# MARKETING AND CROP INSURANCE COMBINED TO MANAGE RISK ON A CASS COUNTY REPRESENTATIVE FARM

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## Title

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## By

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**MASTER OF SCIENCE**

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# ABSTRACT

Clow, Aaron D., M.S., Department of Agribusiness and Applied Economics, College of Agriculture, North Dakota State University, July 1996. Marketing and Crop Insurance Combined to Manage Risk on a Cass County Representative Farm. Major Professor: George K. Flaskerud.

This study analyzed the effects that the use of crop insurance products and marketing alternatives had on the gross revenue per acre for an individual farm in Cass County. Crop insurance products and marketing strategies were analyzed individually to determine if they were effective in minimizing down side risk and combined to determine if integration created synergies. An entire whole farm scenario analysis was run that included integrated strategies that implemented the same insurance coverage and marketing alternatives for each crop.

Several general conclusions can be drawn for situations similar to the representative farm. When analyzed at the individual crop level, the use of crop insurance at the 65 percent level minimizes down side risk in wheat and corn, but not significantly in soybeans. Marketing alternatives generally increase the up side potential of gross revenue per acre while doing little to minimize the down side risk.

The integration of crop insurance products and marketing alternatives creates a synergy at the lower levels of value at risk, where the down side risk is located. However, the use of integrated strategies does not increase the chances of achieving a cash flow breakeven gross revenue per acre over the base strategy, which did not include insurance or marketing alternatives. The breakeven level is not reached until the 70 percent level, which means that, 7 out of 10 years, the farm will not cash flow. Output from the Bullock and AgRisk models is similar.

# ACKNOWLEDGMENTS

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# CHAPTER 1

# INTRODUCTION

Risk management has become increasingly important in farming operations. Over the past decade, there have been government policy changes, as well as climactic occurrences, that have led to increased price and yield risk faced by farmers. A 54 percent decline in median net farm income on farms enrolled in the North Dakota Farm and Ranch Business Management Education Program from 1993-1998 indicates how farmers in this state have been adversely affected by increased risk to their operation (Swenson, 1999).

## Risk Defined

Risk and uncertainty are often used interchangeably, but the two differ considerably. According to Knight (1921), risk is faced when the possible outcomes are known as well as probabilities associated with each. Uncertainty is faced when the possible outcomes are known, but the probabilities are not. Patrick (1992) defines production risk as the random variability inherent in a farm's production process. A few factors that can lead to this variability are weather, disease, pest infestation, fire, wind, and theft. Price risk contains three components: basis risk, futures price risk, and futures price spread risk. Variability in any of these three factors can lead to lower income. Managing risk means defining the potential range of outcomes, taking steps to reduce the chances of an unfavorable outcome, and taking actions which will reduce the adverse consequences of an unfavorable event occurring.

Historical price data are available for most agricultural commodities; therefore, a probability distribution can be built around the possible values faced in the upcoming crop year. Probability distribution can also be done with yield data, whether it is actual farm

production history or county average yields. Farmers can use this information to manage the risk of an unfavorable outcome.

## Policy Changes

Several policy changes have occurred in the past five years, including a major change in the government farm support policy as well as several international trade agreements. The policy changing the government farm support program is called the Federal Agricultural Improvement Reform (FAIR) Act of 1996, also known as the "Freedom to Farm" Act. Included in the international trade agreements are the North American Free Trade Agreement (NAFTA) in 1994, the General Agreement on Trades and Tariffs (GATT), and the Uruguay Round Agreements of 1994 that established the World Trade Organization that "replaced GATT as an institutional framework for overseeing trade negotiations" (USDA, Economic Research Service, 1998). These policies alone have increased price risk, and according to Wisner, Baldwin, and Blue (1998), they have "propelled the global agricultural economy into a more market-oriented environment with reduced government safety nets and less direct involvement of government agencies in stabilizing grain prices."

### Government Farm Support Policy

There are two major legislative changes in the Freedom to Farm bill. First, the government will no longer support commodity prices received by farmers through deficiency payments. Instead, farmers will receive a predetermined "transition" payment each year until 2002. Second, the supply is no longer controlled by acreage limitations, formerly called set aside, as well as government controlled release of grain stocks into the market. These two changes were made in an attempt to produce a more efficient price

discovery process for agricultural commodities. A market equilibrium is now signified by a freely moving price. Previously, the price was constrained to the support level, which could not be considered an equilibrium.

Because of the near perfectly competitive nature of the market, farmers have to accept the market price. Farmers cannot affect this price. Instead, they must adjust production in response to anticipated prices.

A situation involving income risk develops because farmers have a narrow time frame to make production decisions, after which the decisions are difficult, if not impossible, to change. Prices, on the other hand, will change daily. The price a farmer receives may not be sufficient to cover the variable costs, let alone total costs incurred in his operation. According to Ray and Tiller (1997), "if there was one thing analysts could agree on about the new farm bill, it was this: The bill will subject agriculture to increased price and income risk."

**International Trade Agreements**

Trade agreements, including NAFTA, GATT, and the Uruguay Round, have affected the competition from foreign supply in U.S. domestic as well as export markets. In the domestic market, the most notable effects are Canadian wheat exports to the United States which, for hard red spring wheat, "increased from 9.7 million bushels in 1990 to over 79 bushels in 1994," when NAFTA was enacted, "and then decreased to 31.9 bushels in 1997" (Koo, 1998).

GATT and the Uruguay Round were implemented to curb government export subsidies on agricultural commodities, with the Uruguay Round Agreement on Agriculture (URAA) continuing the special treatment of agriculture trade. These agreements are an

attempt to create a "fair" world market for agricultural commodities as subsidies tend to "distort agricultural trade by contributing to weakness in world market prices" (USDA, Economic Research Service, 1998). With these changes yet to be fully realized, farmers will continue to see price variability caused by international market forces.

**Currency Fluctuation**

In this "Global Marketplace," the United States is made more susceptible to foreign currency fluctuations. If a foreign currency devalues relative to the American dollar, it will not have the purchasing power, in American dollars, that it previously had. The same level of U.S. commodities exported to that region will not be supported by the currency. This fact was evidenced in late 1997 and early 1998 during the Asian monetary crisis, which was accompanied by sharply lower corn exports to that region (Wisner and Good, 1998). All of these changes increase supply and demand variability, which increases the risk of price movements that adversely affect North Dakota farmers.

## Climactic Phenomena

Periodic shifts in the currents and temperatures in the equatorial region of the Pacific, commonly called El Niño and La Niña, can have an effect on crop yields. Carlson, Todey, and Taylor (1996) have shown that the Southern Oscillation Index (SOI), a measurement of the strength of these two phenomena, has a significant correlation with crop yields in the major corn-producing states. If the SOI is strongly negative, "the probability of having an adverse year is reduced, and the probability of a favorable season increased" (Carlson, Todey, and Taylor, 1996). A positive SOI increases the probability of a bad year. In essence, it effects the summer temperatures and precipitation. These weather

changes can have an adverse impact on growing conditions, increasing the risk of poor yields.

Crop disease is one effect of poor weather conditions, particularly excessive moisture. In the case of wheat, fusarium head blight, commonly called scab, had a dramatic effect on yields from 1993 to 1997. In 1993 alone, there were $122.39 million in production losses due to scab in hard red spring wheat, with North Dakota experiencing over half of those losses. Through 1997, North Dakota continued to experience at least half of the production losses caused by the disease (Johnson et al., 1998).

## Need for Study

Variability in price and yield of agricultural commodities has a large impact on the net income of a farm which, on average, has been decreasing in recent years. According to the 1993-1997 North Dakota Farm and Ranch Business Management Annual Reports, the average net farm income for the enrolled farms, which excludes farms in the Red River Valley, has dropped by 72 percent from $54,789 to $15,190. However, in 1998, net farm income rose 82 percent from 1997 to $27,707. According to Swenson (1999), this gain was due to government disaster payments as well as record yields in corn, sunflowers, and flax.

In the Red River Valley, there has also been a decrease in net farm income. “The Financial Characteristics of North Dakota Farms” were reported for 1993-95 by Swenson and Gustafson (1996) and for 1995-97 by Swenson (1998). In these studies, a median value for the net farm income was used. Four regions of North Dakota were studied, including the Red River Valley. In the 1993-95 report, the median net farm income in the Red River Valley increased by 140 percent from $21,675 in 1993 to $52,182 in 1995. During the

same time period, all other regions posted a significant decrease, including a 72 percent decrease in the south central region.

The strength in the Red River Valley did not hold over the other regions in the time period 1995-97. In fact, the percentage decrease in median net farm income was greater in the Valley than all other regions except the west. A 46 percent decrease from $52,182 in 1995 to $28,199 in 1997 occurred.

Farmers need to develop strategies to manage the risk of price and yield variability. The Red River Valley, which includes Cass County, historically has had a higher net farm income than the rest of the state, however, it fell at a considerable rate from 1996 to 1998. Because of lower net farm income, there is a need to provide Cass County farmers with information they can use for decision making in risk management strategy formulation.

## Study Objectives

The purpose of this study is to evaluate risk management strategies that integrate responses to both production and price risk that are faced by grain farmers in Cass County, North Dakota. Specific objectives are

1. Analyze the effectiveness of integrated marketing and crop insurance alternatives in reducing gross revenue per acre variability.
2. Develop risk management strategies for Cass County grain farms.
3. Compare available risk management software, particularly the simulation model developed by David Bullock and the AgRisk model.

## Study Area

Cass County, North Dakota, is the focus of this study. One representative farm was developed to include wheat, corn, and soybeans. Actual production history from a farm in

the county raising these three crops was gathered from the Farm Bureau Agency in Fargo. Using the principle of building distributions around unknown price and yield variables, this study will explore and develop strategies to assist Cass County farmers with price and yield risk management.

## Outline

This study is organized in six chapters. Chapter 2 contains a Review of Risk, and responses to price and yield risk. Chapter 3 explains the Data used in the analysis. Chapter 4 reviews the models used in the analysis as well as the various integrated risk-management strategies tested. Chapter 5 contains the Results of the analysis. Chapter 6 is a summary and conclusion of the analysis, including suggestions for further study.

# CHAPTER 2

# REVIEW OF RISK

Risks faced by farmers have been studied and reported in articles for many years. Responses to risk have been identified, and strategies that integrate them have been developed to permit more efficient farm management when risk is encountered. This chapter begins by reviewing risk attitudes and responses to risk, and is followed by recent studies reviewing price and production risk management strategies.

## Risk Attitudes

An individual's attitude toward risk, especially the risk of losing dollars, is important in developing risk-management strategies. Based on the theory of diminishing marginal utility, it can be assumed, that if an individual's utility of wealth function is concave, Figure 1, he will refuse an actuarial fare bet. The expected utility of a 50-50 bet is less than the expected utility of refusing the bet because winning X number of dollars means less to that individual than loosing X number of dollars. The individual is said to be risk averse. However, Bierman , Bonini, and Hausman (1986) state that it is possible for a decision-maker to be risk preferring (Figure 2) over a range of the utility function. In this case, the expected utility of accepting a 50-50 bet is greater than the expected utility of refusing that bet.

"Jerry Robinson, Jr., Professor of Sociology and Rural Sociology at the University of Illinois, suggests four basic classifications of risk attitudes" (Patrick, 1992). They are Avoiders, Calculators, Adventurers, and Daredevils; and are described in this study relative to the utility function.

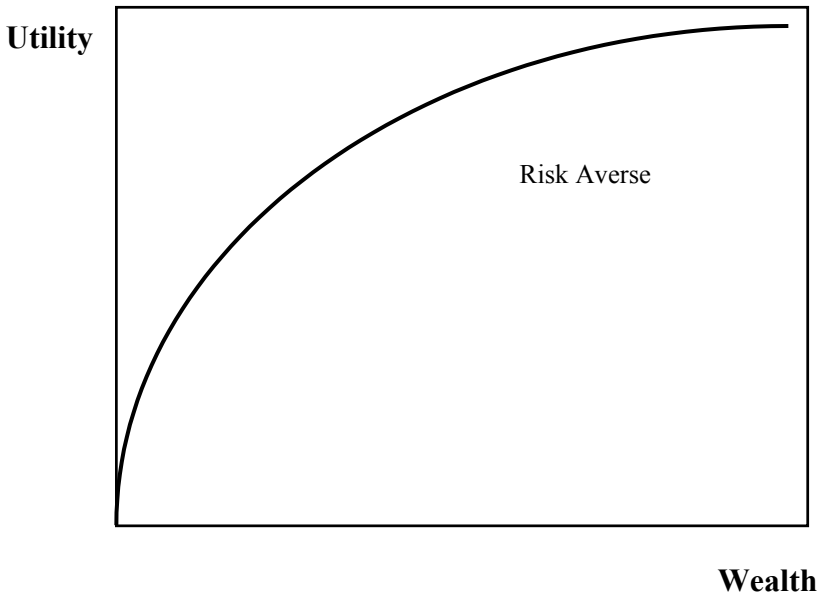



Figure 1. Risk Averse Utility Function.

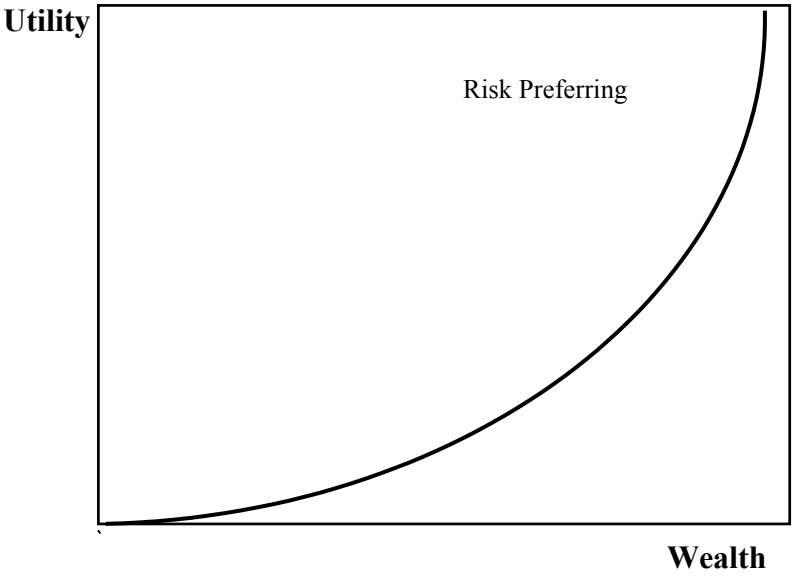



Figure 2. Risk Preferring Utility Function.

Individuals who are considered Avoiders are risk averse and will avoid situations where a loss may occur. Farmers who are of this attitude generally lose, or just manage to survive, because they miss opportunities to profit.

Daredevils are the opposite of Avoiders; they leap into a situation without weighing the possible outcomes. These individuals can be considered risk neutral since risk has no bearing on their decision. Because of their refusal to take precautions, they commonly fail.

Adventurers enjoy risks, and often look for the chance to take risk but keep the stakes reasonable. This type of individual is risk preferring up to the point on the utility curve where the risk of loss is no longer reasonable. After that point is reached, the individual becomes risk averse. Many farmers may fall into this category with their marketing plans; if financial survival is not at stake, they may enjoy "playing" the market.

