousands of possible random draws (multi-draw analysis). The worst case scenario is -$7,841 and the best case scenario is +$10,388 on a NPV basis for any one year.

The brown curve in Figure 15 represents possible annual NPV returns for each year of a single draw (single draw analysis).

Recalculating the MTRA spreadsheet by clicking the Run button, will produce a new brown curve based on a new single draw. Since the green curve represents all possible draws, the brown curve will always be bounded on the left and the right by the end points of the green curve. In addition, the green curve will not change with a new Run, unless the user modifies one or more of the underlying parameters.

Figure 12: Expected Cash Annual Returns versus Best and Worst Case Scenarios for the Pasture Improvement Decision

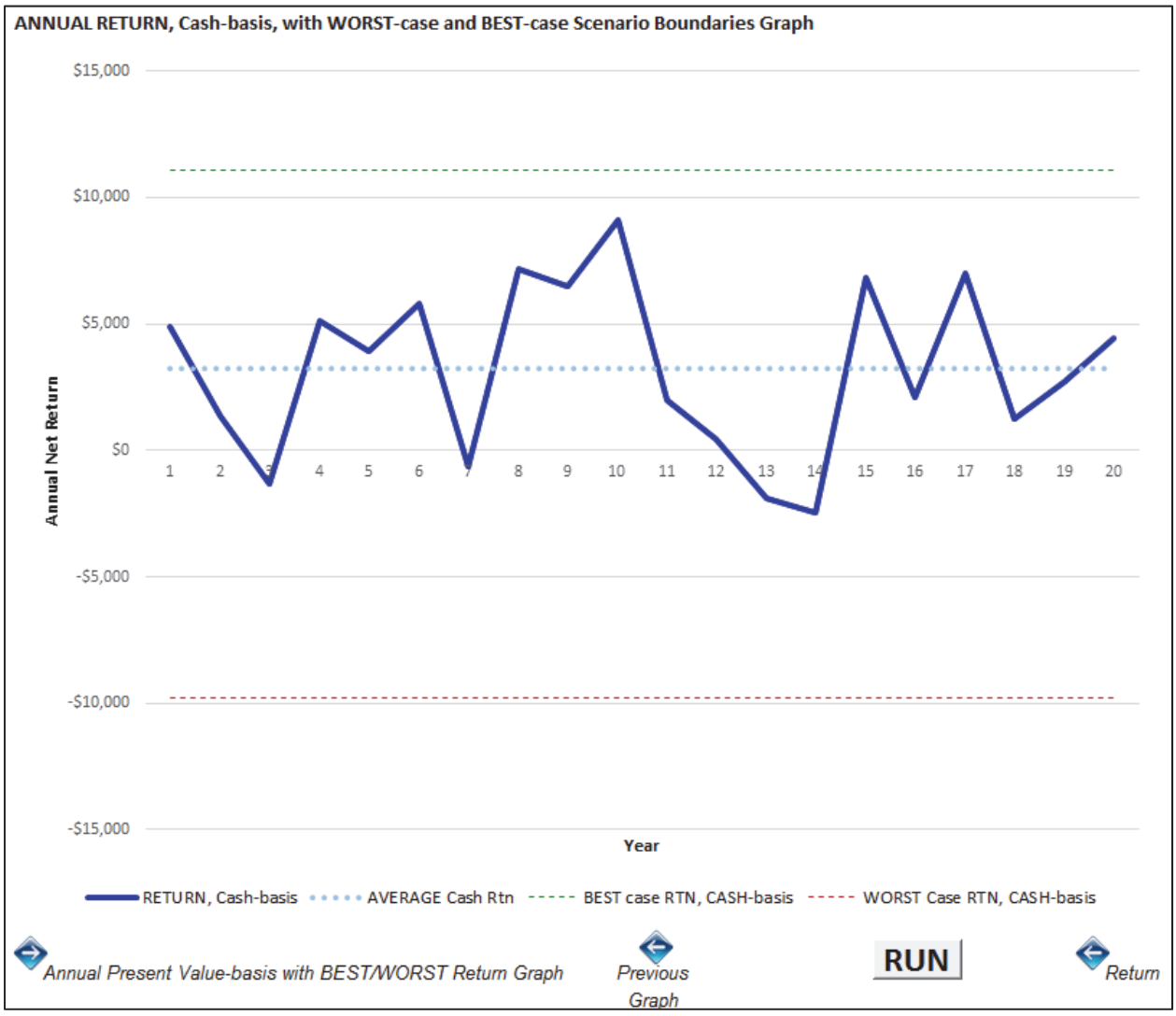


Figure 13: Expected NPV Annual Returns versus Best and Worst Case Scenarios for the Pasture Improvement Decision

