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Research Article

Risk Navigator SRM: An Applied Risk Management Tool

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Risk Navigator SRM is a ten-step risk management program for agricultural producers, which is based on the strategic planning process. The ten steps are designed to integrate disparate and difficult risk management concepts into a single system that is easy to use, yet still effective. With the aid of computers and the internet, producers can work through each step toward a final comprehensive plan. The website includes 25 decision tools that help producers accomplish each step and provides links to complementary educational programs, like a national agricultural risk education library, the award-winning risk management simulation program called Ag Survivor, and a recently published book that describes the program and provides additional depth and explanations. The ten-step program has been presented in over 200 workshops with over 90 percent approval by participants. The website has averaged over 1,000 unique visitors per month from 120 countries.

1. Risk Navigator SRM: An Applied Risk Management Tool for Agriculture

Risk management technology has drastically outpaced the ability of most practitioners to adopt innovations. Studies of farmers and ranchers, for example, consistently show that they do not utilize what is available; some even seem to virtually disregard risk altogether [1, 2]. One survey of nearly 1,000 farmers for Farm Futures [3] found that only 5 percent use available tools. That survey also showed that those that did manage risk tended to be high-end managers with skills not typical of the industry. Agricultural producers were said to resist change because there are too many decisions and too little time.

Congress considered agricultural risks so important that in 1996 it created the Risk Management Agency (RMA) in the US Department of Agriculture. Its purpose is to promote, support, and regulate sound risk management solutions for agricultural

Table 1: Risk management sources and controls; see source in [6].

Risk	Defined	Sources	Management Controls
Production	Uncontrollable events such as weather, pests, or disease make yields unpredictable. Changing technology makes a manager or capital obsolescent. Inputs are unavailable or low quality	Weather, extreme temperatures, pests, disease, technology, genetics, inputs (availability, quality, price), equipment failure, labor, ...	Diversification, insurance (crop, revenue), buildings, storage, vaccines, extra labor, production contracts (e.g., ensure input supply and quality), new technologies (e.g., automate watering)
Marketing and Price	Prices of inputs or outputs change after a producer commits to a plan of action. Price fluctuations stem from domestic and international supplies or substantial changes in demand	Product quality (genetics, disease, handling, input/feed) Product price (quality, timing, global market, weather, government policy, contracts, ...)	Futures and options, forward contracting, retained ownership, quality controls, storage (timing), cooperatives, niche/value-added marketing, ...
Financial	Stems form the way a business is financed Borrowed funds leverage business equity but increase business risks	Market, production, legal and human risk, interest rate changes, natural disasters (drought), land market changes, foreign exchange, loan calls, ...	Cash reserves, equity, borrowing capacity, reducing other types of risk (production, marketing, etc.), insurance
Institutional	Government or other institutional rules, regulations, and policies effect profitability through costs or returns	Taxes, contract disputes, regulations, government policies, law suits, ambiguous and/or unwritten agreements, neighbors, environmental programs, ...	Estate planning, tax planning, contracts, bonds (e.g., environmental liability), research and education about local laws, ...
Human Resources	The character, health, or behavior of people introduces risk. This could include theft, illness, death in the family, loss of an employee, or a divorce for example	Ambiguous and/or unwritten agreements, poor planning, miscommunication, health or other family disasters, ...	Family planning, including labor planning, clear contracts, training and goal setting, communication, estate planning, ...

producers [4]. According to RMA, there are at least five major forms of agricultural risks [5]: production, market/price, financial, institutional, and human. As shown in Table 1, agricultural producers face many sources of risk and a multitude of ways to manage them across and within these five categories. Price risk, for example, can be affected by product quality, exogenous supply, and government policies; it has at least seven management options, including futures, forward pricing, and storage. RMA efforts have substantially boosted the output of risk information and education to address these risks.

While there is little doubt about its importance for decision making, the "challenge is to know how to describe, measure, and communicate risk" [7, page 4]. Consider the parallels to understanding and using probability, which is itself an important component for risk management. Myerson [8] concludes that there is a disconnection between theory

and practice because formulas traditionally taught in probability courses are hard to apply to real problems. He suggests that recent advances in computer technology can help overcome these disconnects. Aven [7] goes further by suggesting that a common unifying framework is also needed. For example, websites now combine a framework and computer technology to make managing a stock portfolio relatively simple, even for those people with only a minimal understanding of price analysis. These frameworks require integrating multiple fields, like economics, finance, and statistics, and finding an acceptable balance between the precision and usability.

Agricultural economics and related fields have contributed greatly to developing innovative and effective tools for managing risk in agriculture. But, as is the case with probability, these sometimes disparate theories and concepts can be difficult to understand, which may make integration difficult. Numerous books, articles, and materials are available but are generally inaccessible except by specialists [2]. A 2007 study in Nevada, for example, showed that after six months only 50% of program participants planned to incorporate what they had learned in a risk management workshop [9]. A 2007 study [10] showed that older producers had less knowledge about risk management tools, compared to younger producers, and had less interest in learning more about them. This supports the Farm Futures survey [3] in that many producers view the human capital investment required to learn how to properly incorporate the use of risk management tools into their operation as significant.