Most farmers are Calculators, understanding that they must take some risk to get ahead, but before making a decision, they gather information and weigh the odds. Calculators recognize the risks and try to keep them at acceptable levels. They may be more or less risk averse. That is, they may appear to be risk-seeking at times when, in reality, cash flow needs may be forcing them to take actions that they would prefer not to take. In essence, cash flow considerations trump risk aversion.

## Ability to Assume Risk

A producer's ability to assume risk is directly associated with his current financial situation. More exactly, the ability to assume risk is related to the solvency and liquidity of the individual's financial situation.

Liquidity is the ability to satisfy financial obligations when they come due without disrupting the business. It is usually measured with a current asset to liability ratio, which

shows how much of the individual's assets can quickly be converted to cash with little or no loss in value. Solvency is the relationship between total assets, liabilities, and owner equity. It is the individual's ability to repay all debts if assets were liquidated.

The ability to assume risk is also affected by cash flow requirements. These obligations include cash costs, taxes, loan repayment, and family living expenses that must be met each year. The greater the percentage of these obligations to total cash flow, the lower is the ability to assume risk. Wisner (1998) emphasizes that "one size does not fit all" when risk management strategies are developed, stating that they need to be "coordinated with the farm's financial structure and needs."

Edwards (1998) uses a cash flow risk ratio to measure what level of crop production can be subjected to price risk. This ratio is calculated by dividing the cash flow breakeven price per bushel by the expected market price per bushel, which measures the degree of marketing flexibility that the financial situation allows.

Edwards (1998) also developed four example financial situations for a particular farm. They were owners, cash renters, crop-share renters, and new buyers, which are represented in Table 1. Owners are debt free and hold title to all of the land. Cash renter's cash rent their entire land base and have some machinery debt. Crop-share renters have a 50-50 lease agreement on all of their land, with some machinery debt. Buyers have recently purchased some of the land and cash rent the rest. They hold the same machinery debt as the cash and crop-share renters. Because of their differing financial situations, "they take very different approaches to managing risk and pursuing profits" (Edwards 1998).

Table 1. Example Farm Financial Situations: Costs Per Acre

| Item | Owner | Renter | Crop-Share | New Buyer |
|---|---|---|---|---|
| Seed, Fertilizer, Pesticides | 110 | 110 | 55 | 110 |
| Insurance, Interest, Misc. | 20 | 27 | 15 | 30 |
| Fuel and Repairs | 20 | 20 | 20 | 20 |
| Drying | 14 | 14 | 7 | 14 |
| Custom Hire and Labor | 10 | 10 | 10 | 10 |
| Rent and Real Estate Taxes | 21 | 120 | 0 | 79 |
| Fixed Debt Payments | 0 | 11 | 11 | 64 |
| Family Living, Income Tax | 69 | 56 | 57 | 60 |
| **Total Cash Flow Needs** | **$264** | **$368** | **$175** | **$377** |

Source: Edwards (1998).

In a 1998 study, O'Toole examined how financial situations may affect the risk management decisions of a farmer. Using the Agricultural Risk Management Simulator (ARMS) model, value at risk distributions were calculated for various strategies that included diversification, crop insurance, and forward contracting. For a producer in the Minot, North Dakota, area, a diversification strategy realized less net cash flow on average than a non-diversification strategy, however, chances of survival were better because the breakeven net cash flow strategy was at a higher probability level.

This example implies that a producer with little or no debt, such as an owner, may choose a basic crop mix because the upside potential is probably greater. A producer with a high debt-to-asset ratio would more likely choose diversification because survival is more certain.

## Responses to Price and Yield Risk

A study was conducted in 12 states to determine which sources of variability, or risk, are important in crop production. A small number of producers were asked to indicate

which sources they found most important. The results indicated that weather and output prices held the greatest importance. Other sources of risk mentioned included technological, legal, and human risks (Patrick, 1984).

There are pre-harvest marketing alternatives that can be used as responses to price risk, as well as insurance products developed as responses to both yield and price risk. Marketing alternatives to be considered are harvest time cash sales, forward contracting, short hedging with futures, and hedging with options. Federally subsidized multi-peril crop insurance products include catastrophic coverage (CAT), multi-peril coverage (MPC), crop revenue coverage (CRC), income protection coverage (IP), and revenue assurance (RA). Unsubsidized insurance products are offered by private companies and may include hail and other "weather" insurance, as well as multi-peril add-ons.

## Marketing Responses

Pre-harvest marketing responses are used to reduce the adverse effects of price movements by reducing the possible price outcomes that may be realized at the time of sale. Wisner (1998) found historically that, in new crop pricing opportunities from planting to harvest, the probability for price weakness is greater than for price strength in corn and soybeans.

Basis risk, futures price risk, and spread risk are the three components of price risk that must be managed. Spread risk can be eliminated if all forward contracting and hedging are done with the same month and market used for delivery. This strategy will eliminate the need to roll a position, a procedure that is exposed to spread risk. Because spread risk can be avoided, futures and basis risk have been the main focus in farm price risk reduction. There are four principal forward elevator contracts in the cash market which are

used to manage futures and basis risks. These four contracts include cash forward, basis, futures fixed, and minimum price contracts; and are described below. Short futures hedging and the use of put options can also be used to eliminate futures price risk.

**Elevator Contracts**

Cash forward contracts allow farmers to fix a settlement price for future delivery, eliminating basis and futures risk. These contracts work well when a price objective is reached during the growing season and when crops are large. As with all four types of forward contracts described, there is a risk of not meeting the quantity specification of the contract, so the purchase of adequate insurance should be considered to guarantee the amount of crop that is contracted.

Basis contracts fix the basis, calculated as the local cash price minus the futures price, allowing the futures portion of the settlement price to be fixed at a later date. Basis fixed contracts are optimal when the basis is relatively strong and there is potential for an increase in the futures price.

Futures fixed contracts, or hedged-to-arrive contracts (HTA), are similar to a short hedge in the futures market, except the elevator takes on the short futures position and pays any margin calls incurred by that position. This contract allows the producer to fix the futures price on the date of the contract while the basis level is selected in the future. The HTA is useful when the futures price is favorable and the basis is expected to strengthen.

Minimum price contracts establish a price floor. A call option is usually purchased by the elevator at the strike price specified by the producer. The premium and a service fee are subtracted from the current, cash forward contract price to establish the minimum cash price. The producer will benefit from a price move above the call strike price that is greater

than the option premium plus the service charge. Any risk from a price movement below the minimum price is eliminated, therefore eliminating both futures and basis risk.

**Futures Market Contracts**

Short futures hedging involves selling futures contracts to protect the value of the underlying cash position, eliminating futures risk. A short hedge will work well if prices are declining, reducing the down side risk to basis risk. However, the ability to capture the upside potential is removed. To avoid speculating, the short futures position should be offset when a cash sale is made by buying back the futures position that was sold.

Despite the theoretical advantages of hedging with futures, it appears that many U.S. farmers use futures to a limited extent. Some reasons for not hedging may include the production risk involved, lack of knowledge of the hedging process, margin calls, forward contract alternatives, and production not matching the size of a futures contract.

Put options on futures contracts can be used as price insurance by paying a premium to establish a price floor. A put option gives the owner the right, but not the obligation, to sell the underlying futures contract at the specified strike price. A typical way of closing a long put option position is by offsetting, in effect selling a put at the same strike price. A profit on the position will be realized if the premium from the sale less transaction costs is greater than the premium paid. If the sale premium less transaction costs is less than the purchase premium, there will be a loss on the position. A sale closing a put option position will only be made if the premium received is greater than selling costs, in which case, if a loss is incurred, it will be less than the loss from allowing the option to expire worthless.

Income level and variation for selected marketing strategies were compared for various crops including hard red spring wheat in southeast central North Dakota by Elhard in 1988. The post-harvest strategies were statistically tested with a mean-variance dominance test. Surviving strategies were then included in a target-MOTAD linear programming model. The study found that absolute income deviations increased as the net income requirements were increased. Marketing strategies which used the futures market entered the solution when lower incomes entered the model. Included in the resulting strategies for hard red spring wheat was selling one-third of the production in each of October, November, and May. These months were also used for selling when hedging one-third in the Minneapolis Grain Exchange (MGE) December futures contract.

Flaskerud and Shane examined pre-harvest pricing techniques for hard red spring wheat in 1993. They stated that a producer may choose to sell the first one-third of anticipated production using cash forward contracts or minimum price contracts. Achieving that much production was seen to be highly probable, and would result in acceptable cash flows for most producers. A minimum price for the second one-third would be set using a September put option, which establishes a price floor but would not require delivery.

## Crop Insurance Products

Crop insurance products are risk management tools that transfer production risk, and, with certain products, price risk from the farmer to others through a premium. They protect against losses while offering the opportunity for more consistent gains. Crop insurance coverage brings two important benefits. First, a specific level of cash flow can be ensured. Second, marketing plans can be pursued more aggressively as a level of

production has been ensured, allowing for the confident use of forward pricing mechanisms on that level of production.

In a 1996 study of preferred risk management strategies under the 1994 Federal Crop Insurance Act, Hu found that participation in the crop insurance program has increased. This analysis implies that farmers are now more readily using insurance as a risk management tool.

The insurance product that farmers have focused on the most has been subsidized multi-peril insurance, which covers almost any natural cause of production loss. These causes may include drought, excess moisture, frost/freeze, hail, wind, plant disease, flood, insects, and others such as wildlife.

**Catastrophic Coverage**

CAT coverage is the lowest level of subsidized multi-peril insurance available. It was also the lowest level required in order to be eligible for any government programs in 1995. Today, uninsured producers must waive the right to any emergency assistance on insured crops, except emergency loans (Edwards, 1999). Premiums for CAT are entirely subsidized by the government, but farmers have to pay an administrative fee. The coverage level offered is 50 percent of the actual production history (APH) of the farm for that particular crop, and indemnities will be paid at 55 percent of the Federal Crop Insurance Corporation (FCIC) price. The APH is a simple average of from 4 to 10 consecutive years of actual yields. If the farmer is missing one of the four years of APH for that crop, a county "t-yield" is used for the missing year. However, if two or more years are missing, only a percentage of the county t-yield can be used (Hofstrand and Edwards, 1999).

**Multi-Peril Coverage**

Multi-peril insurance allows the farmer to buy larger levels of protection over CAT coverage. Two decisions determine the amount of coverage obtained from MPC, the level of yield coverage and the level of price coverage. The level of yield coverage can generally be from 50 to 75 percent, in 5 percent increments, of the APH or county t-yields. In Cass County, coverage for wheat can be from 50 to 85 percent. The level of price coverage can be 55 to 100 percent of base price established by the Risk Management Association (RMA). Usually the 100 percent level of price coverage is selected. An indemnity would be paid by multiplying the price selection by the amount the yield selection on the insured production exceeds the actual production. The farmer has the option of combining all of the acres of a crop in the county into one unit to be insured, or the crop can be separated into smaller units, usually no less than a quarter section (160 acres). Also included in this plan is re-plant and prevented planting coverage. Re-plant coverage will pay the cost for re-planting if the crop is severely damaged and will not produce 90 percent of the guaranteed yield. Prevented planting will guarantee 60 percent of the original yield coverage if the crop cannot be planted at all (Hofstrand and Edwards, 1999).

**Crop Revenue Coverage**

CRC resembles MPC as it utilizes the same means to cover production losses, but it also adds selling price protection. To establish a price guarantee, a base price and a harvest price are calculated. The greater of the two is used in the calculation for the guaranteed revenue. Limits are placed on the fluctuation of the harvest price above and below the base price. For wheat it is $2.00, corn $1.50, and soybeans $3.00.

In an example using hard red spring wheat, the base price is the daily average of the MGE September hard red spring wheat futures contract settlement price in the month of February. The harvest price is the daily average settlement price of the MGE September hard red spring futures contract in the month of August. The guaranteed revenue per acre is calculated by multiplying the greater of the two prices by the insured production level. Harvest revenue is calculated by multiplying the harvest price as determined in the CRC contract by actual production. An indemnity payment is made if the guaranteed revenue is greater than the harvest revenue. The payment will equal the difference between the guaranteed and harvest revenues. Re-planting and prevented planting are covered by the final guarantee and are subject to the same specifications as those in MPC.

**Income Protection**

IP coverage is somewhat similar to CRC. The difference is that the total acres of a crop in a county cannot be split into separate units, they must be in one "enterprise" unit. The base price and the harvest price are calculated exactly the same as in CRC, except the CBOT futures contracts are used for all crops. The use of the Chicago Board of Trade (CBOT) wheat futures price will create a spread risk between the MGE and CBOT when calculating prices for hard red spring wheat. The guaranteed income is the base price times the APH insured. An indemnity occurs when the harvest price times the actual yield is less than the guarantee.

**Revenue Assurance**

RA coverage is another product that offers selling price protection. The units insured can be separated down to the quarter of land, enterprise units, or whole farm units. Whole farm coverage includes all of the wheat, corn, and soybeans in a county. Coverage

levels for the basic and optional units are from 65 to 75 percent. Enterprise and whole farm coverage levels are from 65 to 85 percent. The projected price used for the revenue guarantee is calculated in the same manner as the base price for CRC. A harvest price is also calculated in the same manner as CRC. The revenue guarantee for RA is the base price times the selected yield coverage. However, a harvest price option is available for an additional cost. The harvest option makes the coverage similar to CRC without the limits on the harvest price/base price differential.

In 1986, Petry evaluated the risk reduction for each insurance coverage option offered from an individual and whole farm perspective. The results indicated that crop insurance could eliminate all farm net cash flows less than 51 to 65 percent of the average net cash flow. “In other words, crop insurance could make up the shortfall of a few observations below a relatively low target value” (Petry, 1986). Crop insurance did not guarantee profits, as it had little effect on average returns. Thus, producers with high cash flow needs cannot effectively “eliminate all detrimental net cash flow outcomes” (Petry, 1986).

## Integrated Strategies

Wisner, Baldwin, and Blue (1998) state that the pre-harvest pricing objective is not to minimize variance of gross returns over a period of years, nor is it focused on generating a higher net price than harvest cash sales. It is to meet the cash flow needs of the farm by protecting favorable net returns offered at a point in time. In their cash flow analysis, they find that minimizing variance on income is not necessarily an effective risk management strategy for producers who face high cash flow risk ratios.

Much research has dealt with minimizing hedge ratios, which calculate a percentage of the expected production to be hedged. However, these studies neglect the yield portion of the risk management problem. “Avoiding exposure to futures losses that are not offset by cash market gains are key factors in making the pricing objective work effectively” (Wisner, Baldwin, and Blue, 1998).

Their study indicated that pre-harvest pricing plus MPC held significantly greater returns in both Iowa and Ohio for soybeans, but only in Ohio for corn, than the naive harvest pricing strategy. CRC plus pre-harvest pricing did not generate significantly different net returns than the naive strategy.

# CHAPTER 3

# DATA

Information on what data were used and how they were gathered is included in this chapter. The decision on what crops to include is discussed first, followed by county and state data used in calculating price and yield correlations. Individual farm data, including yield history, insurance premiums paid, and pre-harvest pricing levels, are discussed in the last sections.