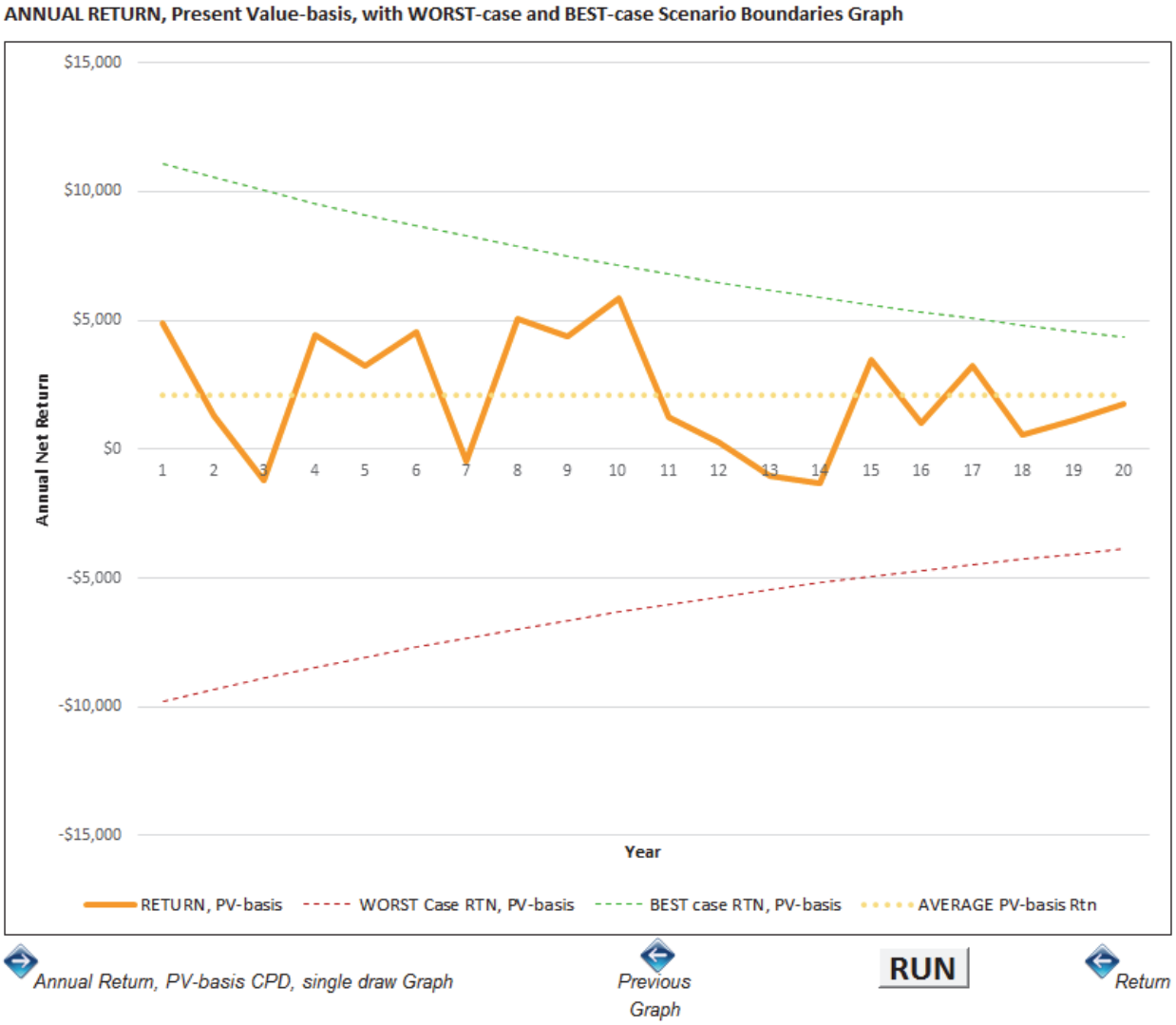


Figure 14: Expected Annual Returns Cash versus Present Value Scenario for the Pasture Improvement Decision

