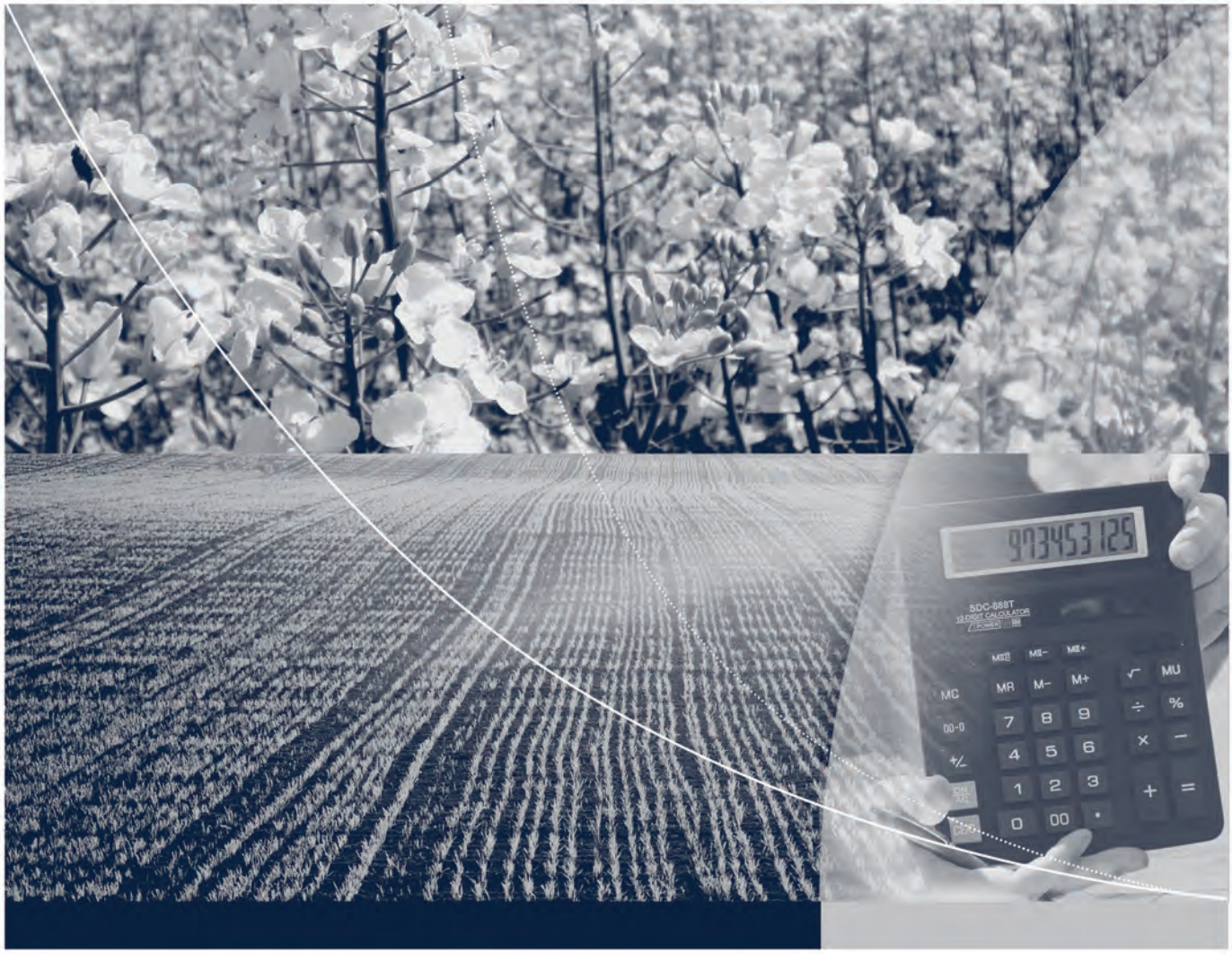
CREDIT AND INSURANCE

Manual 4

WORLD BANK GROUP



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IN PARTNERSHIP WITH DONORS

WORLD BANK GROUP

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Preface and Acknowledgements

Five manuals were prepared by IFC for the development of agri-insurance markets where the public and private sectors work together in a partnership (PPP). The manuals are designed to strengthen the capacity of the government and market players to effectively design agri-insurance products, both traditional indemnity and index, introduce them to the market, and build sales. The manuals are designed to be succinct yet at the same time sufficient to create the technical and administrative foundation for a modern agri-insurance system, and to allow programs in early stages of development to properly plan the required system. Finally the manuals are designed to train practitioners, to build local capacity for skills that are required to start the program, and to enable the program to grow over time.

The principle author of the manuals is Professor Myles Watts, University Professor, Lead Actuary at Watts & Associates, Member of the Board at the Federal Agricultural Mortgage Corporation, and 5th Generation Montana Farmer. Watts and Associates designed and launched numerable agri-insurance products in North America, frequently consults for the major reinsurers, and supports insurance programs around the world. They have established their own index insurance company, eWeatherRisk. The manuals incorporate practical lessons learned over the past 40 years.

The development of the manuals was a joint activity of the Ukraine Agri-Insurance Project (2007-2015), IFC's Global Agri-Finance Team, and the Global Index Insurance Facility (GIIF) (2009 to present). Dr. Gary Reusche led the Ukrainian project, served as a technical specialist on the global agri-finance team, and as a member of the GIIF technical committee and core management team. Agri-insurance development is closely linked to agricultural finance and value chains and they are effectively developed in unison.

The manuals result from training workshops developed by the agri-insurance project in Ukraine and globally by GIIF technical experts. The entire agri-insurance team in Ukraine made practical contributions to the manuals, with special recognition due to Victoria Yakubovich for collecting, organizing and preparing the initial drafts and Andrey Zaripov a member of the GIIF team for helping to develop the reinsurance and cash flow models. The project team included experts from the Alberta (Canada) provincial agri-insurance program, in particular Richard McConnell, who contributed his experience and expertise to the training activities.

Peer review and Spanish language translations of the manual resulted from IBRD consultants in Central and South America, especially Pablo R. Valdivia Zelaya and Roberto Dario Bacchini.

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Finally support for the manuals was provided by the Canadian government, and the Global Index Insurance Facility (GIIF) lead by Gilles Jacques Galludec (Program Manager) funded by the European Union, Japan and the Netherlands.

Acronyms

IFC – International Finance Corporation

IIARM – International Institute for Agricultural Risk Management

DFATD – Foreign Affairs, Trade and Development Canada

CDI – Credit Default Insurance

GATT – General Agreement on Tariffs and Trade

GIIF – Global Index Insurance Facility

IBRD – International Bank for Reconstruction and Development

LGD – Loss-Given Default

MFI – Micro-Finance Institution

NPL – Non-Performing Loans

ROE – Returns on Equity

SFSA – Syngenta Foundation for Sustainable Agriculture

UAP – Unidentified Aerospace Phenomena

WTO – World Trade Organization

1.0. Introduction

Agricultural production is inherently subject to a variety of risks because management decisions or states-of-nature often generate future outcomes (either favorable or unfavorable) that cannot be predicted with certainty. The variability of these outcomes represents risk. Risk is frequently measured in terms of the probability of various outcomes.

Agricultural producers face a variety of risks including production (yield), output price, and input price risk. Some of these risks are managed through production and financial decision-making, while others are simply accepted as costs of doing business. Some risks can be managed thorough a variety of contractual and insurance-related products.

Agricultural production risks ultimately impact the financial viability and sustainability of farms and ranches. Agricultural production is often coincident with high short-term credit risk because of the combination of high fixed costs, weather and disease variability, and variations in cash receipts. In an average year, annual net farm revenues may be sufficient for agricultural producers to meet principal and interest payments on debt and realize profits, but across-year revenue variability may cause farm businesses to fail because of periodic inabilities to service debt obligations. Whether an agricultural producer self-insures or uses formal mechanisms for transferring risk to others, risk is a cost that must be effectively managed.

Managing risk is particularly important for agricultural producers in developing economies. For example, social unrest in many developing countries is often associated with low agricultural production and incomes — especially for subsistence farmers. In addition, many developing countries depend on healthy farm economies to generate economic activity through agricultural exports. Furthermore, many social issues are exacerbated by rural emigration to urban regions. This migration increases in years of low farm production and farm business failures. Finally, many rural areas would benefit from the adoption of modern technologies, but time and financial resources are often needed to learn and adopt new technologies. Variable income levels reduce the adoption of risky new technologies, even if these technologies would improve long-term producer and societal well-being.

A perfect risk management situation occurs when a party pays an actuarially sound amount to another that perfectly offset the impacts of adverse events. That is, if the transaction costs of risk management instruments (e.g., insurance premiums, interest rate risk premiums) are zero, then the benefits received from the instrument triggered by adverse events would perfectly offset the costs of the instrument. In the long run, transaction costs — such as underwriting, monitoring, collateralization, contracting, foreclosure, loss adjusting, financial business operations costs, etc. — represent the costs of risk when they are incorporated into insurance premiums or interest rates. In practice, perfect risk management is unattainable because of transaction costs, market imperfections, uncertainty surrounding risky events, moral hazard, adverse selection, fraud, and the pragmatic aspects of contractually describing all possible risky outcomes.

Although a variety of approaches exist for managing risk, each involves transaction costs and risk premiums that must be paid by the party that is trying to mitigate risk to those who are willing to accept added risk. Transaction costs and risk premiums can be incorporated into: (1) interest rates, (2) insurance, and (3) other instruments. These approaches can be viewed as "options." Options are financial instruments that contractually specify the events that trigger offsetting payments.

