RISK IN U.S. AGRICULTURE: NEW CHALLENGES AND NEW APPROACHES

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Abstract

Dramatic changes are occurring in the agricultural sector – changes which will result in agricultural industries having many of the characteristics of manufacturing industries. The rapidly changing business climate is creating a new agriculture with new risks. And many of these risks require new approaches and different perspectives to adequately assess and manage them. The new risks will create both challenges and opportunities for farm and agribusinesses and those who finance them.

Keywords: Strategic risk, real options, risk scorecarding, credit risk, uncertainty

Risk in U.S. Agriculture: New Challenges and New Approaches*

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Change and the risk and uncertainty that result are not new to agriculture. But the rate of change appears to be accelerating. For example, biotechnology and genetic engineering have reduced the time lapse from trait identification to commercialization in corn genetics from 10-12 years to 7-8 years. The consolidation and restructuring of the food retailing industry has occurred very rapidly; consolidation of the chemical manufacturing and retail input supply industries has also occurred at an increasingly rapid pace. The rate of adoption of some new technologies such as biotechnology is much more rapid than that of the past as evidenced by adoption of hybrid corn.

Fine refers to the speed of change in an industry as "clockspeed", and argues that competitive pressures and technological innovative as driven by more rapid scientific discovery has increased the rate of change in products, processes, and organizational structure. This increased rate of change, or "clockspeed" in 1) product and process innovation; 2) organizational structure in terms of mergers and acquisitions; and 3) reconfiguring of the supply/value chain through joint ventures, strategic alliances, acquisitions and other forms of vertical integration and coordination arrangements means that successful managers must be alert to the increasingly rapid changes in their customers and competition, the business climate, and the science and technology that underpin their business and industry.

Many perceive change and uncertainty as a threat, and there is a natural tendency to resist threatening environments. But change and uncertainty also provide opportunity, and anticipating them enables managers to not just adjust, but profit from them. In fact, the business community appears to be increasingly focused on "managed" risks providing opportunities, (Pascale) whereas the capital markets have a much different perspective of risk as evidenced by the discounting and reduced value imposed on risker projects or firms. This gap in perspectives of risk between business managers (entrepreneurs) and financial providers represents one of the more fundamental challenges in understanding risk and its implications for the economic performance of the agricultural sector.

*This paper draws heavily from Boehlje, Michael and David Lins, "Risks and Risk Management in an Industrialized Agriculture", *Agricultural Finance Review*, May 1998, and *Assessing Risk in Production Agriculture*, Centrec, Savoy, Illinois, 2002.

The New Industrialized Agriculture and Risk

One of the most dramatic changes in the agricultural sector, particularly the livestock sectors, is commonly referred to as the industrialization of agriculture -- the application of modern industrial manufacturing, production, procurement, distribution, and coordination concepts to the food and industrial product chain.

This new industrialized agriculture is characterized by:

1. biological manufacturing which uses modern business principles and manufacturing approaches including procurement, inventory management and process control techniques. This has transformed farming from a rural lifestyle to a business in many situations.

2. differentiated products which have transformed farming from an industry that produces commodities for example (#2 yellow corn) to one that manufactures raw materials with specific attributes (high oil corn or specific amino acid composition soybeans). This has also required segregation and identity preservation in the marketing and distribution systems.

3. precision production which uses science and technology to "real time monitor" the production processes and exercise control over those processes through biotechnology and nutritional technology. Farmers are adopting technology and management practices to standardize, routinize, and generally manipulate and control the biological process of crop and livestock production.

4. supply chains which are tight alliances and linkages in the value chain from input suppliers through producers to processors and retailers. This movement to tightly aligned value or supply chains has resulted in better quality control, improved product flow scheduling, and stronger qualified supplier arrangements throughout the chain.

5. consolidation and concentration at all stages of the food production and distribution value chain. Accompanying this trend are vertical business arrangements (contracts, strategic alliances, qualified supplier programs, and vertical integration) across previously independent, market coordinated segments of the industry.

Drabenstatt and others have documented the movement of various sectors of agriculture from a traditional to an industrialized structure. In the livestock industries, much of the poultry sector moved to this structure during the 1960's and 1970's. The pork industry is currently transitioning from a traditional to an industrialized structure; for example at the production level 5% of the total pork supply was produced by the 40 largest producers in 1986, whereas 31% of the supply was produced by the 40 largest in 1996. Dairy is moving more slowly to larger-scale, industrialized operations compared to pork, at least in the Midwest, but the trend is still clear in the Western and

Southern U.S. In beef the feeding activity moved to an industrialized model during the 1970s and 1980's, but the beef cow sector remains fragmented.

In plant agriculture, processed fruits and vegetables, sugar, potatoes and similar crops have adopted an industrial production and distribution structure. The commodity sectors (corn, soybeans, cotton, wheat, rice) have remained more traditional in structure. But in recent times differentiated products with specific end-use characteristics such as white food corn, waxy maize, high-oil corn, high protein wheat, colored cotton, high amoloyze soybeans, etc. have been introduced into the market, and the production and distribution systems for many of these differentiated products exhibit the characteristics of the industrial model.

The implications of these profound changes for the risk and uncertainty in the agricultural industry are profound. What are the new risks that will result? How might we analyze them? Who will bear them? What mechanisms are available to manage them? What are the financing implications? And in general what are the important issues that we must emphasize in future research and out-reach programs in risk management for the agricultural sector?

New Perspectives on Risk

The rapid changes occurring in the agricultural sector have not just introduced more risk and uncertainty in the industry, they have stimulated new perspectives on risk and uncertainty. We will briefly introduce some of those new perspectives here.

Time and Risk

In a decision environment characterized by risk and uncertainty, timing of decisions and managing time are critical to effective decision-making. Timing is particularly important in decisions that involve technological innovations and marketing positioning. Most new innovations involve a high degree of risk in terms of the potential payoff, but the innovator or early adaptor also typically has the highest potential to capture the most revenue or benefit from that innovation -- when everyone else is doing it, the incremental benefits from the new technology are marginalized. So adopting new technology earlier typically results in higher returns, but also higher risk if the technology is inefficient or ineffective. Adoption late has lower risk, but the payoff is typically small. In fact, the reason for adopting by late adopters may not be to increase profitability, but to just stay in business -- to survive.

Likewise in market positioning there is typically a first-mover advantage whereby the first to enter a market can establish a position that is difficult for competitors that follow to overcome. A quick follower may not lose a lot to a first-mover in market share and market positioning, but a late entrant typically can only grow volume and gain market share by offering superior products and services (which typically costs more and thus has lower margins), or by price cutting to "buy" market share which also pressures margins. Again timing is important in market positioning with the advantage typically being captured by those who enter or move early compared to those who delay and are late movers.

But first response (i.e., earlier compared to later) is not always best. There is also a phenomenon known as the follower's advantage -- the benefits that a second mover can obtain by carefully monitoring the successes and failures of the early adopter or first mover and learning from those experiences. In fact, time and time delays can have real value.

