

Teaching Agricultural Producers to Consider Risk in Decision Making

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Presented at Western Agricultural Economics
Association 1997 Annual Meeting
July 13-16, 1997
Reno/Sparks, Nevada

July 1997

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February 1997

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Abstract

The 1996 FAIR Act has emphasized the importance of teaching agricultural producers to understand and respond rationally to risk. The following are guidelines for considering risk: (1) analyze decisions using a payoff matrix, (2) estimate the probabilities of events, (3) consider individual attitudes about taking risks, and (4) adopt management strategies to control risk. Much still remains to be learned about how to teach risk management.

Introduction

The Federal Agriculture Improvement and Reform (FAIR) Act of 1996 presents new management challenges, allowing producers more planting flexibility, but also eliminating the price support safety net. Helping agricultural producers to understand and respond rationally to the risks inherent in their decisions should be a high priority for agricultural economics educators. This review outlines some of the primary considerations in designing extension educational programs to enhance the understanding of risk and its consideration in producers' decision-making processes.¹

Definitions

Uncertainty and risk are what make decision making both challenging and frustrating. Every decision has at least two alternatives, each of which has some future consequences--we do not make decisions about the past.

- Uncertainty refers to a situation where the consequences include a number of possible outcomes, irrespective of their desirability.
- Risk refers to the chance of adverse outcomes associated with an action.

Decision making under uncertainty is challenging because of the risk it imparts. Some of the possible outcomes have negative consequences, which managers would prefer to avoid. Because the future is unpredictable, risk can not be eliminated, even if this were desired. Eliminating risk also would eliminate the potential profits. Successful farm and ranch management depends on taking risk consistent with the goals and financial position of the business. The key to success is to take the ***right*** risks.

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This paper is based on the observations of the author who was co-leader for a special project sponsored by the USDA Extension Service and conducted jointly by Oregon State and Oklahoma State Universities, 1974-78. The project developed teaching methods and audio-visual materials for use by educators in teaching farmers and students how to deal explicitly with risk.

Conceptual Framework

Agricultural producers use a variety of approaches in making decisions. They range from simple and traditional methods to more modern techniques. There also are alternative theories about how risk considerations should be incorporated into the decision-making process. Regardless of the theoretical formulation employed, however, the following decision-making guidelines should help agricultural producers to react deliberately and reasonably to risk²:

1. Analyze decisions in terms of alternative actions, possible events, and payoffs (the payoff matrix).
2. Estimate the odds (probabilities) associated with the events affecting the decision payoffs.
3. Consider the business's financial position and the manager's attitudes about taking risks (risk preference).
4. Adopt management strategies to control or counteract risk.

This management approach is a logical procedure for making risky decisions. It brings together all the pertinent aspects of the decision. Most importantly, it fully recognizes the personal element involved in decision making: (1) the manager's knowledge and beliefs and (2) the manager's goals and attitudes about risk-taking. The guidelines amount to no more than spelling out the thought processes many agricultural producers already use intuitively in making risky decisions. Most management decisions, however, are too complex and important to be handled by intuition. This more formalized

² These guidelines were developed based on a review of literature (Walker and Nelson 1977) and a survey of extension and classroom educators in farm management (Walker 1977).

approach helps assure that risky choices are made in line with the manager's goals and that all the information available has been fully utilized.

Premises

Before proceeding with the design and development of educational programs, it is useful to specify some key premises about how decision makers behave and the appropriate components of the teaching materials. The survey and literature review were used as a starting point in identifying these premises. Then, they were tested with producers and students and modified based on their evaluations. Following are the key assumptions (Walker and Nelson 1980):

1. There is a human tendency to ignore risks and uncertainties.
2. The greatest potential for helping producers to improve their decision making processes is through the use of the payoff matrix and decision tree concepts.
3. Decision makers can consider future events in terms of subjective or personal probabilities and learn techniques to accurately quantify their beliefs.
4. The risk attitudes of agricultural producers range from risk taking to strong risk avoidance. No presumptions are made about the risk preferences held by individual producers.
5. Some decision makers seek to control at least a portion of the risks affecting their business operations.

Sources of Risk

Identifying the sources of risk is the initial step in the process of risky decision making. The following is an overview of the primary sources of risk that should be considered by the manager: (1) production risk, (2) market risk, (3) financial risk,

(4) obsolescence risk, (5) casualty loss risk, (6) legal risk, and (7) human risk.