## Crops Included

A total of 1,800 acres of cropland was used in the Cass County representative farm. Crops included in the operation were wheat, corn, and soybeans. The county highlights section in the 1998 North Dakota Agricultural Statistics (NDAS) publication show that these three crops had the highest number of harvested acres in 1997 in Cass County.

The harvested acres for the three crops in Cass County were used to calculate the acres of these crops planted on the representative farm. The three were added together, and a percentage of that total was calculated for each crop. This percentage was then multiplied by the total representative farm acres to arrive at the acres planted for each crop, Table 2.

## County, Crop Reporting District, and State Data

County, crop reporting district (CRD), and state data were used in the calculations of price, yield, and price/yield correlation coefficients. These data are frequently used rather than individual farm data in calculating these types of correlation coefficients.

Table 2. Calculation of Acres Planted on a Representative Farm

| Crop | Harvested Acres* in Cass County 1997 | Percentage of Total Harvested Acres | Calculated Acres of Each Crop on Representative Farm | Acres of Each Crop Planted on Representative Farm |
|---|---|---|---|---|
| Wheat | 377,000 | 47 | 846 | 860 |
| Soybeans | 349,800 | 43 | 774 | 780 |
| Corn | 72,300 | 9 | 162 | 160 |

*Source: North Dakota Agricultural Statistics Service.

Cass County yields, Table 3, were gathered from the NDAS, 1980-98. For each crop, yield was calculated per planted acre (bushels per acre). Using this measure of yields gives the best representation of total crop yield variability and enterprise production. All planted acres may not have been harvested, but they have a cost associated with them, which needs to be considered. To calculate corn yields, silage and forage acres were subtracted from the total corn acres planted. Forage was included in NDASS tables until 1985.

In a 1998 study, O'Toole tested for trend in county yields for the 10 most common crops grown in North Dakota. T-tests were conducted on regression coefficients for each crop in seven counties, Cavalier, Trail, Foster, Adams, Stark, Ward, and Williams Counties, to determine if a trend was present. Results indicated that no trend was present at the five percent significance level. Therefore, actual yields were used.

The prices used were marketing year seasonal average prices received by producers, gathered from NDASS, 1980-98. For wheat, the East Central CRD values were used. For corn and soybeans, state values were used, which are predominantly from

southeast North Dakota. Prices were adjusted for inflation using the index of prices paid by farmers with

Table 3. Cass County Yields (bu/a) Per Planted Acre

| Year | Wheat | Corn | Soybeans |
|---|---|---|---|
| **1980** | 25.5 | 52.3 | 19.4 |
| **1981** | 31.0 | 83.0 | 29.5 |
| **1982** | 38.5 | 69.3 | 22.4 |
| **1983** | 32.1 | 75.4 | 29.4 |
| **1984** | 48.4 | 66.8 | 22.0 |
| **1985** | 55.2 | 76.1 | 28.0 |
| **1986** | 33.3 | 104.7 | 37.9 |
| **1987** | 42.7 | 97.1 | 34.2 |
| **1988** | 18.0 | 46.5 | 13.0 |
| **1989** | 38.8 | 52.2 | 19.4 |
| **1990** | 53.4 | 84.3 | 28.0 |
| **1991** | 40.5 | 96.0 | 31.5 |
| **1992** | 48.9 | 59.6 | 26.8 |
| **1993** | 30.4 | 45.3 | 15.4 |
| **1994** | 34.7 | 95.5 | 28.9 |
| **1995** | 31.8 | 82.3 | 27.8 |
| **1996** | 44.5 | 93.2 | 30.8 |
| **1997** | 30.8 | 103.0 | 31.4 |

Source: NDAS, 1980-1998.

base years of 1910-14 = 100 (National Agriculture Statistical Service (NASS), 1987 and 1997). To inflate prices to current levels, the 1996 index was divided by each year's index and then multiplied by that year's price, Table 4.

Table 4. Inflated Marketing Year Average Prices ($/bu) 1980-1996

| Year | Wheat | Corn | Soybeans |
|---|---|---|---|
| **1980** | 5.84 | 4.09 | 6.22 |
| **1981** | 4.88 | 2.99 | 4.70 |
| **1982** | 4.64 | 3.12 | 4.31 |
| **1983** | 4.82 | 3.82 | 5.88 |
| **1984** | 4.39 | 3.18 | 4.38 |
| **1985** | 4.14 | 2.76 | 3.86 |
| **1986** | 3.41 | 1.89 | 3.91 |
| **1987** | 3.73 | 2.52 | 4.40 |
| **1988** | 4.93 | 3.06 | 5.61 |
| **1989** | 4.38 | 2.70 | 4.13 |
| **1990** | 2.92 | 2.50 | 4.07 |
| **1991** | 3.7 | 2.51 | 3.92 |
| **1992** | 3.52 | 2.10 | 3.83 |
| **1993** | 3.87 | 2.52 | 4.30 |
| **1994** | 3.73 | 2.23 | 3.55 |
| **1995** | 4.95 | 3.33 | 4.33 |
| **1996** | 4.21 | 2.43 | 4.47 |

Source: NDAS, 1980-98.

Yield, price, and price-yield correlation coefficients were calculated using the yearly data from 1980-96. The correlation matrix, Table 5, includes the correlation coefficients of the price and yield for each crop.

Table 5. Price and Yield Correlation

| | Wheat Yield | Corn Yield | Soybean Yield | Wheat Price | Corn Price | Soybean Price |
|---|---|---|---|---|---|---|
| Wheat Yield | 1.000 | 0.305 | 0.387 | -0.601 | -0.396 | -0.611 |
| Corn Yield | 0.305 | 1.000 | 0.931 | -0.455 | -0.420 | -0.434 |
| Soybean Yield | 0.387 | 0.931 | 1.000 | -0.457 | -0.408 | -0.396 |
| Wheat Price | -0.601 | -0.455 | -0.455 | 1.000 | 0.867 | 0.771 |
| Corn Price | -0.396 | -0.420 | -0.408 | 0.867 | 1.000 | 0.822 |
| Soybean Price | -0.611 | -0.434 | -0.396 | 0.771 | 0.822 | 1.000 |

## Individual Farm Yield Data

Yield data from an individual farm was used for the evaluation of risk management strategies. Unlike the calculation of correlation coefficients, the variability in individual farm data is needed for this process. If county, CRD, or state data were used, the high and low values for individual farms would be eliminated, reducing the effectiveness of the output in the decision process of individual farmers.

Yield data were collected for a single farm in Cass County that had a 10-year history of raising wheat, corn, and soybeans. This information was provided by the American Farm Bureau Insurance Services Agency in Fargo. APH was calculated for each crop by averaging the historical yields, Table 6. Also included in the table are the yield standard deviations and coefficients of variation.

Table 6. Individual Farm Yield (Bu/A) Data

| | Wheat | Corn | Soybeans |
|---|---|---|---|
| 1987 | N/A | 110.0 | 39.5 |
| 1988 | N/A | 19.0 | 19.0 |
| 1989 | 40.7 | 30.0 | 18.1 |
| 1990 | 50.9 | 97.0 | 42.7 |
| 1991 | 43.2 | 108.0 | 42.6 |
| 1992 | 52.0 | 69.0 | 31.4 |
| 1993 | 30.9 | 3.0 | 25.9 |
| 1994 | 28.7 | N/A | 25.6 |
| 1995 | 15.3 | 53.0 | 30.8 |
| 1996 | 46.4 | N/A | 33.8 |
| 1997 | 23.5 | N/A | 31.1 |
| **APH** | **36.8** | **61.1** | **31.0** |
| **STDV** | **12.8** | **41.6** | **8.4** |
| **CV** | **0.4** | **0.7** | **0.3** |

Source: American Farm Bureau Insurance Agency, Fargo, ND.

The Bullock model uses a double-truncated normal distribution for yields; therefore, minimum and maximum yields must be specified for each crop. Zero yield was used for the minimum in all crops. For the maximum yield, 80 bushels per acre was used for wheat, 200 bushels per acre for corn, and 60 bushels per acre for soybeans.

Insurance premium quotes for these crops were provided by American Farm Bureau Insurance Agency in Fargo. Policies quoted were CAT, MPC, CRC, RA, and IP for wheat only. Table 7 includes the premiums per acre for the 65 percent level of coverage. The

Table 7. Insurance Premiums and Base Prices

| | Wheat | Corn | Soybeans |
|---|---|---|---|
| **CAT** | | | |
| Base Price ($ per bu.) | 1.82 | 1.16 | 2.89 |
| Cost per Policy | 60.00 | 60.00 | 60.00 |
| **MPC** | | | |
| Base Price ($ per bu.) | 3.30 | 2.10 | 5.25 |
| 65% (premium per acre) | 3.29 | 8.24 | 3.96 |
| **CRC** | | | |
| Base Price ($ per bu.) | 3.53 | 2.40 | 5.11 |
| 65% (premium per acre) | 4.79 | 13.29 | 5.64 |
| **RA** | | | |
| Projected price ($ per bu.) | 3.53 | 2.40 | 5.11 |
| 65% (premium per acre) | 4.97 | 12.77 | 6.71 |
| **IP** | | | |
| Projected price ($ per bu.) | 2.89 | N/A | N/A |
| 65% (premium per acre) | 2.61 | N/A | N/A |

Source: American Farm Bureau Insurance Agency, Fargo, ND.

premium for CAT coverage is also included, but it is quoted per policy because it is only an administrative fee.

## Prices

Several sets of prices were used in the analysis, including local elevator forward contracting prices, futures prices, and put option premiums. All prices were collected for April 26, 1999.

Prices for cash forward, minimum price, basis fixed, and HTA contracts were collected from Hunter Grain Company, Hunter, North Dakota, Table 8. Forward contracts

Table 8. Hunter Grain Company Forward Contracting Prices ($/bu)

| | Wheat | Corn | Soybeans |
|---|---|---|---|
| Cash Forward | 3.01 | 1.78 | 4.35 |
| Minimum Price | 2.81 | 1.56 | 3.98 |
| Basis Fixed | -0.38 Sept | -0.57 Dec | -0.70 Nov |
| HTA | 3.40 | 2.35 | 5.05 |
| Short-Fall Penalty | 0.05 | 0.05 | 0.05 |

Source: Hunter Grain Company, Hunter, ND.

were for August delivery in wheat, and October for corn and soybeans. A two-cent service charge was included in the minimum price contract, and a five-cent shortfall penalty was specified if the contracted bushels could not be delivered. An 11-year historical basis average and standard deviation were calculated for the specified delivery months at the Hunter Grain Company, Table 9.

Table 9. Hunter Grain Company 11-Year Historical Average and Standard Deviation of the Basis During Specified Delivery Months (in parentheses)

| | Wheat (August) | Corn (October) | Soybeans (October) |
|---|---|---|---|
| Futures Contract | September | December | November |
| Average | -0.166 | -0.328 | -0.45 |
| Standard Deviation | 0.206 | 0.096 | 0.073 |

Source: Flaskerud, George. Basis for Selected North Dakota Crops, 1997.

Futures prices were collected from the Data Transmission Network (DTN) and included the MGE September contract for wheat, the CBOT November contract for soybeans, and the CBOT December contract for corn. They can be found in the HTA section of Table 8. Premiums for the $3.40 September Minneapolis wheat, $2.30 December corn, and $5.00 November soybean puts were also collected, Table 10. These strike prices

Table 10. Put Premiums, April 26, 1999

| | Wheat | Corn | Soybeans |
|---|---|---|---|
| 3.40 Sept. Put | 0.195 | | |
| 2.30 Dec. Put | | 0.1575 | |
| 5.00 Nov. Put | | | 0.31 |

Source: Data Transmission Network (April 26, 1999).

were selected to be as close to at-the-money as possible. Call option premiums at the same strike prices are listed in Table 11. These values were needed to calculate the implied volatility of the corresponding futures market contract, which is used to calculate the standard deviation of the futures price.

Table 11. Call Option Premiums, April 26, 1999

| | Wheat | Corn | Soybeans |
|---|---|---|---|
| 3.40 Sept. Call | 0.185 | | |
| 2.30 Dec. Call | | 0.2025 | |
| 5.00 Nov. Call | | | 0.35 |

Source: Data Transmission Network, 1999.

Transactions in the futures market have a cost associated with them, mainly a commission fee, which must be included. The cost of $.016 per bushel was used for futures transactions; $.007 per bushel was used for buying options; and $.0075 per bushel was used for selling options. An initial margin deposit is required for futures contracts and is usually a percentage of the value of the contract. The Linnco Futures Group requires three

percent for hedging positions; therefore, $500 is required for wheat, $300 for corn, and $800 for soybeans.

Cass County loan prices were needed to calculate any possible loan deficiency payments (LDP) for the three crops. Values for 1999 had not been released, but according to the Farm Credit Services Agency of Cass County, they were expected to be close to the same as 1998, so those values were used. The loan value was $2.72 for wheat, $1.76 for corn, and $4.94 for soybeans.

# CHAPTER 4

# MODELS AND STRATEGIES

Two simulation models were used in the analysis of integrated farm risk management strategies. The Bullock model was spreadsheet based while AgRisk was a stand-alone program. Both of these models estimate the distribution of a farm's gross revenue at harvest time and have been the latest models developed for the study of risk-management strategies. The Bullock model was used to analyze strategies that were compared with results from the AgRisk model. Descriptions of each model will be presented, followed by an explanation of the strategies tested.

## Bullock Model

Bullock (1999) developed a Microsoft Excel Spreadsheet based model which uses the @Risk™ add-on package to perform simulation modeling. This model was chosen because its calculations can be viewed, which provides for an understanding of how it works.

The model is divided into seven sections in which price and yield data are entered. All cells in the model which require user input are color coded blue; the black-coded cells display the calculations of the model.

### Farm Information

The first section is called "Farm Information." In this section, a farm name, the present date, and the crop year can be specified. The model has the capacity to analyze five separate crop enterprises and will include those which are specified with a "1" in the "Include in Analysis?" cell. The name of the crops, the acres planted of each, and the unit measurement (bushels) are specified. A target value, which is usually a breakeven value

selected by the individual, is also included. This value will be used in the calculation of the net revenue distributions.

**Crop Distributions**

Crop distribution information is entered in the second section, with a separate sheet for each crop. The appropriate futures contract and price for that crop are entered. This price will be used as the expected value, or mean, in a lognormal price distribution. To calculate the volatility of the market, the Black–Scholes Model for option pricing is used. The implied volatility calculated from this model is multiplied by the futures price to find the standard deviation of the price distribution. Values that are needed in the implied volatility calculation are an at-the-money call option strike price and premium, the expiration date of the option, and the interest rate on a three-month T-bill. There is also a space to manually enter a volatility instead of using the model's calculation.

Two methods are available for the input of historical basis and yield data. They can be entered in a table, which automatically calculates the average and standard deviation, or if those values have already been calculated, they can be entered manually. Minimum and maximum values need to be entered because the distribution used for yields is a double-truncated normal. A zero value should be used for the minimum while the maximum is arbitrary but within reason. A normal distribution is used for the basis distribution.

Spread risk is also addressed in this section. If there is a spread risk involved with any of the insurance products, such as IP coverage in wheat, an expected value and standard deviation of that spread are entered to form a normal distribution.