Many decisions, particularly major decisions involving the commitment of money and resources, can be made sequentially rather than all at once. Managing this sequencing process and taking advantage of time delays is critical to making risky decisions.

One effective way to manage time in a risky environment is to use time delays to gather additional information or to learn. New information might be of the following forms:

1. additional information about odds or chances (the probabilities) concerning the risky events that might occur, thus giving the decision-maker more confidence in the original estimates of the probability distribution.

2. changes in the environment surrounding the decision problem which alters the original probability distribution with some events becoming more likely and other events less likely.

3. changes in the accuracy of estimating the consequences or payoffs so that a more accurate decision problem and payoff matrix is used in the final analysis.

4. changes in the environment which actually alter the results or consequences of various decisions and, thus, increase or decrease the actual payoffs used in the analysis.

A related benefit of time delays is the learning that might occur during that delay. This concept of learning is beyond that of obtaining new information about the probabilities and consequences. Learning involves new ways of thinking about the decision problem, new ways of framing and specifying the problem, new events that should be recognized, new sources of cost and revenues that should be considered in estimating the payoffs, or new uncontrollable variables that might impact the odds or chances of a specific event. Learning activities, thus, can result in: 1) respecification of the problem, 2) identification of new events or respecification of events, 3) estimation of new probability distributions for the events or the revision of those probability distributions, 4) identification of new actions or respecifications of actions, or 5) identification of new consequences or payoffs, or the respecification of payoffs. In essence, learning goes beyond obtaining new information, because it may result in the identification and definition of a new decision problem rather than simply a more accurate specification of the current problem.

Dynamic Uncertainty

The typical way that uncertainty and the potential risks that result are measured is the range or variability in particular events or outcomes. In addition to the variability in an outcome and the skewness in that variability, the pattern an uncertain or stochastic variable exhibits over time may also have significant implications for the risk a manager faces. For example, Figure 1 illustrates two different possible price patterns for corn over a period of time. Graph A shows random fluctuations in price with no extended sequential periods of high and low prices, whereas Graph B has a similar range in the fluctuations but exhibits a short sequential period of high prices and a much longer sequential period of low prices. The uncertainty faced by a manager and the availability of tools to manage those uncertainties are significantly different for these two sets of circumstances. For the price variability exhibited in Graph A, traditional hedging and forward pricing tools can be quite effective in reducing the potential loss exposure of low prices. It is more difficult to use these tools to manage the uncertainty reflected in Graph B of an extended period of time or a multi-year sequence of low prices; for example, forward pricing using futures or options markets for three to four years in the future is difficult if not impossible to use because such hedging instruments are not available that far into the future. In essence, a short period of high prices (or high payoffs in general) followed by an extended sequential period of low prices (low payoffs in general) is a much different and more difficult risk and uncertainty scenario to manage than one of random non-sequential fluctuations in prices or payoffs. Patterns of fluctuations in outcomes over time – whether they are random or time dependent (for example low for a long period) – will have an important impact on the magnitude of the loss exposure and the management strategy used to mitigate that exposure.

Sources of Risk

The risks faced in agriculture have often been classified into such categories as production, marketing, financial, legal and human risks (Banquet, et.al.). An alternative and possibly more useful taxonomy is to categorize risk as tactical or operational risk and strategic risk. As agriculture becomes more industrialized, strategic risks are likely to become increasingly more important, and as we will note are typically more difficult to manage.

Tactical or Operational Risk

The traditional risks faced by farm and agribusiness firms can be categorized as business risk and financial risk. Business risk is commonly defined as the inherent uncertainty in the financial performance of the firm independent of the way it is financed. Thus, business risk includes those sources that would be present with 100 percent equity financing. The major sources in any production period are price, cost, productivity and production uncertainty; a number of factors may affect this variability over time.

Financial risk or uncertainty is defined as the added variability of net returns to owner's equity that results from the financial obligation associated with debt financing. This risk results primarily from the use of debt as reflected by leverage; leverage multiplies the potential financial return or loss that will be generated with different levels of operating performance. Furthermore,

there are other risks inherent in using debt. Uncertainty associated with the cost and availability of debt is reflected partly in fluctuations in interest rates for loans and partly through nonprice sources. Nonprice sources, a type of institutional uncertainty, include differing loan limits, security requirements, and maturities, which impact the availability of loan funds over time. Thus, financial risk also includes uncertain interest rates and uncertain loan availability.

Strategic Risks

The focus of strategic risk is the sensitivity of the strategic direction and the ultimate value of a company to uncertainties in the business climate. These uncertainties include: 1) political, government policy, macro-economic, social and natural contingencies, and 2) industry dynamics involving input markets, product markets, competitive and technological uncertainties. Tactical or operational risk is easier to manage than strategic risk, in part because information is generally available to measure these risks, and because of the availability of accepted tools and techniques to transfer these risks to others, such as insurance and futures markets.

Most strategic risks cannot be managed or transferred through conventional futures or insurance instruments or markets. Strategic risk is multidimensional, so managers cannot assume the simple one-to-one mapping between exposures and hedging or insurance instruments. Creative strategies must be developed to manage strategic risk exposure; approaches include flexibility, adaptability and diversification and options.

To illustrate, one of the strategic risks farmers are facing because of the industrialization of agriculture is contractual or relationship risk. The expanding use of contractual agreements and other forms of negotiation-based linkages between the various stages within the agricultural production and distribution system, combined with the decline in impersonal, market-based transactions, results in price risk being replaced by relationship or contractual risk for many businesses. A grower may have a contract that guarantees a price for the crop, but what happens if the processor goes bankrupt? What happens to the contract (availability or terms) next year if the processor finds other suppliers in other areas who can satisfy their needs at a lower price? This risk is not unlike that of losing a landlord or a lender, but losing access to the product market has typically not been a significant risk in commodity based agriculture.

Another strategic risk that seems to be increasing in recent years is that of compliance or regulatory risk. Farm and agribusiness firms are facing increasing regulation in all aspects of their business transactions. Added to the traditional areas of regulation concerned with transportation, taxation and labor use are two rapidly growing regulatory areas: food safety and the environment.

The Universe of Risk

When viewed from the broader perspective of both strategic and tactical or operational risks, the total risk that farm and agribusiness firms face is much more complex and more pervasive than is often perceived. In fact, as the agricultural sector increasingly exhibits the characteristics of an industrial model, the types of risks it will face will also change. A taxonomy of the broader

dimensions of risk that farm and agribusiness firms will be facing in the future is presented in Figure 2. From both an analytical and managerial perspective, a major challenge in the future will be to quantify both the frequency or probability of occurrence and the magnitude of exposure from each of these potential sources of risk.

Options Thinking

Options theory provides a conceptual framework for measuring and pricing risk, and it is widely used in financial markets to transfer and price interest rate, foreign exchange rate, commodity price, stock price and other risks through both organized futures and options exchanges and privately negotiated arrangements such as strips and swaps in the financial markets. More recently the concepts of options theory have been extended beyond the financial markets to investment and strategic decisions in a risky environment -- real options. (Dixit and Pendyck, Amran and Kulatilaka).

