Volume 9, Issue 6 June 2021

RightRisk™

RightRisk News

Evaluating Threats Using a Payoff Matrix

Dates to Remember

Spring crop acreage reporting deadline
- July 15

Annual Forage Insurance Plan
Sales Closing Date - July 15

Forage Insurance
- September 30th

For more information see:
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How Much Risk is Right for You?

Evaluating risk strategies often involves assessing potential payoffs for different decision alternatives. The May issue of *RightRisk News* covered how a decision tree or decision flow diagram provides a graphical representation of risk management decisions, associated uncertainties, and potential outcomes. A payoff matrix is another method for displaying this type of information. A payoff matrix is more compact, less graphically intense, and fits into a spreadsheet table where summary statistics can be added with little additional work.

Corn Marketing Decision

Figure 1 presents the payoff matrix for the simple decision tree presented in the May *RightRisk News*. It represents a single corn crop marketing decision followed by two possible event outcomes: 1) a short crop/favorable market outcome or 2) a normal crop/unfavorable market outcome, with associated probabilities of occurrence of 60 percent and 40 percent, respectively. The marketing decision involves three possible courses of action: 1) selling on the cash market at harvest, 2) forward contracting a little over half of the expected sales for delivery at the local elevator, and 3) hedging a little over half of the expected sales on the Chicago Board of Trade.

Figure 1: Example Payoff Matrix for Corn Farmer Marketing Decision

				Decision Alternatives		
Risk Outcomes	Harvest Cash Price	Harvest Basis	Probability	#1 Cash Market 137,000 bu.	#2 Forward Contract 70,000 bu. @ $5.32	#3 Hedge 70,000 bu. @ $5.52 (-$0.20 basis)
Normal US Crop	$4.62	-$0.35	40%	$632,940	$681,940	$671,440
Short US Crop	$5.65	-$0.15	60%	$774,050	$750,950	$755,850
			Expected Value	$717,606	$723,346	$722,086
			Standard Deviation	$69,129	$33,808	$41,352

The six possible outcomes that populate the right-hand side of the decision tree are compactly represented in a spreadsheet table as payoffs. Notice the two lines added to the bottom of the table to include the calculated values Expected Value and Standard Deviation for each of the three alternatives considered.

The decision alternative to sell on the cash market at harvest would net the highest revenue at $774,050 if a short crop occurs and markets are favorable and the lowest revenue at $632,940 if a normal crop occurs and markets are unfavorable. Therefore, it has the highest risk of the three alternatives considered. This is represented by the highest standard deviation among the alternatives at $69,129.

A decision maker comparing alternative #1 to alternative #2 can easily see that alternative #2 involves less risk (i.e. lower standard deviation) and that it has a higher expected return. In fact, the same thing can be said when comparing alternative #2 and alternative #3 but differences in the standard deviation and expected value are not as large.

Alternative #2 will result in a return that is $49,000 higher than alternative #1 and $10,500 higher than alternative #3, if a normal crop occurs and markets are unfavorable. However, if a short crop occurs and markets are favorable, alternative #2 will result in a return that is $23,100 lower than alternative #1 and $4,900 lower than alternative #3.

In summary, alternative #2 has a much higher minimum payoff but a lower maximum payoff than the other two alternatives. This tighter range of outcomes is reflected in a much lower standard deviation for alternative #2. Also notice that with only a 40 percent chance of a normal crop and unfavorable markets, alternative #2 has a higher expected value than both alternative #1 and alternative #3. A rational decision maker will likely choose alternative #2 over the other two alternatives in this situation, even though there is a 60 percent chance that it may result in a lower payoff. The payoff matrix is a compact, clear method for displaying all of this information to the decision maker.

Complex Risk Decisions

Many risky decision problems involve several more choices and possible outcomes than those depicted in Figure 1. A payoff matrix can summarize this information in a much more compact format than a decision tree. However, a decision tree can better represent a series of linked decisions. This is a limitation of the payoff matrix. A payoff matrix can capture a series of uncertainties occurring through time by calculating conditional probabilities for the different combinations of outcomes. However, a payoff matrix is not designed to present the elements of time and sequence of events. Instead, it offers a clear-cut comparison of a single set of decision alternatives for a single decision point.

