2010

Risk management by farmers, agribusinesses, and lenders

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Disciplines
Agricultural Economics | Behavioral Economics | Econometrics

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Risk Management by Farmers, Agribusinesses, and Lenders
Ashok K. Mishra and Sergio H. Lenese

Abstract

Producers and lenders seek to avoid agricultural production-related risks through various managerial and institutional mechanisms. For individual farmers and agribusinesses, risk management involves choosing among alternatives for reducing the effects of risk on the firm, thereby affecting the firm's welfare position. Risk management often requires the evaluation of tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other factors. Research on risk management issues in agriculture has been among the main topics of interest of the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors. This paper reviews and summarizes much of the Committee's work and provides a discussion of related topics of interest for prospective future research.

Key words: farm financial performance, federal subsidies, risk-management tools

In order to discuss risk management issues in agriculture or any other industry, it is essential to define the concept of risk. For the purposes of the present study, risk is defined as the uncertainty faced by a firm (be it an individual, agribusiness, or lender) that affects its welfare. Specifically, risk is often associated with adversity and loss by the firm, and also with its survival as a business, risk is uncertainty that affects an individual's welfare, and is often associated with adversity and loss; risk is uncertainty that "matters" and may involve the probability of losing money.

Agricultural production is risky because it is subject to unpredictable, random shocks caused by weather events, pest damages, diseases, and other natural disasters. The relative frequency of such events (e.g., flood, fire, hail, hurricanes, and drought) is believed to generate significant yield instability. Farms in agriculture are also exposed to substantial price volatility, usually much more so than firms in other sectors of the economy. The sizable volatility of agricultural prices stems in large part from the significant randomness in supply coupled with the inelastic demand which characterizes most agricultural products.

Gabriel and Baker (1986) define two types of risk in agriculture. First, business risk—risk associated with production and price risk—generally is reflected in the variability of net operating income or net cash flow. This would also include technological risks, institutional risk.

"Others use the variance of returns on assets as an alternative measure of business risk.
casiualty loss risk, legal risk, and human resource risk. Second, financial risk is a source of risk that is very real and has potential effects on the solvency of firms in agriculture. Financial risk differs from yield and price risks in that it results from the way the firm's capital is obtained and financed. A farmer may be subject to fluctuations in interest rates on borrowed capital, or face cash flow difficulties if there are insufficient funds to repay creditors. The use of borrowed capital means that a share of the returns from the business must be allocated to meet debt payments.

In short, risk is prevalent in the agricultural sector. Further, there is strong evidence showing farmers are typically risk averse (Just and Pope, 2001; Innes and Ardila, 1994; Hartliser, Hulme, and Anderson, 1997) and that they seek to avoid risks through various managerial and institutional mechanisms (Robinson and Barry, 1987). The incidence of risk and risk-averse behavior in farming is important to policy makers for various reasons. For example, fluctuating farm incomes, and particularly the risk of catastrophic losses, may present welfare problems for farmers and their families. Farmers exposed to severe risk are also more likely to default on bank loans, which may lead to bad debts and farm foreclosures. In the case of systemic risks (e.g., when catastrophic losses are experienced by many farmers simultaneously), farm failures may trigger failures of other agribusinesses and lenders.

For individual farmers and agribusinesses, risk management involves choosing among alternatives for reducing the effects of risk on the firm, thereby affecting the firm's welfare position. Risk management often requires the evaluation of tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other factors. Some risk management strategies reduce risk within the firm's operation, others transfer risk outside the firm, and still others build the firm's capacity to bear risk (such as maintaining liquid assets).

Just and Pope (2001) point out that farmers have different attitudes toward risk, which is consistent with the findings of Goedicke and Kastens (1993); Innes and Ardila (1994); and Barry and Bailey (1984). Therefore, the "one-size-fits-all" paradigm does not apply in the analysis and implementation of risk management strategies by farmers. For an individual farmer, risk management involves finding the preferred combination of activities with uncertain outcomes and varying levels of expected return. Specifically, one might state that risk management involves choosing among alternatives for reducing the effects of risk on a firm, and in so doing, affecting the firm's welfare position.

In the present study, risk management strategies are classified into two main categories: "within-firm" strategies and "risk-sharing" strategies. Within-firm strategies include, among others, (a) on-farm enterprise diversification; (b) collecting more information about scenarios involving uncertainty; (c) enhancing product flexibility and/or asset flexibility; (d) avoiding risky technologies; (e) reducing leverage; and (f) increasing liquidity (i.e., the firm's ability to generate cash quickly and efficiently in order to meet financial obligations) and maintaining financial reserves.