The basic premise of real options theory is that many investments (as well as most strategic decisions) involve risk and uncertainty concerning future payoffs and costs, but they can often be divided into stages and sequenced so that more information is available after the first stage which will influence the probability as well as the potential size of the expected payoff. In these circumstances, the initial stage investment or commitment is much like buying a call or an option, i.e. the opportunity but not the obligation to make additional investments or commitments at a later stage.

Options thinking considers the benefits of delaying a decision or financial commitment in an uncertain environment. In essence, there are two financial benefits of any delay in committing funds. First is the interest or earnings received on those funds not committed but instead invested elsewhere while you wait. This benefit accrues no matter what happens to the risk or uncertainty during the delay. A second benefit of delaying is that in most cases additional information can be gathered, or a more detailed analysis can be completed that will increase the certainty about the future costs and benefits that result from the decision or investment commitment.

Delaying has a benefit irrespective of what we find out about the payoff -- whether it is bigger than we originally thought or smaller than we originally anticipated. And the more uncertainty there is about that payoff (whether negative or positive), the larger the value of the option to delay making the investment or decision. In essence, delaying a decision to have more certainty about either good or bad events in the future has value for two reasons: 1) to capture the benefits of completing the investment if they are higher than expected, and 2) maintaining the flexibility to avoid a mistake if the benefits are not as high as expected. Having the opportunity to obtain more accurate information about the future is valuable, even if that future is negative.

Real options concepts have the potential to be very useful in analysis of strategic risks in particular. For example, decisions concerning the profitability of capital investments including R&D expenditures, and the timing and staging or sequencing of such decisions in an uncertain environment, can be best understood as a real options problem. They can also be used to determine

the optimal timing and sequencing of real investments such as land purchases, large scale new venture livestock production facilities or company acquisitions.

Real options theory also may be useful to understand and evaluate the payoffs and risk of joint ventures and strategic alliances. A number of alliances, joint ventures and similar vertical linkages have been formed recently in the grain and input supply industries (ADM and Growmark, Monsanto's acquisitions of Holden Seeds and DeKalb, joint ventures in the input supply industries between Land O Lakes and Cenex Harvest States, etc.) Licensing and other agreements are increasingly dominating the biotechnology industry. From a strategic positioning perspective such arrangements compared to acquisitions might be viewed as acquiring an option, or as a preemptive move, yet maintaining flexibility until new information is available. Folta and Miller have applied real options theory to strategic alliances in the biotechnology industry. In similar fashion real options concepts maybe useful in understanding recent developments to form downstream linkages in the grain and oilseeds industries.

Assessing and Analyzing Risk

There are numerous ways to evaluate and analyze risks. These methods vary from highly quantitative techniques such as computing probability distributions, to subjective procedures such as those used in risk scorecard techniques. A discussion of different procedures for evaluating and analyzing risk is given below; these procedures are not all new but provide additional opportunities for both analyzing and communicating risk in this new agriculture.

Probability Distribution Techniques

Risk is commonly measured as the variability of various physical or financial performance measures. Consequently, there has been a long history of measuring risk on the basis of variations in yields, prices, net farm income and other performance measures. At the most basic level, this involves the measurement of means, standard deviations, coefficients of variation and cumulative density functions for the various variables of interest. Historical data is the basis for such measurement of risk. Probability density functions (PDFs) and cumulative density functions (CDFs) are an effective way to communicate the risk implications of various decisions and events.

The shape of a PDF or distribution is important in understanding risk and particularly the potential for loss exposure. Some distributions are concentrated on the left as in Figure 3 with a long tail to the right (skewed to the right); with this shape there is a higher probability of obtaining low values -- in this case low prices compared to higher prices. A distribution might be shaped in the opposite direction where the probabilities of obtaining higher values are generally larger than those of obtaining lower values. Although most discussions of probability distributions or density functions assume normality or a bell shaped curve, this shape frequently does not occur in the real world.

An additional concern about the shape of a probability distribution is that of truncation -- in some cases the tails of the distribution are or can be eliminated. For example, use of options and

hedging marketing strategies can be used to guarantee minimum prices for some agricultural crops, thus truncating the lower tail of the price distribution and thus the loss exposure a producer might face. And current farm programs that support prices at a specific level have the same effect of reducing or eliminating the probability of low prices -- thus truncating the lower tail of the price distribution.

Moving beyond the basic measures, various procedures have been used to help select among risky choices. For example, stochastic dominance has been used extensively in agricultural economics studies to order risky choices (Robison and Barry). In addition, modern portfolio theory (MPT) has been used to determine optimal portfolios, including studies that have examined the role of farmland in optimal investment portfolios of institutional investors. (Lins et. al.)

Fairly recent advances in computer programs have allowed researchers to more easily incorporate risk into spreadsheet programs. For example, the program "BestFit" allows one to quickly and easily determine the distribution that "best" reflects the distribution from which a historical set of data was drawn. Output from the BestFit model can then be directly inputted into spreadsheet programs such as "@RISK" in Lotus or "Crystal Ball" in Excel. Studies where these techniques have been used include Barry et. al., Mazzocco and Laduzinski, and Powell et. al.

Value at Risk

Closely associated with probability distribution techniques, value at risk (VAR) is a procedure for specifying the minimum amount of money one could expect to lose with a given probability over a specified period of time. The concept has become quite widely accepted in the corporate business world as a mechanism for more effectively communicating the dollar amount of risk associated with a given portfolio position. A 1995 *Institutional Investor* survey found that 32 percent of the firms used VAR as a measure of market risk; a survey by the Stern School of Business reported that 60 percent of pension funds used VAR measures (Linsmeier).

The VAR measure has three components. The first is the probability level used to specify the minimum amount of money one could expect to lose. Since the objective is to evaluate an unusual or abnormal loss, this probability is often set quite low. One, two and five percent probabilities are the most commonly used. The second component is the length of time over which the loss can occur. This could be a day, week, month, year or any other relevant time interval. The third component is the actual dollar amount of the potential loss. For example, consider an integrated livestock producer with a total investment of $5 million. This producer might find that the VAR for the firm for one year with a five-percent probability level is $200,000. This means that the firm is expected to show a loss of $200,000 **or more** during the year with a probability of 5 percent.

The concept of VAR is appealing because it allows one to consider the dollar amount of risk associated with the entire portfolio, or set of business ventures, not just one component of the portfolio. In essence, the focus of VAR is on the loss exposure as measured by the reduced value of a business or business venture that results from unpredictable events. To quantify this risk, one must compute the probability distributions associated with the components of the portfolio. Linsmeier and

Pearson have identified three different approaches to measure probability distributions: 1) historical simulations, 2) variance-covariance approach, and 3) Monte Carol simulation. They describe the pros and cons of each approach and their synopsis will not be repeated here. However, they suggest a number of advantages to the Monte Carlo approach -- an approach that is quite easily accomplished with the @Risk and Crystal Ball programs described above.