**Correlation**

Price and yield correlation coefficients are entered in the third section. These values are not calculated by the model and must be entered manually. This section is similar to Table 5, however, only half of the matrix needs to be entered; the model enters the redundancies.

**Crop Risk Management Components**

Crop risk management components are specified in the fourth section. There is a separate sheet for each crop. First, a county loan rate is specified, which is used to calculate any LDP. Prices for forward elevator contracts are specified next; and include cash forward, minimum price, basis fixed, and HTA. A contract shortfall penalty for non-delivery is also specified.

The futures market is the next part of this section. The futures price for the appropriate contract month is entered, as well as a futures contract purchase cost. Call and put option strike prices and premiums can be entered in table form, with space for 10. A cost for purchasing and selling options can also be entered. As with the futures cost, this value is calculated by dividing the commission fee by the units (bushels) in the contract.

Insurance products are covered next. The APH is entered for that crop, as well as the coverage price for MPC and projected prices for CRC, RA, and IP. Coverage level and price election can be specified for each type of coverage. Also entered are service fees and premiums for each type of coverage. The premium is the only value entered for CAT coverage. The model then calculates a net indemnity payment, which will be negative if there is not a shortfall.

A “Master Strategy” list is the next section. The names for up to 10 strategies to be analyzed are entered here. The model pastes these names to the following “Crop Strategy” section.

**Crop Risk Management Strategies**

In the “Crop Strategy” section, the user can specify if an available LDP will be collected. Also in this section, bushels to be forward contracted at the elevator and on the futures market are entered. The quantity specifications of futures and options contracts must be followed when entering amounts for those contracts. Insurance products are selected by placing a “1” in the cell representing the type and level of coverage for a specific strategy, however, only one type and level of coverage other than CAT can be used per crop. The single crop gross and net revenues are then calculated for each strategy.

These values are summed under each strategy and divided by the total acres to arrive at a whole farm gross and net revenue per acre for the strategy, which is found in the last section, “@Risk Outputs.” These values can then be selected as output values to be calculated by the simulation procedure.

Results from the simulation are given by @Risk and will include a statistics section that contains the values at risk, mean, and standard deviation. A description of the sensitivities of each output value specified is given, based on a standardized coefficient of the independent variables, and ranks the independent variables on how greatly they are affecting the value of the dependent variable. Scenarios can also be specified which will give the percentage of occurrences when the actual value of the output will be below the value entered.

## AgRisk Model

AgRisk is a stand alone risk-management analysis program developed by Schnitkey, Miranda, and Irwin (Miranda, 1999). This model uses simulation modeling to project the distribution of a farm's gross revenue at harvest time for alternative risk-management strategies. The model has three sections in which information is entered.

### Farm Information

The first section, "Farm Information," is divided into several windows, each asking for data about the individual farm. A farm name can be specified, followed by the crop year that is being analyzed. The state and county where the majority of the crops are grown must also be specified as the model uses the average county yield for that year if individual farm yields are not entered. Wheat, corn, soybeans, and grain sorghum are the crops that can be specified. The acres planted of each crop are also entered. When the crops have been specified, the model calls for a 10-year yield history of each, allowing individual yields to be entered if they are available. Again, if they are not, county average yields from the model's database will be used. Once all of the information in this section is entered, distributions for the crop yields are calculated by the model.

### Market Information

The "Market Information" section includes information on futures, options, and basis. The date for which prices are available is entered in the first page, followed by the interest rate on a six-month T-bill. The prices of the appropriate futures contract, an at-the-money put option strike, and premium are called for in the following windows. The last window of this section asks for a harvest time average basis, which the model uses to project a basis distribution. Basis can be input as a local harvest price relative to the

appropriate futures contract, or the county basis provided from the models database can be used. When all of the information has been entered, AgRisk calculates a nonuniform discrete distribution for the price of each crop.

**View Results**

The "View Results" section calculates a gross revenue distribution for the farm based on specified strategies. A base strategy representing cash harvest sales, with no insurance or marketing alternatives included, is presented upon entering this section. Three strategies can be formulated, and the base strategy can now be altered. Results from the three strategies can be viewed together with the base strategy results, which include the average gross revenue, and the 5, 10, and 25 percent levels of value at risk. The gross revenue distribution can be viewed as dollars per whole farm or dollars per acre. More detailed information on the distribution that will include more percentage levels of values at risk and the standard deviation can be viewed. Also included in the details section is a graph showing the gross revenue distribution.

The three strategies can also be modified by adding or deleting market contracts and insurance products. Included in the marketing alternatives are cash forward and minimum price contracting at the elevator. In the futures market, futures hedging as well as put and call options are offered as alternatives. Insurance products included are MPC, CRC, and RA.

## Strategies Tested

Strategies tested (Table 12) were a combination of marketing alternatives and insurance products, and included a base strategy. The base strategy was a harvest cash sale of all production with CAT coverage. CAT coverage was included in the base strategy

Table 12. Marketing Strategies Used in the Initial Whole Farm Scenario Simulation

| CFC | Min Price | Basis Fixed | HTA | Puts | Futures |
|---|---|---|---|---|---|
| 33% | 33% | 33% | 33% | 33% | 33% |
| 66% | 66% | 66% | 66% | 66% | 66% |
| 33% + 33% Puts | 33% + 33% Puts | | | | |
| 33% + 33% Futures | | | | | |

because it is the minimum level of insurance required to receive any type of government payment; therefore, it was assumed that most farmers would carry that level of coverage. All forward elevator contracts available in the Bullock model were used at the 33 and 66 percent contracting levels. Futures hedging and options were used individually and in conjunction with forward contracts. Futures hedging was combined with cash forward contracting at the 33 percent level, and put options were combined with minimum price and cash forward contracts at the 33 percent level.

The 16 marketing strategies were tested with 5 types of insurance products. All marketing strategies were specified and run together under one type of insurance coverage. The five types of insurance coverage were CAT, MPC, CRC, RA, and IP. In the IP coverage scenario, IP coverage was used only for wheat, with corn and soybeans covered by CRC.

These strategies were first run in a whole farm scenario with the same marketing and insurance alternatives used for each crop. Selected strategies were taken from this simulation and tested on the individual crops. The best strategy for each crop was then selected and used in a whole farm simulation.

# CHAPTER 5

# RESULTS

The analysis begins with an initial whole farm scenario where the same type of insurance coverage and marketing strategies is used for all three crops. A single crop analysis follows, comparing the performance of the insurance products and marketing strategies on each individual crop. The most beneficial strategies from each crop are then combined in a secondary whole farm scenario.

Gross revenue per acre, defined as total revenue per acre less marketing and insurance costs, was calculated for each strategy. These values are presented as a cumulative distribution of gross revenue per acre. An example would be at the 10 percent level. The interpretation is that the gross revenue generated by that strategy would be less than the value indicated 10 percent of the time, or it would be greater 90 percent of the time.

A model comparison is done in the last section. The initial whole farm results from the Bullock model are compared to results from the AgRisk model, using the same input data for both models.

## Initial Whole Farm Scenario

The goal of integrated risk-management strategies is to use a combination of insurance products and marketing alternatives to produce a higher gross revenue per acre than if they were used individually or not at all. If this goal is met, the question becomes which component of the strategy is more important. Do the insurance products or the marketing strategies have a larger effect on the outcome? To answer this question, the two components were analyzed separately and in conjunction with each other.

**Insurance Products Compared**

To analyze the effectiveness of the insurance products, a comparison was made between the gross revenue per acre generated by a base strategy with no insurance products and the gross revenue per acre generated by each type of insurance. The results of the comparison are listed in Table 13.

Table 13. Comparison of Gross Revenue Per Acre of Each Insurance Product and a Base Strategy that Included No Insurance

| | **Base** Strategy With No Insurance Coverage | **CAT** Insurance 65% Coverage level | **MPC** Insurance 65% Coverage Level | **CRC** Insurance 65% Coverage Level | **RA** Insurance 65% Coverage Level | **IP** Insurance 65% Coverage Level |
|---|---|---|---|---|---|---|
| *Mean* | *139* | *140* | *138* | *138* | *135* | *138* |
| *Std. Dev* | *31* | *29* | *27* | *26* | *28* | *27* |
| 10% | 99 | 102 | 105 | 106 | 100 | 103 |
| 20% | 113 | 114 | 114 | 115 | 110 | 114 |
| 30% | 124 | 123 | 122 | 122 | 117 | 121 |
| 40% | 132 | 132 | 130 | 129 | 127 | 129 |
| 50% | 139 | 140 | 137 | 136 | 134 | 137 |
| 60% | 148 | 146 | 144 | 143 | 141 | 143 |
| 70% | 154 | 156 | 153 | 151 | 150 | 152 |
| 80% | 163 | 166 | 162 | 160 | 159 | 161 |
| 90% | 176 | 177 | 173 | 173 | 171 | 172 |

All types of insurance tested, except RA, generated a higher gross revenue per acre than the base strategy up to the 20 percent level of value at risk. CAT coverage continued to generate a higher gross revenue per acre than the base at the 50, 70, 80, and 90 percent levels. MPC, CRC, and IP lost their advantage of a higher gross revenue per acre than the

base strategy at the 20 percent level. These results indicate that the use of crop insurance products is beneficial in protecting against the down side risks faced when no crop insurance is used.

Since insurance is beneficial, a type of coverage to be used was specified. Since CAT coverage on insurable crops is required in order to be eligible for government emergency assistance and because of its relatively small premium, it is assumed that most farmers would carry at least that level of coverage. With that assumption, the other insurance products were compared to CAT coverage to find if the extra insurance coverage offered by them is beneficial in generating a higher gross revenue per acre.

The results indicate that MPC, CRC, and IP generate a higher gross revenue per acre than CAT coverage at the 10 percent level of value at risk. At the 20 percent level CRC is the only coverage with a higher gross revenue than CAT. Above the 20 percent level, no insurance coverage generates a higher gross revenue per acre than CAT. Since CRC has a higher gross revenue at the 20 percent level, it is the coverage that would be specified.

**Marketing Alternatives Compared**

The 15 marketing strategies specified in Table 12 were compared in the same manner as the insurance products. A base strategy that did not include any type of marketing alternative other than a harvest time sale was specified. The simulation results for five selected strategies are listed in Table 14. These results indicate that the marketing strategies listed, except the 66 percent HTA contract and the 33 percent cash forward contract plus 33 percent put options strategies, produce a higher gross revenue per acre

than the base at the 50 percent level of value at risk and above. These results demonstrate that

Table 14. Comparison of Gross Revenue Per Acre of Selected Marketing Alternatives with a Base Strategy that Included a Harvest Time Sale of All Production

| | **Base** Strategy with Harvest Time Sale | **33% Minimum Price** Contract | **66% Minimum Price** Contract | **66% Hedge-to-Arrive** Contract | **33% Cash Forward** Contract Plus **33% Put Options** | **33% Minimum Price** Contract Plus **33% Put Options** |
|---|---|---|---|---|---|---|
| *Mean* | *139* | *141* | *143* | *139* | *138* | *142* |
| *Std. Dev* | *31* | *32* | *34* | *42* | *39* | *35* |
| 10% | 99 | 100 | 100 | 87 | 91 | 99 |
| 20% | 113 | 114 | 114 | 104 | 105 | 113 |
| 30% | 124 | 125 | 125 | 118 | 117 | 125 |
| 40% | 132 | 132 | 133 | 130 | 127 | 133 |
| 50% | 139 | 140 | 142 | 139 | 135 | 142 |
| 60% | 148 | 149 | 151 | 151 | 149 | 150 |
| 70% | 154 | 157 | 160 | 162 | 159 | 160 |
| 80% | 163 | 166 | 169 | 175 | 170 | 171 |
| 90% | 176 | 181 | 184 | 189 | 185 | 187 |

the use of marketing alternatives is beneficial in increasing upside gross revenue per acre potential over that of the base strategy.

To answer the question of which component is more important, the gross revenue per acre distributions for each marketing alternative were compared. If the gross revenue per acre cumulative distribution function from the insurance products, Table 13, is compared to that of the marketing alternatives, Table 14, a point is reached at the 20 percent level and below where the insurance products generate a higher gross revenue per

acre than the base strategy. From the 20 percent level and above, the marketing strategies take over and continue to generate a higher gross revenue per acre than the base. Therefore, the insurance products are more important in protecting the down side risk while the marketing strategies are more important in allowing the gross revenue per acre to reach a higher level.

The fact that this switchover occurs indicates that combining the insurance products and marketing alternatives in an integrated risk management strategy may be beneficial. Table 15 lists the gross revenue per acre distributions for CRC and 66 percent minimum price contracting individually and combined in an integrated strategy.

Table 15. Comparison of Gross Revenue Per Acre of Individual Strategies with a Integrated Strategy to Check for Synergies

| | **Base** | **CRC 65% Coverage Level** | **66% Minimum Price Contract** | **CRC 65% Coverage Level with 66% Minimum Price Contract** |
|---|---|---|---|---|
| *Mean* | *139* | *138* | *143* | *142* |
| *Std Dev* | *31* | *26* | *34* | *28* |
| 10% | 99 | 106 | 100 | 108 |
| 20% | 114 | 115 | 114 | 117 |
| 30% | 124 | 122 | 125 | 125 |
| 40% | 132 | 129 | 133 | 133 |
| 50% | 139 | 136 | 142 | 139 |
| 60% | 148 | 143 | 151 | 146 |
| 70% | 154 | 151 | 160 | 157 |
| 80% | 163 | 160 | 169 | 166 |
| 90% | 176 | 173 | 184 | 181 |

The comparisons indicate that a synergy only exists at the 20 percent level and below. Above the 20 percent level, the individual marketing strategy becomes more beneficial. The increase of gross revenue per acre over the individual strategies at the 20 percent level and below is important because the down side risk is further protected.

**Integrated Strategies Compared**

Because integrated risk-management strategies are beneficial at the 20 percent level and lower, a particular integrated strategy that is the "most" beneficial was specified. To do so, all 5 types of insurance products were tested in combination with all 15 marketing strategies specified in Table 12. The gross revenue per acre cumulative distributions of the strategies tested are listed in Tables A.1 through A.5 in Appendix A.

Using a whole farm cash flow breakeven value of $155 per acre, the cumulative distribution of gross revenue per acre for each integrated strategy indicates that the cash flow breakeven value is not reached until the 70 percent level in the strategy with CAT coverage. The strategies with the other types of insurance are at the 75 percent level before they cash flow which means that, 3 out of 4 years, the farm will incur a loss. If the decision has been made to plant these crops, there is a good chance of losing money, thus most farmers, or Calculators from Chapter 2, would attempt to minimize their down side risk. To minimize risk, CRC coverage would be selected over the CAT coverage as it was in the "Insurance Products Compared" section. If a Daredevil were in this situation, he may only look at the upside potential at the 90 to 95 percent levels and see that CAT coverage offers $3 to $6 an acre more gross revenue than CRC coverage, and decide to use that insurance product. This strategy would still have the high likelihood of a loss without protection from down side risk.

Several methods can be used to select an efficient strategy from the 15 analyzed under the CRC coverage. The first method would be a comparison of the values in the table, which was used to compare the individual insurance products and marketing alternatives. Several levels of risk would be selected and the values compared to find the highest gross revenue. This method was also used for analyzing the integrated strategies. The three marketing strategies with the highest gross revenue at each percentage level are highlighted in the tables in Appendix A.