1.1 Interest Rates and Risk

Farm expenses represent cash outflows that, in general, occur throughout a year and (in large part) prior to the receipt of cash inflows. Cash inflows usually occur much less frequently and are often associated with harvest seasons. The difference in cash flow timing and seasonality often causes farmers to use operating lines of credit to meet cash needs throughout a year. In addition, because many agricultural production assets require large initial outlays that are expected to yield benefits over many years, intermediate-term financing is often used to acquire breeding livestock, machinery, and buildings. The purchase of agricultural land often requires long-term financing.

At the time many production expenditures are incurred, production and market outcomes are often uncertain. As a result, poor crop outcomes or low market prices can result in loan defaults. The risk of such defaults can be incorporated into interest rates on operating and intermediate-term loans and mortgages.

The advantage of incorporating risk premiums into interest rates (rather than other instruments) is that the transaction costs for doing so are reduced because only two parties (a borrower and a lender) are involved. The costs of risk transfer increase as additional entities are included. For example, a third party (e.g., insurance company, brokerage firm) requires substantial information regarding borrower risks, thereby increasing total transaction costs.

Nonetheless, including risk premiums in interest rates can be problematic. For example, higher interest rates increase the probability of loan defaults and, often, the termination of a farm business. This results in the repossession of collateral, which is costly and highly disruptive to both individuals and communities. In developing economies, such outcomes often exacerbate undesirable migration from rural communities to urban communities. Finally, risk-appropriate interest rates on high-risk agricultural loans can exceed usury laws in some countries and reduce investments in production agriculture.

1.2. Insurance

Using interest rates to compensate lenders for high credit risk increases interest payments, reduces farm profitability and repayment capacities, and hampers investment in production-expanding technologies. Coupled with the probability of crop failures, interest rates on agricultural operating, intermediate assets, and real estate loans increase with credit risk.

The availability and use of agricultural insurance reduces credit risk, lowers interest rates, improves repayment capacities, increases credit availability, and reduces financial and business risk. If an insured peril occurs, an indemnity is paid to the producer and the farm business can continue within the confines of normal business operations. In the absence of insurance, a peril may cause loan defaults. In this case, normal business operations cannot continue, as collateral repossession actions are often triggered. Insurance indemnities are normal business procedures, while loan defaults represent business disruptions for farm business and lenders.

Crop insurance costs, however, can also be substantial. For example, crop insurance is subject to relatively high monitoring and rating costs, must account for temporal and spatial commodity price differences, requires large amounts of high-quality data to establish actuarially sound premium rates, and is subject to moral hazard and adverse selection problems.

1.2.1. Yield Insurance. Individual yield-based insurance product indemnities are triggered when individual farm yields decline below a trigger level. Indemnities are based on the difference between trigger yields and actual yields. In some cases, more than one peril may be insured, but each must be specified in an insurance contract.

Insurers often offer a range of coverage levels. By selecting a coverage level, a farmer is simultaneously selecting a deductible loss level. The indemnity trigger yield is the coverage level multiplied by expected yield. As coverage levels increase, the likelihood of receiving an indemnity payment also increases. Consequently, premium rates are higher for higher coverage (i.e., lower deductible) levels.

An indemnity is paid when actual yield is less than the indemnity trigger yield. This difference is multiplied by a pre-established per unit price to determine a per acre indemnity. The price used to value crop losses is critical for both insurers and farmers. Insurance providers determine a per unit price at which producers may value their insurable losses. This price is identified in insurance contracts and is based on expected harvest prices at the time a contract is purchased.

Several basic principles are used to establish premium rates. Pure risk premium rates are established for each coverage level and are equal to the pure risk premium rate plus any load factors. The pure risk rate is calculated by dividing expected indemnities by the product of the trigger yield and a predetermined crop price. Load factors represent transaction costs involved in servicing crop insurance contracts. These include any additional risks associated with uncertainty, poorly enforced property rights, moral hazard, adverse selection, or fraud.

1.2.2. Price Insurance. Price insurance is not widely used and, where offered, participation rates are quite low. Its primary application is in the U.S. livestock industry. Price insurance requires a producer to identify the livestock to be insured and the period of insurance coverage. The insured period begins when a producer buys insurance and ends when livestock are expected to be sold. When the contract is purchased, the expected end-of-contract sale price is identified (usually using livestock futures market prices). A producer selects a price coverage level (a percentage of the expected price), which becomes the indemnity trigger price. If livestock prices at the end of the contract are lower than the trigger price selected by the farmer, the farmer receives an indemnity.

Service costs for price insurance are relatively low, and livestock producers receive protection against the risk of low prices. Price insurance does not insure against morbidity, mortality, or production losses. In addition, insurers have to verify cattle ownership, which can be costly.

1.2.3. Revenue Insurance. Revenue insurance products generally insure against declines in per hectare revenues (i.e., commodity price multiplied by yield) rather than simply per hectare yields. Many of the basic elements of yield insurance are also relevant for individual revenue insurance products. Expected yields are established in the same manner as with yield insurance. Insurers specify an expected harvest price when contracts are purchased.

Expected revenue per hectare is equal to expected yield multiplied by the expected harvest price established in the contract. Producers select a coverage level (a percentage of the expected revenue), typically between 50% and 85%. A producer's per hectare revenue indemnity trigger is equal to expected revenues per hectare multiplied by the coverage level.

At harvest, loss adjustors determine yield losses and insurance providers use a pre-specified method to determine the harvest price for calculating indemnities. Harvest price is often determined using a nationally-published source at the time of harvest rather than the price an individual producer actually receives for a crop. This may differ from the expected harvest price specified in the initial insurance contract. Revenue per hectare is calculated by multiplying actual yields by the specified harvest price.

Because higher coverage levels result in higher expected indemnities, pure risk premium rates are established for each coverage level. Premium rates for each coverage level are equal to the pure premium risk rate plus any loading factors.

1.2.4. Income or Credit Default Insurance. Credit default insurance contracts transfer credit risk between two entities. Credit default insurance is similar to other types of insurance in that it provides a lender (who often owns the underlying credit risk) with protection against default by a borrower. The credit default insurer assumes risk that a lender does not wish to retain in exchange for a fee that is similar to an insurance premium.

The insurer pays the lender an indemnity if a negative credit event occurs. In this case, the insurer who sold the credit protection and has assumed the credit risk must deliver any deficient principal and interest payments covered by the contract to the lender. If a negative credit event does not occur (i.e., the borrower meets all repayment obligations), the insurer retains the credit insurance premium and incurs no financial outlay.

Credit default insurance is a hedge or insurance against the default of a loan. An individual or company that has exposure to credit risk can shift that risk to others by purchasing credit default insurance. This may be preferable to selling the security or loan if an investor simply wants to reduce, rather than eliminate, risk exposure.

The principal concern with this approach is that the loan originator often retains the servicing aspects of the loan under consideration. Because a credit default insurer is not involved in servicing the loan, the insurer has less incentive to reduce default parameters and losses in the case of loan defaults. In practice, credit default insurance is not often used in agricultural lending because of high transaction costs and potential for moral hazard. Conversely, such contracts are frequently used for high loan-to-value home loans in developed countries. The additional cost of credit default insurance to the lender (i.e., the transaction costs of buying credit insurance) will be reflected in interest rates paid by borrowers.

1.3. Other Risk Management Instruments

In addition to risk-adjusted interest rates and crop insurance products, a variety of formal and informal risk management instruments exist. For example, forward contracts, formal futures markets, and crop share, machinery, livestock, and land leases are also used to manage risk. Less formal mechanisms such as diversification strategies, off-farm income, and legal business structures can also be used to mitigate risk.

1.3.1. Forward Contracts. The forward contracting of crop or livestock sales is a mechanism for managing both price risk and access to markets. In most cases, forward contracts stipulate specific prices to be paid upon delivery of a commodity and are legally enforceable. In addition to quantities to be delivered, contracts often include a variety of quality specifications.

Producers often forward contract agricultural inputs when input prices are considered relatively low. These contracts specify quantities, prices, and timing of input deliveries.

Although forward contracting can be used to mitigate some types of risk, they do not reduce production risk and can actually add risk. For example, if a forward-production contract does not stipulate an "Act of God" clause, then a producer may be responsible for satisfying the delivery portion of the contract even if a weather event causes a crop failure. In such cases, producers may have to purchase the commodity from others to meet their delivery obligation.

1.3.2. Futures Markets. Formal commodity futures markets offer input and output price risk management opportunities. Much like forward contracting, commodity futures markets can be used to establish sales (or purchase) prices. Unlike forward contracting, however, basis risk (the difference between prices established at a formal commodity futures exchange and actual local prices) can alter net prices. Nonetheless, basis variability is generally much lower than the variability of commodity prices.

Formal agricultural futures markets exist throughout the world. In general, each specializes in specific crop and livestock products. Futures contracts allow agricultural producers to hedge crop, livestock, and input prices against future price changes. In the absence of basis variability, hedged positions result in the establishment of a price floor for output prices and a price ceiling for input prices net of basis risk.

In addition, many formal agricultural commodity exchanges also offer Options as a second risk management strategy. Put Options offer a type of price insurance by establishing a price floor (in exchange for a premium payment) without placing a limit on potential price increases. Call Options establish a price ceiling for input prices without limiting gains from potential price declines.

Credit worthiness is enhanced when agricultural producers reduce input and output price risk. Of course, such hedges against price variability are not without costs. Brokerage fees, interest on margin money, option premiums, and unexpected basis movements all represent costs of using futures and options markets.

Futures markets, however, are not highly useful in many developing economies because of a paucity of domestic markets which are needed to establish commodity prices and force the convergence of cash and futures market prices. Cross-hedging on foreign commodity markets often increases basis variability and introduces exchange-rate risk. Hence, price risk may actually be increased rather than reduced. Furthermore, crop revenue insurance products usually rely on futures markets for rating purposes and to establish harvest prices. As a result, revenue insurance products are often not viable in regions for which futures market prices are not highly correlated with local prices.