While VAR has been quite widely accepted in the corporate finance world, it has seen limited use in agriculture. Schnitkey, et. al. have used it to assess the consequences of various grain marketing strategies. As agriculture increasingly utilizes corporate finance tools and techniques, firms seem more likely to adapt to and use this risk assessment tool to analyze implications of strategic risk in particular.

Risk Scorecarding/Mapping

Many of the new risks that are part of today's agriculture can only be assessed subjectively or qualitatively: sufficient numerical observations are not available to provide objective assessment of probabilities so as to develop market instruments for risk transfer and allocation, or use actuarial techniques to insure and mitigate risk. Although objective measurement of risk is preferred to subjective assessments, the increasing relative importance of subjective risks in agriculture suggests that they cannot be ignored because they can not be quantified. Until more objective evidence is available to build actuarially sound numerical estimates of risk, a systematic procedure to assess the frequency and consequences of these new risks may be essential. This in fact is the emphasis of recent developments in scorecarding (Thornton).

Risk scorecarding is similar in approach to that of credit scorecarding used by lenders to assess the credit risk of various customers. The concept is to identify the potential sources of risk for a particular business, to assess the severity of those risks, and to aggregate these scores into an overall risk assessment that then can be compared to a standard which discriminates acceptable from unacceptable risks. Objective, quantifiable measures of risk are preferred, but as in the early days of credit scorecarding, a systematic approach to subjective assessment of risk is facilitated by the scorecarding approach. An illustrative risk assessment scorecard that is structured to assess various risks is presented in Figure 4.

Figures 5 and 6 provide a tool that might be used to summarize the risk management implications of the scorecard. For each of the risk categories identified in Figure 4, the probability of occurrence and the magnitude of the potential consequences are evaluated on a scale of 1 to 5 with 1 defined as low and 5 as high for each scale. These numbers are recorded in Figure 5. A pair of numbers can then assess each risk for a specific business. For example, (2, 4) would indicate a ranking of 2 on the probability of occurrence scale and 4 on the potential consequences scale. This pair of numbers then provides the coordinates to visualize that particular risk in the graph of Figure 6. Example assessment numbers have been assigned to the fourteen different risk categories to illustrate how these various risks can be visualized by their score coordinates in Figure 6.

The different risks are reflected by their coordinates in the graph of Figure 6 along with the general strategies that can be used to manage risk. The assessment provided by the graphical images of Figure 6 are that the most vulnerabilities that this business faces are from business partners and partnerships (risk category 6), and possibly the dated nature of the technology used by the business (risk category 14). Most of the other risks can be either retained or readily transferred/shared with appropriate market or other instruments. Note how this graphical representation provides a useful and meaningful synopsis of the many dimensions of the risks faced by the business and can be used to assess not only the key sources of exposure or vulnerability, but also how they can be managed.

Scenario Analysis and Stress Testing

As we have noted, in many cases the probabilities of the potential risk or loss exposures are not revealed by historical data, yet there is legitimate concern about the potential magnitude of a loss exposure that might occur. This may be particularly true when there are significant structural and other changes in an industry that are beyond the bounds of historical information. In such cases, scenario or "what-if" analyses may be the most useful technique to determine the magnitude of the risk exposure. The basic approach of scenario analysis is to identify specific values for the uncertain variables that describe a particular future, and then to simulate the consequences or outcomes resulting from that particular set of values. As suggested by the "what-if" descriptor, scenario analysis attempts to evaluate the implications of different assumed prospective futures -- in some sense it attempts to identify and describe the consequences of potential surprises. A procedure described as Monte Carlo simulation is often used to develop quantitative estimates of the risk consequences or loss exposures in scenario analysis. In essence Monte Carlo simulation uses random draws from a pre-specified distribution of possible future events or scenarios, computes the consequences for each of those potential events or scenarios, and thus creates a distribution of consequences that describe the potential loss exposures.

An increasingly common approach to scenario analysis in the financial industry, particularly in terms of assessing portfolio risk, is commonly referred to as stress testing. Stress testing can be applied to any business -- financial or nonfinancial -- and in reality is a process of assessing the severity of the potential loss exposure from any uncertain event. In reality, stress testing is a form of "what if" analysis whereby the severity of the consequences of future uncertain events is measured. Again, Monte Carlo simulation procedures are frequently used in numerical analysis. With the growing importance and awareness of strategic risk in the agricultural sector, stress-testing will likely become an increasingly more common component of the assessment of future financial performance and financial risk.

Strategy Development and Risk

Developing strategy and managing strategic risk in an environment of risk and uncertainty is a complex and ambiguous process. Courtney has described a useful framework for developing strategy and managing strategic risk. He identifies four levels of strategic uncertainty: 1) a clear enough future where a single forecast of the future business environment is sufficiently narrow to point to a single strategic direction; 2) alternative futures where the business environment can be

delineated in a few discrete scenarios; 3) a range of futures where the business environment can be defined by the range of alternative futures, but not by a discrete specific set of scenarios; 4) and true ambiguity where the future business environment is essentially impossible to predict. Visual images describing these four levels of uncertainty are shown in Figure 7. Different approaches to managing strategic risk are most useful depending upon the different levels of uncertainty in the future business environment.

Courtney suggests that developing strategy in an uncertain environment is a two-stage process: first, choosing a strategic posture which defines the intent of strategy; and, second, selecting a portfolio of actions that are the specific moves or activities that can be used to implement the strategy. Three strategic postures are identified: 1) shapers who attempt to drive their industry toward a new structure of their own design, 2) adaptors who take the current and future structure of the industry as given and react to the opportunities that structure offers, and 3) reservists who take a wait and see approach but reserve the right to play by making incremental resource commitments to enhance their ability to be a successful market participant in the future. These different strategic postures are illustrated in Figure 8.

Once a strategic posture has been selected three different types of actions or moves can be made to implement the strategy (Figure 9): 1) no regrets moves that are expected to pay off no matter what future comes to pass; 2) an option which is designed to secure high payoffs in the best case scenarios while minimizing losses in worst case scenarios; and 3) a big bet which involves large commitments of resources that will either pay off big or lose big.

A couple of examples may help our understanding of the applicability of these concepts to strategic risk management in agriculture. A key issue faced by many farmers is what strategy to use in expanding the land base in their business (rent vs. buy) given uncertainty about future prices and government programs. It is typically feasible to identify alternative scenarios for prices and government program payments that define the future, so some form of scenario analysis using game theory or option valuation approaches is typically applicable. A most likely strategic posture is to adapt to the future or reserve the right to play; a big bet move would be implemented with a land purchase decision; whereas a no-regrets move might be implemented with a crop share lease where future risk of prices and government payments are shared between tenant and landlord. An option move might be implemented with a longer term cash lease that includes an option premium and a right to purchase the property at some future period. Note that these different approaches to managing the strategic risk may be adopted by different players in the same market as a function of their financial condition and their risk attitudes.