The purpose of this manuscript is to describe a new framework for risk management called Risk Navigator SRM. The program is too involved to fully describe here, and it was prepared for education and extension programs, rather than basic research. Nevertheless, researchers might be interested in how disparate parts were integrated to strike a balance between precision and usability, with the purpose of making the components of risk management more usable through a synergistic and reinforcing framework. Precision can interfere with usability and vice versa. That balance in Risk Navigator SRM is based on interaction with producers at over 200 meetings in over a dozen states. This includes a description of supporting software tools made available by website. Our focus here is on showing how probability is integrated with other risk concepts to make risk management more accessible to producers. All ten steps of the process were fully applied to a case study, EWS Farms, which also may be of interest. EWS Farms produce primarily corn and wheat in Northeastern Colorado [6].

We proceed with a description of Risk Navigator SRM and explain the SRM process, which has ten steps. A brief summary is provided for all ten steps, but a more complete description is provided about steps viewed to be of more interest to this readership. We also provide examples of the computer tools available to help producers with each step where appropriate.

2. Risk Navigator

Risk Navigator SRM is a program developed to make risk management accessible to typical agricultural producers. The process is general enough that it can be applied to other applications, but all of the examples and tools are customized for agriculture. SRM stands for Strategic Risk Management. Strategic planning [11, 12] is an umbrella framework used to organize and integrate risk management concepts and tools for farmers and ranchers. The SRM process has been taught to hundreds of farmers and ranchers under the brand name Risk Navigator SRM or under previous incarnations branded “RightRisk”. Risk Navigator SRM is

housed on a public website at http://www.RiskNavigatorSRM.com/. The website includes detailed descriptions about a ten-step strategic risk management program and 25 customized computer tools to help decision makers with each step. The tools are matched to the steps and standardized through Xcelsius flash files from Excel where possible. Some files are pdf or Excel spreadsheets. The site also includes links to complementary educational materials, such as a risk practice simulator called Ag Survivor, http://www.AgSurvivor.com/, a comprehensive book titled *Applied Risk Management in Agriculture* [6], and a general education website called RightRisk, at http://www.RightRisk.org/. The book includes a comprehensive discussion about risk management, matched to the ten steps, and includes a case study to demonstrate each step. The RightRisk.org website has publications, workshops, and access to resources such as the National Ag Risk Education Library.

3. The Strategic Risk Management Process

The framework chosen to make risk management more accessible is strategic planning [6]. The foundation of strategic planning is based on three major phases: strategic, tactical, and operational [12, 13]. The strategic phase of strategic planning is designed to set boundaries based on resources, opportunities, and threats, and to set goals. The tactical phase is designed to evaluate various alternatives for reaching the strategic vision and goals and to develop a solid plan to achieve them. Implementation, evaluation, and replanning occur in the operational stage.

The strategic, tactical, and operational phases have also been linked to agriculture in previous studies. For example, Aull-Hyde and Tadesse [14] modeled strategic differences when long- and short-term risks are considered in agricultural production. Fountas et al. [15] modeled the effects of information flows for strategic, tactical, and operational differences in the context of precision agriculture. Other models review specific details of tactical or operational implementation, while assuming that the strategic phase of the model has already been conducted (Ahumada and Villalobos [16]).

Not surprisingly, risk management researchers have proposed frameworks that intuitively capture the strategic planning process. For example, Clemens and Reilly [17] propose the following steps that are typical of many risk researchers (e.g., [2, 18, 19]):

(1) identify decision,

(2) identify alternatives,

(3) decompose the problem,

(4) choose best alternative,

(5) conduct sensitivity analysis,

(6) repeat if necessary.

These are the same principles found in the tactical and operational phases of strategic planning. The strategic phase is more commonly addressed separately through risk preference and tolerance (e.g., [17, 19]).

Risk Navigator SRM provides formality to agricultural risk management and condenses this information in a way that is understandable to agricultural operators by fitting risk management into the strategic management framework. Hoag [20] developed ten steps that map existing risk management concepts into the three phases (Figure 1). There are three steps in the first phase: (1) determine financial health, (2) determine risk preference, and (3)

Figure 1: Strategic risk management process; see source in the study of Hoag in [6].

establish risk goals. These steps are not typically covered in risk management frameworks, but were inspired by the strategic planning process. The first two of these steps were chosen to set boundaries on tactical choices, which are then used to set goals in Step 3, as set forth by the strategic planning process.

There are four steps in the next phase, the tactical stage, which constitute Steps 4–7 in the SRM process: (4) determine risk sources, (5) identify management alternatives, (6) estimate risk probabilities, and (7) rank management alternatives. This tactical phase is based on another framework, the payoff matrix (Table 2), which is commonly used in risk analysis to capture frameworks like that shown above [17, 18]. Each of these steps is designed to elicit a component of a payoff matrix. The payoff matrix is a construct that displays payoffs, usually profits, by management actions (e.g., cash sale, contract sale, hedging on the futures market, etc.) and states of nature (e.g., normal weather resulting in a normal crop and typical crop prices, or bad weather, resulting in a short US crop and high crop prices). Probability is displayed next to each state of nature. The matrix is designed to show risk dimensions in a way that helps decision makers rank risks based on their risk personality, which is further described in Step 7. Summary statistics can be displayed at the bottom of the table to provide more information, such as expected value and standard deviation. For the purposes of illustration, the EWS Farms case study manages corn price risk. There are three marketing management alternatives: selling on the cash market, forward pricing, or hedging. The source of risk is the likelihood of a short U.S. crop.

One limitation of the payoff matrix is that it only addresses one risk at a time. It can accommodate complex problems with multiple management alternatives, but only one source. Our attempts to discuss joint distributions in risk training workshops, such as price with yield, reduced comprehension and acceptance by producers when presented; therefore we chose to focus on addressing multiple management options for a single risk. Joint distributions and extensions of the model are described by Hoag in [6]. In addition, Ag Survivor risk simulations are based on joint distributions, where appropriate.