1.3.3. Crop Share Lease Arrangements. Crop share leases stipulate that landowners receive a portion of the sale of crops or livestock produced on their property in lieu of cash rental payments. In general, landowners also share a portion of operating expenses with lessors. Consequently, production, input price, and output price risk are shared between the two parties commensurate with crop share percentages. This arrangement reduces a lessor's operating capital needs and production risks, but landowners are more likely to be involved in management issues relative to cash lease situations.

1.3.4. Machinery, Livestock, and Land Leases. Leasing land, livestock, or equipment reduces liability, capital needs, and depreciation expenses. Lower fixed costs can allow for more nimble decision-making and reduce technical risk. However, leasing arrangements often reduce flexibility in terms of timeliness or management decisions and may also increase uncertainty with regard to long-term planning.

1.3.5. Diversification. Enterprise diversification is a risk management technique that combines less-than-perfectly correlated instruments into a portfolio. Such activities can reduce the variability of returns — sometimes without reducing average returns.

Many farmers produce a variety of crop and livestock products as a means of income diversification. Such actions often produce additional benefits such as improving soil characteristics, reducing weeds vectors, limiting insect infestations, and smoothing labor requirements.

The prices of many agricultural commodities, however, are often positively correlated which limits diversification benefits. In addition, individual producer yields tend to be positively correlated across crops. For these reasons, many agricultural producers diversify across livestock and crop enterprises. Nonetheless, diversification advantages can be offset by the loss of gains obtained from specialization. This is especially true if diversification requires that new skill sets and equipment be developed or acquired.

1.3.6. Business Structures. Legal organizational structures of farm businesses can also help mitigate risk. For example, various corporate forms of legal business organization (including limited liability corporations) can insulate personal assets from business assets. Hence, while loan default on a farm business may lead to the loss of business collateral, personal assets can be protected if they are titled separately from farm business assets.

2.0. The Role of Agricultural Insurance

Agricultural insurance can reduce credit risk, increase repayment capacity, and mitigate adverse weather and price outcomes associated with agricultural production. Although agricultural insurance programs are costly, they can improve producer access to credit, mitigate production risk, reduce the probability of farm business failures (bankruptcy), provide a support mechanism for agriculture that is generally palatable to governments and trading partners, and decrease incentives for rural-to-urban migration.

2.1. Credit Access

Agricultural insurance programs provide a substantial benefit to agricultural producers in terms of accessing credit. The seasonality of monetary inflows into most agricultural operations often dictates that farm business firms use operating lines of credit. In addition, purchasing capital assets often requires intermediate- and long-term financing. The costs associated with debt acquisition are highly influenced by risk. Crop insurance can be used to reduce yield risk, which is the principal risk concern of agricultural lenders. Reductions in production and revenue risk not only improve the ability for agricultural producers to acquire debt financing, they also reduce the transaction costs associated with high interest rates.

2.2. Risk Mitigation

Agricultural crop insurance mitigates the primary risk faced by agricultural producers. Consequently, producers are more likely to invest in technologies that have the potential to increase average returns over time, even if the variability of those returns may also be exacerbated. Mitigating risk also allows producers to specialize in producing crops for which they have the highest comparative advantage.

Comparative advantages can increase the output of agricultural production for regions and countries. That is, producers often diversify their production portfolio in the interest of mitigating risk outcomes. Furthermore, they often divide their management and labor activities between on-farm and off-farm income generation for the same reason. While such activities can be a wise use of labor, agriculture insurance is often a less expensive way of managing overall income risk and allows producers to focus on activities with the highest potential value.

2.3. Bankruptcy Avoidance

Credit providers can incorporate the riskiness of agricultural production debt financing into their calculations of risk-adjusted interest rates. The outcomes of higher interest rates on debt financing include reductions in debt repayment capacity and the amount of credit available to farm operations. Ultimately, reductions in debt repayment capacities result in higher bankruptcy rates and collateral acquisition by lenders. Bankruptcies are expensive because they generate substantial dispersion and asset transfer costs. Conversely, indemnity payments help avoid bankruptcy situations and represent normal, continuing business operations.

In addition to the personal distress caused by bankruptcy proceedings, other social factors can be adversely influenced by these individual actions. For example, crop failures are often regional in nature and can cause multiple loan defaults simultaneously within a single region. Therefore, placing substantial amounts of acquired property onto markets is likely to depress asset prices within any given region, which increases business risk for other agricultural producers.

In many economies, crop failures and associated bankruptcies may increase unwanted rural-to-urban migration. Such migration not only reduces agricultural output, but increases social problems and the need for additional infrastructure in urban communities.

2.4. Trade Compliance and Other Government Considerations

In many countries, a variety of government programs supports production agriculture. To maintain World Trade Organization (WTO) compliance, most of these programs in developed countries consist of direct payments to producers that are decoupled from actual production. Such payments increase producers' financial reserves. In addition, programs that provide minimum price supports or countercyclical payments for specific commodities reduce financial risk by reducing price variability. However, because they are often tied to actual production, such programs are less WTO-compliant.

Many countries provide *ad hoc* disaster aid programs that offset losses caused by catastrophic weather events. Disaster aid programs have some advantages over other types of support in that they are targeted to those who have actually suffered losses. However, *ad hoc* programs often generate substantial administrative costs because each new disaster may require new administrative and operational structures.

Agricultural support programs are heavily scrutinized for compliance with international trade agreements, including WTO/GATT (World Trade Organization/General Agreement on Tariffs and Trade) obligations. WTO trade agreements limit the amount of agricultural support by country. In general, safety net programs such as crop insurance or disaster programs are not trade-distorting and do not count toward support limits if they follow certain rules.

Governments play a variety of roles in crop insurance programs. They may develop and provide crop insurance products, reinsurance, stop-losses, or serve as regulators. In terms of regulation, government agencies often monitor the financial integrity of issuing agencies and reinsurers. Regulatory activity is particularly important for confirming that issuing agencies have sufficient cash reserves to cover their share of liability and that any remaining liability is the responsibility of groups with ample financial reserves.

Government agencies also enforce government subsidy policies and audit issuing agencies. Government agencies often transfer funds to private insurance companies to offset administrative expenses, confirm that issuing agencies are establishing actuarially sound premium rates, and enforce contracts through judicial systems or mediation. Governments desiring to provide safety nets for agricultural producers in the form of crop insurance usually provide premium subsidies. In addition, many countries encourage high participation in agriculture insurance to reduce the need for *ad hoc* disaster programs, which tend to be expensive and inefficient.

2.5. Social Structures

In general, the public policy objectives of agricultural insurance programs are used to reduce the year-to-year variability of individual farmers' incomes. When successful, this reduces the incidence of catastrophic financial losses that often result in farm bankruptcies. Agricultural insurance may also reduce government expenditures by limiting the need for expensive *ad hoc* disaster programs.

In addition to reducing the variability of farm income, other social issues are often cited as reasons for government involvement. For example, social unrest in many developing countries is often associated with low production and incomes – especially for subsistence farmers. In addition, many developing countries depend on a healthy farm economy to generate revenues through agricultural exports. Furthermore, many social issues are exacerbated by emigration from rural regions into urban areas. This migration increases in years of low farm production. Finally, many rural areas would benefit from adopting modern technologies, but it takes time and financial resources to adopt and learn new technologies. In the absence of income levels guaranteed by crop insurance, risky new technologies are seldom adopted, even if these technologies would improve producer well-being.

3.0. Roles of Lenders, Insurers, and Input Suppliers

Agricultural lenders, insurers, and input suppliers are important contributors to agricultural production systems. That is, each provides products and services used by agricultural producers to build successful farm businesses. However, the roles of each of these groups have evolved over time, so that input suppliers are increasingly providing credit and insurance services.

3.1. Evolving Relationships

Historically, input suppliers provided seed, chemicals, fertilizers, machinery, and other inputs to farm businesses in simple transactions that involved payment-in-full at the time of delivery. Although some exceptions have always existed, input suppliers have not generally provided credit or insurance services to agricultural producers. Recently, however, input suppliers are increasingly providing credit to producers by financing the sale of agricultural inputs.

These transactions can take the form of short-term loans in which discounts are provided for prompt cash payments, longer term payment schedules for which interest rates are explicitly specified as part of a repayment schedule, and machinery loans, which are often amortized over several years. In addition, several major input suppliers have begun to offer insurance services, as have some traditional lending institutions.

Input suppliers may even be better positioned to offer insurance to agricultural producers than traditional insurers. In some cases, agricultural insurance may not be the principal focus of insurance companies, even though they offer such products. Furthermore, lenders and other input suppliers may be better able to gauge the potential for moral hazard and adverse selection associated with specific producers because of knowledge gained through repeat customer transactions and on-farm observations. Such knowledge can reduce transaction and monitoring costs. Finally, many lenders and input suppliers are likely more knowledgeable about production agriculture and associated risks than insurers.

3.2. Potential Conflicts of Interest

Although input suppliers and lenders may have better knowledge about specific agricultural producers than insurers, those suppliers also often have vested interests in encouraging sales of agricultural inputs, financing, and insurance. That is, substantial conflicts of interest can occur when an input supplier profits from the sale of a product that is packaged with insurance. In addition, many input suppliers have incentives to encourage adoption of new technologies, especially if these are proprietary in nature. However, not all new technologies are equally valuable.

It is certainly possible for agricultural producers to become too attached to a single-source supplier of agricultural inputs or packaged products. Consequently, the benefits of lower insurance transaction costs gained by input supplier knowledge may be offset by "less-than-arms-length" transactions of associated agricultural inputs.