Psychological studies have shown that many business managers tend to suppress or disregard risk when making decisions. Ignoring risk may be a natural tendency to protect our sanity. By ignoring risk, managers do not have to anguish over the probabilities and consequences. But past good luck does not guarantee continued success. Good decision making requires explicit consideration of the sources of risk.

The Payoff Matrix

The framework for making risky decisions is based on the idea that the decision maker can choose among alternative actions, the outcomes of which depend on something called **events**. These events are beyond the control of the decision maker and their occurrence is uncertain and possibly risky. The outcome resulting from each action and event combination is called a payoff and a table showing the actions, events, and payoffs is called a **payoff matrix**. The payoff matrix encourages explicit consideration of risk and provides a convenient format for summarizing the components of the decision problem.

The simplicity of the payoff matrix can be deceptive. Several types of events may affect the payoffs. For example, in a real-life management decision, both prices and yields may be subject to uncertainty and the combined effect of the price event and yield event will determine the payoff. Also, many more than three alternative actions may be possible. Finally, the payoffs may require very complex budgeting procedures for estimation.

In carrying out these steps for many decision problems, it will be impractical to assess all possible actions and events. There are just too many for practical consideration. The key is to limit the decision problem to the most promising actions and the most significant events affecting the payoffs of these actions. Some experience and skill are

needed, therefore, to keep the matrix as simple as possible without losing the essentials of the decision problem.

Once the decision has been specified in terms of the alternative actions and possible events, the next step is to budget the payoffs for each action-event combination. Budgeting in the framework of a payoff matrix involves preparing not just one budget, but budgets for each action and event combination. Things may not go as planned, but with careful budgeting of all the possible payoffs in the matrix, the actual outcome should be no surprise.

Depending on the decision situation, the payoffs might be measured in terms of net income, return to labor, return to capital, or return to management. How the alternatives will affect the business' liquidity might also be of interest and measured as net cash flow. The appropriate measure or measures will depend on the particular decision and the manager's goals. If there are multiple goals, it's quite appropriate to put more than one measure in each cell of the payoff matrix.

Personal Probabilities

Probabilities provide a means for summarizing what the decision maker knows and believes about the future. A **probability** is a number that measures the likelihood or chance that a particular **event** will occur. An **event** is something (a price or yield level) that might happen in the future over which the decision maker has no control.

Probabilities based on a decision-maker's personal beliefs about the chance of occurrence of a particular future event are called **subjective** or **personal** probabilities. In estimating these personal probabilities, decision-makers should examine their own experience, the data that are available, and consult whomever time and money allow.

Personal probabilities allow decision makers to summarize everything known about a future occurrence in the form of numbers with which they can work.

It is quite possible that two producers will assign different probabilities to the same event. This doesn't mean, however, that these probabilities are arbitrarily assigned. Rather, they have different information and are using different experiences for interpreting this information. If two people have roughly the same experience and are given the same information regarding a particular event, they should both assign it roughly the same probability.

Personal probability estimates should incorporate all the information that can be obtained from a variety of sources, including what's happened in the past. The decision maker's own intuitive judgment is applied to this information to come up with the probability estimates. These probability estimates should also be subject to revision when the quantity and quality of information available changes. Thus, as time passes, decision makers should continue to review the situation, collect more information, and revise their probabilities to reflect new knowledge.

These probabilities provide a mechanism for the decision maker to communicate beliefs about what the future holds with someone else. When probability estimates are compared with those of a partner, spouse, or a friend, it would be very surprising to find that they are exactly the same. Comparing the probabilities, however, will generate discussion about why the various probabilities were assigned and the sources of information used. After the exchange of information, the decision makers might revise their probabilities.

Various techniques can be used to elicit or quantify these personal probabilities. Examples are presented by Hogarth, Nelson *et al.*, Nelson and Harris, and Nelson (1980). These techniques are relatively easy to teach and apply, but can become complicated when considering several interrelated sets of events.

Financial Position and Attitudes Toward Risk

The next step is to consider the manager's attitude and financial ability to assume risks. Attitudes toward risk depend on (1) goals, (2) financial position, and (3) the potential gains and losses.