Among risk-sharing strategies, the following are of special note: (a) buying insurance (e.g., crop insurance, revenue insurance, insurance on buildings and/or machinery, etc.); (b) hedging using contracts traded in derivatives markets (e.g., futures and options contracts); (c) for more information on sources of risk in agriculture, see Hartliser, Hulme, and Anderson (1997); Goedicke and Trice (1987); Prusak, Hambleton, and Just (1997); and Finletter (1996).
(c) producing under production and marketing contracts; (d) leasing inputs and hiring custom work; and (e) obtaining off-farm sources of income (e.g., off-farm employment by the operator, the spouse, or both).

To evaluate whether various risk-management tools and strategies are effective in achieving managerial goals regarding risk, it is essential to express risks in quantitative terms. Substantial research has been conducted estimating the price and yield risk faced by farmers (Goodwin and Ker, 1998, 2001; Goodwin, 1994; Rie and Coble, 2000). The exact distribution of these risks has been a topic of much discussion for many years. Economists have used various alternative approaches to model decision making in situations involving risks. These approaches are based on the notion that each risk strategy offers producers a different probability distribution of income, and that determining the best strategy involves describing the different distributions and developing rules to choose among them.

Research on risk-management issues in agriculture has been among the main topics of interest of the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors. Given the wealth of research performed by the Committee over the years, the purpose of the present study is to review and summarize such work, and to discuss related topics of interest for future research.

The first two sections of the study focus on the research insights gleaned from the papers presented over the past 20 years at the annual meetings of the Committee which dealt with risk-management issues in agriculture. For this purpose, studies are grouped according to the main type of risk-management strategy addressed, by following the previously identified strategy classifications—i.e., within-firm strategies and risk-sharing strategies. The final section is devoted to a discussion of research topics of potential interest which agricultural economists could undertake over the next few years.

Within-Firm Risk-Management Strategies

Diversification

The Farm Credit System expanded its agricultural debt in the 1970s compared to other lenders. Farm financial stress during the early 1980s placed agricultural financial intermediaries in a precarious situation. Since the Farm Credit System was the largest farm real estate lender, it was the most severely affected financial intermediary during periods of farm stress. Moss and Peathersone (1988) examined the possibilities of diversification opportunities within the Farm Credit System. Using the Arbitrage Pricing Theory to test whether risk-free profits could be obtained by trading loans within the districts of the Farm Credit System, they concluded that additional diversification within the Farm Credit System was not likely, and thus trading loans between districts would not result in risk-free profits.

More recently, Katchova (2002) conducted an empirical examination of the effect of diversification across agricultural activities on profitability. She found that a crop/livestock diversified farm had lower average value and lower average return on equity than a combination of a specialized crop farm and a specialized livestock farm with similar overall output. Katchova's results imply diversification in agriculture does not make sense as a strategy to enhance value, but the results do not rule out diversification as an effective strategy to reduce risks. However, because of the data used in her analysis, Katchova's findings should be interpreted with caution.
Sandra (2004) investigated enterprise diversification and found that benefits could be more pronounced, but elsewhere (under and authors examined various enterprise diversification could be more beneficial.

In another study, Maima, El-Osta, and Saudette (2004) investigated enterprise diversification by U.S. farmers as a self-insuring strategy. In particular, the authors examined various farm, operator, and household characteristics on the level of off-farm enterprise diversification. The study found that large farms were more specialized, and that farms located near urban areas, farmers who participated in off-farm work, and farms with higher debt-to-asset ratios were less likely to diversify. Further, the findings suggest a positive relationship between diversification and participation in crop insurance and direct government payments.

Information

In a Purdue University survey study of large-scale farmers, agricultural lenders, and professional farm managers, Ulbrich and Patrick (1995) summarized sources of information, sources of and responses to risk, and the willingness of farmers, lenders, and farm managers to pay for risks. The authors reported that all three groups rated information sources as important in making production decisions. Fewer sources of information were rated important in making marketing and financial decisions. These included information on employees and records, tenants, or borrowers. Ulbrich and Patrick reported significant differences among the three groups in the individual's self-assessed willingness to take risk. Results of the survey also indicated no significant differences in risk aversion between farm managers and agricultural bankers.

The use of business information by farmers was examined by Gloy and LaDue (2002), who looked at the business analysis techniques used by a group of New York dairy farmers and their respective financial performance. The most commonly used business analysis method employed by these farms was trend analysis. Findings also revealed that almost 75% of farms prepared financial budgets either on an annual basis or when they were planning to make major changes in operations. Importantly, Gloy and LaDue uncovered a strong positive relationship between a farm's usage of investment analysis and its profitability.