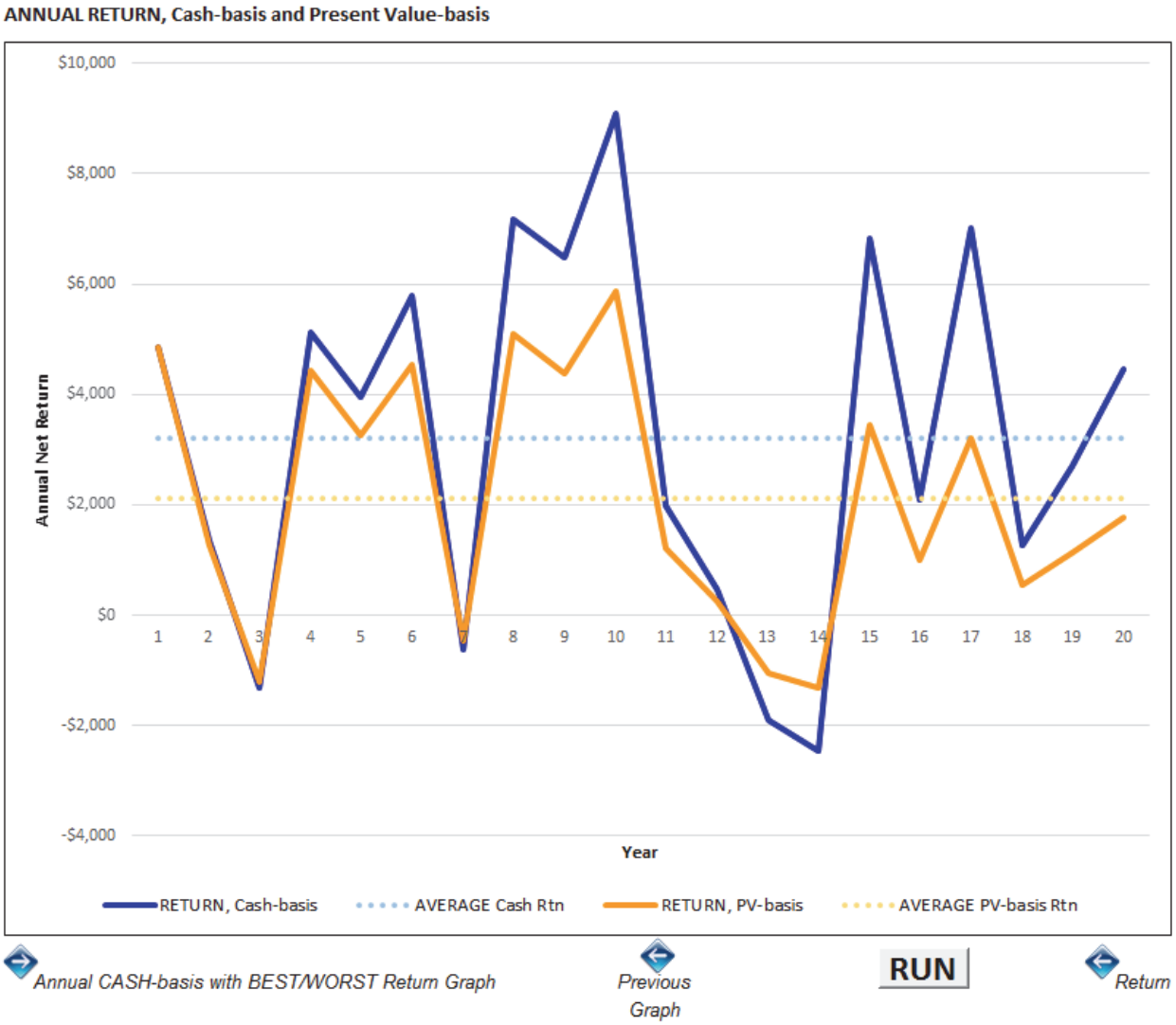
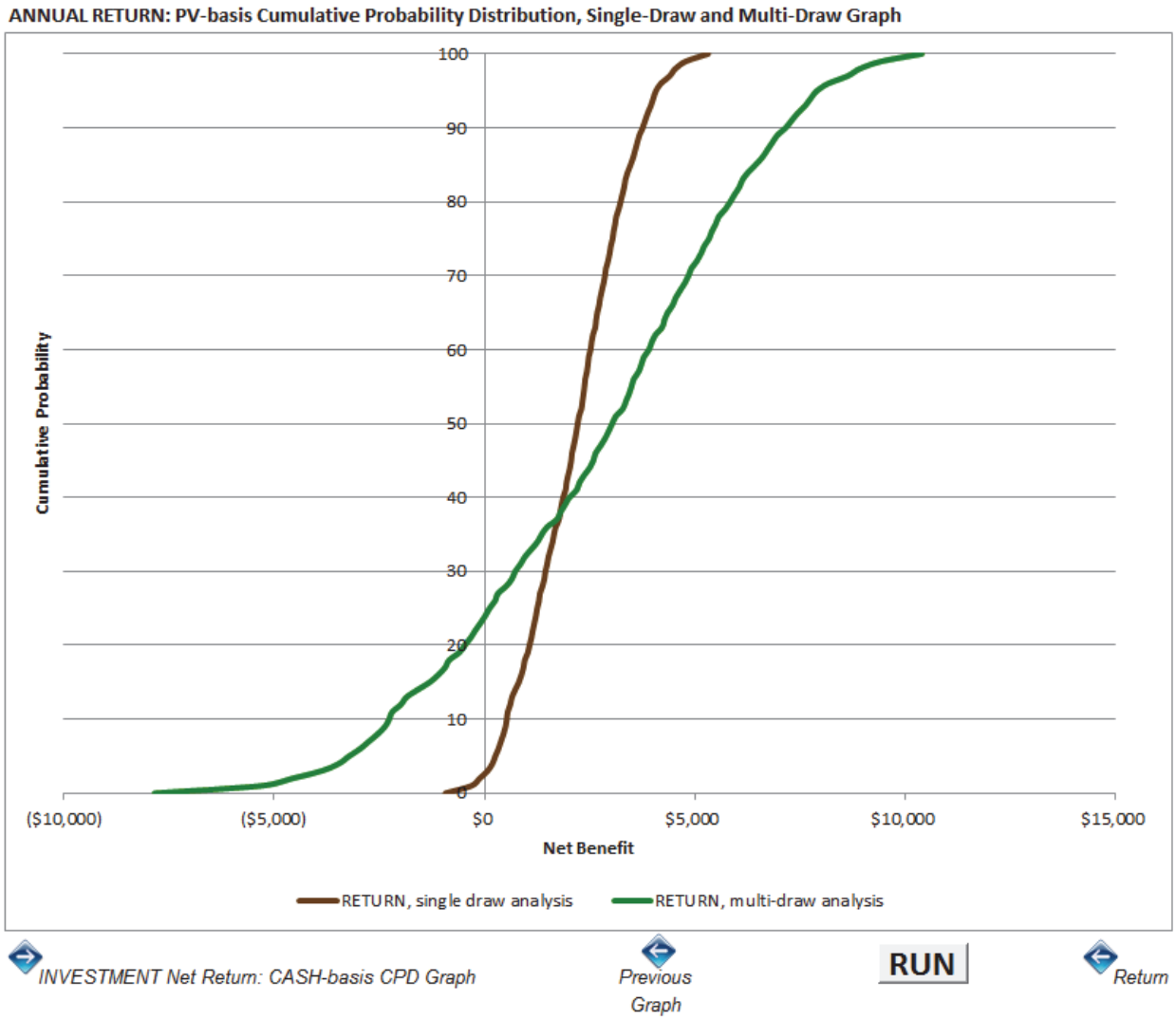