4.0. Relationship of Agricultural Credit to Agricultural Insurance

Those involved in subsistence agriculture are often relatively risk averse because crop failures may not only result in the loss of a farm business and livelihood, but also starvation. These producers often hesitate to adopt new, output-enhancing technologies because of associated increases in risky outcomes. This is especially the case for producers who have small cash reserves and limited off-farm income opportunities. Agricultural producers in developing economies are less likely to adopt new technologies for two reasons: (1) new technologies often involve debt financing, which increases business risk, and (2) new technologies may result in increased income variability, despite the fact that new technologies often result in increased farm income on average. An additional barrier to providing capital to small producers occurs because it is more costly to service small loans relative to large loans. Agricultural insurance can reduce those costs and improve the profitability of servicing small loans.

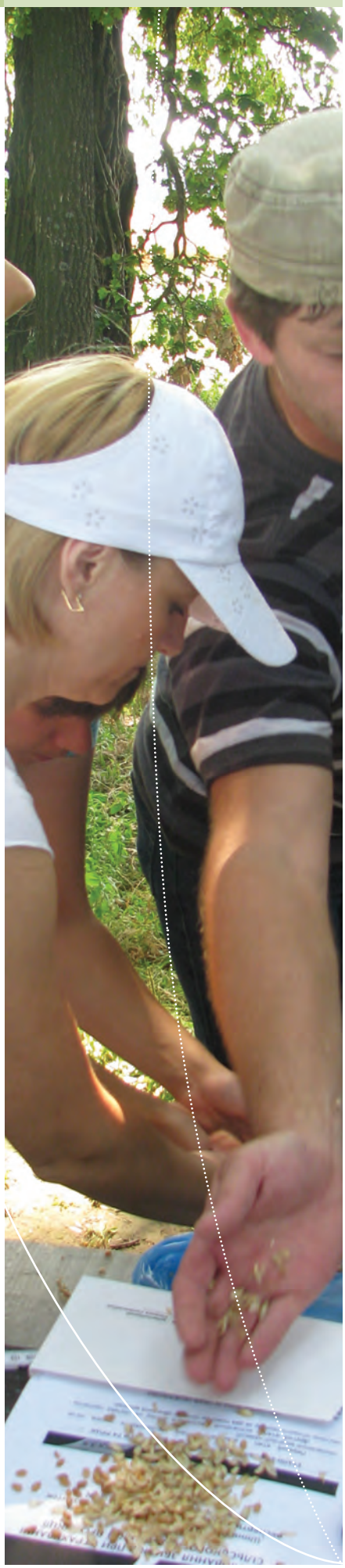
4.1. Agricultural Lending Issues

Financial institutions must earn profits to be sustainable. When deciding whether to make a loan, lenders want to maximize risk-adjusted returns and generate profits commensurate with shareholder expectations. Although agricultural loans expand lending portfolios, they also create additional risk because of the seasonal nature of agricultural production. In addition, lenders prefer servicing larger agricultural producers because loan servicing costs are lower per unit of loan volume relative to small producers. However, the presence of agricultural insurance can mitigate some of these risk-related costs.

4.1.1. Importance of Loan Size

A simulation model is used to illustrate the impact of loan size on servicing costs and returns on equity (ROE). The model assumes that a minimum of 15 percent ROE must be earned to satisfy lending institutions' shareholders. Thus, loans estimated to generate less than 15 percent ROE would not be offered while loans above that generate returns above that threshold will meet investor standards. Therefore, agricultural lending activities will be supported by shareholders only when this threshold is met.

The model uses agricultural lending costs and returns to calculate the minimum average loan size needed to obtain a 15 percent ROE (see Reusche, Huijser, Watts, and Kostromytskyi, The Profit Motive: Encouraging Bank and MFI Lending to Farmers and Agri-Businesses, for model details). Figure 1 illustrates that interest rates must rise substantially for loan sizes that are less than $25,000 in order to maintain specific ROE targets.



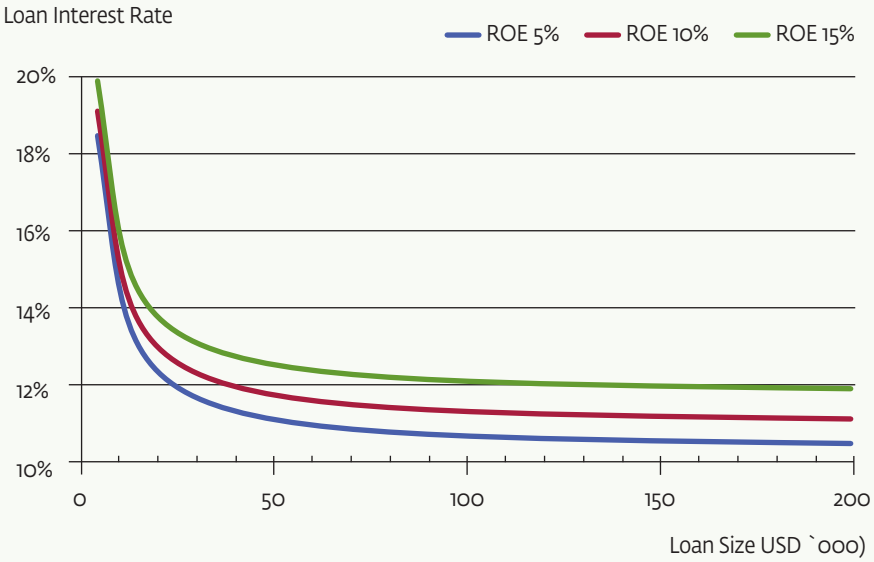


Figure 1. Tradeoffs between Loan Interest Rates and Loan Sizes

Based on assumptions regarding personnel and other costs including risk, the model finds that loan sizes of $25,000 can be profitable. For loans that are less than $20,000, interest rates charged by lending institutions must increase substantially to maintain a 15 percent ROE. Conversely, a 15 percent ROE can be obtained for loans sizes greater than $30,000 without commensurate interest rate increases. Thus, $25,000 is the low-end threshold at which banks can expect to generate 15 percent ROE because of per unit servicing costs.

It is often the case that small loans can only be profitable if loan-processing and monitoring costs can be reduced. Parametric methods for evaluating smaller loans can be used to reduce per unit loan costs. Such parametric statistical assessments of clients can substantially reduce loan costs by automating loan evaluations and reduce loan-processing time by several days in some regions. The outcome is that minimum profitable loan sizes can be reduced by almost 60 percent.

4.1.2. Role of Agricultural Insurance

Agricultural insurance is a key risk management tool. If a farmer expects to produce 100 tons of a crop in a given year but generates one-half that amount because of drought, the probability of a loan payment default increases substantially. Insuring crops against such weather events helps agricultural producers meet repayment requirements.

For commodities covered by crop insurance, adverse weather events trigger indemnity payments from insurance companies. Indemnity payments can be used to service debt. Because this reduces loan defaults, crop insurance indemnity payments are often pledged to a lender as part of a loan agreement. Hence, agricultural insurance helps lenders provide loans to producers because of substantial reductions in default risk.

Risk can be further reduced by lending to agricultural aggregators. In many regions, small agribusinesses and producers collaborate to form collective legal entities known as agricultural aggregators. By accepting some assessment processes and spreading repayment responsibility across many producers, these groups reduce costs and ameliorate loan default risk. In these cases, the aggregator represents a single entity which allows for the provision of larger loan sizes and reduces loan costs. From a lender's perspective, an aggregator is the loan client and the object of due diligence. By collectively forming a larger legal entity, small-scale farmers and agribusinesses become more attractive clients. Nonetheless, proper administration protocols must be adopted and maintained by aggregators.

4.1.3. Constraints on Agricultural Lending

In developing economies, the International Finance Company (IFC) provides credit through both direct lending activities and lending institutions. Because of monitoring costs, direct lending is typically inappropriate for small and medium-sized operations. Therefore, IFC finances small agricultural producers and agribusiness through existing local lending institutions. However, lending institution development programs that encourage lending to small agricultural producers and agribusinesses have experienced limited success.

Various strategies have been used to increase lending to small producers including government-mandated loan portfolio percentages, specialized state-owned banks, interest-rate subsidies, and risk sharing mechanisms. In general, these strategies have not been successful. The common viewpoint is that lending to small agricultural producers is very risky. However, lenders who use adequate risk assessment instruments have successfully functioned and prospered in this sector. Furthermore, non-performing loans (NPLs) in this sector are no higher than in other sectors. Thus, lending to agricultural producers and agribusinesses is a business opportunity rather than a social or government response to food shortages and rural poverty. However, the sector does require that lenders use proper risk assessment systems, fully understand the sector, and use strong risk management tools.

IFC programs must use several approaches to decrease risk, increase profit potential, and encourage financial institutions to provide loans to agribusinesses and farmers. Efforts to increase lending to small agricultural producers will only be successful if approached from the perspective of financial institutions.

4.2. Technology Adoption

New agricultural production technologies generally increase incomes on average. However, new technologies are often accompanied by substantial learning curves, which may increase the variance of returns and the probability of lower returns. Figure 2 presents the distribution of returns from an old technology with mean of $\bar{X}_o$ and a variance of σ_0^2. A new technology may have a higher mean $\bar{X}_n$ as well as a higher variance σ_n^2. Hence, on average, the adoption of the new technology will be beneficial to producers, but the larger variance may inhibit adoption. For example, if returns below twenty-five are considered catastrophic (e.g., initiate bankruptcy or result in starvation), then it is unlikely that the new technology will be adopted. However, agricultural insurance can eliminate the lower tail of the new technology's distribution while maintaining higher mean returns.