Table 2: Payoff matrix for EWS farms' corn pricing decision; see source in [6].

			Whole Farm Returns for Management Alternatives		
			no. 1	no. 2	no. 3
	Outcome			Forward	
Risk states	$/*bushel corn*	Probability	Cash market	Contract	Hedge
Normal crop	$2.10/bu	.35	$287,700	$305,900	$298,200
Short crop	$2.50/bu	.65	$342,500	$332,700	$339,000
Expected value			$323,320	$323,320	$324,720
Standard deviation			$38,749	$18,900	$28,850

The last phase, the operational stage, utilizes three steps intended to carry out the plans made in the tactical stage: (8) implement plans, (9) monitor and adjust, and (10) replan. The first step focuses on the day-to-day activities to assure that good planning efforts are carried out. Monitoring can provide the information needed to determine whether plans should be adjusted. Re-planning takes the decision maker around the circle to start over.

4. The Strategic Phase

We proceed with a brief description of each step. An application to the case study and examples of tools available at the RiskNavigatorSRM.com website are included, where space is appropriate for this audience.

Step 1 (Determine Financial Health). The first step is to determine financial health in order to determine a person's financial capability to take on risks. Financial health refers to assessing the well-being of a business's financial resources, with respect to their ability to take on risk. Educational programs about financial management are widely available in agricultural extension programs. There are six tools available at http://www.RiskNavigatorSRM.com/ that were based on an extension program in Montana developed by Duane Griffith (http://www.montana.edu/softwaredownloads/financialmgtdownloads.html). This includes typical tools to develop not only commonly used financial statements, like a balance sheet and cash flow statement, but also tools specifically designed to help people understand how health affects risk resilience. Specifically, the "RDfinancial" tool and "Sweet Sixteen Ratio Analyzer" tool identify strengths and weaknesses of a decision maker's financial position. RDfinancial and the Ratio Analyzer provide a plethora of financial information, including the sixteen financial ratios commonly used to describe financial health. RDfinancial also contains a credit scoring model.

Step 2 (Determine Risk Preference). The second step involves assessing a person's risk preferences, which affects a person's attitude about taking on risks. There are many limitations regarding the elicitation of risk preferences [17, 18] but, sometimes, it is worth living with these problems if producers need the extra information at the decision margin. The Risk Navigator SRM's "Risk Preference Calculator" tool offers three different methods to help people gauge their preferences. One method, shown in Figure 2, computes a relative Pratt-Arrow risk preference score [21, 22]. The coefficient of absolute risk aversion, $r_a(W)$, is the negative of the second derivative of utility, U, for wealth, W, divided by the first

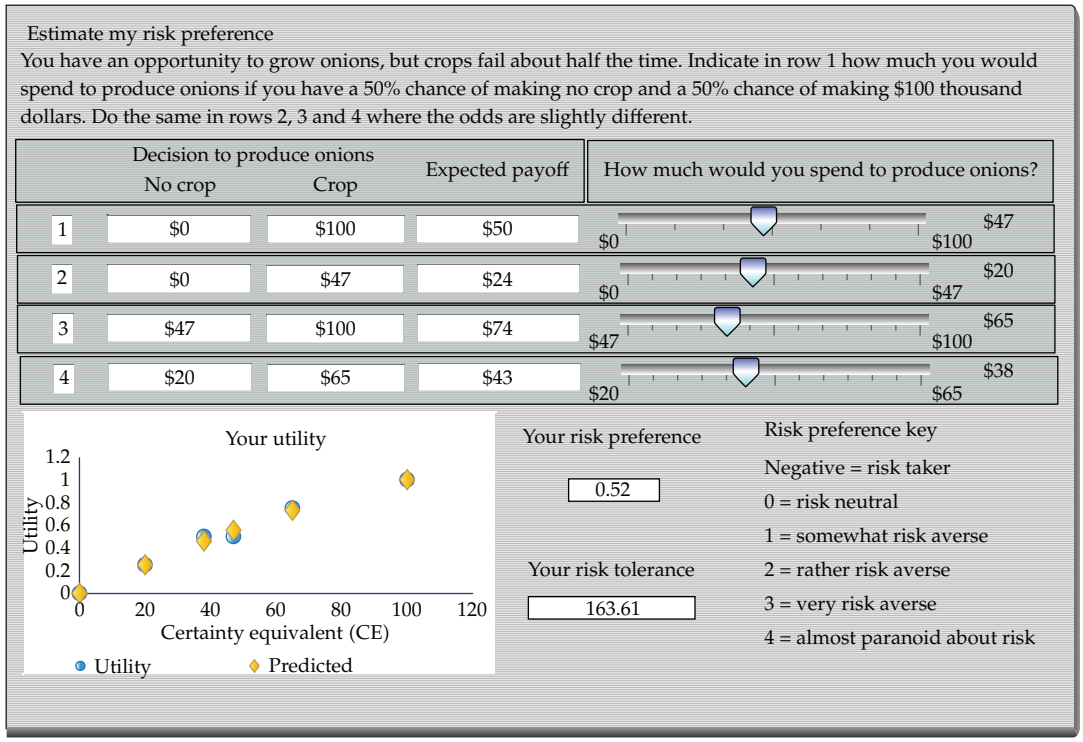


Figure 2: Elicitation of risk preference/tolerance in Risk Preference Calculator. See source in [6].