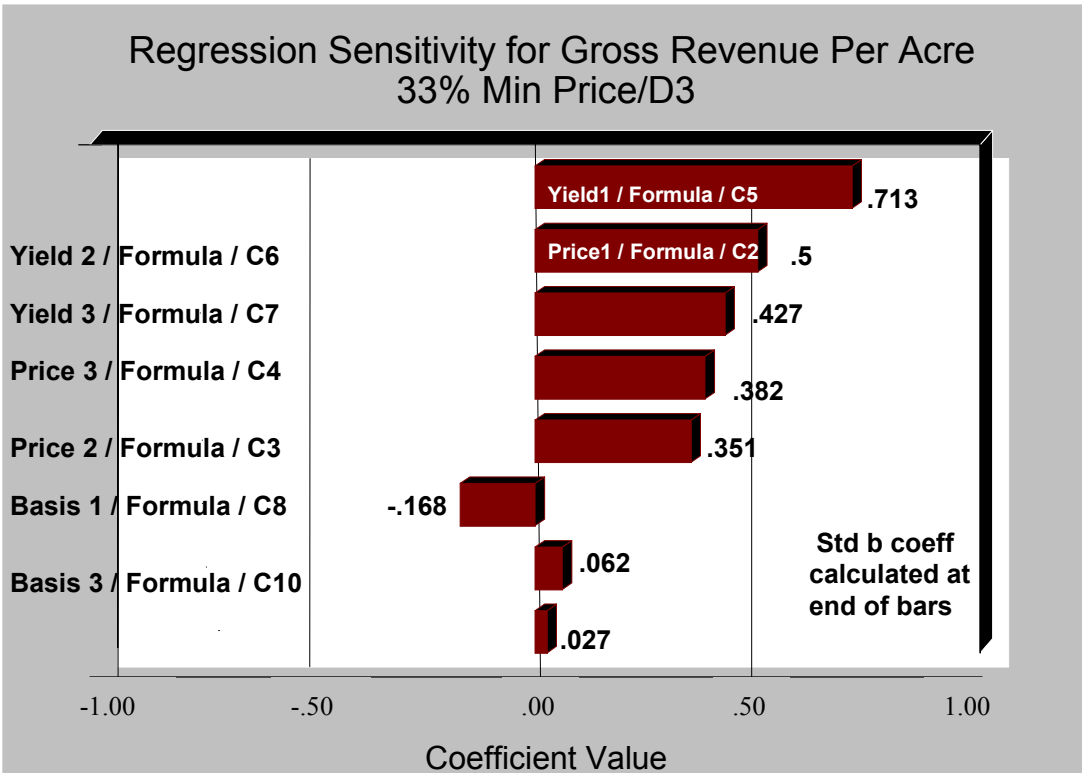
When CRC coverage is used, minimum price contracting 66 percent of the expected production has the highest gross revenue at the 10 and 50 percent levels, with $108 and $139 per acre, respectively. Using a HTA contract on 66 percent of the expected production has the highest gross revenue at the 90 percent level with $185 per acre. Results for these two strategies as well as three comparison strategies with CRC coverage are listed in Table 16.

Table 16. Gross Revenue Per Acre of Marketing Strategies Combined with the 65 Percent Coverage Level of CRC Insurance

| | **Base** | **33% CFC** | **33% Min Price 33% Puts** | **66% Min Price** | **66% HTA** |
|---|---|---|---|---|---|
| *Mean* | *138* | *136* | *142* | *142* | *138* |
| *Std. Deviation* | *26* | *28* | *30* | *28* | *35* |
| 10% | 106 | 100 | 106 | 108 | 85 |
| 25% | 118 | 113 | 120 | 120 | 113 |
| 50% | 136 | 133 | 138 | 139 | 137 |
| 75% | 156 | 155 | 162 | 161 | 162 |
| 90% | 173 | 175 | 182 | 181 | 185 |

**Sensitivity Analysis**

For all insurance products, the minimum price contracts were the most consistent marketing strategies, being in the top three over all percentage levels. The factors affecting the minimum price contracts, which allow them to consistently outperform the other marketing strategies, can be ranked by a sensitivity analysis. A sensitivity analysis identifies the input distributions that are significant in determining the value of the output variable through multivariate stepwise regression. The output for this analysis, which was conducted on the 33 percent level of minimum price contracting with 65 percent CRC coverage, is shown in the tornado graph in Figure 3. The longer bars at the top of the graph represent the most significant independent variables, while moving down the graph, the




Yield 1 = Wheat yield, Yield 2 = Corn Yield and Yield 3 = Soybean yield.
Price 1 = Wheat price, Price 2 = Corn Price and Price 3 = Soybean price.

Basis 1 = Wheat basis and Basis 3 = Soybean basis.

Figure 3. Tornado Graph of Sensitivities of the 33 Percent Minimum Price Contracting Strategy Combined with 65 Percent CRC Coverage

bars become shorter and the independent variables they represent become less significant. Wheat yield is the most significant variable, specified by "yield 1," followed by wheat price, "price 1." Corn price and yield are specified as "price 2" and "yield 2." Soybean price and yield are "price 3" and "yield 3."

These independent variables have the same ranking of significance for all other minimum price contracting strategies analyzed, but with differing values of the standardized beta coefficient, shown at the end of the bars.

**Stochastic Dominance Test**

A second method of selecting efficient strategies would be to use a stochastic dominance test. This test can be conducted by graphing the cumulative distribution functions of each strategy, Figure 4. The probability of X or less gross revenue per acre is on the Y-axis, and the gross revenue per acre is on the X-axis. A strategy will first-order stochastically dominate another if the probability of realizing X or more dollars of gross revenue per acre is at least as large as the probability of realizing X or more dollars of gross revenue per acre for the second strategy for all values of X. The graph shows that the 66 percent minimum price contracting strategy first-order stochastically dominates the 33 percent cash forward contracting strategy. These two strategies, however, do not dominate the 66 percent HTA contracting strategy, which demonstrates that stochastic dominance can only be used as a partial decision criterion that can eliminate some inferior alternatives.

**Mean-Variance Test**

A third decision criteria is the mean-variance (M-V) test. This test may be used for long-run decision making. In the long run, the average gross revenue per acre would be

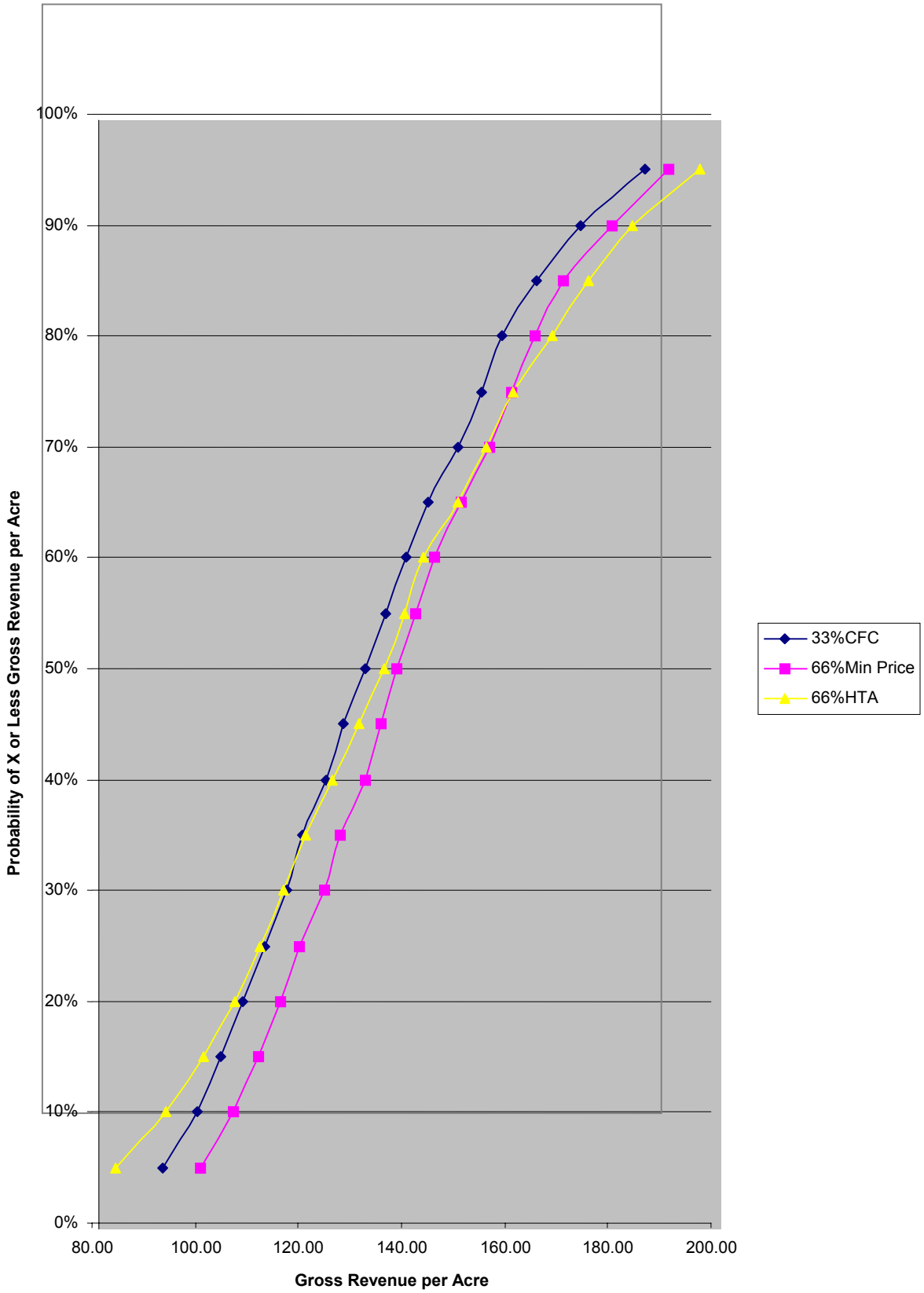

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of X or Less Gross Revenue per Acre
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Gross Revenue per Acre
33%CFC
66%Min Price
66%HTA

Figure 4. Stochastic Dominance Test of CRC Marketing Strategies.

studied in order to see if it is at a cash flow breakeven level. If it is, then a decision may be made to raise a crop even if there is a chance of a loss that year because those losses may be made up in following years in order to approach the current average.

This test can be conducted by plotting the mean and the variance, in this case, the standard deviation, of particular strategies. The mean is on the X-axis, and the standard deviation is on the Y-axis, Figure 5. The further up and to the left on the graph that the strategy lies, the more appealing it is. If there is no obvious "best" strategy, as in Figure 5, the decision will be based on the location of the farmer's utility curve within the graph. However, the set of efficient choices can be narrowed by eliminating M-V dominated alternatives. In this case, the 33 percent cash forward contract is dominated by all other strategies. The 33 percent puts are dominated by the 33 percent minimum price strategy. The 33 percent minimum price/33 percent puts strategy is dominated by the 66 percent minimum price strategy and leaves three M-V efficient choices: base, 33 percent minimum price, and 66 percent minimum price. Depending on the level of risk aversion and the producer's ability to bear risk, the optimal strategy can be chosen from these three M-V efficient strategies.

## Single Crop Scenarios

The gross revenue per acre cumulative distributions of the single crop strategies tested can be found in Tables B.1 through B.9 in Appendix B. Since the IP and RA insurance coverages were not found to be as beneficial as CRC and MPC in the whole farm analysis, they were not included in the single crop scenarios.

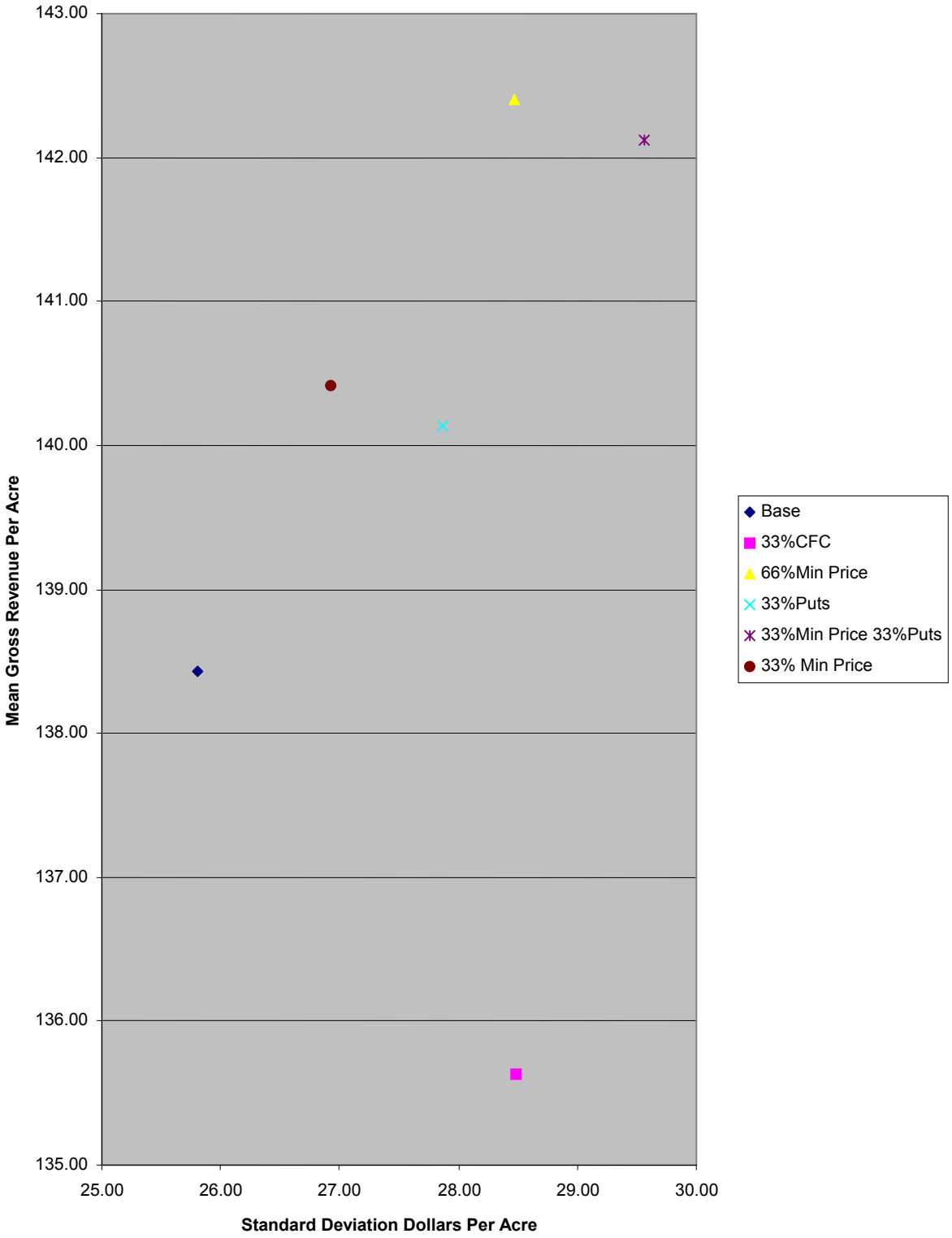



Figure 5. Mean-Variance Test of CRC Marketing Strategies.