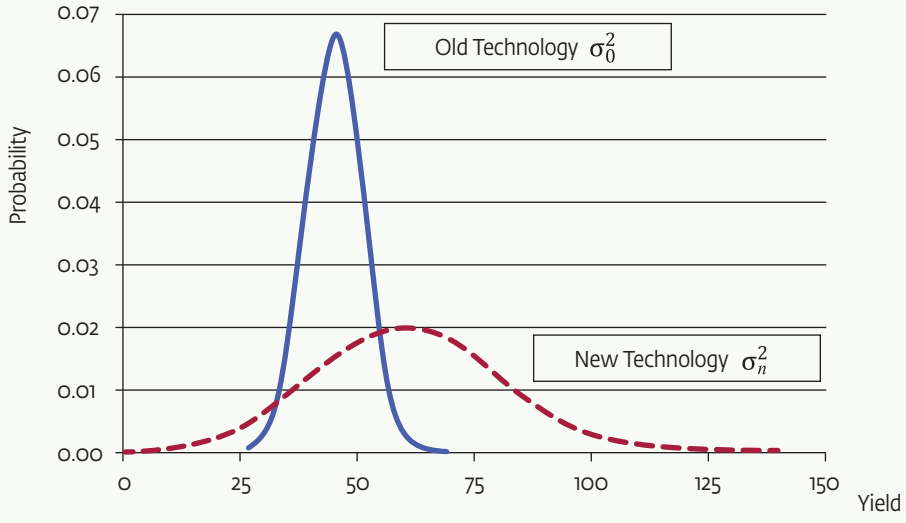


Figure 2. Mean and Variance Increasing Technology Adoption

4.3. Portfolio Comparisons

It is instructive to formally present a mathematical overview of the relationship between the interest rate risk premiums (a credit approach to pricing risk) and expected indemnity payments (an insurance approach to pricing risk). In the credit approach, risk is priced by increasing debt interest rates with an associated risk premium. In the insurance approach, insurance premiums are paid based on expected indemnity payments. The extent to which interest rate risk premiums can be reduced by insurance coverage describes the efficacy, or perfection, of insurance in reducing the risk of credit payment default.

4.3.1. Credit Approach. Using the following notation:

L = loan amount at the beginning of the period
r = riskless interest rate
v = interest rate risk premium rate
$v + r$ = contractual interest rate
P = total loan payment at the end of the period = $L(1+r+v)$
x = funds available for loan interest payment with a probability density function (pdf) of $f[x]$ and a cumulative density function (cdf) of $F[x]$,

assume risk neutrality and a single period model. Then,

$$L(1+r) = \int_{-\infty}^{P} xf[x]dx + \int_{P}^{\infty} Pf[x]dx$$

The right side of the equation is the expected loan payment, which includes principal payments and a riskless interest payment. The first term on the right side represents the payment if there are insufficient funds (payment default), and the second term is the payment if sufficient funds exist (full payment). This can be rewritten as:

$$\begin{aligned} L(1+r) &= E[x/x<P]F[P] + P(1-F[P]) \\ &= P - (P - E[x/x<P])F[P] \\ P - L(1+r) &= (P - E[x/x<P])F[P] \\ vL &= (P - E[x/x<P])F[P] \end{aligned}$$

Note that vL is the risk premium that compensates a lender for situations in which a full debt payment cannot be made (i.e., when $x<P$). $F[P]$ is the probability of default (PD) and $P\text{-}E[x/x<P]$ is the Loss Given Default (LGD).

4.3.2. Insurance Approach. Using the following notation:

z = insured variable with a pdf of $g[z]$ and a cdf of $G[z]$
$E[I]$ = expected indemnity
t = indemnity trigger

then:

$$\begin{aligned} E[I] &= \int_{-\infty}^{t} (t-z)g[z]dz \\ &= \int_{-\infty}^{t} tg[z]dz - \int_{-\infty}^{t} zg[z]dz \\ &= tG[t] - E[z/z<t]G[t] \\ &= (t - E[z/z<t])G[t] \end{aligned}$$

Note that t - $E[z/z<t]$ is the insurance severity and $G[t]$ is the indemnity frequency.

4.3.3. Comparing Credit and Insurance Approaches. The Loss Given Default (LGD) in the credit approach is analogous to severity in the insurance approach. Furthermore, the probability of default in the credit approach is identical to frequency in the insurance approach. The symmetry between the two approaches is not surprising. A perfect insurance product would result in $t = P$, $z = x$, and $f(x) = g(z)$. Consequently, an indemnity payment would perfectly offset any loan payment deficiencies so that, even when $x<P$, the insurance indemnity perfectly offsets payment deficiencies such that the loan payment can always be made in full.

In a risk-neutral environment with no transaction costs and perfect insurance, the risks are the same whether embedded in insurance premiums or interest rates. However, insurance is never perfect for a variety of reasons. Therefore, insurance will only partially offset loan payment deficiencies. It is also possible for insurance indemnities to be paid even if loan payment deficiencies do not occur.

4.4. Credit and Insurance Examples

The theoretical constructs noted above provide a mathematical illustration of the differences and similarities of using credit and insurance markets to manage risk. Credit market approaches add risk premiums to interest rates charged on debt financing. These interest rates can be reduced if insurance is used as a risk management tool. The following numerical examples are presented to further illustrate these tradeoffs.

4.4.1. Credit Approach without Insurance. Table 1 presents a simulated example of the effects of risk on interest rates using twenty years of hypothetical data. This example is presented for illustrative purposes only; more data would be necessary for actual rating purposes. The example considers variability in wheat yields over a twenty-year period. Yields vary from 10 to 45 bushels/acre over this period, and the average yield is 30 bushels/acre. Output prices average $6.00/bushel over the period, but vary from a low of $3.20/bushel to a high of $7.70/bushel. Revenues per acre are calculated by multiplying per acre yields by per bushel prices in each year. Per acre variable costs average $120/acre and also display some variation. Costs in each year include variable production expenses as well as interest expense on an operating loan used to purchase inputs using a risk-free interest rate.

Net returns per acre average are calculated by subtracting costs per acre from revenue per acre. Net returns per acre represent returns over variable production costs and are used for loan repayment. Insufficient net returns can result in loan defaults. Net returns average $60.14 over the time period but vary from a low of -$42.12/acre to a high of $207.60/acre. The final column of the table indicates that $6.63/acre is the required risk premium that would need to be added to interest expenses to compensate a lender for risk incurred. The risk premium was determined by searching for the value that caused the average of the final column to equal zero. Assuming a risk-free interest rate of 5% on the average operating costs of $120/acre or a loan of that size, the per acre risk-free interest costs total $6.00/acre, which is included as a cost. Therefore, total interest expense is $12.63/acre or 10.5%. Hence, the interest rate needed to offset production and marketing risks using credit markets would be slightly more than double the risk-free rate.

In five of the twenty years, net returns are less than $6.63/acre, which would cause loan default. Hence, the probability of default is 0.25 or 25%. The average loss given default is $19.89/acre. This simulated high default rate would not be common in actual applications. For example, U.S. agricultural loan default rates average less than 2%. However, default rates are higher in developing agricultural economies.

Table 1. Interest Rate Risk Premium without Insurance

Year	Yield (bu/acre)	Price ($/bu)	Revenue ($/acre)	Costs ($/acre)	Net Returns ($/acre)	Default Interest or Risk Payment ($/acre)
1	26	5.20	135.20	101.99	33.21	6.63
2	36	6.05	217.80	133.54	84.26	6.63
3	18	5.80	104.40	107.62	-3.22	-3.22
4	28	6.57	183.96	129.42	54.54	6.63
5	38	6.53	248.14	125.31	122.83	6.63
6	32	4.35	139.20	111.30	27.90	6.63
7	20	7.50	150.00	106.88	43.12	6.63
8	45	7.35	330.75	123.15	207.60	6.63
9	33	5.20	171.60	127.68	43.92	6.63
10	30	3.57	107.10	132.58	-25.48	-25.48
11	40	7.50	300.00	122.47	177.53	6.63
12	28	4.80	134.40	115.66	18.74	6.63
13	19	5.70	108.30	124.47	-16.17	-16.17
14	39	7.70	300.30	125.75	174.55	6.63
15	37	3.20	118.40	103.84	14.56	6.63
16	41	6.80	278.80	120.67	158.13	6.63
17	18	6.15	110.70	123.19	-12.49	-12.49
18	21	6.09	127.89	112.29	15.60	6.63
19	10	7.64	76.40	118.52	-42.12	-42.12
20	41	6.33	259.53	133.71	125.82	6.63
Mean	30.00	6.00	180.14	120.00	60.14	0.00
Std Dev	9.80	1.31	79.04	9.87	75.42	13.59

4.4.2. Credit Approach with Yield Insurance. Table 2 repeats the previous hypothetical simulation using yield insurance. A trigger yield of 20 bushels/acre (67% coverage) is assumed, which generates indemnities in four of the twenty years. Over the twenty-year period, indemnities average $4.50/acre. In the absence of transaction costs, this would also be the actuarially sound insurance premium. Therefore, it has been subtracted from the net returns column in each year. The final column illustrates the effect of yield insurance on interest rate risk premiums. Interest rate risk premiums have been reduced to $2.92/acre, a reduction of more than 50% relative to the example in which crop insurance was not available. The number of years of loan default has been declined from five to three, and the average loss given default has declined from $19.89/acre to $16.55/acre.