derivative of utility for wealth:

$$r_a(W) = -\frac{U''(W)}{U'(W)}. \tag{4.1}$$

This coefficient is positive for risk-averse individuals, zero for risk neutral individuals, and negative for risk-loving individuals. People that are risk averse would pay a premium to avoid risk. Risk-neutral individuals maximize expected values and ignore risk. Since "r" changes with the size of the gamble, the concept of a coefficient of relative risk aversion (RAC) was created simply by multiplying the coefficient of absolute risk aversion by wealth:

$$\text{RAC} = W r_a(W). \tag{4.2}$$

The RAC equals 0 for someone that is risk neutral. It varies from about 0.5 to 4.0 for risk-averse people, as suggested by Hardaker et al. [18]:

(i) RAC(W) = 0.5: hardly risk averse at all,

(ii) RAC(W) = 1.0: somewhat risk averse (normal),

(iii) RAC(W) = 2.0: rather risk averse,

(iv) RAC(W) = 3.0: very risk averse,

(v) RAC(W) = 4.0: almost paranoid about risk.

A common, yet limited, functional form used for utility is the negative exponential utility function:

$$U(W) = 1 - \exp^{(-rW)}. \tag{4.3}$$

This is a convenient functional form for illustration since the coefficient of absolute risk aversion is r.

The RAC can be found by eliciting a person's utility function, which can be estimated by the ELCE (Equally Likely Certainty Equivalents) method as described by Hardaker et al. in [18] (Figure 2). ELCE elicits equally likely certainty equivalents by asking a series of questions that present 50-50 bets, which can be used to sketch a utility function like that shown in the lower left quadrant of Figure 2. The certainty equivalent is the certain amount that a person would be indifferent to receiving compared to an expected value with risk. To provide a more realistic scenario, onion production was chosen for the ELCE questions in the Risk Preference Calculator tool, since the crop tends to produce boom or bust returns (so we could use the 50-50 technique). These "bets" are presented by slider bars as shown in Figure 2. This allowed the program to remain simple and realistic, and fit well with a 50-50 bet for agricultural producers. Using the Hardaker et al. scale, the EWS case study farmer turned out to be quite risk tolerant, with a risk preference score of 0.52 (somewhat risk averse). This score is based on derivatives from the utility curve fitted in the lower left quadrant of Figure 2.

The second risk preference assessment method (not shown) in the Risk Preference Calculator provides users the option of taking a short risk quiz designed by Grable and Lytton [23]. The quiz asks 13 questions, which are tabulated to provide a score from "low risk tolerance" to "high risk tolerance." More than one method is offered to counteract inherent difficulties in measuring risk preferences. In this case, psychological research offers a completely unique approach in the form of this quiz.

The third method links risk preference to risk tolerance, which is the amount \$$X$, where a person would be indifferent between an equal chance of receiving \$$X$ and losing \$$X/2$ [8]. A risk-averse person that would pay a certainty equivalent of \$7,000 for a risky, 50-50 bet of receiving either 0 or \$20,000, for example, has a risk tolerance of \$15,641; risk tolerance increases to \$99,833 for someone willing to pay \$9,900 for that same bet. A risk-neutral producer would of course be willing to pay \$10,000. Risk tolerance uses a different means than ELCE to elicit tolerance, but is closely linked to preference. Relative risk tolerance (RRT) can be derived from the RAC, since absolute risk tolerance, R, is the inverse of absolute risk preference, r, in the negative exponential utility function. The scale of RRT spans from 0.25 (1/4) for a person who is almost paranoid about risk to 2 (1/0.5) for someone who is rarely risk averse to 10 (1/.1) for someone that is almost risk neutral. This allows the Risk Preference Calculator to provide a comparable estimate of the relative risk preference based on risk tolerance, which opens the door to an entirely separate and more prevalent literature. For example, Howard [24] defined R for firms that he looked at in terms of annual sales, equity, and income. He found that $R = 1.24$ multiplied by net income, or 6.4% of sales, or 15.7% of equity for the businesses that he examined. The Risk Preference Calculator can therefore provide a parallel estimate of risk preference by simply asking the producer for net income, sales, or equity.

Utilizing three methods to elicit risk preferences makes the Risk Preference Calculator tool more accessible to users with differing tastes. It also provides some continuity and comparability for those users willing to apply all three methods, which helps combat the inherent problems with estimating risk preferences [17].

Step 3 (Establish Risk Goals). There are seven goal planning tools on the Risk Navigator SRM website, including action planning, team roster, mission statement, time management, and transition planning. These classic tools are updated to assist decision makers with developing their goals in the "Strategic Goal Worksheet." EWS Farms' strategic goals were [6] the following.

(i) Strategic Goal no. 1 (Financial): Ensure short- and long-term financial success by maintaining business profitability, while expanding the overall business financial resource base.

(ii) Strategic Goal no. 2 (Family): Continue to live, work, and grow our families in a rural, agricultural environment. Encourage individual development and exploration in a manner that is consistent and flexible in order to allow all individuals to reach their full potential.

(iii) Strategic Goal no. 3 (Organizational): Continue to pursue organizational structures that fit the family dynamics of the operation, as well as allow for strategic goal attainment. Also, increase the business activities efficiency of the operation.

(iv) Strategic Goal no. 4 (Integrated Farm Management): Manage our farm as a cointegrated unit, while providing a step-by-step process for developing a strategic risk management plan.

A comprehensive description of all of their goals and mission statement can be found in Applied Risk Management in Agriculture [6].