Options concepts may also be useful in making decisions to enter new businesses such as production of specialty crops. In most cases, transitioning from commodity crop production to specialty crop production involves sequential investments in increasingly specialized machinery and equipment in an uncertain environment concerning future growth in demand, price premiums, yield drag, etc. If the required investment must be made up-front with limited capacity to make adjustments, the expected benefit stream or the expected payoff may not justify the outlay. But if critical investments such as storage facilities for identity preservation can be made in the first year --

and specialized planting, pest control and harvesting equipment investments delayed for a year or two until new information is available on the magnitude of the price premium or yield drag for example, the option value of delaying part of the investment outlay plus buying time to obtain more certainty about future payoffs may convert an unacceptable business venture into one that is acceptable. An example of sequential expansion in livestock facilities would be constructing finishing barns initially, and then a breeding/gestation/nursery unit two or three years later if initial uncertainty concerning pork prices and feed costs subsequently suggests that margins will be on the higher end of the original probability distribution function rather than the lower end of that function. These examples suggest not only the benefits of using the options approach to making investment or strategic decisions, but also indicate the value of making such decisions sequentially when possible.

Critical Issues

A number of issues that surface in the new agriculture have already been identified including the importance of strategic risks, the potential usefulness of value at risk and real options concepts, and the new risks and new ways of managing risk that result from contract production. This discussion will present selected additional issues that in our judgment merit attention.

Risk and Product Differentiation

The food and industrial use markets for agricultural products are increasingly characterized as segmented or niche markets that can appear and disappear rapidly. Some food distribution channels may require particular quality characteristics which may not be available in predictable quantities in open, spot markets. For many agribusiness firms that are in the food processing and distribution business, the risk of changing consumer preferences or a food safety scare may be a much more critical and important risk to manage than price or availability of raw materials. One reason for a contractual arrangement to source raw materials from a qualified supplier is to reduce price and availability risk as well as food safety risks from contamination, and simultaneously obtain the attributes needed in the final product from the specific attribute raw material. But as noted earlier, this arrangement may reduce flexibility and introduce relationship risk.

The transformation of a segment of agriculture from a commodity to a differentiated product industry introduces at least three new risks. First, differentiated products are positioned to respond to unique market segments that value the attribute that is differentiated. Assuming this attribute is measurable (which may be a risk in itself since many food attributes including quality are difficult to measure), one risk is that consumers and end-users attitudes and willingness to pay for some attributes may change over time. For example, consumer attitudes with respect to food additives, biotechnology, and genetically modified organisms (GMOs) do not appear to be stable or predictable across cultures and across time. Secondly, alternative techniques to accomplish product differentiation will like develop over time, and those firms or individuals that can produce the differentiated product will likely increase. Thus, differentiated products are regularly commoditized over time, and initially higher margins are eroded as new competitors appear. And the speed of commoditization is also a source of uncertainty. Finally, differentiated products in the food market, particularly if that product is a branded product, also carry the risk as well as the reward of branding.

Brand value can be quickly destroyed by defects or quality lapses, and in the food product markets, food safety is a risk that can quickly destroy brand value.

Risks in Value Added Investments

Investment in value-added activities by producers is appealing because margins are often perceived to be better in these activities, and more control of the food production - distribution chain can be acquired by involvement in additional activities in the value adding process. Furthermore, the common perception is that vertical linkages or alliances through ownership or contract production will also reduce quality and quantity risk.

But the implications for financial and strategic risk are less clear. If the margins in the value-added activities are negatively correlated with margins in production activities, risks are reduced from a portfolio perspective. But given that in the long run the same fundamental supply and demand drivers will shape the profitability and margins in the entire production and distribution chain, it is quite possible that these margins are not negatively correlated but positively correlated -- thereby limiting risk reduction potential (Perry). Furthermore, if additional debt capital is acquired in the acquisition of the capital assets to implement the value-added activities, the leverage position may be increased and thus the financial risk would be greater. And even if the financial leverage of the vertically integrated firm is no different than the aggregated financial leverage of separate firms involved in the same stages of the food chain, the fact that this equity is supplied only by one firm or a smaller set of equity holders compared to the broader set associated with independent ownership of the stages of the production/distribution system will typically result in increased absolute risk exposure for those individuals and thus a redistribution of risk. In essence, the dispersion and/or concentration of financial risk as one moves from independent firms to vertical linkages is a critical issue that merits analysis.

A further dimension of this issue of changes in risk exposure with producer investments in value-added activities is the potential new risks that may exist or be introduced. These new risks may be in the form of strategic risk such as business partners and partnerships, competitors and competition, distribution and distribution channels, etc. rather than operational risk (price, quality or quantity). These strategic risks will be encountered by both independent or integrated firms; but the magnitude and complexity of these risks are expected to be larger and more difficult to assess and manage in a more integrated system compared to more fragmented and independent production and distribution systems. Thus, as producers invest in additional activities further down the chain, they would likely face a new and different set of strategic risks than have been faced in the past.

New Business Models and Risk

Many independent producers have entered into contractual agreements with other businesses; this business arrangement is increasingly used for example in the hog industry. Kliebenstein and Lawrence illustrate that while contract production reduces the level of risk for the producer, risks and returns vary by contract. A key consideration in assessing the economic impact of contracting and other business arrangements on the producer is the interrelationships between the risk aversion (and

risk-return trade-offs) of the producer and the risk attitudes of lenders and the capital markets as reflected by the financing terms and arrangements and credit availability under different business arrangements. Because of their risk averse nature, lenders are careful in extending credit to businesses that exhibit significant operating risk; they will often extend more credit to those businesses that manage the operating risk through various techniques such as contract production. To transfer operating risk to someone else requires the producer to accept a lower profit margin, (since the risk taker must be compensated to accept that risk) and thus return on assets. But the real issue for the producer is what is the impact on return on equity of different business arrangements. If the lender allows a producer to borrow additional funds and expand the business, because of the reduced operating risk under contract production, it is possible for the producer to have a higher mean return on equity and a lower variance of return on equity (Boehlje and Ray). The higher mean return and lower variance on equity may coincide with the producer receiving a lower mean return on assets. This issue of the implications of various contracting arrangements on the risk and return to equity capital (not just to assets or total capital as is typical of most analyses of contract production) is critical to understanding the growing opportunities and interest in contract production.

Market Risk and Performance

The industrialization of agriculture is likely to compound the risk and uncertainty related to the effectiveness of markets in providing accurate messages to consumers and suppliers in the food chain concerning prices, quantities and qualities of products and attributes. With the formation of more tightly aligned food supply chains, it can be argued that messaging is much more precise, timely, and generally more accurate for participants in the chain than might be provided by market forms of coordination. Critical assumptions of this argument are that product attributes are accurately measurable, and that consumer demand for attributes is predictable. Recent studies of this phenomena in the pork industry provides support for this hypotheses, but much further work in this and other industries is needed (Poray et al., Cloutier).