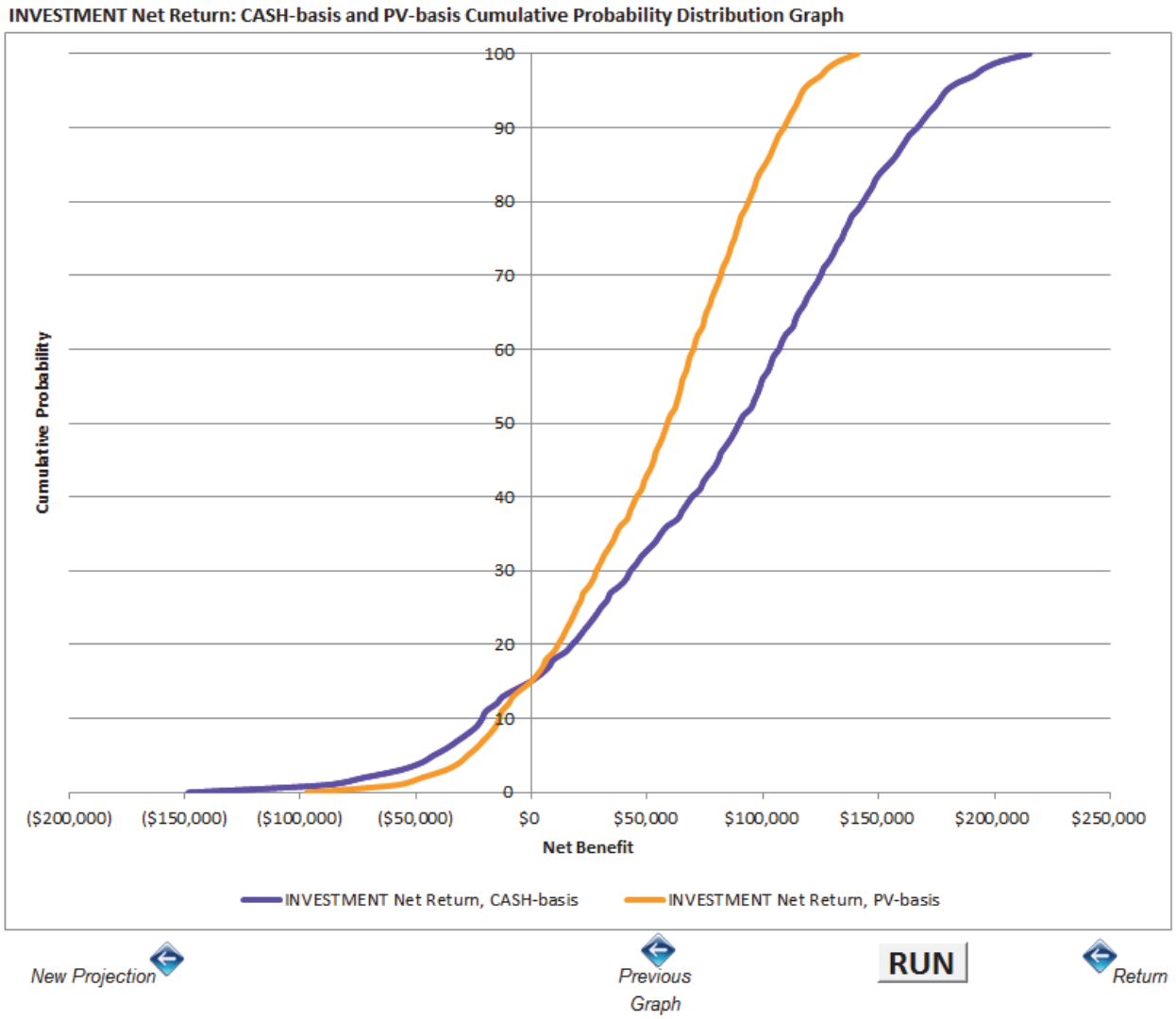
Figure 15: Distribution of the NPV of Annual Returns for the Pasture Improvement Decision