Table 2. Interest Rate Risk Premium with Yield Insurance

Year	Yield (bu/acre)	Price ($/bu)	Revenue ($/acre)	Costs ($/acre)	Indemnity ($/acre)	Net Returns ($/acre)	Default Interest or Risk Payment ($/acre)
1	26	5.20	135.20	101.99	0.00	28.71	2.92
2	36	6.05	217.80	133.54	0.00	79.76	2.92
3	18	5.80	104.40	107.62	12.00	4.28	2.92
4	28	6.57	183.96	129.42	0.00	50.04	2.92
5	38	6.53	248.14	125.31	0.00	118.33	2.92
6	32	4.35	139.20	111.30	0.00	23.40	2.92
7	20	7.50	150.00	106.88	0.00	38.62	2.92
8	45	7.35	330.75	123.15	0.00	203.10	2.92
9	33	5.20	171.60	127.68	0.00	39.42	2.92
10	30	3.57	107.10	132.58	0.00	-29.98	-29.98
11	40	7.50	300.00	122.47	0.00	173.03	2.92
12	28	4.80	134.40	115.66	0.00	14.24	2.92
13	19	5.70	108.30	124.47	6.00	-14.67	-14.67
14	39	7.70	300.30	125.75	0.00	170.05	2.92
15	37	3.20	118.40	103.84	0.00	10.06	2.92
16	41	6.80	278.80	120.67	0.00	153.63	2.92
17	18	6.15	110.70	123.19	12.00	-4.99	-4.99
18	21	6.09	127.89	112.29	0.00	11.10	2.92
19	10	7.64	76.40	118.52	60.00	13.38	2.92
20	41	6.33	259.53	133.71	0.00	121.32	2.92
Mean	30.00	6.00	180.14	120.00	4.50	60.14	0.00
Std Dev	9.80	1.31	79.04	9.87	13.61	70.76	8.22

4.4.3. Credit Approach with Price Insurance. Table 3 repeats the original hypothetical simulation but includes price insurance. A trigger price of $4/bushel (67% coverage) is assumed, which generates indemnities in two of the twenty years. Over the twenty-year period, indemnities average $1.85/acre, which is the pure risk insurance premium. The final column illustrates the effect of price insurance on interest rate risk premiums. Interest rate risk premiums have been reduced from $6.63/acre to $6.39/acre. The risk premium is much higher than the yield insurance scenario, indicating that the primary source of risk is yield variability. The probability of default is 25% and the average loss given default is $19.17/acre.

Table 3. Interest Rate Risk Premium with Price Insurance

Year	Yield (bu/acre)	Price ($/bu)	Revenue ($/acre)	Costs ($/acre)	Indemnity ($/acre)	Net Returns ($/acre)	Default Interest or Risk Payment ($/acre)
1	26	5.20	135.20	101.99	0.00	31.37	6.39
2	36	6.05	217.80	133.54	0.00	82.42	6.39
3	18	5.80	104.40	107.62	0.00	-5.07	-5.07
4	28	6.57	183.96	129.42	0.00	52.70	6.39
5	38	6.53	248.14	125.31	0.00	120.99	6.39
6	32	4.35	139.20	111.30	0.00	26.06	6.39
7	20	7.50	150.00	106.88	0.00	41.28	6.39
8	45	7.35	330.75	123.15	0.00	205.76	6.39
9	33	5.20	171.60	127.68	0.00	42.08	6.39
10	30	3.57	107.10	132.58	12.90	-14.43	-14.43
11	40	7.50	300.00	122.47	0.00	175.69	6.39
12	28	4.80	134.40	115.66	0.00	16.90	6.39
13	19	5.70	108.30	124.47	0.00	-18.02	-18.02
14	39	7.70	300.30	125.75	0.00	172.71	6.39
15	37	3.20	118.40	103.84	24.00	36.72	6.39
16	41	6.80	278.80	120.67	0.00	156.29	6.39
17	18	6.15	110.70	123.19	0.00	-14.34	-14.34
18	21	6.09	127.89	112.29	0.00	13.76	6.39
19	10	7.64	76.40	118.52	0.00	-43.97	-43.97
20	41	6.33	259.53	133.71	0.00	123.98	6.39
Mean	30.00	6.00	180.14	120.00	1.85	60.14	0.00
Std Dev	9.80	1.31	79.04	9.87	5.96	74.11	13.20

4.4.4. Credit Approach with Revenue Insurance. Table 4 repeats the original hypothetical simulation using revenue insurance. Given that both yield and price variability are insured with revenue insurance, one should expect to find further reductions in credit-related interest rate risk premiums relative to insuring solely against negative yield or price events. A trigger revenue of $120/acre (67% coverage) is assumed, which generates indemnities in six of the twenty years (30% of the time). Over the twenty-year period, indemnities average $4.74/acre. The final column illustrates the effect of revenue insurance on interest rate risk premiums. Interest rate risk premiums have been reduced to $2.36/acre which is slightly lower than that generated by yield insurance. The probability of default is 20% with an average loss given default of $9.43/acre.

Table 4. Interest Rate Risk Premium with Revenue Insurance

Year	Yield (bu/acre)	Price ($/bu)	Revenue ($/acre)	Costs ($/acre)	Indemnity ($/acre)	Net Returns ($/acre)	Default Interest or Risk Payment ($/acre)
1	26	5.20	135.20	101.99	0.00	28.48	2.36
2	36	6.05	217.80	133.54	0.00	79.53	2.36
3	18	5.80	104.40	107.62	15.60	7.64	2.36
4	28	6.57	183.96	129.42	0.00	49.81	2.36
5	38	6.53	248.14	125.31	0.00	118.10	2.36
6	32	4.35	139.20	111.30	0.00	23.17	2.36
7	20	7.50	150.00	106.88	0.00	38.39	2.36
8	45	7.35	330.75	123.15	0.00	202.87	2.36
9	33	5.20	171.60	127.68	0.00	39.19	2.36
10	30	3.57	107.10	132.58	12.90	-17.32	-17.32
11	40	7.50	300.00	122.47	0.00	172.80	2.36
12	28	4.80	134.40	115.66	0.00	14.01	2.36
13	19	5.70	108.30	124.47	11.70	-9.21	-9.21
14	39	7.70	300.30	125.75	0.00	169.82	2.36
15	37	3.20	118.40	103.84	1.60	11.43	2.36
16	41	6.80	278.80	120.67	0.00	153.40	2.36
17	18	6.15	110.70	123.19	9.30	-7.93	-7.93
18	21	6.09	127.89	112.29	0.00	10.87	2.36
19	10	7.64	76.40	118.52	43.60	-3.26	-3.26
20	41	6.33	259.53	133.71	0.00	121.09	2.36
Mean	30.00	6.00	180.14	120.00	4.74	60.14	0.00
Std Dev	9.80	1.31	79.04	9.87	10.48	70.25	5.37

4.4.5. Credit Approach with Credit Default Insurance (CDI). Table 5 repeats the original hypothetical simulation using credit default (profit) insurance. In this case, the premium is $6.63/acre, which represents the insurance premium necessary to avoid default in every year. Hence, net returns are reduced by this value. This is exactly the risk premium required by lenders to provide credit in the absence of agricultural insurance. The table shows that insurance indemnities are triggered in five of twenty years. The average of these indemnities over the twenty-year period is $6.63/acre (the risk premium that is needed by lenders in the absence of insurance). The use of CDI results in no years of credit default, because these are the events that trigger offsetting insurance indemnities.

Table 5. Interest Rate Risk Premium with Credit Default (Profit) Insurance

Year	Yield (bu/acre)	Price ($/bu)	Revenue ($/acre)	Costs ($/acre)	Indemnity ($/acre)	Net Returns ($/acre)	Default Interest or Risk Payment ($/acre)
1	26	5.20	135.20	101.99	0.00	26.58	0.00
2	36	6.05	217.80	133.54	0.00	77.63	0.00
3	18	5.80	104.40	107.62	9.85	0.00	0.00
4	28	6.57	183.96	129.42	0.00	47.91	0.00
5	38	6.53	248.14	125.31	0.00	116.20	0.00
6	32	4.35	139.20	111.30	0.00	21.27	0.00
7	20	7.50	150.00	106.88	0.00	36.49	0.00
8	45	7.35	330.75	123.15	0.00	200.97	0.00
9	33	5.20	171.60	127.68	0.00	37.29	0.00
10	30	3.57	107.10	132.58	32.11	0.00	0.00
11	40	7.50	300.00	122.47	0.00	170.90	0.00
12	28	4.80	134.40	115.66	0.00	12.11	0.00
13	19	5.70	108.30	124.47	22.80	0.00	0.00
14	39	7.70	300.30	125.75	0.00	167.92	0.00
15	37	3.20	118.40	103.84	0.00	7.93	0.00
16	41	6.80	278.80	120.67	0.00	151.50	0.00
17	18	6.15	110.70	123.19	19.12	0.00	0.00
18	21	6.09	127.89	112.29	0.00	8.97	0.00
19	10	7.64	76.40	118.52	48.75	0.00	0.00
20	41	6.33	259.53	133.71	0.00	119.19	0.00
Mean	30.00	6.00	180.14	120.00	6.63	60.14	0.00
Std Dev	9.80	1.31	79.04	9.87	13.59	68.29	0.00

4.4.6. Summary of Credit and Insurance Examples. Table 6 summarizes the essential elements of the comparisons between credit and insurance as a means for pricing risk. The table helps us understand the perfection of the various insurance regimes. Credit default insurance is perfected, since no risk premium is incorporated in the interest rates when credit default insurance is used. The other insurance products are less than perfect because they result in an interest risk premium and periodic default. In terms of probability of default and loss given default, yield insurance has a lower probability of default, loss given default, and interest risk premium than price insurance but has a higher insurance premium. Interestingly, revenue insurance has a higher probability of default and insurance premium than yield insurance, but has a substantially lower loss given default and a slightly lower interest risk premium.

Table 6. Summary of Credit and Insurance Examples

Insurance	Probability of Loan Default	Average Loss Given Default ($/acre)	Interest Risk Premium ($/acre)	Insurance Premium ($/acre)
None	0.25	19.89	6.63	0.0
Yield	0.15	16.55	2.92	4.50
Price	0.25	19.17	6.39	1.85
Revenue	0.20	9.44	2.36	4.74
CDI	0	0	0	6.63

In the example data, the coefficient of variation for yield (0.33) is higher than that for price (0.22) and lower than for revenue (0.44). These relationships are typical for crop data. Because the coefficient of variation is higher for yields than for prices, the interest rate risk premium is less when yield insurance is used. Similarly, revenue insurance reduces the interest rate risk premium more than both yield and price insurance because its coefficient of variation is larger than that for yield and price.