What about the risk faced by those who are not part of the tightly aligned supply chain -- are not qualified suppliers? Is there more volatility in the prices they receive because of thin markets? Do they have access to a market or are they closed out because only qualified suppliers can participate? Because of the thinness of these markets, are they not only subject to more volatility, but also more potential for manipulation? Do the prices and other information conveyed by these thin markets provide accurate messages to consumers and suppliers concerning quantities, qualities, cost and value? If the commodity markets become the "salvage" market for products that do not meet specifications in the qualified supplier system, do they become frequently over-supplied with the prospects of more downside price volatility than upside potential? If those who cannot participate in the qualified supplier systems can only sell in commodity markets and these markets take on the characteristics of a salvage market, do the participants incur more of the risk of more tightly aligned chains without the potential of receiving any of the rewards? If markets become sufficiently concentrated that only one or possibly two qualified supplier arrangements are available in a particular locale, how can participants be assured that their share of the risk and rewards of participation are equitable? The fundamental issues of access to information; transaction transparency; equitable sharing of risk and reward by non-participants as well as participants in

tightly aligned supply chains; and the risk associated with market access are all important market risk and performance issues that are part of the changing agriculture.

New Risk Management Instruments/Options

Private sector innovation in the risk transfer/mitigation/allocation markets has resulted in a proliferation of new instruments and alternatives. In grain production, futures trading in yield contracts combined with futures and options on commodity prices has facilitated the development of a broader set of insurance contracts including crop revenue insurance and revenue assurance. More complex risk management alternatives that combine various forms of crop insurance with traditional forwarding pricing, hedging with futures and/or options, contracting or similar instruments are being offered. Contract production in livestock including pen-space, window or minimum price contracting is increasingly common in the pork industry in particular. Income per acre contracting has been used in specialty crop and seed production, and may have potential in commodity production in the wheat and corn industries. More input supply firms are offering performance warranties as part of their product/service package (not just in machinery and equipment, but also in the genetic and chemical industries). And more consulting firms are offering a broader set of risk management/counseling services. The number of instruments and strategies for managing risk in crop and livestock production is proliferating rapidly, yet we know little about how effective these instruments and arrangements are and under what circumstances they may be useful.

Lending or Credit Risk

The risk involved in lending to industrialized production agriculture are different than those in traditional agricultural lending. If the product produced is a specialized or differentiated product rather than a commodity, the risk of market access may increase. Differentiated product markets can disappear and/or be flooded by alternative suppliers; the borrower must have a thorough understanding of the market as well as well-developed marketing and distribution skills to be successful in differentiated product markets. Documenting these potential risks and procedures for assessing and managing them would assist lenders in credit analysis for differentiated product producers. And the growth in differentiated products and contract production may also have important implications for commodity markets and commodity producers. Open access commodity markets may increasingly become residual markets (i.e. the salvage market) with growth in contract and differentiated product production. Those who participate in these markets may thus be subject to increased price variability with the prospect of more downside price risk than upside potential - i.e. a skewed price distribution.

Many of the integrated, new venture projects also involve specialized assets. The technology embodied in these specialized assets may be critical to the physical performance and debt servicing capacity of the venture. The wrong technology could be disastrous, both in terms of operating performance and marketability of assets if default occurs. Although the technological risk for integrated, new venture projects may not be all that different than for traditional loans, the size of the loan and thus the exposure to a bad technological choice is likely to be larger. The implications of

asset specialization and technological risk on credit risk and collateral management are interesting and important issues.

New venture projects are expected to have long lag times during the construction and start-up phase which must be recognized in developing financial projections. It is not unusual for delays in construction of hog buildings and other livestock facilities, resulting in little revenue during the first year and an expanded need for operating funds to cover cash flow deficits during the longer than expected start-up period. It is typical to have the operation running only at 75% to 90% of efficiency and/or capacity during the second year of operation, so cash flow and debt servicing is impeded further. Documenting the magnitude and frequency of these start-up problems and the implications for debt servicing is essential for lenders in assessing credit risk, and in developing loan terms such as deferrals of first year principal payments on building loans or multi-year operating credit lines to accommodate start-up problems.

As a function of the larger scale of operations, industrialized new venture projects may more frequently encounter regulatory compliance risk. Particularly in integrated livestock production, larger scale units may be held to higher standards concerning environmental rules and regulations and labor and worker safety rules. Recent violations of environmental regulations, both in the Midwest and Southeast, have resulted not only in increased monitoring of compliance, but have made the approval and permitting process in some states more formidable. Thus regulatory concerns may not only increase the delays in current and future construction which will impact cash flows, but they also may increase monitoring and compliance cost as well as the potential risk of shutdown because of non-compliance which also will impact debt servicing capacity. Documenting these costs and risks would be useful to understanding the credit risks that lenders who serve this segment of agriculture will face.

Increased integration of the food system also has significant implications for lenders. An integrated food system will mean that individual firms may require financing for a broader set of activities, thus increasing the potential amount of funds needed as well as the types of financing terms and arrangements. If the coordination is accomplished through contracts or strategic alliances, the lender must not only evaluate the internal credit-worthiness of the customer, but also the terms and conditions of the contract or alliance to make sure that the overall arrangement is financially sound. Various coordination systems will likely change the asset structure or the cost and revenue characteristics of a firm, and thus require different criteria for credit assessment. For example, out-sourcing of supplies or contract production frequently reduces the current assets and liquidity of the firm since others own the inventory. Thus, typical measures of liquidity used in credit analysis -- such as the current ratio or liquid asset margin -- will need to be modified. Analytical work to document the risk implications of a more integrated agriculture would not only be useful in lending decisions and credit analysis, but also in policy discussions concerning both safety and soundness in the financial industry, as it attempts to serve the new agriculture; and farm policies and programs to cost effectively mitigate or manage risk in the agricultural sector.

Strategic Risk Analysis

Strategic risks are unique -- there is little historical documentation of their occurrence or severity; thus they have the potential to be real surprises. The chances of occurrence are presumably very low; the consequences are very severe (maybe even a capital wipe-out). And in general, because of their ambiguity, most managers and lenders ignore strategic risks. Strategic risks typically are not reflected in traditional financial documents used in credit analysis, and are rarely documented otherwise. Consequently it is not uncommon for these risks to receive little if any attention in the credit review process.

The implications of these concerns are apparent. First, additional tools must be developed and procedures adopted to assess strategic risks for both borrowers and lenders. Such tools might include further development of the scorecarding and mapping techniques as well as stress - testing technique discussed earlier. In addition, further analysis should be focused on innovative ways to manage strategic risks; even flexibility and avoidance may not be adequate to manage and mitigate the consequences of real surprises. Finally, concerns about strategic risks should include whether or not capital adequacy policies and regulations, whether for borrowers or lenders, adequately account for these risks.

Management vs. Financial Approaches to Managing Risk

Strategies to mitigate and manage risk, whether that be for a farm or agribusiness or a financial institution, can be categorized as either asset/income management strategies or financial/liability management strategies. Asset/income management strategies would include the classic diversification approach to managing a farm business or a lender's portfolio; the pricing and/or hedging approaches to protect margins in a farm business or a financial institution; insurance programs to mitigate loss exposures for assets in a farm or agribusiness firm and the parallel for financial institutions of credit analysis, loan guarantees, and collateral to mitigate losses on credits and other financial assets for a financial institution. The asset/income management strategies to reduce risk exposure for farm and agribusiness firms and lenders have been the focal point of much of the historical assessment of risk management and the evolution of risk management instruments and markets.