The producer's financial position, measured by solvency ratios and cash flow requirements, determines risk-taking ability or, put another way, the vulnerability of the business to risk. Solvency can be measured by the debt to net worth ratio, that is, the adequacy of equity relative to debt. The higher this ratio, the more precarious the business's financial position. Annual cash flow obligations include income taxes, loan repayments, and family living expenses. The higher the cash flow requirements, the less risk the business can safely assume.

Because producers have different goals regarding risk and income, they do not make the same decisions. What may be a good plan for one producer may not be appropriate for the neighbor. Although agricultural producers may desire increased income to provide a higher standard of living, they are also concerned about risk and the security and survival of the business.

Establishing priorities is difficult, because income and security goals often conflict with one another. For example, producers might like to increase their net income, but to take action to do so might jeopardize the survival of their businesses. The combination of

risk and income chosen depends on the priority placed on these two goals--increased income versus security. These priorities vary among agricultural producers, which explains why, when faced with the same risky situation, they respond differently.

Risk Control Strategies

Many managers are interested in actions that might be taken to reduce the risk or ameliorate the impact of risk on their businesses. Strategies, such as forward contracting or hedging, using insurance, maintaining product and cost flexibility, planning for financial liquidity, diversifying enterprises and others listed in Table 1, should be presented in educational programs, along with their advantages and disadvantages and applicability in Table 1. Examples of Risks and Risk Strategies in Farming and Ranching.

Production Risk

- Select Low Production Risk Enterprises
- Diversify the Business
- Maintain Cost Flexibility
- Use Risk Reducing Production Practices
- Invest in Extra Machine Capacity
- Disperse the Operation Geographically
- Negotiate Land Lease Arrangements
- Maintain Resource Reserves
- Purchase Crop Insurance
- Obtain Additional Information

➤ Obtain Property Insurance

Market Risk

- Hedge on the Futures Market
- Sell by Forward Contracts
- Spread Product Sales Over Time
- Maintain Selling Flexibility
- Select Low Price Risk Enterprises
- Diversify the Business
- Negotiate Land Lease Arrangements
- Forward Price Production Inputs
- Obtain More Outlook Information

Casualty Loss Risk

Financial Risk

- Keep Adequate Liquidity
- Maintain a Credit Reserve
- Negotiate Longer Loan Repayment Periods
- Hold a Safe Solvency Position
- Develop Land Leasing Strategies
- Incorporate to Limit Risk
- Obtain More Accounting Information

Technology Risk

- Maintain Flexibility

- Keep Informed of New Developments

Legal Risk

- Maintain an Insurance Program
- Keep Informed of New Regulations

Human Risk

- Plan Back-up Management
- Plan for Loss of an Employee
- Maintain an Insurance Program
- Plan for Estate Transfer

different situations. These strategies suggest relevant actions to be analyzed; for example, a flexible, diversified plan might be compared with a specialized plan.

The challenge in developing education programs around these strategies is that research, on their effects, is limited. And even where research is available, it is often difficult to generalize the results to different agricultural production situations. What is needed are more generally applicable models and analytical capabilities to project the outcomes of alternative strategies for specific situations.

Developing Aids for Risky Decision Making

There are three alternative "stopping points" for "prescriptive" efforts to help producers make risky decisions: (1) define states and actions, and present the payoff table in monetary terms; (2) add probabilities (either prior or both prior and posterior) to the payoff table; and, (3) add probabilities to the payoff table and convert the payoff entries from monetary to utility values. The rapidly increasing computational power of microcomputers allows more thorough and accurate analyses of risky decisions. Much remains to be learned, however, about how to obtain the needed data for input and how to present the results to the decision maker. Should the complete probability distributions of

the outcomes be presented? If so, should they be simple or cumulative probabilities? Should expected values and variances be used? The point is that the format for presenting the results will likely affect their interpretation and influence the decision.

Summary and Recommendations

A substantial gap exists between risk management practices of agricultural producers and the concepts and tools that have been developed by agricultural economists. This paper describes some of the educational methods that might be developed for closing the gap and incorporating risk considerations into producers' decisions. The following priorities are suggested for risk research and educational programs directed to producers:

1. Encourage decision makers to define the risky decision problem in terms of their components (alternative actions, events, and outcomes). This might include helping them improve their skills in formulating payoff matrices or decision trees to organize the analysis of the decision and to consider the risk involved in their choice.
 - a. Educational programs that describe the external trends and developments that are likely to impact business management in the future would help producers gain a better understanding of the various sources of risk they face.
 - b. Other educational needs include identification of major sources of risk and budgeting techniques, including break-even analysis and sensitivity analysis.
 - c. Models that combine production, economic, and financial relationships developed by interdisciplinary teams would help agricultural producers to project the payoffs from the various action-event combinations.
2. Use personal probabilities to help decision makers quantify their perceptions of uncertainty and risk.