5. The Tactical Phase

Step 4 (Determine Risk Sources). The four steps in the tactical phase are those required to build a payoff matrix. The first step is to determine risk sources. In addition to determining risk sources, it is also important to prioritize risks so that management efforts can be focused. EWS Farms chose to focus on price risk for corn. This was interesting since it was not even one of their risk management goals. However, it is not inconsistent with observations at risk education extension meetings. Men that have attended the Risk Navigator SRM workshops have overwhelmingly chosen price and yield risk (revenue) over all other types of risk when doing this exercise. Decision makers are encouraged in this step to review their goals and information with those available in the study by Hoag in [6], like those shown in Table 1.

Several methods are demonstrated in the book titled *Applied Risk Management in Agriculture* [6], such as influence diagrams and SWOT ((S)trengths, (W)eaknesses, (O)pportunities, and (T)hreats) analysis. However, the method chosen for the Risk Navigator tool, "Risk Influence Calculator," uses a risk-influence diagram to help decision makers sort out and prioritize risk. The Risk Influence Calculator is simple and only asks producers to list each risk, then to rate it on a scale of 1 (low) to 10 (high) for (A) probability of occurring, (B) impact if it occurs, and (C) influence to stop it from occurring.

After reviewing his goals and reading what others said about risks (e.g., Table 1), EWS Farms identified the following strategic risks:

(i) *Market/Price*

(a) Corn Price. Will my price cover my costs?

(ii) *Production*

(a) Weather. Will rainfall support my crop stand?
(b) Hail. Will hail destroy half my crop?
(c) Input (seed). Will good corn seed be available at a reasonable price?

(iii) *Financial*

(a) Expansion. Can the operation generate enough profit to cover new land payments?

(iv) *Human*

(a) Family. Will my dad retire?

(v) *Institutional*

(a) Water. Will irrigation water be restricted?

All risks identified are placed in a graph that plots influence against risk, so the decision maker can prioritize risks where the biggest impact can be made. The Risk Influence tool has been one of the most popular in Navigator risk management workshops, as it creates a lot of discussion and rethinking about priorities.

Step 5 (Identify Management Alternatives). The book, *Applied Risk Management in Agriculture* [6], describes four main techniques to manage risks: (1) avoid it, (2) transfer it, (3) assume or retain it, or (4) reduce it. To keep things understandable, we use a risk profile. A risk profile is a multidimensional representation of the consequences that stem from each management action. For simplicity, we use a probability density function (PDF) as the risk profile, since it is familiar to most people and it contains information that is relevant to managing risk, such as mean, mode, maximum, and minimum. We can show the consequences of the four basic management actions mentioned above through simple manipulations of the PDF such as skewing, truncating, changing variance (squishing), or changing the mean (moving). This simple representation of a risk profile (and terms like squishing) is meant to build basic skills and understanding in the participants; however, perhaps more importantly, the graphical depictions engage the audience in what may often be perceived as a dry subject. It also ties the concept of management alternatives to PDFs for the next step concerning likelihood. Like the previous step, the book also provides an extensive list and brief discussion about specific techniques commonly used in agriculture, like crop insurance and the futures market (e.g., Table 1).

Decision makers at EWS Farms identified the following possibilities to manage price risk in their corn:

(i) Cash market sales (selling everything in the market at harvest),

(ii) Forward contracting to a local grain elevator (contracting for a fixed price before harvest),

(iii) Hedging on the futures market (selling a contract on the futures market for a fixed price),

(iv) Spreading out crop sales across the year (multiple marketing points),

(v) Maintaining flexibility on timing of sales (storing, then selling opportunistically).

After more consideration, EWS Farms chose three management alternatives: cash market, forward contracting, and hedging. They developed a comprehensive marketing plan using the "Marketing Plan" tool in Risk Navigator SRM. Six components exist in this marketing plan, and each component has its own worksheet: (1) The Relationship between the Strategic Risk Management Plan and the Marketing Plan; (2) Production History and Expectations; (3) Expected Prices; (4) Production Costs; (5) Price, Date, and Quantity Targets; (6) Review and Evaluation. Each of their marketing alternatives is carefully planned, including the distribution of the sale over time. The marketing alternatives are also based on ten years of local data on EWS Farms and for their local elevator (including basis adjustments for prices).

To help EWS Farms prepare for the remaining steps, the book recommends putting their information into a decision tree and then a payoff matrix. The main value of starting with the decision tree, shown in Figure 3, is in its visual construction [25], which requires the decision maker to identify all relevant courses of action, events, and payoffs in a clear and understandable manner. It also makes it easier to process information to put into a payoff matrix, as shown in Table 2.

Step 6 (Estimate Probabilities). The concept of probability has been cultivated throughout the ten-step process by encouraging decision makers to represent risk with a "risk profile" and to think of a risk profile in terms that can be easily understood from the basic shape of a PDF. They are encouraged in Step 2 to determine their "risk personality" (preference) so they can find the risk profile that best suits them. In Step 5 they are shown how a risk profile is affected by risk management alternatives, where the random variable is usually income or cost. In this section we show how to tie the concept of the risk profile to a probability density function (PDF) or a cumulative density function (CDF) more directly. Much of the book chapter [6] is dedicated toward a basic lesson about the PDF and CDF, including concepts like mean, mode, median, variance, standard deviation, and coefficient of variation. Also included are descriptions about how to interpret basic shapes of the PDF. The discussion is very basic, aimed at making the PDF and CDF concepts that people could use to quickly and intuitively interpret the basic statistical components that are important for risk management (e.g., measures of central tendency, spread, and range). For example, it is easy to convey that management tools like insurance or the futures market "squish," "move," or "truncate," a PDF.