Stocking Rate Decision

The May *RightRisk News*, offered a decision tree for a rancher making seasonal stocking decisions from an initial stocking rate followed by early season growing conditions and subsequent decisions to partially de-stock, followed by late season growing conditions and final outcomes. A payoff matrix has a limited ability to display all of this relevant information. However, a decision maker can use a series of payoff matrices to work recursively* from the later decisions back to the initial decision and the associated payoff matrix for that first choice.

Figure 2: Example Decision Tree for Linked Decision of Rancher Stocking Light and then Experiencing Poor Pasture Conditions Early in the Growing Season

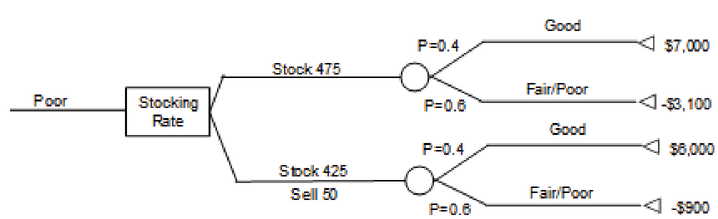


Figure 2 displays a decision tree for a rancher who initially decides to stock light (475 head) and subsequently experiences poor pasture conditions and the follow-on decision to de-stock even further to 425 head. Figure 3 displays the associated payoff matrix for only this follow-on decision. A producer would likely choose alternative #2 in this case because it has a much higher expected value and a lower standard deviation than alternative #1.

Choosing to further de-stock by 50 head makes sense because it avoids a large potential loss if pasture conditions continue to deteriorate in exchange for accepting a slightly lower return if they improve. The decision maker can then produce a full set of possible payoffs for the initial decision to stock light, given this decision.

Figure 3: Example Payoff Matrix for Linked Decision of Rancher Stocking Light and then Experiencing Poor Pasture Conditions Early in the Growing Season

		Decision Alternatives	
		#1	#2
Risk Outcomes	Probability	Stock 475 head	Stock 425 head (sell 50)
Good	40%	$7,000	$6,000
Fair/Poor	60%	($3,100)	($900)
	Expected Value	$940	$1,860
	Standard Deviation	$4,948	$3,380

Similarly, if the initial decision were to stock normal at 500 head, a follow-on decision is created if pasture conditions in the early part of the grazing season turn out to be poor or fair. Figure 4 and Figure 5 display the payoff matrices for each of those two follow-on decisions. In each case, it is reasonable to assume a producer might select alternative #2 with a much lower standard deviation (risk) and a similar or higher expected value.

A payoff matrix for the initial stocking rate decision can be constructed as shown in Figure 6, using the above assumptions for the follow-on decision. The uncertainties of three possible pasture conditions early in the grazing season and two possible pasture conditions late in the growing season result in six possible payoffs for each alternative considered. The decision to stock normal (alternative #1) results in a higher expected value and a higher standard deviation (risk). Note that, unless early pasture conditions turn out to be poor, alternative #1 results in a higher return, regardless of late season pasture conditions. The data suggests that 70 percent of the time alternative #1 results in a higher return so a decision maker may logically decide to go with alternative #1 and initially stock 500 head.

Decisions involving risk are difficult, particularly where there are many factors to consider. As a result, it is not surprising that evaluating these decisions often requires a multi-pronged approach. We illustrated how decision trees can be used to map out a sequence of decisions and risks over time, in the May *RightRisk News*. This article explores those same situations using a payoff matrix. Each approach has its own strengths and weaknesses. However, combined they can be used to help a decision-maker reach clear-cut insights into the tradeoffs offered by complicated decisions involving risk.

* Recursive: Using a rule or approach that can be applied repeatedly to reach a conclusion/decision.