Until recently financial/liability management instruments and approaches to mitigate risk in agriculture have not been the focal point of as much innovation, and those that have evolved recently in the form of off-balance sheet financing, leasing, and even some of the financial derivatives have fallen into disrepute because of recent misuse and abuses. Consequently, innovative financial management instruments and markets to mitigate risk have been slow to evolve, leaving the most basic of financial management strategies to mitigate risk exposure -- maintaining strong equity capital positions.

But is maintaining a strong equity base the only acceptable financial management strategy to mitigate risk? Could more creative financing instruments be used that might share some of the upside potential while accepting some of the downside risk? What is the potential of some of the

investment banking principles used in other industries to expand the set of financial/liability management strategies for risk management in agriculture and agricultural lending? Have we been as creative as we might be to use the financial futures and derivatives markets to truncate the loss exposure on the liability side of the balance sheet for businesses and/or banks? Is there an opportunity in the financial markets to extend securitization and reinsurance principles to further reduce credit risk so that higher leveraged positions do not generate unacceptable loss exposures. In fact, the opportunity to mitigate some of the strategic risks noted earlier with traditional asset/income management strategies maybe difficult if not impossible. It may become increasingly important to develop innovative financial/liability strategies for risk management because many firms will be unable to increase their equity capital base and maintain even higher equity financing positions if that is the only strategy available to mitigate the loss exposure from strategic risks.

Integration of Risk and Financial Markets

Important changes are occurring in the product and service industries that supply production agriculture. One of these changes is the integration of the financial services industry and the risk management services industry. Insurance companies have always been significant players in both the risk and financing markets, but not as integrated providers. Instead, the investment division of life insurance companies in particular have been important providers of mortgage credit to farmers, whereas specialty crop and casualty insurance companies have been the major participants in the risk management markets. But risk is a key issue impacting the terms and rates of the financing package offered to specific customers, and it has been common-place for lenders to require various risk management strategies such as purchasing crop insurance as a condition for extending credit. More recently, new risk management instruments including price, yield and performance warranties by input supply companies and net income contracting in grain and livestock production have been introduced into the market by input suppliers and product purchasers. These new instruments and arrangements are resulting in an increasingly integrated risk management service industry, financial products/services industry and real product input supply and product processing industries.

A Final Comment

Dramatic changes are occurring in the agricultural sector -- changes which will result in agricultural industries having many of the characteristics of manufacturing industries. The rapidly changing business climate is creating a new agriculture with new risks. And many of these risks require new approaches and different perspectives to adequately assess and manage them. The new risks will create both challenges and opportunities for farm and agribusiness firms and those who finance them.

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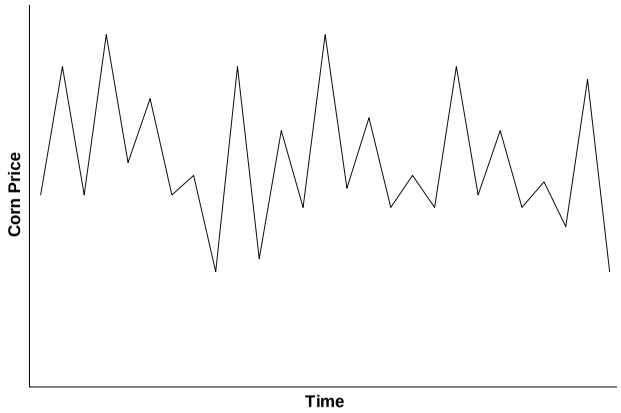
Figure 1—Alternative Price Patterns

Graph A—Random Fluctuations



Graph B—Sequential Fluctuations

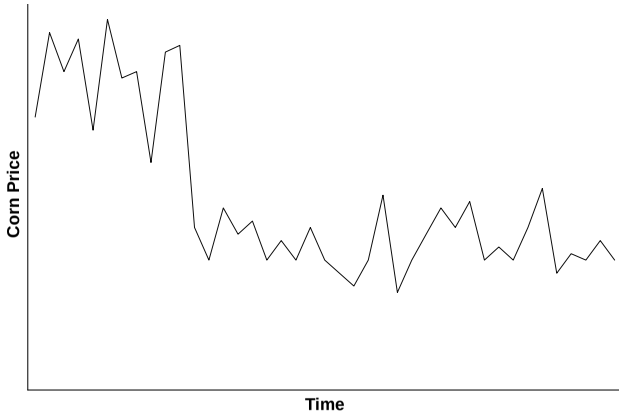


Figure 2—The Universe of Risk

Categories of Risk	Illustrative Sources of Risk
Financing and Financial Structure	Debt servicing capacity, leverage, debt structure, nonequity financing, liquidity, solvency, profitability
Market Prices and Terms of Trade	Product price volatility, input price volatility, cost structure, contract terms, market outlets and access
Business Partners and Partnerships	Interdependency, confidentiality, cultural conflict, contractual risks
Competitors and Competition	Market share, pricing wars, industrial espionage, antitrust
Customers and Customer Relationships	Product liability, credit risk, poor market timing, inadequate customer support
Distribution Systems and Channels	Transportation, service availability, cost, dependence on distributors
People and Human Resources	Employees, independent contractors, training, staffing adequacy
Regulatory and Legislative	Export licensing, jurisdiction, reporting and compliance, environmental
Political	Civil unrest, war, terrorism, enforcement of intellectual property rights, change in leadership, revised economic policies
Reputation and Image	Corporate image, brands, reputations of key employees
Strategic Position and Flexibility	Mergers and acquisitions, joint ventures and alliances, resource allocation and planning, organizational agility
Technological	Complexity, obsolescence, workforce skill-sets
Financial Markets and	Foreign exchange, portfolio, cash, interest rate
Operations and Business Practices	Facilities, contractual risk, natural hazards, internal processes and controls

Adapted from Teach, Edward, "Microsoft's Universe of Risk" CFO, pp. 69-71, March 1997.