The vast majority of the existing crop insurance and risk management literature is underpinned by the assumption that producers accurately understand and rationally respond to the risks they face. Sherrick (2001) asserts that subjective probability beliefs about important weather variables are systematically misaligned to the true distributions. In his study, Sherrick examines the assumption that producers possess accurate probability beliefs when evaluating risk variables which affect their financial well-being. He concludes that significant errors in producers' risk assessments and insurance valuations arise simply because producers possess systematically inaccurate probability beliefs, especially about the weather.

Differences in yield-model specifications can significantly impact quantitative assessments of revenue risk, insurance values, and other components of farmers' risk management decisions. In a related study, Zandini et al. (2000) evaluate parametric yield specifications and assess their implications for valuation of average production history and crop revenue insurance products. The authors conclude that having yield specifications as an unexamined premise may lead to incorrect conclusions in other important areas of insurance research, such as policy rating and quantitative assessment of expected losses from different types of policies.
Leverage

Guy and Baker (2001) argue that risk aversion and financial leverage are important when making risk-management strategy selections. The authors also show that the stochastic dominance approach with risk-free asset criteria reduces the number of risk-management strategies a manager must consider without making strong assumptions about risk preferences. Adding leverage was found to be a more efficient way to increase returns than reverting to a strategy with a greater mean and business risk.

Using data from U.S.-based food processors, Spronk and Moss (2001) found leverage was negatively related to the amount of intangible assets, profitability, and investment autonomy. Their results suggest food processors view equity and debt not as much as alternative financing instruments and/or strategies, but as alternative governance structures, with equity providing greater decision making discretion than debt. Spronkler and Moss report that managers prefer equity capital financing over debt.

Decisions about financial leverage can have major impacts on the long-run survival of agricultural firms. Given the level of business risk, the owner will choose a capital structure or a level of financial leverage which will maximize expected utility of returns to equity, subject to personal risk preferences. Risk-balancing issues as influenced by leverage are well documented in the literature (Gabriel and Baker, 1986; Baker and Baker, 1984; Collins, 1985). Using panel data from Kansas over the period 1973-1988, and assuming maximization of the expected utility of returns to equity, Jensen and Langenmeier (1998) investigate optimal leverage and the factors affecting leverage. Based on their findings, leverage is affected theoretically and empirically by tax policy, risk, farm profitability, and growth rate in the value of assets.

The relationships among business risk (Gabriel and Baker, 1986), profitability (Collins, 1985), price supports (Featherstone et al., 1988), taxes (Moss, Ford, and Boggess, 1989), and financial risk constitute risk-balancing dimensions of agricultural policy. Risk balancing refers to the adjustments in the components of total risk (i.e., business risk and financial risk) resulting from an exogenous shock to the existing balance (Gabriel and Baker, 1986).

Abreuclroom, Collender, and Dixson (1994) extended the basic model of Collins and Barry (1989) and added to the dimensions of risk balancing through relationships among depreciation, investment, tax credits, and financial risk. The authors concluded that policies (such as depreciation and investment tax credit deductions) which increase farmers' profits or decrease farmers' business risk may, in fact, reduce farmers without constrained credit to increase financial risk through capital structure adjustments. However, as the authors point out, the adjustment process is likely to be slow.

The tax treatment of capital gains is a potentially important factor affecting investment in agriculture. Moss, Ford, and Boggess (1989) construct a theoretical model explaining the effect of the elimination of capital gains deduction on investment decisions in U.S. agriculture. Using aggregate U.S. data, their analysis shows that elimination of the capital gains exclusion raises optimal leverage levels and the probability of a negative rate of return to equity for all levels of risk aversion.

Equilibrium analysis under risk evaluates a firm's possible responses to changes in the risk characteristics of its environment. Barry and Robinson (1987) employ equilibrium analysis under risk to analyze financial structure at the firm level. In particular, using the portfolio theory framework, concepts of business risk, financial risk, and risk balancing, they assess the possible responses in financial
structure to changes in a firm's operating environment and to the investor's risk attitudes. Their results show important linkages between theory and practice in financial responses to risk and provide general guidelines for implementing portfolio adjustments.

**Liquidity and Financial Reserves**

A study by Burghardt and Robison (1984) explains the application of a computer simulation model built to facilitate the examination of alternative risk-management strategies on agricultural firms' liquidity, financial stress, and investment management under uncertainty. Their model was designed to integrate financial strategies with production, marketing, and risk-management strategies of typical Midwest cash grain farms.

Chhikara (1988) developed a model based on the expected-utility paradigm to explain an agricultural firm's demand for cash and credit reserves (i.e., unused credit or borrowing power) as a response to risk. In general, he confirmed empirical support for the model when he tested it using data from Illinois farms. Chhikara found that liquidity value curves declined monotonically with debt levels, implying credit reserves quickly lost their liquidity value for financially stressed farms. Based on this result, credit reserves were of little use to distressed farms as a risk-management tool.