- a. More information will help producers to estimate their own probabilities and narrow their prior probability distributions. Analysis of historical data to quantify the variability of agricultural phenomena, dissemination of probabilities elicited from experts, and teaching producers to develop their own management information systems are all ways to enhance the information available. Research to estimate the value of various forms of management information will help in setting priorities.
 - b. Because of the difficulties inherent in estimating probabilities that reflect the decision maker's true beliefs, education programs to teach agricultural producers to estimate and use probabilities should allot sufficient time and effort to assure that the educational goals are accomplished. The mathematical manipulation of probabilities, such as computing joint, cumulative, and conditional probabilities, is another needed skill.
3. Help decision makers consider their risk preferences and financial situations so they can help interpret the implications of the risky decision for their personal satisfaction and the survival of their businesses.
 - a. To enhance producers' understanding of their ability to assume risk, they should be taught to use the tools and techniques of financial analysis emphasizing solvency and liquidity. This might include worksheets to determine the critical level of net cash flow needed to maintain the business's financial position.
 - b. Educational programs incorporating case studies and role-playing techniques may help producers to identify with their own risk attitudes.

4. Approach producers' planning decisions from a strategic perspective by considering risk control options and viewing planning as an adaptive process. This means considering future decision options when making current decisions, but keeping these prerogatives open. Decision trees are an effective tool for such analyses.
 - a. Educational programs should emphasize the concepts and procedures for strategic planning and the advantages and disadvantages of alternative risk control measures.
 - b. Simulation models for representative farms are needed to measure income variability and to analyze the effectiveness of alternative risk control measures (diversification, financial reserves, etc.).

Agriculture continues to be a risky venture with new threats on the horizon. We have much to learn about teaching the concepts of risky decision making to agricultural producers. The development and evaluation of new educational methods and materials should be pursued as a high priority.

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May 29, 1997

References

- Hogarth, R.M. "Cognitive Processes and the Assessment of Subjective Probability Distributions." *Journal of American Statistical Association* 70(1975):271-294.
- Holt, J. and K.B. Anderson. "Teaching Decision Making Under Risk and Uncertainty to Farmers," *American Journal of Agricultural Economics* 60 (1978): 249-253.
- Nelson, A.G. "The Case for and Components of a Probabilistic Agricultural Outlook Program." *Western Journal of Agricultural Economics* 5(December 1980):185-193.
- Nelson, A.G. "How Farm Managers Make Risky Decisions." In: *Farm Management: How to Achieve Your Farm Business Goals*, Yearbook of Agriculture, Washington, DC: USDA, 1989, pp. 35-39.
- Nelson, A.G., G. Casler, O.L. Walker. *Making Farm Decisions in a Risky World: A Guidebook*. Oregon State University Extension Service, 1978.
- Nelson, A.G., and T.D. Harris. "Designing an Instructional Package: The Use of Probabilities in Farm Decision Making." *American Journal of Agricultural Economics* 60(1978):993-997.
- Walker, O.L. "Teaching Decision Making Under Uncertainty in the Farm Management Curriculum." In: *Proceedings of Farm Management Teaching Workshop* at Michigan State University, April 14-15, 1977, New York: Agricultural Development Council, Inc., 1977, pp. 124-130.
- Walker, O.L. and A.G. Nelson. "Dealing with Risks in the Management of Agricultural Firms: An Extension-Teaching Viewpoint." In: *Risk Analysis in Agriculture: Research and Educational Developments*, Proceedings of seminar sponsored by Western Regional Research Project W-149, Tucson, Arizona, January 16-18, 1980, University of Illinois, Department of Agricultural Economics AE-4492, 1980, pp. 22-53.
- Walker, O.L. and A.G. Nelson. *Agricultural Research and Education Related to Decision Making Under Uncertainty: An Interpretive Review of Literature*, Oklahoma State University Research Report P-747, March 1977.