Investment Analysis: Pasture Improvement Decision

Finally, the MTRA tool can produce a cumulative probability distribution for the investment analysis on a cash basis and NPV basis (see Figure 16).

Figure 16: Investment Analysis of the Pasture Improvement Decision



On a cash-basis, the investment analysis in Figure 16 shows the cumulative net return on the pasture improvement could be as high as $215,202 or as low as -$148,269.

When the time value of money is taken into account, the picture is tightened up. The investment net return over twenty years on a PV-basis could be as low as -$97,007 or as high as $140,800. On a NPV basis, there is a 50 percent chance that the net returns from the decision could be above $58,694 and a 50 percent chance it could be below $58,694.

Overall, it looks like a good decision would be to make the pasture improvements but there is a 15 percent probability that the decision will lose money upon implementation.

RightRisk™ is an innovative risk research and education effort. It uses real world farm and ranch information and agricultural economics to help farm and ranch managers better understand and explore risk management decisions and evaluate the effects of those decisions. Mangers learn about their personal risk management style and build decision-making skills.

RightRisk™ has developed *Ag Survivor* a computerized risk simulation, *Risk Navigator: Strategic Risk Management* a ten-step process for strategically managing risk, and many self-study courses in risk management. Managers also have on-going access to agricultural economists with expertise in risk management. The RightRisk™ Education Team consists of a team of researchers and extension specialists from eight Western states including Arizona, Colorado, Idaho, Montana, Nevada, Utah, Washington, and Wyoming.

For more information about RightRisk™, please visit our website. There you can learn more about RightRisk™, about risk and risk management, how to contact resource people, and where and when up-coming RightRisk™ workshops will be held. Also, you can use many if not most of the RightRisk™ tools online!

Funding partners:

RightRisk™ programs are available to all without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.