Finance theory suggests that increases in financial leverage raise the expected level and variability of returns on a firm's equity capital, provided the returns on assets exceed the cost of borrowing. Because risk attitudes (and expectations) may differ among farmers, it is plausible to expect a wide range of optimal financial structures. Gwin, Barry, and Ellinger (1982) derive risk-efficient growth plans and financial structures for representative cash grain farms under a broad set of sources of risk and various levels of risk aversion. Farm size, asset structure, and debt level are shown to change significantly with risk-aversion levels and are consistent with empirical observations. Farmers with low levels of risk aversion, or even risk neutrality, will prefer higher debt-to-asset ratios and achieve higher operations, faster financial growth, and larger expected incomes.

**Other "Within-Firm" Risk-Management Strategies**

Singer (1990) discusses reasons why managers may "smooth" income, i.e., engage in activities to reduce the fluctuation of their firms' reported net income. An important potential reason is that income-smoothing may improve the perception of the firm's risk by providers of external capital (e.g., equity investors and lenders). Singer develops a special mechanism for smoothing income available to commercial banks—namely, the provision for loan losses. The provision for loan losses is the amount banks charge against current earnings to build reserves aimed at absorbing future loan losses. He found significant evidence that rural as well as urban banks use the provision for loan losses to smooth income. This finding is important from a regulatory standpoint because using the provision to smooth income is at odds with the regulatory guidelines for commercial banks.

**Risk-Sharing Management Strategies**

**Insurance**

The Federal Insurance Act of 1980 authorized an expansion of the insurance program to become the primary form of disaster protection for farmers. Insurance may protect farmers from yield shortfalls and thereby stabilize income and provide liquidity when crop losses occur.

Leatham, Richardson, and McCarl (1985) evaluated a producer's choice of crop insurance and investigated the implications of this choice on the lender's performance.
The authors found crop insurance favors producers with higher levels of yield variability. The choice of crop insurance by producers depends principally on their expected insurance loss ratio and risk aversion.

Federal subsidies to crop insurance products have increased, thereby lowering premiums paid by farmers for insurance products. These changes were made with the goal of improving the attractiveness of crop insurance to farmers. Little direct evidence exists concerning the effects of crop insurance use on crop revenue risk, and still less work examines the relative performance across alternative insurance products (e.g., types and coverage levels) and across different yield risk conditions.

Schnitkey, Sherrock, and Irwin (2002) investigate the risk implications of a wide range of crop insurance products in actual farm contexts. Risk implications are analyzed by comparing gross revenue distributions without crop insurance to gross revenue distributions resulting from the inclusion of different crop insurance products. Findings indicate the group policies often result in average payments exceeding their premium costs. Individual revenue products reduce risk in the tails more than group policies, but result in greater reductions in mean revenues. Rankings based on certainty equivalent returns and low frequency VaR (value-at-risk) generally favor revenue products. As expected, crop insurance is associated with greater relative risk reduction in locations with greater underlying yield variability.

The costs and benefits from using crop insurance may differ based on the design of the instrument chosen by the producer. Wang et al. (1997) study the relative performance of individual-yield and area-yield crop insurance programs. Performance is measured by farmers’ participation rates and farmer welfare in an expected utility framework. Using a portfolio setting (producers have a variety of risk-management instruments including options, futures, government payments, and crop insurance), Wang et al. found that an insurance contract based on an area yield index is less expensive to implement and may have more attractive premiums than a contract based on an individual farm yield index.

An important aspect of insurance (and of other risk-management strategies as well) is that its use by a firm makes the firm more attractive to potential external providers of capital (e.g., lenders and external investors). In this regard, financial adversities experienced by the farm sector in the 1980s highlighted the close relationship between farm borrowers and lenders. It became very clear that both parties had a significant stake in actions which influenced the profitability, liquidity, and risk position of farm businesses. Plüger and Barry (1985) analyzed the relationship between farmers’ use of crop insurance and the cost and availability of credit from their major non-real estate lenders. Based on survey data and on the results from a simulation model, the authors found that, at least from the lenders’ viewpoint, the use of crop insurance by a farm could reduce its business risk enough to allow higher financial risk arising from the greater amount of credit made available to borrowers. Plüger and Barry concluded crop insurance may have considerable merit when combined with other management or policy actions that reduce indebtedness or increase revenues for highly leveraged, low-equity crop farms.

More recently, See, Leatham, and Mitchell (2003) used a principal-agent model to determine an external investor’s preference for crop insurance and the farmer’s production decisions. The authors further determined the optimal risk-sharing between the investor and farmers with crop insurance and external financing.