Figure 3—Skewed Probability Density Function (PDF) for Corn Price

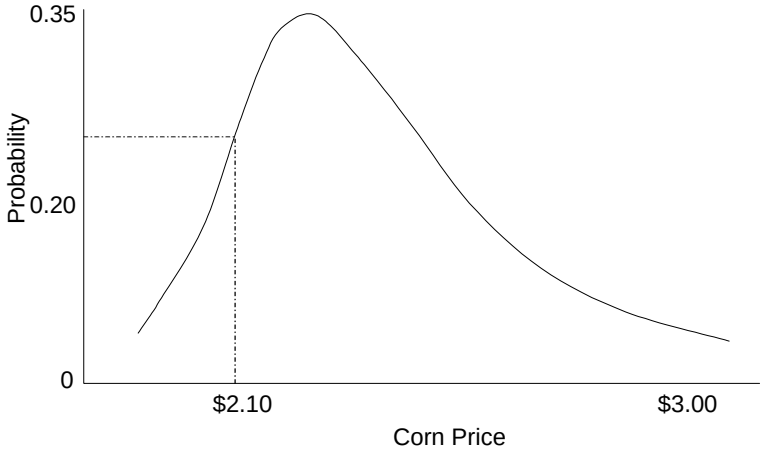


Figure 4—Risk Assessment Scorecard

		ASSESSMENT									
	CATEGORY OF RISK	Low Risk									High Risk
1	Financing and financial structure	1	2	3	4	5	6	7	8	9	10
2	Market prices and terms of trade	1	2	3	4	5	6	7	8	9	10
3	Business partners and partnerships	1	2	3	4	5	6	7	8	9	10
4	Competitors and competitions	1	2	3	4	5	6	7	8	9	10
5	Customers and customer relations	1	2	3	4	5	6	7	8	9	10
6	Distribution systems and channels	1	2	3	4	5	6	7	8	9	10
7	People and human resources	1	2	3	4	5	6	7	8	9	10
8	Political factors	1	2	3	4	5	6	7	8	9	10
9	Regulatory and legislative factors	1	2	3	4	5	6	7	8	9	10
10	Reputation and image	1	2	3	4	5	6	7	8	9	10
11	Strategic position and flexibility	1	2	3	4	5	6	7	8	9	10
12	Technological factors	1	2	3	4	5	6	7	8	9	10
13	Financial markets and instruments	1	2	3	4	5	6	7	8	9	10
14	Operations and business practices										

TOTAL SCORE:

Figure 5—Risk Exposure Assessment

	Severity	
	Probability	**Consequences**
Business/Operational		
1. Operations and business practices		
2. People and human resources		
3. Strategic position and flexibility		
Financial		
4. Financing and financial structure		
5. Financial markets and instruments		
Business Relationships		
6. Business partners and partnerships		
7. Distribution systems and channels		
Market Conditions		
8. Market prices and terms of trade		
9. Competitors and competition		
10. Customers and customer relations		
11. Reputation and image		
Policy and Regulation		
12. Political factors		
13. Regulatory and legislative factors		
Technology		
14. Rate of change and innovation		

Figure 6—A Graphical Synopsis of Risk Exposures

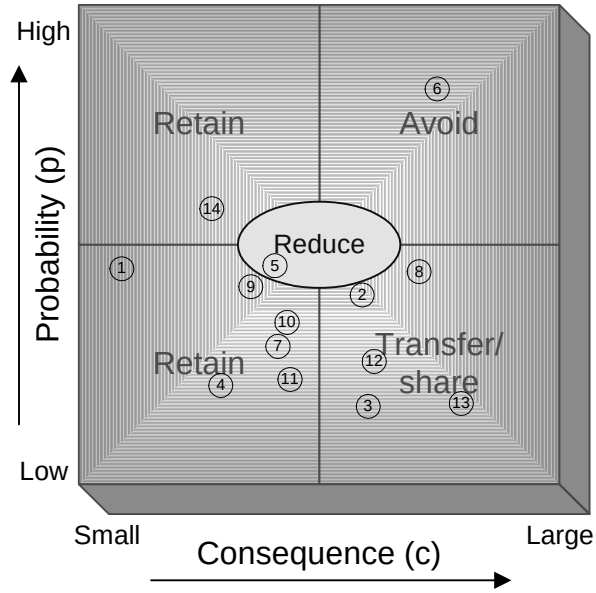
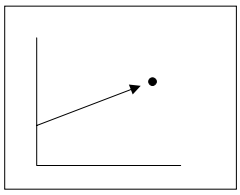
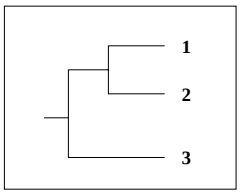


Figure 7—Strategy Under Uncertainty

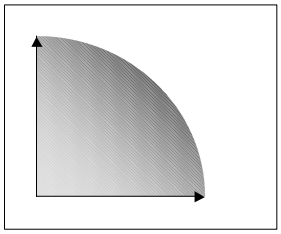


A Clear-Enough Future

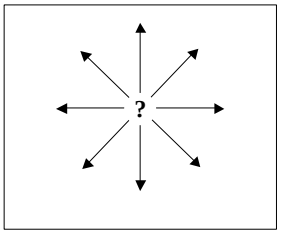


Alternate Futures

What Can Be Known?	A single forecast precise enough for determining strategy	A few discrete outcomes that define the future
Analytic Tools	"Traditional" strategy tool kit	Decision analysis Operation valuation models Game Theory
Examples	Strategy against low-cost airline entrant	Long-distance telephone carrier's strategy to enter deregulated local-service market Capacity strategies for chemical plants



A Range of Futures

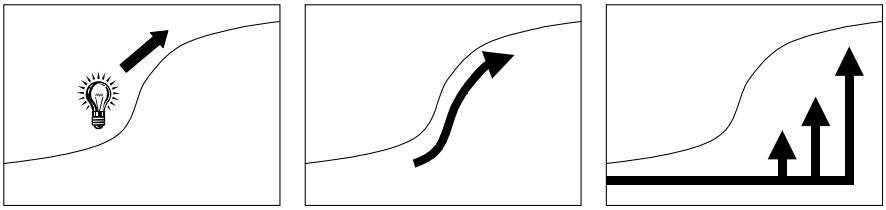


True Ambiguity

What Can Be Known?	A range of possible outcomes, but no natural scenarios	No bias to forecast the future
Analytic Tools	Latent-demand research Technology forecasting Scenario planning	Analogies and pattern recognition Nonlinear dynamic models
Examples	Entering emerging markets, such as India Developing or acquiring emerging technologies in consumer electronics	Entering the market for consumer multimedia applications Entering the Russian market in 1992

Source: Courtney et al.

Figure 8—The Three Strategic Postures



Shape the Future
Play a leadership role in establishing how the industry operates (for example, setting standards, creating demand)

Adapt to the Future
Win through speed, agility, and flexibility in recognizing and capturing opportunities in existing markets

Reserve the right to play
Invest sufficiently to stay in the game but avoid premature commitments

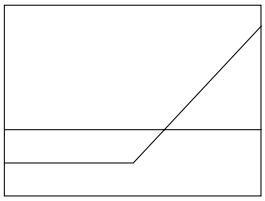
Source: Courtney et al.

Figure 9—What's in a Portfolio of Actions?

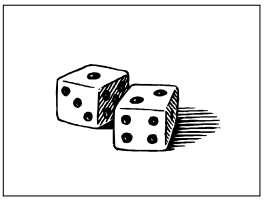
These building blocks are distinguished by three payoff profiles that are the amount of investment required up front and the conditions under which the investment will yield a positive return.

Scenario	Value
1.	+
2.	+
3.	+
4.	+

No-regrets moves
Strategic decisions that have positive payoffs in any scenario



Options
Decisions that yield a significant positive payoff in some outcomes and a (small) negative effect in others



Big Bets
Focused strategies with positive payoffs in one or more scenarios but a negative effect in others

Source: Courtney et al.