**Insurance Products Compared**

In the single crop scenarios, each crop was tested individually with CAT, MPC, and CRC insurance coverage. The marketing strategies included were the base strategy and the three minimum price alternatives offered in the whole farm scenario. Seven other strategies included the use of 33 and 66 percent put options, 33 percent futures hedging, 33 percent cash forward contracts, 33 percent HTA contracts, and 33 percent cash forward contracts combined with 33 percent put options.

The type of insurance selected for each crop was done in a similar manner as for the whole farm. The insurance and marketing alternatives were again analyzed to find out if their use increased the gross revenue per acre for that particular crop. The results of the comparison indicate the same effects as in the whole farm scenario, except for one difference. No insurance product produced an average gross revenue per acre larger than the base strategy in soybeans. Because of the assumption that CAT coverage is carried by most farmers, it was used in the insurance comparison for soybeans. For soybeans, CRC and MPC coverage produced higher gross revenue at the 5 and 10 percent levels over CAT coverage. Since this is a low coverage level and gross revenue is less for CRC than for CAT at all other levels, CAT coverage was used for soybeans in the secondary whole farm analysis. CRC performed much the same as it did in the whole farm scenario for wheat and corn, becoming beneficial at the 15 to 20 percent levels.

**Marketing Strategies Compared**

As with the whole farm scenario, the three strategies with the highest gross revenue per acre were selected at each percentage level in each scenario. These levels can be found in the highlighted cells in the tables in Appendix B. Minimum price contracting 66 percent

of the expected production was the only marketing strategy that was in the top 3 strategies for all percentage levels up to the 85 percent level in soybeans with CAT coverage. From the 75 to 95 percent level, using a HTA contract on 33 percent of the expected production had the highest gross revenue per acre.

Minimum price contracting 66 percent of the expected production as well as minimum price contracting 33 percent of the expected production combined with purchasing put options on 33 percent of the expected production were the 2 strategies which were in the top 3 from the 10 to 90 percent levels in the wheat and corn scenarios with CRC. Results are listed in Table 17.

## Secondary Whole Farm Scenario

Combining the insurance products and marketing strategies specified for each individual crop, four whole farm strategies were analyzed. The results can be found in Table 18. The first strategy, strategy #1, uses the strategies that were specified for each individual crop and includes minimum price contracting 66 percent of the expected production of soybeans while using CAT coverage. Wheat and corn are covered by CRC while minimum price contracting 33 percent of their expected production combined with the purchase of put options on 33 percent of the expected production.

Table 17. Gross Revenue Per Acre for Single Crop Analysis of Marketing Strategies with Wheat and Corn Having CRC Insurance and Soybeans Having CAT Insurance

| | 66% Min Price | 33% Min Price 33% Puts | 33% HTA |
|---|---|---|---|
| **Wheat** *(CRC)* | | | |
| *Mean* | *123* | *123* | *119* |
| *Std. Deviation* | *31* | *31* | *30* |
| 10% | 84 | 85 | 83 |
| 25% | 99 | 99 | 94 |
| 50% | 118 | 119 | 115 |
| 75% | 143 | 143 | 139 |
| 90% | 161 | 163 | 159 |
| **Corn** *(CRC)* | | | |
| *Mean* | *140* | *140* | *137* |
| *Std. Deviation* | *58* | *59* | *58* |
| 10% | 78 | 76 | 78 |
| 25% | 93 | 92 | 88 |
| 50% | 127 | 126 | 121 |
| 75% | 175 | 175 | 174 |
| 90% | 220 | 222 | 219 |
| **Soybeans** *(CAT)* | | | |
| *Mean* | *166* | *163* | *162* |
| *Std. Deviation* | *44* | *45* | *50* |
| 10% | 107 | 104 | 97 |
| 25% | 135 | 132 | 127 |
| 50% | 166 | 164 | 163 |
| 75% | 195 | 193 | 195 |
| 90% | 223 | 223 | 225 |

Table 18. Gross Revenue Per Acre of the Four Strategies Tested in the Secondary Whole Farm Simulation

| | **Strategy #1** | **Strategy #2** | **Strategy #3** | **Strategy #4** |
|---|---|---|---|---|
| **Wheat And Corn** | CRC with 33% Min Price and 33% Puts | CRC with 33% Min Price and 33% Puts | CRC with 66% Min Price | CRC with 66% Min Price |
| **Soybeans** | CAT with 66% Min Price | CRC with 66% Min Price | CAT with 66% Min Price | CRC with 66% Min Price |
| *Mean* | *143* | *142* | *144* | *142* |
| *Std. Deviation* | *31* | *30* | *31* | *29* |
| 10% | 105 | 106 | 106 | 108 |
| 20% | 116 | 115 | 117 | 116 |
| 30% | 124 | 123 | 125 | 124 |
| 40% | 131 | 130 | 132 | 130 |
| 50% | 139 | 138 | 140 | 138 |
| 60% | 148 | 146 | 149 | 147 |
| 70% | 157 | 155 | 158 | 156 |
| 80% | 168 | 166 | 168 | 167 |
| 90% | 185 | 182 | 184 | 182 |

The second strategy, strategy #2, is the same as the first except the specification for CAT coverage on soybeans is changed to CRC coverage. In the third strategy, strategy #3, wheat and corn retain the CRC coverage while soybeans are covered by CAT. The marketing strategies are changed to include minimum price contracting 66 percent of the expected production of all three crops. The fourth strategy, strategy #4, is similar to the third, except the insurance coverage on soybeans is switched from CAT coverage to CRC.

### Strategies Compared

The first and second strategies, which include the marketing strategy that combines minimum price contracting and put options, are stochastically dominated by the third strategy, which only includes minimum price contracting. The fourth strategy has a higher gross revenue per acre than the third up to the 10 percent level because CRC insurance is used on soybeans in that strategy and provides greater down side protection. At levels higher than 10 percent, the values of the third strategy continue to increase over the fourth because CAT coverage is used on soybeans, which incurs a lower cost than CRC does. A person classified as a Risk Avoider may choose the fourth strategy, minimum price contracting 66 percent of the expected production with CRC coverage, which is one of the strategies specified as being optimal in the initial whole farm scenario while a Calculator may find the third strategy more appealing.

Using a whole farm cash flow breakeven value of $155 per acre, the results indicate that the breakeven level will not be reached until the 70 percent level for all strategies tested. This result is slightly better than the strategies in the initial whole farm scenario where a majority of the strategies tested did not break even until the 75 percent level.

## Model Comparison

To compare the Bullock and the AgRisk models, several strategies using the same input data were run with both models. A base strategy that included no marketing strategies or insurance products was run as well as a strategy that included CRC with no marketing strategies. The base strategy was also run with and without the consideration of the LDP in the Bullock model. Five strategies, with and without the LDP, that included marketing strategies were also run with CRC coverage.

The results of all the strategies, including the base, indicate that the AgRisk model consistently underestimates the values at each level by $10 to $15 when compared to the strategies from the Bullock model that consider the LDP. The most important factor in this difference is that the AgRisk model does not consider the LDP. The Bullock model calculates a LDP based on the county loan rate that is entered in the model. An average LDP of $24 per acre for soybeans, $6 per acre for wheat, and $1 per acre for corn, which were calculated by the Bullock model, will allow its output values to be larger than those from AgRisk.

When all comparison strategies are run in the Bullock model without an LDP payment, the AgRisk model begins to increase over the Bullock model at the 20 to 50 percent levels, Table 19. The differences are not very large, with the greatest difference of $10 per acre coming at the 80 to 95 percent levels.

To explain the remaining differences in the output from the two models, the means by which each estimates the price and yield random variables was explored. Viewing the graphical representation of the yield distribution calculated by the AgRisk model shows that it is not truncated at a minimum or maximum value. There are negative values shown at the low end of the distribution and very large values at the high end. Also indicating that the distribution is not truncated is the fact that, by using the indicator bars below the graph, the model will calculate a percentage of the time the yield value will fall between the lowest negative number and zero. AgRisk uses “non-parametric empirical distributions to model prices and yields” (Miranda, 1999).

Table 19. Gross Revenue Per Acre Output Comparison of Bullock and AgRisk Models, Where the Bullock Model is Calculated with and without the Inclusion of an LDP on the Crops.

| | Base | | | CRC Insurance Only | | |
|---|---|---|---|---|---|---|
| | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* |
| **Mean =** | **139** | **125** | **130** | **138** | **124** | **129** |
| **Std Dev =** | **31** | **28** | **30** | **26** | **25** | **26** |
| 5% Perc = | 88 | 83 | 80 | 100 | 90 | 90 |
| 20% Perc = | 113 | 101 | 103 | 114 | 102 | 105 |
| 35% Perc = | 127 | 112 | 117 | 125 | 111 | 116 |
| 50% Perc = | 139 | 122 | 129 | 136 | 120 | 127 |
| 65% Perc = | 151 | 132 | 142 | 147 | 132 | 139 |
| 80% Perc = | 163 | 148 | 157 | 159 | 144 | 153 |
| 95% Perc = | 190 | 173 | 183 | 186 | 170 | 177 |
| | **66% Puts** | | | **33% CFC 33% Puts** | | |
| | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* |
| **Mean =** | **141** | **127** | **129** | **137** | **123** | **125** |
| **Std Dev =** | **31** | **23** | **26** | **33** | **22** | **26** |
| 5% Perc = | 98 | 93 | 91 | 90 | 89 | 85 |
| 20% Perc = | 112 | 107 | 105 | 107 | 102 | 101 |
| 35% Perc = | 126 | 115 | 115 | 121 | 113 | 112 |
| 50% Perc = | 138 | 125 | 126 | 131 | 122 | 123 |
| 65% Perc = | 151 | 134 | 138 | 148 | 130 | 136 |
| 80% Perc = | 164 | 143 | 152 | 164 | 141 | 150 |
| 95% Perc = | 193 | 167 | 176 | 194 | 163 | 172 |
| | **33% Min Price** | | | **66% Min Price** | | |
| | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* |
| **Mean =** | **140** | **126** | **129** | **142** | **128** | **130** |
| **Std Dev =** | **28** | **24** | **27** | **29** | **23** | **26** |
| 5% Perc = | 100 | 94 | 91 | 101 | 95 | 91 |
| 20% Perc = | 115 | 105 | 104 | 115 | 108 | 105 |
| 35% Perc = | 127 | 113 | 115 | 127 | 116 | 116 |
| 50% Perc = | 138 | 123 | 126 | 139 | 125 | 127 |
| 65% Perc = | 149 | 133 | 138 | 151 | 134 | 139 |
| 80% Perc = | 161 | 145 | 153 | 164 | 145 | 154 |
| 95% Perc = | 190 | 170 | 179 | 193 | 170 | 179 |
| | **33% CFC** | | | **33% Min Price 33%Puts** | | |
| | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* | *Bullock (LDP)* | *Bullock (No LDP)* | *AgRisk* |
| **Mean =** | **135** | **121** | **125** | **141** | **127** | **130** |
| **Std Dev =** | **29** | **22** | **26** | **30** | **23** | **26** |
| 5% Perc = | 93 | 90 | 87 | 99 | 94 | 91 |
| 20% Perc = | 108 | 101 | 101 | 113 | 107 | 105 |
| 35% Perc = | 121 | 111 | 112 | 127 | 116 | 116 |
| 50% Perc = | 131 | 119 | 123 | 139 | 126 | 127 |
| 65% Perc = | 145 | 127 | 135 | 151 | 135 | 139 |
| 80% Perc = | 160 | 139 | 149 | 165 | 144 | 153 |
| 95% Perc = | 186 | 163 | 173 | 195 | 168 | 178 |

Since the Bullock model uses a truncated normal yield distribution, the base model was run with and without the truncation values specified to allow for a better comparison of the models. The Bullock model does not allow a negative minimum yield value because actual yields cannot fall below zero so that limit remained in place. Entering a large number such as 9,999,999 eliminated the maximum limit. The simulation results from the Bullock model indicate that eliminating the maximum yield changes the values per acre in each strategy compared by no more than $0.16. For the comparison of the two models, the maximum yield limit was eliminated.

The distribution used for price, the second source of variability in the model, was also compared. The Bullock model uses a lognormal distribution where all values of X are greater than zero and the distribution is skewed to the right. The graphical representation of the "non-parametric price distributions" (Miranda, 1999) in the AgRisk model show a distribution that appears normal with a minimum value of zero. The graphs are produced through the use of "kernel smoothing techniques" (Miranda, 1999). Since a lognormal distribution is skewed to the right, it helps to explain why the quasi-normal AgRisk output values begin to constantly increase over the Bullock model.

A difference also occurs in the calculation of the average yield for a crop. The AgRisk model will input average county yields that are retrieved from its database in years that the individual farm does not have a yield. In the Bullock model, those years are not calculated in the mean.

# CHAPTER 6

# SUMMARY AND IMPLICATIONS

Over the past decade, there have been government policy changes as well as climactic occurrences that have led to increased price and yield risk faced by farmers. With a 54 percent decline in median net farm income on farms enrolled in the North Dakota Farm and Ranch Business Management Education Program from 1993-98, research is needed to assist farmers in developing strategies to manage those risks. The main goal of this study was to evaluate risk-management strategies that integrate responses to both production and price risk that are faced by grain farmers in Cass County, North Dakota.

The first objective of this study was to analyze the effectiveness of integrated marketing and crop insurance alternatives in reducing gross revenue per acre variability. A second objective was to develop risk-management strategies for Cass County grain farms based on that analysis. A final objective was to compare available risk-management software, particularly the simulation model developed by Bullock and the AgRisk model developed by Schnitkey, Miranda, and Irwin.

This study analyzed the effects that the use of crop insurance products and marketing alternatives had on the gross revenue per acre for an individual farm in Cass County. Individual farm yield data for wheat, corn, and soybeans were gathered from the American Farm Bureau Insurance Agency in Fargo. Basis and forward contract prices were gathered from Hunter Grain Company. Price and yield correlations were determined by using county-level yields, and crop reporting district and state level prices. The Bullock model was used to determine the gross revenue per acre cumulative distributions of each strategy.

Crop insurance products and marketing strategies were analyzed individually to determine if they were effective in minimizing down side risk and combined to determine if integration created synergies. A whole farm scenario analysis was run that included integrated strategies that implemented the same insurance coverage and marketing alternatives for each crop. A strategy was selected based on the comparative advantages of its gross revenue cumulative distribution. A single crop scenario was then run where the integrated strategies were analyzed on each individual crop. The optimal strategies, selected in the same manner as in the whole farm analysis, for each crop from the single crop analysis were then combined in a secondary, whole farm scenario analysis.

Several general conclusions can be drawn for situations similar to the representative farm. When analyzed at the individual crop level, the use of crop insurance at the 65 percent level minimizes down side risk in wheat and corn, but not significantly in soybeans. Marketing alternatives generally increase the up side potential of gross revenue per acre while doing little to minimize the down side risk. The integration of crop insurance products and marketing alternatives creates a synergy at the lower levels of value at risk, where the down side risk is located. However, the use of integrated strategies does not increase the chances of achieving a cash flow breakeven gross revenue per acre over the base strategy, which did not include insurance or marketing alternatives. The breakeven level is not reached until the 70 percent level which means that, 7 out of 10 years, the farm will not cash flow.