**Hedging with Contracts Traded in Derivatives Markets**

Because of the farm crisis that took place in the United States in the early to mid-1980s, much of the attention at the...
time focused on the financial situation of farms and the lending sector. Government, researchers, and policy makers were interested in finding ways to reduce the burden of debt owed by farmers and bankers. Financial management became a very important issue, and along with it the tools to manage financial risk. The September 1984 meeting of Committee N-161 was dedicated to financial futures and options and their potential use in agriculture. Lima (1984) reported a rise in financial risk, through more borrowed funds and macroeconomic factors, during the early to mid-1980s. The author outlined several policy instruments affecting interest rate variability and parties who were affected by increased interest rate variability. Lima proposed interest rate futures and options as an effective mechanism for lenders and borrowers to offset their interest rate risk.

Solverson and Herr (1984) presented a development of futures markets and explained the basic terminology used by traders—especially those trading financial futures. Heffernan and Lee (1984) outlined hedging strategies for Farm Credit System lenders. The authors described and analyzed the debt management program and then compared two hedging strategies. Solverson and Herr found interest rate hedging would allow the Farm Credit System banks and associations to broaden their range of services beyond the dominant variable rate loan. By hedging a portion of the debt portfolio, the Farm Credit System could offer borrowers fixed rates for at least some specified time period.

Drabentzott and McDonley (1984) discussed the issues surrounding the use of financial futures by agricultural banks in the early 1980s. They also reported data on the use of financial futures by agricultural banks obtained from a survey. The authors pointed out that agricultural banks were slower to incorporate futures into their risk-management strategies than urban lenders. Financial futures were found to be most effective when incorporated into a well-planned asset/liability management strategy. Based on their survey results, not many agricultural banks were using financial futures, but financial futures were effective tools to deal with interest rate risk. The survey also revealed that large banks were more likely to use financial futures, and small banks lacked expertise to become involved in financial futures.

Commercial banks have always encountered risks in their normal course of business. However, when interest rates are volatile (as they were in the early 1980s), there is an increased risk of mismatching interest-sensitive assets and liabilities. Drabentzott and McDonley (1984) employed an economic model of a rural bank to demonstrate the importance of hedging on bank performance. Findings showed that hedging the cost of borrowing when rates are rising enables banks to increase overall portfolio size and significantly raise earnings.

The use of derivatives by lending institutions was the focus of a study by Yang and Leatham (1990). They reviewed the use of interest rate derivatives by major lenders to agriculture, more specifically commercial banks, thrift institutions, and life insurance companies. They also discussed the benefits and risks of using financial derivatives by such institutions.

Hedging in financial futures markets can offset the dollar loss on the loan additional interest cost due to rising rates with a gain in the futures market. Leack and Leuthold (1984) examined the use of hedging by grain elevators on variable rate debt and concluded grain elevator managers could reduce interest rate risk and the cost of debt by hedging borrowed debt in the financial futures market. Further, the authors found that hedging costs were usually greater for private grain elevators than for cooperative elevators because the cost of debt for the former was reflected by the prime rate and was more volatile than for cooperatives.
Financial futures are useful for hedging situations in which there is asymmetry of gains and losses. In the case of asymmetrical gains and losses, a conventional futures market hedge may only reverse the symmetry. Thus, risk would not be reduced efficiently, if at all. A potentially useful risk-management tool applicable to these cases is call options. Leatham and Baker (1984) discussed methods of using financial options by providing background information about options on financial futures and then illustrating a hypothetical hedging situation. The authors suggested that call options would serve banks and lenders better for fixed-rate loans.

Farmers' use of futures and options to hedge growing and stored crops can reduce price risk and decrease the variance on the returns to equity. Turvey and Baker (1988) argued that data from Ontario farms do not support the expected behavior of risk-averse farmers, as only 11% of farms used hedging. The authors examined alternative motivations, especially the liquidity motive, to farmers' use of hedging strategies. They found a direct correlation between relative risk aversion and hedging, and an inverse relationship between credit reserves and hedging. Results of their study supported their hypothesis that liquidity may be a motivation for farmers' use of futures and hedging.

Turvey and Nayak (1987) explored the relationship between hedging with futures and farm capital structure. They estimated a simultaneous hedging model for price, yield, and foreign exchange. In particular, they investigated the impact of the hedging decisions of a Canadian firm using U.S.-based price and yield futures on farm business, financial, and total risks. The authors developed a risk-minimizing hedge ratio for the joint hedging decisions, and concluded that jointly hedging price and yield can reduce revenue risk more than hedging only with price futures. Turvey and Nayak envisioned the possibility that revenue hedge insurance/assurance programs provided by the government, or crop insurance, could be marketed publicly or privately, could be marketed through effective hedging in Canada and the United States.