Tables 5 and 6 illustrate that CDI is a perfect form of insurance. However, substantial obstacles limit its use. Usually, insurers and lenders are separate entities. As a result, there is a tendency for conflicts to arise when defaults occur. Specifically, the assessment of costs used to determine fund availability for loan repayment is often controversial because it relies on producer records. In addition, producers may not have an incentive to purchase inputs at the lowest possible cost. Monitoring these discrepancies is often prohibitively expensive.

On the other hand, other insurance products are somewhat less expensive to monitor because standard procedures have been developed to determine yields and obtain market price information. In developing countries, however, futures markets and price reporting mechanisms are often unavailable, which reduces the viability of price and revenue insurance products. Consequently, index or yield products may be the only viable crop insurance options.

4.5. Agricultural Credit and Insurance Applications

Many subsistence farmers in developing economies have limited access to credit. Consequently, they often forego making investment decisions that would, on average, increase their net incomes. Such investments often entail additional risk, uncertainty, and experience factors. If risk transfer mechanisms are unavailable or not trustworthy, many producers make rational decisions to avoid risky (albeit profitable) investments in yield-improving seeds, fertilizer, and equipment. Likewise, the absence of risk management tools also reduces lenders' willingness to provide credit or increases interest rates to reflect additional risk. Risk transfer tools also encourage financial institutions and agribusinesses to extend credit to farmers.

The relationship among risk, credit, and investment has prompted a variety of attempts to link insurance with credit access. Many of these activities involve index insurance products as a way to reduce moral hazard and monitoring costs. For example, the Global Index Insurance Facility (an IFC/IBRD collaboration within the Access to Finance's Global Retail/Microfinance product line) provides two examples that illustrate the synergy between agricultural credit and insurance. The first involves MicroEnsure's program in Rwanda and the second is the Syngenta Foundation for Sustainable Agriculture (SFSA)/UAP Insurance program in Kenya. These two programs have provided index insurance for loans used to purchase inputs such as seed and fertilizer to 63,400 small producers. In 2013, over 30,000 farmers were able to access $5.5 million in credit because they had purchased index insurance products. In addition, surveys indicate that insured farmers increased investments in their farms more than those who were uninsured. To date, these successes have been generated without premium subsidies from governments.

4.5.1. MicroEnsure Rwanda. In Rwanda, MicroEnsure uses weather station and satellite data to design and implement weather index products. The program uses weather index products to mitigate drought and excessive rainfall events. The initial design used existing weather stations for rating and implementation, but because of low data quality, reinsurance loadings made these insurance products prohibitively expensive. In 2012, MicroEnsure developed a new index product based on satellite imagery of evapotranspiration, but the process for initiating indemnity triggers proved to be difficult to explain to farmers and other interested parties. Consequently, MicroEnsure invested in new automated weather stations to provide data for Rwanda index products. To date, over 7,000 producers have participated in the program.

4.5.2. SFSA/UAP Kenya. The SFSA/UAP program also incorporates satellite and automated weather station data to design and implement index insurance products. As a result, SFSA and UPA developed products that included two covers in 2013: (1) a weather station-based weather index cover, and (2) an area yield cover based on county-level data. The area yield component insures individual farmers against county-level harvest yields that fall below five-year county averages. In addition, the weather index cover provides protection from regional basis risk. In 2013, SFSA/UAP, the One Acre Fund, and the Kenya Seed Company insured over 56,000 farmers with the combined cover product.

5.0. Requirements for a Viable Insurance Program

Various social, cultural, institutional, and government conditions must exist for agricultural credit markets and crop insurance products to function successfully. Nonetheless, even when the necessary conditions are met, other factors may prevent credit and insurance markets from functioning. For example, agricultural producers, insurance providers, credit officers, and government regulators must be well-versed in risk and crop insurance issues. Furthermore, a variety of actions can cause participation erosion.

5.1. Social, Cultural, Institutional, and Government Requirements

Market-based social coordination requires clear, enforceable social rules and strong government institutions. Specifically, credit markets cannot function if property rights have not been clearly defined. Private investment in long-term capital investments is hampered if property rights are not well-defined. Clear definitions allow investors to manage, control, and retain value created by capital investments. Consequently, governments and cultural norms must include consistent rules of law that are enforceable and transparent.

In addition, markets require many consistent and stable regulations and institutions to support business activity. Governments must enforce contract law, including insurance agreements, so that indemnities are paid in their entirety and in a timely fashion. Insurance markets will fail if issuing companies are not required to maintain sufficient reserves to pay indemnities resulting from crop failures.

5.2. Education and Marketing

An important element of credit and crop insurance synergies involves educational efforts. In general, much of these efforts are considered part of crop insurance marketing, but the marketing of crop insurance products and programs must include a high degree of comprehensible education. Producers, insurers, lenders, and government regulators must understand all aspects of crop insurance programs.

Educational programs must extend beyond the simple element of providing information. Participants must understand the purpose of crop insurance products and the mechanisms associated with them. For example, participants must be educated about signup dates, covered perils, best management practices, loss reporting, quality control, trigger yields, coverage levels, attachment dates, indemnity calculations, risk, and adjusting processes. Such education must be conducted by unbiased, knowledgeable, and experienced educators to avoid potential conflicts of interest.

U.S. and Canadian experiences suggest that producers are more likely to continue participating in crop insurance programs if high-quality educational programs are available. Marketing and advertising campaigns appear to be relatively ineffective at permanently expanding sales and increasing participation relative to increasing human capital through education.

5.3. Participation Erosion

Successful crop insurance programs must be designed to avoid problems created by participation erosion. Participation erosion occurs when crop insurance products have been improperly rated with respect to risk.

For example, assume that a crop insurance product is purchased by ten producers, each of whom faces a different risk of crop failure. It is common to rate an insurance product for the average level of risk for all ten producers rather than on a producer-specific basis. Therefore, one-half of the producers will be paying premium rates that are higher than their actual risk level. These producers are not likely to participate in the program. If they do not participate, then the product has been improperly rated. Because the remaining producers have higher risks relative to the determined rate, the product will not be actuarially sound. Hence, it will eventually have to be re-rated, and premiums will increase. However, this will exacerbate the problem, as those producers with the lowest risk who remain in the pool will also choose to not purchase the product. Eventually, participation will be low and the program will not be viable.

Participation erosion can be ameliorated by pooling producers who have similar risks so that the rates better reflect each producer's individual risk and reduces the variability of risk within each pool. Various factors are used to pool producers, including expected yields, regions, crops, and production practices. However, if these variables do not sufficiently partition producers with different yield variability, then other differentiating characteristics should be used to maintain the viability of the program.

6.0. Constraints on Agricultural Credit and Agricultural Insurance

In addition to requiring various social, cultural, institutional, and government conditions for success, agricultural insurance programs will fail if they do not effectively address insurance fraud in a timely and consistent manner. Insurance programs must include well-defined (and well-publicized) fraud detection methodologies.

6.1. Sources of Fraudulent Activities

A variety of fraudulent activities can occur in crop insurance programs. Fraud can be committed not only by agricultural producers, but also by insurers, insurance agents, crop adjusters, and regulators. Most fraud requires the collusion of two or more of these participants.

Producers' fraudulent activities can result from moral hazard by not adhering to best management practices. In addition, producers may under-report yields or move a portion of a crop from one insured parcel (contract) to another. This "yield switching" can occur within single farms or across farm owners. Yield switching results in indemnity payments on those acres for which harvested crops were moved or under-reported.

Insurance agents and insurance issuers can also commit fraud by under-reporting yields, incorrectly calculating indemnities, or improperly withholding subsidies intended to be transferred to producers. Such actions often require the complicity of insurance regulators, crop adjusters, or both.

6.2. Fraud Detection

Crop insurance programs must diligently and consistently identify fraudulent activities. When discovered, serious consequences must be imposed quickly.

Fraud detection begins by ensuring that crop ownership, property titles, and contract provision documents are accurately maintained. This must begin with the point of first contact between issuing agents and producers. In addition, such documentation must follow standardized forms and procedures to protect underwriting provisions. Special attention needs to be given to producers who are related to one another.

Because fraud often involves the cooperation of crop adjusters, adjustment outcomes need to be compared within regions and across adjusters. Alternative adjusters should be used to randomly check adjustment outcomes. Fraud can often be reduced by employing independent adjusters rather than those provided by an insurance company. It is especially important that conflicts of interest between insurance agents and crop adjusters be avoided. These two groups must operate independently.

A variety of data-mining techniques have been developed to detect crop insurance fraud. Such activities must occur constantly and be updated as new information is generated. For example, data mining can detect regions in which crop losses are unusually large and identify instances in which a single producer or a group of producers serviced by a specific crop adjuster or insurance agent has crop losses that are substantially different from neighboring producers. Insurance agents and adjusters can be compared across regions by evaluating loss adjustment outcomes.

Figure 3 illustrates how fraud that can be detected by data-mining algorithms. Consider two producers (A and B) who are neighbors. In year 1, producer A reported a relatively high crop yield, while producer B reported a low yield. In year 2, the opposite occurs; producer A reports a low yield and producer B reports a high yield. These types of patterns are consistent with yield switching, in which the two producers are cooperating by moving some of their own production to the other party. They also alternate years in terms of under- and over-reporting so that each receives an unwarranted indemnity payment every other year. It is possible that neither producer would have received an indemnity payment in any year if they had properly reported their yields. Such schemes also require the reporting of unusually high yields in alternate years by a producer to prevent substantial declines in indemnity triggers. Alternatively, a producer must also report relatively low yields in alternate years to trigger indemnities. Hence, reported yields that are higher or lower than most regional harvest outcomes provide another means for detecting fraud.