The "Risk Profiler" tool makes it relatively easy for producers to build probability density functions (PDF's), which then can be used to provide information for probability in the payoff matrix. The "art" of eliciting probability is fraught with limitations (e.g., [17–19]),

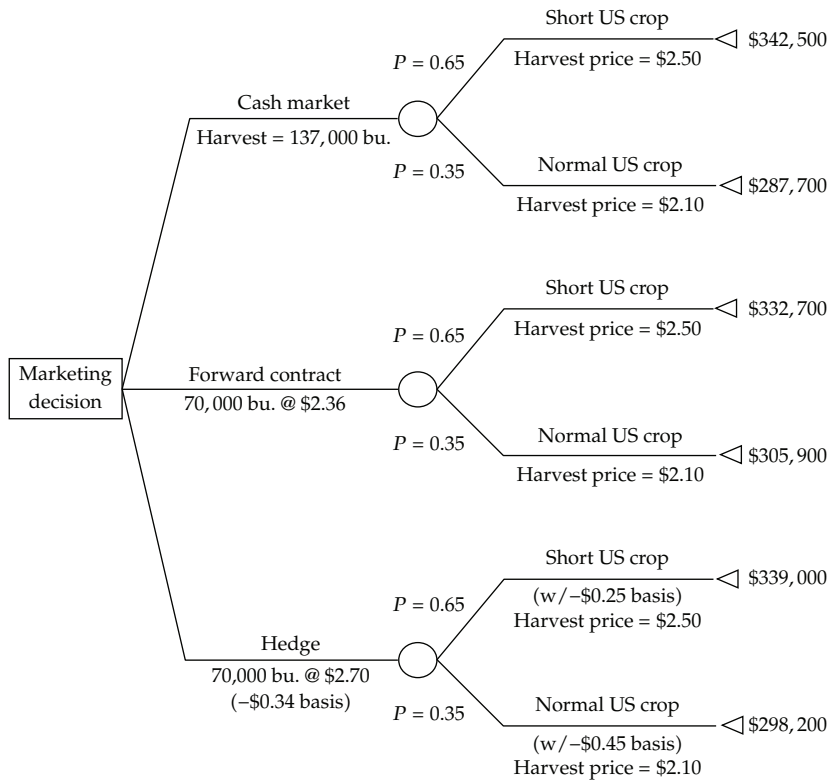


Figure 3: Decision tree for EWS Farms corn pricing decision; see source in [6].

but the PDF's are used here to simplify the process of estimating probability in the payoff matrix and to provide a stable mechanism to tie the steps together. Furthermore, Hoag [6] discusses some of the common problems, like anchoring, and how to avoid them.

There are at least two major ways to elicit probability information (6,10): asking the expert about his or her degree of belief about an outcome or present the expert with a lottery that reveals their probability values. Risk Profiler provides three options to elicit a PDF by asking the expert about what they believe will happen. The most straightforward method assumes that the future will look like the past ten periods. Figure 4 shows ten annual corn price entries for EWS Farms and resulting PDF, CDF, histogram, and summary statistics. The PDF is assumed to be Normal for simplicity. However, for increased education, a histogram is also drawn to help decision makers understand what might be hidden behind the normalized function. For example, a bimodal distribution is hidden by the normal distribution in the case of corn price on EWS farms. A few summary statistics are also provided for each estimation method.

The second method offered by Risk Profiler to elicit a PDF involves having the user "describe profile features." In this case, a PDF can be drawn based only on the minimum, most likely, and maximum values elicited from the decision maker for the random variable. The PERT distribution is applied as follows:

$$\mathrm{PERT}(a,b,c) = \mathrm{Beta}(\alpha_1,\alpha_2) * (c-a) + a, \tag{5.1}$$