Yields and revenues obtained by crop producers have both systemic (thought and price drop) and poolable (localized yield shortfall) risks. Farmers cannot hedge the poolable or localized sources of revenue risk on speculative markets, and insurance companies will not accept risk which has a systemic component. As a result, a hybrid mechanism has evolved in U.S. crop insurance markets wherein the federal government agrees to accept the systemic risk so that private insurance companies will sell crop and revenue insurance to producers.

Mason, Hayes, and Lence (2001) estimated the total risk absorbed by the U.S. crop insurance industry and separated it into poolable and systemic components. They then used option pricing theory to value the reinsurance provided by the federal government when it absorbs this systemic risk. The authors also examined the possibility of using speculative markets in prices and yields to hedge the systemic risk accepted by the government. They concluded that risk reduction achievable by hedging is appreciable, but use of derivative contracts alone is clearly no panacea.

Production and Marketing Contracts

A study byDodson (1998) focused on the potential implications of production contracts for risk management. He concluded the risk-return tradeoff for the contracted commodity is likely to be a major determinant of the use of contracts by farmers. For commodities like processed fruits, vegetables, and some specialty crops, Dodson argued that farmers engaged in contract output may not only be able to reduce their risks but also increase their profit margins. In contrast, for other farms such as those...
engaged in hog production, contracts may only provide a means to reduce risk.

Dodson's conclusions were based on his finding that crop farms with contracts were larger, had more equity, and enjoyed higher returns than crop farms without contracts, whereas poultry and hog farms with contracts had less equity, higher debt levels, and exhibited more financial stress than poultry and hog farms without contracts.

**Leasing Inputs**

The effects of interest rate volatility and tax regulations on the choice between lease and ownership of farm machinery was investigated by Pederson (1984) by means of a simulation model. Purchasing was found to weakly dominate leasing for risk-averse farmers in many scenarios, and leasing was the most risk-efficient choice for risk-prefering farmers.

However, Pederson cautioned that results were quite sensitive to the future dynamics of interest rates.

In times of financial crisis in agriculture, greater emphasis has been placed on measuring farm financial performance. In much of the literature, the debt-to-asset ratio is used as an indicator of financial stress. Ellinger and Barry (1987) point out that tenure has significant implications for performance. Tenure is important because a considerable amount of land is operated by farms under various types of leasing arrangements. The authors evaluated the effects of farmers' tenure position on two key performance measures—profitability and solvency. Their findings reveal that higher land ownership is associated with lower accounting rates of return and lower leverage positions. As tenancy increases, rates of return on assets and leverage positions are consistently higher. Further, as tenancy increases, farm size as measured by acres also increases.

Leasing land for agricultural production is another way to reduce risk (Barry, Escalante, and Moss, 2002). The long-standing practice of share leasing farmland is increasingly giving way to cash leasing and to combinations of cash and share leasing (Reiss, 1984). The drivers of change primarily involve risk, income, managerial control, and land values issues facing farmers, landowners, and professional farm managers who represent landowners (Sotomayor, Ellinger, and Barry, 2000).

Barry, Escalante, and Moss (2002) conceptualized the risk-adjusted valuation of cash versus share leases for farmers and landowners, and tested their model using farm-level data from Illinois. In particular, the authors empirically determined how rental spreads between cash and share leases are related to risks and other farm characteristics. They concluded that non-risk factors are likely to be the primary determinants of the magnitude and sign of the rental spread, and point out that high cash rents may be a hedging strategy to control additional leased acreage and thus expand farm size.

**External Equity**

Advantages and disadvantages of resorting to external equity as a means to reduce risks and/or increasing capital were addressed by Lowenberg-DeBoer et al. (1987). Overall, they argued that external equity was not likely to be an economically viable strategy, because of its relatively high transaction costs and the potential distortion of management incentives. However, they stress that their conclusions were limited by the small amount of research available regarding usage of external equity by farms, and by proprietary firms in general. Their study concluded with a long list of topics of relevance for future research in the area.

**Off-Farm Income and Investments**

Deregulation of financial markets in the late 1980s provided farmers with new opportunities to diversify their investments into off-farm financial assets. However, survey data on South Dakota farmers, collected and analyzed by Gustafson and
Mishra (1992) in the early 1990s, revealed respondents had not taken advantage of the new investment opportunities. Most of the respondents' investments were concentrated in local savings accounts, checking accounts, and farm real estate. Few farmers held investments outside of the state, or held mutual funds, government securities, and common stocks. Respondents were primarily concerned with the yield and safety of financial assets, and stated that coping with emergencies and retirement were their main reasons for investment.