## Integrated Risk Management Strategy Implications

Even though individual situations are different, it has been demonstrated that the use of risk-management strategies that integrate the use of insurance products and

marketing alternatives minimizes the gross revenue per acre down side risk potential. There were several strategies that outperformed others, and there were strategies that are clearly inferior, even to the base strategy. In an individual farm decision process, the inferior strategies will be eliminated from consideration, and a decision will be made on the remaining strategies based on the risk attitude and financial situation of the farmer. On this representative farm, it appears that minimum price contracting in conjunction with crop revenue coverage produces the best results when analyzing the minimization of down side risk and the increased up side potential. These results occurred in both the initial and secondary whole farm scenarios. With similar results coming from both scenarios, it appears that the only benefit from analyzing each crop separately and then combining them into a whole farm scenario is the understanding of how each crop is affected by the strategy.

The synergies that are present when insurance and marketing alternatives are combined indicate that the use of crop insurance can eliminate fears associated with forward contracting and futures hedging--mainly the fear of inadequate yields not being able to offset a short futures position or meet the forward contract specifications. Crop revenue coverage insurance is most effective in this aspect in all crops except soybeans. One possible reason for the discrepancy in soybeans is the differential in the loan rate and the contracting prices offered. Because the loan rate is higher than the predicted future price, hedging with futures prices at the current level is not necessary.

The results will also be affected by the current level of prices received by farmers for the specific crops relative to the level of production costs associated with each crop. Currently, the prices received by farmers for their crops is quite low relative to the cost of production, as demonstrated by the difficulty of achieving a breakeven cash flow. With

commodity prices at such a level, the marketing alternatives that establish a price floor, such as minimum price contracts, while allowing for up side potential will be the most beneficial. If the prices received are relatively high and the need to realize an increase in price is not as great, cash forward contracts may be more beneficial than minimum price contracts. Cash forward contracts also establish a price floor but do not incur the cost of minimum price contracts.

These differences demonstrate that this method of analyzing risk management strategies cannot be used as the only source of information when making a decision on which strategy to use. It is only one tool to be used in the decision-making process.

## Model Implications

Although there are differences in the output of the two models tested, they both are beneficial in the decision making process. Once the main cause of the difference in the output from the AgRisk model relative to the Bullock model was identified and accounted for, the results became somewhat similar thus lending viability to the use of the AgRisk model as a tool in a farmer's risk-management decision making process.

Because AgRisk is a stand-alone program and the calculation process could not be directly observed, the results were suspect. However, comparing the results with those from the Bullock model, where the calculation process could be verified, and finding that they were similar provided confidence that AgRisk could be used effectively. Because there are still differences present and because it is rather easy to use, AgRisk would be more appropriate to be used to arrive at a "ballpark" figure for a general analysis by a producer.

Since the Bullock model is spreadsheet based, the process of calculating the output variable can be verified. The model does calculate a LDP payment, which allows for a more accurate representation of the gross revenue per acre. This process lends to the credibility of the model and the results it produces.

Because of these advantages, the Bullock model seems to be better suited for a more in depth study of the effects of risk management strategies on gross revenue per acre. However, a difficulty in the use of the model may arise if an individual is not proficient in the use of spreadsheet software and, in particular, the operation of the @Risk™ add-on software. The use of the Bullock model may be more appropriate for individuals who do analysis for producers and make recommendations about the types of risk-management strategies that appear to be beneficial.

## Limitations of Study and Suggestions for Further Research

A limitation faced by this study is that it used data from only one farm in Cass County. Even though individual farm yield data was used instead of county data in order to capture the possibility of higher yield variability, every farm will be different. Also, the values used to calculate the cash flow breakeven level will vary among farms. Again, every farm situation will have a different budget that needs to be analyzed separately.

This study may be used as a guide for producers and analysts in studying risk-management strategies. To assist in the individual decision-making process, further study will need to be done with yield data and budget amounts from the individual farm.

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# APPENDIX A

## INITIAL WHOLE FARM SIMULATION OUTPUT

Table A.1. Gross Revenue Per Acre for CAT Coverage with Selected Marketing Strategies

| Name | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 65.34 | 40.88 | -14.41 | 65.20 | 64.76 | 61.11 | 56.49 | 43.49 | -5.29 |
| Maximum = | 240.10 | 251.31 | 262.76 | 248.21 | 256.49 | 237.24 | 234.32 | 254.21 | 268.61 |
| **Mean =** | **139.86** | **137.07** | **134.18** | **141.85** | **143.84** | **137.07** | **134.18** | **139.90** | **139.89** |
| **Std Dev =** | **29.29** | **32.92** | **39.56** | **30.41** | **31.93** | **29.22** | **29.25** | **32.99** | **39.64** |
| Variance = | 858.08 | 1083.75 | 1565.36 | 925.02 | 1019.42 | 854.03 | 855.61 | 1088.37 | 1571.49 |
| Mode = | 123.29 | 161.34 | 136.25 | 162.12 | 154.94 | 143.35 | 133.73 | 144.86 | 148.51 |
| | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
| 5% | **93.24** | 81.79 | 66.81 | **93.88** | **94.45** | 90.94 | 88.00 | 84.49 | 72.57 |
| 10% | 102.12 | 95.49 | 85.83 | **103.03** | **103.19** | 99.58 | 96.77 | 97.96 | 91.10 |
| 15% | 107.34 | 102.59 | 94.98 | **108.48** | **109.35** | 104.80 | 101.81 | 105.28 | 101.02 |
| 20% | **114.48** | 109.39 | 102.79 | **114.69** | **115.81** | 111.73 | 108.36 | 111.62 | 107.42 |
| 25% | 118.83 | 114.17 | 107.99 | **119.73** | **120.85** | 115.98 | 113.62 | 117.39 | 113.82 |
| 30% | 123.01 | 119.83 | 113.10 | **124.18** | **124.99** | 119.81 | 117.28 | 122.78 | 118.59 |
| 35% | 127.22 | 124.06 | 118.40 | **128.90** | **130.28** | 124.41 | 121.35 | 126.75 | 124.10 |
| 40% | 131.54 | 127.87 | 123.23 | 133.00 | **134.46** | 128.65 | 125.89 | 130.49 | 129.42 |
| 45% | 135.35 | 132.05 | 128.14 | 137.32 | **138.45** | 133.18 | 130.13 | 134.79 | 133.79 |
| 50% | 139.75 | 136.78 | 134.31 | 141.23 | **142.83** | 137.11 | 133.86 | 139.89 | 140.49 |
| 55% | 143.27 | 141.11 | 138.29 | 144.77 | **145.86** | 140.17 | 137.47 | 143.91 | 144.51 |
| 60% | 146.19 | 144.68 | 143.05 | 148.55 | **150.51** | 143.55 | 140.77 | 147.30 | 148.64 |
| 65% | 150.69 | 149.39 | 148.84 | 153.26 | **155.06** | 147.29 | 144.43 | 152.50 | 154.73 |
| 70% | 156.44 | 154.17 | 155.06 | 158.20 | **161.43** | 153.31 | 150.08 | 157.42 | **161.16** |
| 75% | 160.95 | 160.35 | 160.78 | 163.17 | **166.31** | 157.73 | 154.85 | 162.92 | **166.49** |
| 80% | 165.72 | 164.58 | 168.08 | 167.38 | 170.33 | 162.58 | 159.57 | 167.50 | **174.03** |
| 85% | 170.39 | 171.58 | 175.86 | 173.26 | 176.78 | 166.91 | 164.12 | 173.84 | **181.76** |
| 90% | 176.60 | 180.15 | 184.49 | 180.32 | 185.02 | 173.82 | 170.99 | 182.42 | **190.54** |
| 95% | 188.07 | 192.06 | 198.56 | 192.29 | 197.47 | 186.02 | 182.75 | 194.81 | **203.55** |

Table A.1. ( Continued)

| Name | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
|---|---|---|---|---|---|---|---|
| Minimum = | 37.54 | 61.59 | 64.54 | 62.53 | 62.85 | 52.99 | 64.33 |
| Maximum = | 263.75 | 236.71 | 252.53 | 260.71 | 270.55 | 303.92 | 260.64 |
| **Mean =** | **138.78** | **136.82** | **141.57** | **142.76** | **139.62** | **139.44** | **143.56** |
| **Std Dev =** | **36.34** | **29.06** | **31.42** | **33.29** | **29.86** | **32.54** | **33.05** |
| Variance = | 1320.83 | 844.66 | 987.08 | 1108.45 | 891.87 | 1058.65 | 1092.15 |
| Mode = | 128.22 | 143.78 | 131.79 | 148.34 | 152.34 | 139.95 | 102.11 |
| | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
| 5% | 79.99 | 91.23 | 92.11 | 90.29 | 92.93 | 91.77 | 92.08 |
| 10% | 93.43 | 99.65 | 101.25 | 100.15 | **103.22** | 100.21 | 101.87 |
| 15% | 101.01 | 104.36 | 107.73 | 107.28 | **109.03** | 107.11 | 108.23 |
| 20% | 108.04 | 111.38 | 113.38 | 112.78 | 113.44 | 112.63 | 113.88 |
| 25% | 113.66 | 116.18 | 118.53 | 118.58 | 118.67 | 116.69 | **119.62** |
| 30% | 118.99 | 120.08 | 123.24 | 123.44 | 122.32 | 121.50 | **124.34** |
| 35% | 123.33 | 124.21 | 128.22 | 128.07 | 126.99 | 125.28 | **129.02** |
| 40% | 127.85 | 128.55 | 131.97 | **133.05** | 130.90 | 129.48 | **133.52** |
| 45% | 133.13 | 132.67 | 137.01 | 137.30 | 134.05 | 133.55 | **138.15** |
| 50% | 137.65 | 136.73 | 140.77 | 141.23 | 137.65 | 137.23 | **142.02** |
| 55% | 141.62 | 140.03 | 144.08 | 144.68 | 141.47 | 140.54 | **145.51** |
| 60% | 146.04 | 143.54 | 148.43 | **150.01** | 145.84 | 144.78 | **150.45** |
| 65% | 151.76 | 147.15 | 153.66 | **155.00** | 149.57 | 148.94 | **155.56** |
| 70% | 157.40 | 152.51 | 159.13 | 160.73 | 153.25 | 152.85 | **161.11** |
| 75% | 161.93 | 157.35 | 164.02 | 164.88 | 157.91 | 157.37 | **165.51** |
| 80% | 169.52 | 161.99 | 168.11 | **170.61** | 162.89 | 164.34 | **171.26** |
| 85% | **178.07** | 166.92 | 174.28 | 177.66 | 169.17 | 169.82 | **177.83** |
| 90% | **186.03** | 173.08 | 181.47 | **187.43** | 177.18 | 178.32 | **186.97** |
| 95% | 199.82 | 184.80 | 195.08 | **200.12** | 191.92 | 199.21 | **200.44** |

Table A.2. Gross Revenue Per Acre for CAT Coverage with Selected Marketing Strategies

| Name | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 80.41 | 74.00 | 12.38 | 80.68 | 80.84 | 78.67 | 76.18 | 76.62 | 21.50 |
| Maximum = | 236.14 | 247.36 | 258.80 | 244.26 | 252.53 | 233.29 | 230.37 | 250.26 | 264.66 |
| **Mean =** | **138.46** | **135.67** | **132.78** | **140.45** | **142.43** | **135.67** | **132.77** | **138.50** | **138.49** |
| **Std Dev =** | **26.88** | **29.83** | **36.21** | **27.93** | **29.40** | **26.80** | **26.82** | **29.90** | **36.29** |
| Variance = | 722.48 | 889.67 | 1310.83 | 780.28 | 864.56 | 718.35 | 719.05 | 894.15 | 1316.68 |
| Mode = | 140.05 | 121.67 | 131.66 | 158.14 | 139.99 | 114.63 | 136.74 | 138.27 | 136.81 |
| | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
| 5% | **98.93** | 89.61 | 76.33 | **99.89** | **100.23** | 96.19 | 93.87 | 92.69 | 82.16 |
| 10% | 104.53 | 97.41 | 87.82 | **105.08** | **105.41** | 101.50 | 98.62 | 100.36 | 93.27 |
| 15% | **109.44** | 102.99 | 95.71 | **110.04** | **110.53** | 106.53 | 103.56 | 106.05 | 101.44 |
| 20% | 113.58 | 108.10 | 101.61 | **114.69** | **114.99** | 110.86 | 107.78 | 110.77 | 106.61 |
| 25% | 117.49 | 113.23 | 106.78 | **118.91** | **119.65** | 114.82 | 112.53 | 115.91 | 112.39 |
| 30% | 121.54 | 117.76 | 111.60 | **123.04** | **123.90** | 118.88 | 115.87 | 120.53 | 117.18 |
| 35% | 125.77 | 121.36 | 115.39 | **126.72** | **127.83** | 122.67 | 119.55 | 124.34 | 121.38 |
| 40% | 129.65 | 125.81 | 121.23 | **131.25** | **132.62** | 126.89 | 123.95 | 128.52 | 127.05 |
| 45% | 133.49 | 129.57 | 126.16 | **135.20** | **136.43** | 130.24 | 127.68 | 132.44 | 131.26 |
| 50% | 137.16 | 134.15 | 131.15 | **138.59** | **140.15** | 134.36 | 131.61 | 137.10 | 136.98 |
| 55% | 140.18 | 138.02 | 135.27 | **141.86** | **143.56** | 137.54 | 134.58 | 140.59 | 141.20 |
| 60% | 143.64 | 141.28 | 140.11 | 145.30 | **147.32** | 140.54 | 137.53 | 144.17 | 145.63 |
| 65% | 147.34 | 146.33 | 145.43 | 149.59 | **152.39** | 144.52 | 141.78 | 149.38 | 151.43 |
| 70% | 152.81 | 151.27 | 151.11 | 155.01 | **158.13** | 150.10 | 147.25 | 154.42 | **157.21** |
| 75% | 157.55 | 156.83 | 156.83 | 159.89 | **162.72** | 154.55 | 151.41 | 159.09 | **162.62** |
| 80% | 162.09 | 160.64 | 164.53 | 164.35 | **166.95** | 159.14 | 155.92 | 163.87 | **170.22** |
| 85% | 166.95 | 167.78 | 171.90 | 169.86 | 173.06 | 163.34 | 160.88 | 170.15 | **177.80** |
| 90% | 173.23 | 176.20 | 180.54 | 177.33 | 181.35 | 170.45 | 167.23 | 178.46 | **186.59** |
| 95% | 184.11 | 188.11 | 194.61 | 188.33 | 193.52 | 182.06 | 178.80 | 190.85 | **199.60** |