Figure 4: Example Payoff Matrix for Linked Decision of Rancher Stocking Normal and then Experiencing Fair Pasture Conditions Early in the Growing Season

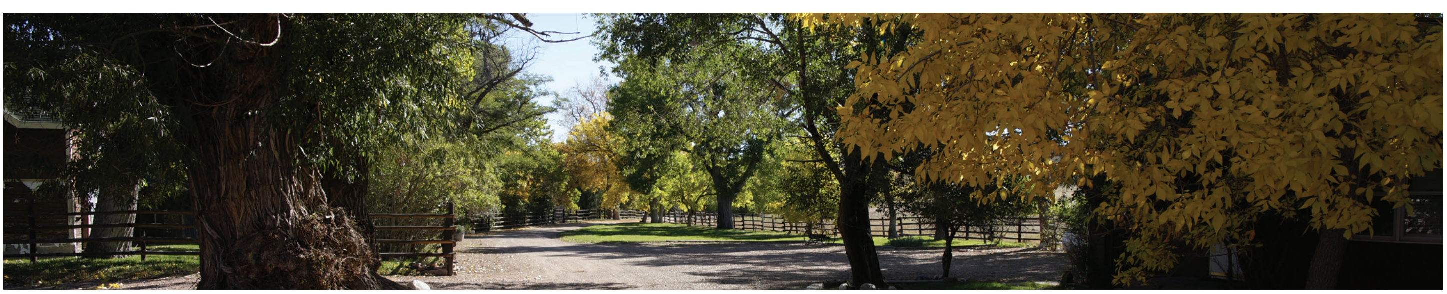
		Decision Alternatives	
		#1	#2
Risk Outcomes	Probability	Stock 500 head	Stock 450 head (sell 50)
Good	40%	$17,000	$10,000
Fair/Poor	60%	$5,900	$8,900
	Expected Value	$10,340	$9,340
	Standard Deviation	$5,438	$539

Figure 5: Example Payoff Matrix for Linked Decision of Rancher Stocking Normal and then Experiencing Poor Pasture Conditions Early in the Growing Season

		Decision Alternatives	
		#1	#2
Risk Outcomes	Probability	Stock 450 head (sell 50)	Stock 400 head (sell 100)
Good	40%	$7,000	$5,000
Fair/Poor	60%	($3,900)	($1,500)
	Expected Value	$460	$1,100
	Standard Deviation	$5,340	$3,184

Figure 6: Example Payoff Matrix for Rancher Stocking Decision and Experiencing Two Pasture Conditions during the Grazing Season

		Decision Alternatives	
		#1	#2
Risk Outcomes	Probability	Stock Normal 500 head	Stock Light 475 head
Good-Good	12%	$38,000	$27,500
Good-Fair/Poor	18%	$31,500	$25,000
Fair-Good	16%	$10,000	$9,950
Fair-Fair/Poor	24%	$8,900	$5,950
Poor-Good	12%	$5,000	$6,000
Poor-Fair/Poor	18%	($1,500)	($900)
	Expected Value	$14,296	$11,378
	Standard Deviation	$13,635	$10,129



~ Other RightRisk News ~

News Release - MAY 14 | RightRisk

Farm Credit Conditions Show Additional Strength

Overall, farm borrowers in the District were in a better financial position than at the beginning of 2020, but the pace of improvement was notably slower for livestock producers and for producers in areas affected by severe drought . . .

For more see: RightRisk.org\News

Highlighted Publication: *Ag Help Wanted - UPDATE*

Job Descriptions Why Waste the Time?

Investing time and energy into developing a strategy for hiring workers, including drafting a clear job description, can pay dividends over the long run. No matter how the information about a job is obtained, putting it into a written job description lays the foundation for recruitment, selection, and management later on. What is a job description? It is simply a verbal sketch of a given job—its purpose, content, and attributes or characteristics of the people likely to perform it well. Some firms also use the job description to formally describe the terms of employment such as pay, benefits, and performance standards. . .

To read more or to access the publication, see: **RightRisk.org > Products > Ag Help Wanted > Updates**

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