Financial responses to risk may include transferring risk outside the business—such as investing in nonfarm financial assets. By holding a portfolio of farm and nonfarm assets, farm households can diversify risk (Mishra and Morehart, 2001). Using national farm-level data from the U.S. Department of Agriculture, Mishra and Morehart investigated the factors affecting off-farm investment of farm households. They found operator's age, educational level, off-farm income, farm size, and household net worth were positively related to off-farm investment decisions. Further, increased on-farm diversification and higher debt-to-asset ratio reduced the likelihood of off-farm investment.

Mocke, Bohlje, and Pederson (1990) employed historical data for 1965-1988 together with stochastic dominance analysis to investigate pre-retirement investment strategies for farmers, and off-farm investments in particular. Based on their results, almost all risk-averse farmers would favor a diversified portfolio over any single real or financial asset, but dominant portfolios typically involved just two or three assets.

Schmitzke and Lee (1995) reported that farmland accounted for a substantial proportion of the assets held by Ohio farmers in the early 1990s. They used historical data in a mean-variance portfolio framework to demonstrate that diversifying investments into off-farm financial assets (e.g., stocks and bonds) may allow farmers to achieve a better combination of expected return and variance of returns than portfolios comprised mostly of farmland.

Betbuzia and Leatham (1990) also focused on agricultural firms' potential gains from diversifying into off-farm financial assets. Unlike Schmitzke and Lee, they looked at the dynamics of accumulating financial assets and at the implications of off-farm diversification on the firm's liquidity, leverage, and tenure. According to the results from their model, diversification into mutual funds would make farmers better off.

The results obtained by Schmitzke and Lee (1995), and Betbuzia and Leatham (1990) were consistent with the findings reported by Lira, Kowalski, and Hoffman (1991). Based on the growing interest of institutional investors in farmland as a means to diversify their portfolios, Lira, Kowalski, and Hoffman assessed the diversification potential of farmland for portfolios dominated by U.S. stocks and bonds. Using historical data for 1970-1990 together with a mean-variance approach, farmland was found to offer good diversification potential for investors who held U.S. stocks and bonds. Further, their results showed that diversifying into farmland allowed investors to achieve gains similar to those obtained by investing in foreign stocks.

Mishra and Morehart (2000) noted farmers may use off-farm investments to manage risks, as such investments may help in stabilizing income and providing for retirement and unexpected personal (e.g., health) expenditures. They reported that the ratio of off-farm investments to total assets for U.S. farm households increased from 18% in 1992 to 31% in 1999, showing off-farm investments are an important component of the investment portfolio of U.S. farm households. Specifically, the largest share of U.S. farmers' off-farm investments corresponds to retirement accounts, followed by stocks and mutual funds. Mishra and Morehart found that
off-farm investments tended to be higher for younger and more educated farmers, for farm households with greater off-farm income and total household income, for small and diversified farms, and for farms with lower debt-to-asset ratios.

Risk Management Tools and Financial Performance

The 1996 Federal Agriculture Improvement and Reform (FAIR) Act shifted the dairy industry toward a more market-oriented pricing structure, with more input and output risk transferred back to dairy producers. Britica, Stiles, and Weaver (1999) investigated the use of Multiple Peril Crop Insurance (MPCI), Income Protection (IP), and Group Risk Plan (GRP) insurance risk management strategies on the financial performance of dairy farms in Pennsylvania. Results of the study indicated risk management tended to marginally lower some measures of financial performance for dairies farms. This was especially true for production hedging, largely due to the more frequent resetting of hedges.

Agricultural Lenders and Risk Management

According to Collins and Barry (1986), loss sharing among Farm Credit System districts creates a free-rider problem. They provided a framework to argue that a central entity could evaluate the riskiness of each district and adjust the cost of funds to each district so as to reflect its corresponding external costs. In this manner, costs of funds would be internalized and the free-rider problem would be eliminated. Collins and Barry also explained ways to determine risk premiums. They suggested that the calculation of the cost of funds which internalize the external costs of risk management for each district and create an actuarially neutral "insurance" fund hinged on the probability density function (pdf) of the rate of return on assets. Collins and Barry pointed out that implementation of their instrument required the estimation of the pdfs, and challenged future researchers to undertake this task.

In the mid-1980s, deregulation of interest rates, inflation and deflation, and agricultural recessions combined to destabilize the earnings of commercial banks. In response to this volatile financial environment, bankers employed various portfolio adjustments and assets and liability management strategies to reduce risk exposure and stabilize profits. The net interest margin (gross interest income less gross interest expense) conveys information on the bank management's effectiveness in allocating funds and controlling expenses.

Pederson, Pokharel and Cone (1986) examined the variability of bank interest income and how it related to bank management and portfolio characteristics. Banks with higher expected net interest margins were also found to exhibit greater systematic net interest income variability. Rao, Pederson, and Boelje (1991) constructed an econometric model of bank investment and funding, and used it to simulate optimal asset-liability management decisions by means of a stochastic control program. When comparing the historical asset and liability decisions made by the Farm Credit Banks with the optimal decisions calculated from their model, the authors found that the former led to faster growth of assets and liabilities than the latter.