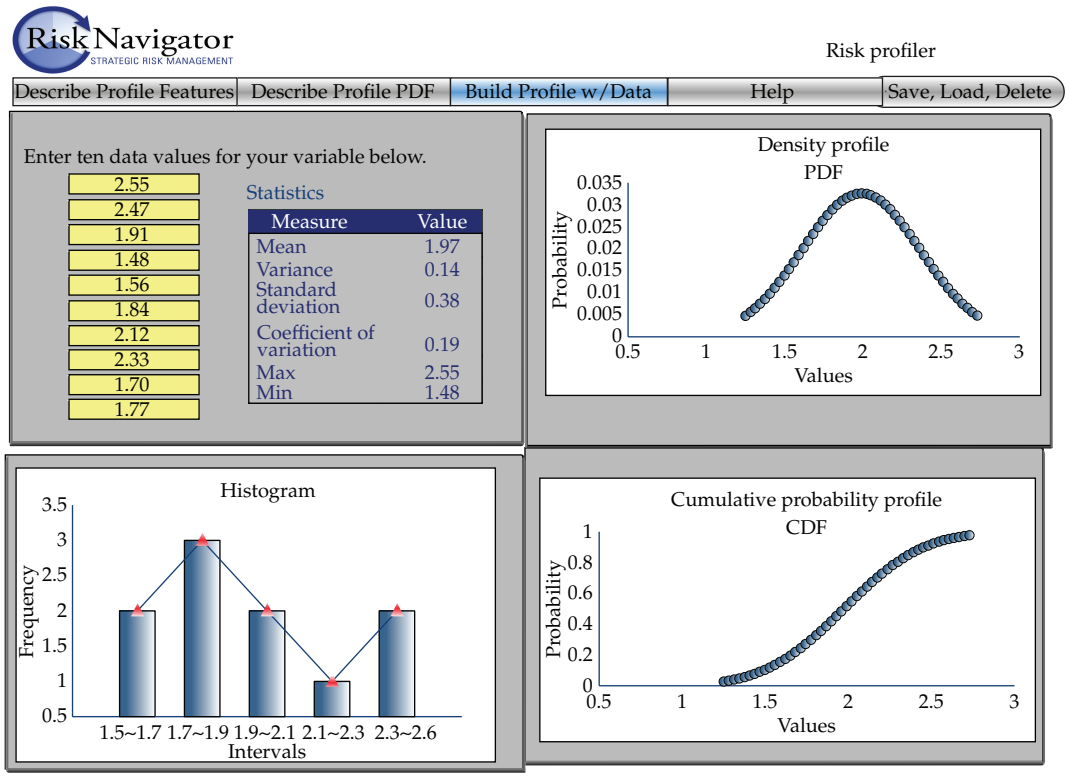


Figure 4: Building a PDF with Risk Profiler; see source in [6].

where "a" is the minimum value, "b" is the most likely value, "c" is the maximum value, and "Beta" is the beta distribution [19].

Furthermore,

$$\alpha_1 = \frac{(\mu - a) * (2b - a - c)}{(b - \mu) * (c - a)},$$
$$\alpha_2 = \frac{\alpha_1 * (c - \mu)}{(\mu - a)}. \tag{5.2}$$

In this case, the resulting PDF and related information are pictured on a screen exactly like that shown in Figure 4, but the upper left quadrant is replaced with a section to collect the PERT input data.

The last method is "describe profile PDF." In this method, people provide five sets of probabilities and values for the random variable, see Table 3.

This is a variation on the fractal method [17, 18]; in eliciting the PDF for prices for a given crop, for example, a decision maker might be asked to pick several price values and give an associated probability for each one. Asking for the producer to supply the probability and values simultaneously is a combination of what Frey [26] called the fixed value method and fixed probability method. The fixed value method asks an expert the probability that

Table 3

Probability	Price
.30	$2.00
.20	$2.25
.40	$2.50
.20	$2.75
.10	$3.00

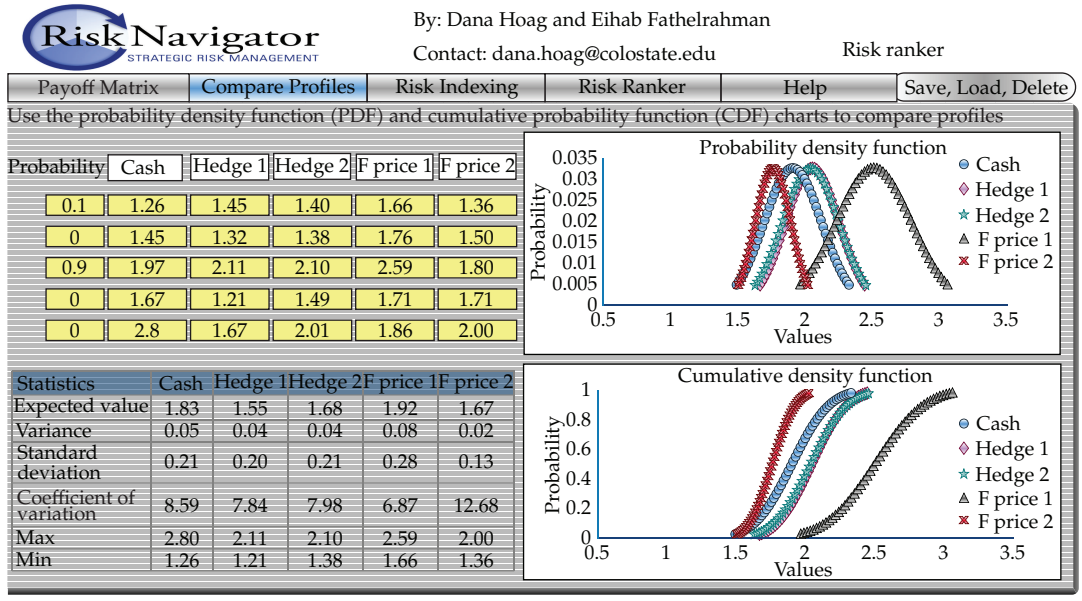
the actual value is higher (or lower) than some arbitrary number for the random variable. The fixed probability method has the decision maker specify the value range for a random variable that corresponds to a specific probability. The Risk Profiler method lets the user simultaneously mix and match the fixed value and fixed probability methods by allowing them to enter either probabilities or values.

Step 7 (Rank Management Alternatives). The final step of the tactical stage is to rank the various alternatives considered to this point and select those with the most desirable outcomes. Risk Navigator SRM offers three tools to help decision makers rank risks. "Value at Risk" (VaR) is a popular method for capturing the downside risk in financial decision making. It is an evaluation of what you stand to lose with an investment. VaR answers the questions "What is my worst-case scenario?" or "How much could I potentially lose in a really bad month?" [27]. This strategic tool considers only the undesirable parts of dispersion, those on the negative side of the mean, as opposed to the standard deviation, for example. The VaR tool is simple to use and involves only one screen (not pictured here). A second tool, the "Risk Efficiency Tool," uses Stochastic Efficiency with Respect to a Function to rank outcomes for all levels of risk preference, except risk preferring.