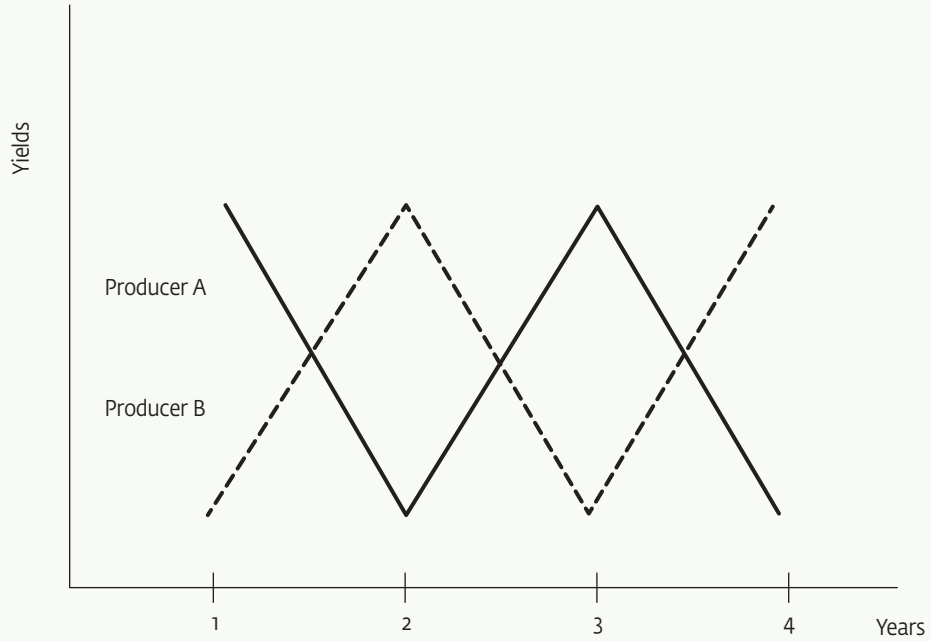


Figure 3. Fraud detection using data mining techniques.

Grain sales receipts are often used to monitor yields. If a producer sells an entire crop and then claims a very low yield, these receipts must be offset by a second producer who will need to report a very high yield. That is, if yields have been under-reported from an area covered by one contract, then they must be over-reported on another. Thus, yield switching activities also increase the variance of yields relative to those producers who are not involved in yield switching schemes. Furthermore, those involved in yield switching will also have low or negatively correlated yields. Data mining can be used to identify fraud in these cases. However, in-person inspections of individuals suspected of yield switching are usually necessary to positively identify such fraud.

7.0. Summary

Agricultural production involves many risks, which ultimately impact the financial viability and sustainability of farms and ranches. Agricultural production is often co-incident with high short-term credit risk because of the combination of high fixed costs, weather and disease variability, and variations in cash receipts. Managing agricultural risks is particularly important for agricultural producers in developing economies. For example, social unrest in many developing countries is often associated with low agricultural production and incomes — especially for subsistence farmers. In addition, many developing countries depend on healthy farm economies to generate economic activity through agricultural exports. Furthermore, rural emigration to urban areas, which increases in years of low farm production and farm business failures, exacerbates many social problems. Finally, while many rural areas would benefit from the adoption of modern technologies in the long-term, it takes time and financial resources to learn and adopt new technologies. The resulting income variability reduces the adoption of risky, new technologies even if these technologies would improve long-term producer and societal well-being.

A perfect risk management situation occurs when a party pays an actuarially sound amount to perfectly offset the impacts of adverse events. In the long run, transaction costs represent the costs of risk when they are incorporated into insurance or interest rates. In practice, perfect risk management is unattainable because of transaction costs, market imperfections, uncertainty surrounding risky events, moral hazard, adverse selection, fraud, and the pragmatic aspects of contractually describing all possible risky outcomes.

Farm expenses represent cash outflows that, in general, occur throughout a year and (in large part) prior to the receipt of cash inflows. Cash inflows usually occur much less frequently and are often associated with harvest seasons. The difference in cash flow timing and seasonality often causes farmers to use operating lines of credit to meet cash needs throughout a year. In addition, because many agricultural production assets require large initial outlays that are expected to yield benefits over many years, intermediate-term financing is often used to acquire breeding livestock, machinery, and buildings. The purchase of agricultural land often requires additional, long-term financing.

At the time many production expenditures are incurred, production and market outcomes are uncertain. As a result, poor crop outcomes or low market prices can result in loan defaults. The risk of such defaults may be incorporated into interest rates on operating and intermediate-term loans and mortgages. The advantage of incorporating risk premiums into interest rates (rather than other instruments) is that the transaction costs for doing so are reduced as only two parties (a borrower and a lender) are involved. The costs of risk transfer increase as additional entities are included. For example, a third party (e.g., insurance company, brokerage firm) requires substantial information regarding borrower risks, thereby increasing total transaction costs.

Nonetheless, including risk premiums in interest rates can be problematic. For example, higher interest rates increase the probability of loan default and, often, the termination of a farm business. This results in the repossession of collateral, which is costly and highly disruptive to both individuals and communities. In developing economies, such outcomes often exacerbate undesirable migration from rural to urban communities.

Finally, the risk-appropriate interest rates on high-risk agricultural loans can exceed usury laws in some countries and reduce investments in production agriculture.

The availability and use of agricultural insurance reduces credit risk, lowers interest rates, improves repayment capacities, increases credit availability, and reduces financial and business risk. The costs of crop insurance, however, can also be substantial. Crop insurance is subject to relatively high monitoring and rating costs, must account for temporal and spatial commodity price variability, requires large amounts of high-quality data to establish actuarially sound premium rates, and is subject to moral hazard and adverse selection problems. Nonetheless, agricultural insurance can reduce credit risk, increase repayment capacity, and mitigate adverse weather and price outcomes associated with agricultural production. Although agricultural insurance programs are costly, they can improve producer access to credit, mitigate production risk, reduce the probability of farm business failures (bankruptcy), provide a support mechanism for agriculture that is generally palatable to governments and trading partners, and decrease incentives for rural-to-urban migration.

Because agricultural crop insurance mitigates the primary risk faced by agricultural producers, producers are more likely to invest in technologies that have the opportunity to increase their average returns over time, even if the variability of those returns may also be exacerbated. Mitigating risk also allows producers to specialize in producing crops for which they have the highest comparative advantage. Using comparative advantages can increase the output of agricultural production for regions and countries.

In general, the public policy objectives of agricultural insurance programs are used to reduce the year-to-year variability of individual farmers' incomes. When successful, this reduces the incidence of catastrophic financial losses that often result in farm bankruptcies. Agricultural insurance may also reduce government expenditures by limiting the need for expensive ad hoc disaster programs.

Historically, input suppliers provided seed, chemicals, fertilizers, machinery, and other inputs to farm businesses in simple transactions that involved payment-in-full at the time of delivery. Although some exceptions have always existed, input suppliers have generally not provided credit or insurance services. Input suppliers, however, are increasingly providing credit by financing the sale of agricultural inputs to producers. Furthermore, input suppliers may be better positioned to offer insurance to agricultural producers than traditional insurers. In some cases, agricultural insurance may not be the principal focus of insurance companies. Lenders and other input suppliers may be better able to gauge the potential for moral hazard and adverse selection associated with specific producers because of knowledge gained through repeated customer transactions and on-farm observations. Such knowledge can reduce transaction and monitoring costs. Finally, many lenders and input suppliers are likely more knowledgeable about production agriculture and associated risks than insurers.

Although input suppliers and lenders may have better knowledge about individual agricultural producers than insurers, those suppliers also often have vested interests in encouraging sales of agricultural inputs, financing, and insurance. Substantial conflicts of interest can occur when an input supplier profits from the sale of a product that is packaged with insurance. In addition, many input suppliers have incentives to encourage the adoption of new technologies, especially if these are proprietary in nature. However, not all new technologies are equally valuable.

Recognizing the relationship between risk, credit, and investment has prompted a variety of attempts to link insurance with credit access. Many of these activities involve index insurance products as a way of reducing moral hazard and monitoring costs. In addition, per unit costs of servicing credit increase substantially as loan amounts decline. Agricultural insurance can reduce some of these costs.

Various social, cultural, institutional, and government conditions must exist for agricultural credit markets and crop insurance products to function successfully. Even with the existence of these necessary conditions, other factors may prevent credit and insurance markets from functioning properly. For example, agricultural producers, insurance providers, credit officers, and government regulators must be well-versed in risk and crop insurance issues. A variety of actions can cause insurance participation erosion.

Market-based social coordination requires clear, enforceable social rules and strong government institutions. Specifically, credit markets cannot function and private investment in long-term capital investments is hampered if property rights have not been clearly defined. Clear definitions allow investors to manage, control, and retain value created by capital investments. Consequently, governments and cultural norms must include consistent rules of law (including contract law) that are enforceable and transparent.

An important element of credit and crop insurance synergies involves educational efforts. In general, many of these efforts are considered part of crop insurance marketing, but marketing crop insurance products and programs must include a high degree of comprehensible education efforts. Producers, insurers, lenders, and government regulators must understand all aspects of crop insurance programs.

Successful crop insurance programs must be designed to avoid problems created by participation erosion. Participation erosion occurs when crop insurance products have been improperly rated with respect to risk. In addition, a variety of fraudulent activities can occur in crop insurance programs. Fraud can be committed not only by agricultural producers, but also by insurers, insurance agents, crop adjusters, and regulators. In fact, most fraud requires the cooperation of two or more of these participants. Crop insurance programs must diligently and consistently identify fraudulent activities. When discovered, serious consequences must be quickly imposed.

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