Belanga and Gilbert (1989) used data from agricultural banks for 1984-1988 to assess whether banks that failed over this period did so because of their risk-management strategies. They concluded failed banks were exposed to more risks than surviving banks, supporting the hypothesis that vulnerability to failure reflected management portfolio decisions.
Issues for Future Research

As demonstrated by the preceding review, the Regional Research Committee for Financing Agriculture in a Changing Environment, Macro, Market, Policy, and Management Issues (and its predecessors) have devoted significant efforts toward analyzing risk-management strategies in agriculture, and valuable insights have been obtained as a result. However, this area of inquiry is quite rich and there are important issues yet to be investigated. Our knowledge of risk management in agriculture has the potential to be greatly enhanced by future research in the following areas of inquiry, among others:

- **Contract Production.** Production under contract has emerged as the dominant production arrangement in the hog sector. There is little knowledge regarding the implications of contract production on risk management by both contractors and producers. Future research should explore the implications of contracting for lenders as well.

- **Recent Risk Management Tools.** For example, farmers now have available a large menu of novel insurance products designed by the Risk Management Agency (RMA) (e.g., GRIP, revenue insurance, income protection, whole farm insurance). Efforts are needed to assess the impact of these risk management tools on the financial performance of farms, and on the risk-management strategies of lenders.

- **Investment Risks Associated with Contract Production.** Investment in new farm infrastructure (e.g., new buildings and equipment) has been spurred by production contracts. Future studies should analyze the extent of the risk associated with such investments on the face of changes in contract specifications.

- **Forward Covering of Inputs.** Forward contracting of factors of production is a growing activity between the suppliers of inputs and the farmers who use them. Forward contracting inputs could aid planning and allow farmers to diversify purchases over time. Forward contracting of inputs also guarantees participating farmers an assured supply of inputs at a specified price. Studies should be conducted to evaluate the effects of this practice on the financial performance of farm businesses.

- **Reductions in Government Support.** Future farm bills are likely to include provisions to reduce government support of the farm sector, thereby significantly altering the risk management environment faced by farmers. Studies assessing the impact of payment limitations on farm performance, asset values (land values in particular), and economic well-being of farms and farm households should prove to be valuable contributions.

- **Risk Management Tools for Livestock Farms.** In recent years, the RMA has developed risk-management tools specifically designed to manage risks of livestock farms. For example, in 2003, the RMA introduced Livestock Price Insurance (LPI). Studies evaluating the use of LPI and its impact on the financial performance of livestock farms are warranted.

- **New Hazards.** Mad cow disease, bluetongue, and avian flu are prominent examples of risks faced by agricultural producers which were unheard of just a few years ago. A thorough examination of the tools available to manage such risks and their impact on the financial performance of agribusinesses and lenders seems necessary.

- **Enhanced Producer Flexibility.** The 1996 Farm Act gave farmers greater flexibility to choose among crops to be produced. Studies are needed to investigate how this legislation has affected risk-management decisions at the farm level.
New Technologies. New technologies may have an important impact on risk management. For example, cross-pollination of non-genetically modified (non-GM) crops with GM crops may greatly reduce the value of the former. Studies should be conducted to investigate whether recently introduced technologies have affected existing risk-management practices, and whether new risk-management tools need to be developed to cope with the new risks involved.

Off-Farm Income and Investment. Off-farm income and investment have exhibited a positive trend over time. However, the amount of research devoted to them has not been commensurate with their relative importance. Studies focusing on the development of a greater understanding of off-farm income and investment patterns and opportunities should prove valuable.

Production Practices and Risk-Management Tools. Some production practices (e.g., integrated pest management) may provide effective ways to manage risks, whereas other practices may require a careful choice of risk-management tools to be attractive. Competition versus complementarities in the use of production practices and financial instruments to manage risks clearly is an area worthy of research efforts in the future.

In summary, risk is a critical characteristic of production agriculture, and farms, agribusinesses, and lenders are all substantially exposed to various types of risks. Consequently, it is not surprising that substantial resources have been devoted to research regarding risk-management issues. The present study surveys the significant body of research on the topic generated by the Regional Research Committee for Financing Agriculture in a Changing Environment: Macro, Market, Policy, and Management Issues, and its predecessors.

For this purpose, risk management strategies are classified into two main categories—"within-firm" strategies and "risk-sharing" strategies. Given the literature examined here and the recent developments that have occurred in the U.S. agricultural sector, the present study identifies a number of research topics worthy of attention for future research in the field. The hope is that such research endeavors will be as productive as the previous efforts reported here have proven to be.

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