The easiest and most effective tool, "Risk Ranker," uses the payoff matrix to link risk personalities with the risk profiles. This tool allows a user to directly compare risk profiles, which can provide a lot of information by itself, and offers an instant comparison of the management alternatives under consideration with seven ranking rules that cater to different risk personalities (e.g., someone that is avoiding risk as compared to someone that wishes to maximize expected value).

After filling out a payoff matrix for up to five management alternatives, the program can be used to compare risk profiles. For example, on the second tab, "Compare Profiles," shown in Figure 5, the payoff matrix entered by the decision maker is reprinted in the upper left corner. The first column paired with any management alternative (e.g., cash) replicates the information entered in "Risk Profiler," which provides continuity to the program and reinforces how the risk profile integrates with the payoff matrix. All five PDFs and CDFs for EWS Farms are plotted in one graph and summary statistics are provided in tabular form. Decision makers are provided with information about how to rank alternatives with methods that use only distributions, such as stochastic dominance [6], and may therefore use this method alone to rank risks.

In many, if not most, cases risks cannot be ranked by visual inspection of the PDF or CDF. Therefore, the next tab over, "Risk Ranker" displays seven different risk ranking measures for the payoff matrix, all on one screen: Maximize EV, Maximax, Most likely, Minimax regret, Hurwicz, Maximin, and the Laplace Insufficient Reason Index (Table 4). Each of these techniques ranks risks based on different aspects of the payoff that might, or might not match a decision maker's risk personality. For example, Maximize EV (expected



Probability	Cash	Hedge 1	Hedge 2	F price 1	F price 2
0.1	1.26	1.45	1.40	1.66	1.36
0	1.45	1.32	1.38	1.76	1.50
0.9	1.97	2.11	2.10	2.59	1.80
0	1.67	1.21	1.49	1.71	1.71
0	2.8	1.67	2.01	1.86	2.00

Statistics	Cash	Hedge 1	Hedge 2	F price 1	F price 2
Expected value	1.83	1.55	1.68	1.92	1.67
Variance	0.05	0.04	0.04	0.08	0.02
Standard deviation	0.21	0.20	0.21	0.28	0.13
Coefficient of variation	8.59	7.84	7.98	6.87	12.68
Max	2.80	2.11	2.10	2.59	2.00
Min	1.26	1.21	1.38	1.66	1.36

Figure 5: Risk Ranker—compare profiles—see source in [6].

Table 4: Attributes of basic decision rules[a].

Decision Rule	Mean	Variation	Low	High	Other
Maximized Expected Value—Choose alternative with highest expected value	x				
Maximax—Choose alternative with best outcome				x	
Most Likely—Choose alternative that is most likely to occur (subjective)					x
Minimax Regret—Choose alternative with least hindsight regret		x	x		
Hurwicz—Weighted average of maximax and minimax			x	x	
Maximin—Choose alternative with best of the worst outcomes			x		
Laplace—Simple average	x				

[a]See a more detailed description in [6]. An x is placed in the column where the rule is primarily focused.

value) is for risk neutral producers. Maximin chooses the alternative with the maximum, minimum outcome and is therefore designed for very risk-averse individuals.

Table 4 shows that each of the rules focuses on different areas. None is comprehensive, and many are oversimplified. For example, Maximin would choose A in the two five-year income streams A and B shown below, since it focuses only on the minimum; however, most people, if not all, would choose B if they could:

$$A = (10, 10, 10, 10, 10),$$
$$B = (100, 100, 100, 9, 100). \tag{5.3}$$

The table presented in the tool makes it handy to compare rankings quickly and easily so that many dimensions can be considered, and is very effective at getting across the message that people need to match their risk management personality to their risk ranking techniques.

6. The Operational Phase

Steps 8–10.

The operational stage involves putting plans into action. The first step, implementation, involves acquiring the necessary resources, scheduling the tasks to be completed, and overseeing all aspects of the plan [6]. As plans are implemented, the second step in this phase kicks in as resources need to be monitored so adjustments can be made as needed. The last step in the phase, and step ten overall, is re-planning. If not actively brought to the attention of those involved with the program, this step may be easily ignored by many managers since it could highlight what was not achieved. Re-planning is also the first step in preparation for starting the cycle over. There are five SRM tools available on the website for the operational phase: (1) Action Planning Worksheet, (2) Critical Success Indicator Worksheet, (3) Resource Flow Plan, (4) Risk Management Worksheet, and (5) Time Management Worksheet. A detailed description of how EWS Farms applied this step is provided by Hoag in [6].

7. Conclusion

Risk Navigator SRM integrates risk management techniques into one place and provides farmers and ranchers the resources to use the products from their home office. It is both a learning tool as well as a means to help producers actually manage risks, financial and other, in their operations. It is also very practical for students in economics and business. The manageable steps allow for farmers and ranchers to learn the tools at their own speed, while providing the opportunities to customize the data for their own farm/ranch. We find that the difference between this and other programs designed to manage risk is the integration of basic risk management principles into a structured and easy to learn format. This allows people to use concepts that have been individually available for decades, but inaccessible, because they are most valuable in a framework, which typically requires expertise to build. The book, *Applied Risk Management in Agriculture* [6], can supplement the website by providing detailed descriptions of each step and by providing additional educational opportunities. Navigator workshops have been presented in formats from 45 minutes to two days. The program has grown and the tools can be continuously upgraded since they are offered at the Navigator website. A blog has been added and a free, ten-step online education program is nearly complete.

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