Table A.2. (Continued)

| Name | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
|---|---|---|---|---|---|---|---|
| Minimum = | 70.66 | 77.41 | 80.08 | 80.11 | 66.00 | 55.59 | 80.35 |
| Maximum = | 259.79 | 232.76 | 248.58 | 256.76 | 281.41 | 314.78 | 256.69 |
| **Mean =** | **137.38** | **135.42** | **140.17** | **141.35** | **138.21** | **138.04** | **142.16** |
| **Std Dev =** | **33.27** | **26.78** | **28.84** | **30.66** | **28.69** | **32.13** | **30.45** |
| Variance = | 1106.81 | 717.29 | 831.52 | 940.16 | 822.97 | 1032.36 | 927.46 |
| Mode = | 137.43 | 141.39 | 122.28 | 107.70 | 127.59 | 139.82 | 134.71 |
| | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
| 5% | 87.43 | 95.96 | 97.90 | 97.17 | 95.50 | 91.83 | 98.39 |
| 10% | 95.00 | 101.16 | 104.26 | 103.73 | 103.47 | 99.24 | **104.63** |
| 15% | 101.73 | 106.75 | 108.64 | 107.79 | 108.22 | 105.97 | 109.21 |
| 20% | 107.39 | 111.16 | 113.55 | 112.93 | 113.52 | 110.92 | **114.02** |
| 25% | 112.63 | 114.67 | 117.61 | 117.87 | 117.53 | 115.45 | **118.85** |
| 30% | 117.25 | 118.85 | 121.89 | 121.86 | 121.82 | 119.68 | **122.77** |
| 35% | 121.83 | 122.40 | 126.37 | 125.90 | 125.93 | 123.49 | **127.19** |
| 40% | 124.72 | 126.44 | 130.38 | 131.05 | 129.12 | 128.02 | **131.89** |
| 45% | 130.50 | 130.29 | 134.65 | 134.91 | 132.98 | 131.68 | **135.74** |
| 50% | 134.55 | 133.89 | 137.99 | 138.11 | 136.30 | 135.99 | **139.00** |
| 55% | 138.49 | 137.06 | 141.37 | 141.68 | 139.82 | 139.61 | **142.73** |
| 60% | 143.01 | 140.51 | 145.00 | **146.80** | 143.66 | 143.03 | **147.01** |
| 65% | 148.55 | 143.91 | 149.98 | **152.51** | 147.18 | 147.11 | **152.35** |
| 70% | 153.87 | 149.51 | 155.67 | 157.16 | 151.22 | 151.01 | **157.82** |
| 75% | 158.24 | 154.19 | 160.34 | 161.60 | 155.11 | 156.73 | **161.90** |
| 80% | 165.74 | 158.52 | 164.31 | 166.92 | 160.24 | 161.96 | **167.70** |
| 85% | **174.11** | 163.44 | 171.04 | 173.95 | 166.04 | 167.04 | **174.21** |
| 90% | **182.07** | 169.52 | 177.61 | 183.48 | 173.73 | 176.55 | **183.02** |
| 95% | **195.86** | 180.88 | 191.13 | 196.17 | 188.74 | 195.76 | **196.50** |

Table A.3. Gross Revenue Per Acre for 65% CRC Coverage with Selected Marketing Strategies

| Name | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 82.88 | 82.26 | 42.54 | 83.15 | 83.30 | 81.83 | 80.64 | 84.14 | 51.66 |
| Maximum = | 238.67 | 245.47 | 256.91 | 242.37 | 250.64 | 236.39 | 233.83 | 248.37 | 262.77 |
| **Mean =** | **138.43** | **135.63** | **132.74** | **140.41** | **142.40** | **135.63** | **132.74** | **138.46** | **138.46** |
| **Std Dev =** | **25.81** | **28.49** | **34.79** | **26.93** | **28.47** | **25.73** | **25.74** | **28.56** | **34.86** |
| Variance = | 666.22 | 811.67 | 1210.29 | 725.39 | 810.70 | 662.26 | 662.79 | 815.84 | 1215.52 |
| Mode = | 125.12 | 119.83 | 137.21 | 125.00 | 128.09 | 126.04 | 140.22 | 128.79 | 135.46 |
| | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixe* | *33% HTA* | *66% HTA* |
| 5% | **100.15** | 93.71 | 78.75 | **100.33** | **101.13** | 97.98 | 95.48 | 96.43 | 84.59 |
| 10% | 105.88 | 100.33 | 88.17 | **106.82** | **107.50** | 103.49 | 100.28 | 102.79 | 94.24 |
| 15% | **111.17** | 104.94 | 96.36 | **112.10** | **112.33** | 108.44 | 105.10 | 107.33 | 101.72 |
| 20% | 115.05 | 109.37 | 101.67 | **115.86** | **116.59** | 112.45 | 109.83 | 112.22 | 107.62 |
| 25% | 118.16 | 113.43 | 107.04 | **119.68** | **120.13** | 116.03 | 113.29 | 116.52 | 112.61 |
| 30% | 122.45 | 117.71 | 111.20 | **124.17** | **124.98** | 119.77 | 116.72 | 120.17 | 117.18 |
| 35% | 126.42 | 120.69 | 115.68 | **127.44** | **128.26** | 123.49 | 120.47 | 123.85 | 121.35 |
| 40% | 129.35 | 125.49 | 120.68 | **131.50** | **132.85** | 126.95 | 124.29 | 128.58 | 126.56 |
| 45% | 133.52 | 128.74 | 126.03 | **135.17** | **136.18** | 130.92 | 127.97 | 132.06 | 131.82 |
| 50% | 136.45 | 133.07 | 130.28 | **138.03** | **139.22** | 133.93 | 130.83 | 136.38 | 136.67 |
| 55% | 139.28 | 136.87 | 134.83 | **141.45** | **142.77** | 136.60 | 133.88 | 139.22 | 140.50 |
| 60% | 142.89 | 140.79 | 139.31 | 144.47 | **146.35** | 139.87 | 136.63 | 143.64 | 144.33 |
| 65% | 145.98 | 145.31 | 144.36 | 149.14 | **151.72** | 143.37 | 140.41 | 148.77 | 150.84 |
| 70% | 151.35 | 150.83 | 149.89 | 154.08 | **157.09** | 148.72 | 145.97 | 153.19 | **156.45** |
| 75% | 156.01 | 155.42 | 155.57 | 158.44 | **161.33** | 153.36 | 150.24 | 158.00 | **161.59** |
| 80% | 160.42 | 159.58 | 162.90 | 163.02 | 166.02 | 157.31 | 154.37 | 162.71 | **169.31** |
| 85% | 165.29 | 166.16 | 170.46 | 169.22 | 171.41 | 162.43 | 159.50 | 168.33 | **176.20** |
| 90% | 173.05 | 174.59 | 179.53 | 176.51 | 180.85 | 170.22 | 166.46 | 176.98 | **184.78** |
| 95% | 183.01 | 187.26 | 193.06 | 187.27 | 191.63 | 180.66 | 177.56 | 189.19 | **197.92** |

Table A.3. (Continued)

| Name | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
|---|---|---|---|---|---|---|---|
| Minimum = | 78.92 | 81.13 | 82.55 | 82.58 | 79.26 | 76.97 | 82.82 |
| Maximum = | 257.90 | 243.96 | 246.69 | 254.87 | 294.58 | 327.94 | 254.80 |
| **Mean =** | **137.34** | **135.38** | **140.14** | **141.32** | **138.18** | **138.01** | **142.13** |
| **Std Dev =** | **32.09** | **25.77** | **27.87** | **29.75** | **28.13** | **31.89** | **29.56** |
| Variance = | 1030.00 | 663.90 | 776.47 | 885.34 | 791.33 | 1017.28 | 873.76 |
| Mode = | 116.65 | 134.64 | 114.59 | 135.97 | 125.95 | 141.14 | 132.82 |
| | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
| 5% | 91.40 | 97.91 | 99.14 | 97.84 | 97.96 | 94.56 | 99.75 |
| 10% | 98.06 | 102.87 | 105.86 | 105.30 | 104.06 | 100.12 | **106.48** |
| 15% | 102.97 | 108.48 | 110.47 | 110.29 | 108.71 | 106.16 | 110.90 |
| 20% | 108.21 | 111.95 | 114.70 | 114.39 | 113.89 | 110.34 | **115.52** |
| 25% | 112.88 | 115.81 | 118.40 | 118.61 | 117.34 | 114.48 | **119.71** |
| 30% | 116.80 | 119.49 | 122.91 | 122.27 | 121.48 | 118.76 | **123.69** |
| 35% | 121.29 | 123.52 | 126.76 | 127.52 | 125.22 | 122.91 | **128.09** |
| 40% | 125.08 | 126.68 | 131.06 | 131.06 | 128.07 | 126.49 | **132.11** |
| 45% | 130.12 | 130.18 | 133.86 | 134.49 | 132.11 | 130.83 | **135.31** |
| 50% | 133.78 | 133.76 | 137.39 | 137.46 | 135.43 | 135.00 | **138.23** |
| 55% | 137.81 | 136.89 | 140.38 | 141.26 | 139.40 | 138.46 | **142.02** |
| 60% | 142.57 | 139.63 | 144.34 | **146.01** | 143.53 | 142.06 | **146.54** |
| 65% | 147.77 | 143.06 | 149.39 | **151.58** | 146.59 | 145.91 | **152.00** |
| 70% | 152.67 | 148.51 | 154.63 | 155.91 | 150.94 | 151.19 | **156.46** |
| 75% | 157.35 | 152.96 | 159.05 | 160.68 | 154.83 | 156.37 | **161.56** |
| 80% | 164.96 | 157.07 | 163.28 | **166.36** | 159.43 | 161.54 | **166.90** |
| 85% | 172.52 | 161.76 | 169.88 | **172.81** | 165.68 | 166.91 | **173.28** |
| 90% | 180.88 | 169.97 | 177.36 | **182.14** | 173.37 | 178.21 | **181.69** |
| 95% | 194.25 | 180.17 | 190.06 | **194.28** | 189.42 | **199.07** | **194.61** |

Table A.4. Gross Revenue Per Acre for 65% RA Coverage with Selected Marketing Strategies

| Name | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 76.26 | 49.26 | 1.63 | 76.05 | 75.44 | 73.22 | 68.60 | 51.88 | 10.75 |
| Maximum = | 233.75 | 244.96 | 256.40 | 241.86 | 250.14 | 230.89 | 227.97 | 247.86 | 262.26 |
| **Mean =** | **135.26** | **132.47** | **129.58** | **137.25** | **139.24** | **132.47** | **129.58** | **135.30** | **135.29** |
| **Std Dev =** | **27.66** | **31.43** | **38.30** | **28.86** | **30.47** | **27.59** | **27.61** | **31.50** | **38.37** |
| Variance = | 764.90 | 987.95 | 1466.52 | 833.02 | 928.25 | 761.06 | 762.48 | 992.26 | 1472.03 |
| Mode = | 128.95 | 104.08 | 103.26 | 129.12 | 127.42 | 125.61 | 132.22 | 146.57 | 142.13 |
| | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
| 5% | **93.43** | 81.51 | 66.20 | **93.56** | **93.31** | 90.37 | 87.83 | 83.31 | 72.40 |
| 10% | **99.57** | 92.77 | 82.38 | **99.92** | **100.62** | 97.10 | 94.07 | 95.49 | 88.04 |
| 15% | 105.79 | 100.46 | 91.11 | **106.40** | **106.80** | 102.83 | 99.57 | 102.90 | 96.83 |
| 20% | **110.09** | 104.97 | 98.22 | **110.67** | **111.27** | 107.47 | 104.70 | 108.04 | 103.61 |
| 25% | 114.00 | 109.84 | 103.51 | **114.92** | **115.94** | 110.99 | 108.49 | 112.60 | 109.42 |
| 30% | 117.45 | 114.72 | 108.95 | 119.09 | **120.08** | 115.28 | 112.47 | 117.73 | 114.45 |
| 35% | 123.10 | 118.65 | 113.33 | **124.32** | **125.58** | 119.84 | 116.91 | 121.61 | 119.40 |
| 40% | 127.47 | 123.27 | 118.80 | 128.85 | **129.52** | 124.71 | 121.81 | 126.29 | 124.65 |
| 45% | 130.78 | 127.12 | 124.21 | **132.07** | **133.84** | 127.71 | 125.15 | 130.01 | 129.41 |
| 50% | 134.36 | 132.25 | 129.22 | **136.12** | **137.59** | 131.45 | 128.59 | 135.33 | 135.05 |
| 55% | 137.56 | 135.66 | 133.17 | 139.47 | **141.46** | 134.79 | 132.02 | 138.36 | 139.13 |
| 60% | 141.43 | 139.41 | 138.02 | 142.95 | **144.92** | 138.19 | 135.14 | 142.22 | 143.38 |
| 65% | 144.85 | 144.17 | 143.66 | 147.69 | **150.16** | 142.13 | 139.43 | 146.75 | 149.93 |
| 70% | 150.36 | 148.87 | 149.12 | 152.88 | **155.54** | 147.58 | 144.85 | 151.77 | **155.69** |
| 75% | 154.99 | 154.44 | 154.95 | 157.13 | **160.24** | 151.80 | 148.85 | 157.13 | **160.64** |
| 80% | 159.46 | 158.64 | 162.33 | 161.65 | 164.58 | 156.27 | 153.23 | 161.51 | **168.17** |
| 85% | 164.08 | 165.38 | 169.86 | 167.35 | 170.55 | 160.64 | 157.94 | 167.75 | **175.67** |
| 90% | 170.69 | 173.96 | 179.02 | 173.97 | 179.77 | 168.06 | 164.99 | 176.42 | **184.28** |
| 95% | 181.72 | 185.74 | 192.55 | 186.55 | 191.12 | 179.67 | 176.65 | 188.45 | **197.41** |

Table A.4. (Continued)

| Name | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
|---|---|---|---|---|---|---|---|
| Minimum = | 45.92 | 73.69 | 72.92 | 70.92 | 76.58 | 71.06 | 72.71 |
| Maximum = | 257.40 | 230.36 | 246.18 | 254.36 | 264.27 | 297.64 | 254.29 |
| **Mean =** | **134.18** | **132.22** | **136.97** | **138.15** | **135.01** | **134.84** | **138.96** |
| **Std Dev =** | **35.03** | **27.42** | **29.93** | **31.91** | **28.31** | **31.16** | **31.66** |
| Variance = | 1227.23 | 751.69 | 896.09 | 1018.25 | 801.51 | 971.09 | 1002.33 |
| Mode = | 116.05 | 127.80 | 132.91 | 133.94 | 127.42 | 140.66 | 106.17 |
| | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
| 5% | 78.25 | 90.42 | 91.38 | 90.20 | 93.74 | 90.52 | 91.51 |
| 10% | 89.93 | 97.18 | 98.10 | 97.74 | 100.65 | 97.62 | 98.82 |
| 15% | 98.58 | 102.55 | 105.36 | 104.74 | 105.08 | 103.88 | **105.97** |
| 20% | 104.34 | 107.56 | 109.20 | 108.84 | 110.14 | 108.04 | 109.88 |
| 25% | 109.51 | 111.09 | 114.02 | 113.75 | 114.21 | 111.96 | **114.77** |
| 30% | 113.89 | 115.16 | 118.94 | **119.46** | 118.19 | 115.97 | **119.96** |
| 35% | 118.28 | 119.05 | 123.84 | 123.51 | 121.75 | 120.33 | **124.49** |
| 40% | 123.14 | 124.23 | 127.16 | **128.88** | 125.48 | 124.53 | **129.35** |
| 45% | 128.54 | 127.34 | 131.95 | **132.07** | 128.94 | 128.56 | **133.06** |
| 50% | 132.52 | 131.16 | 135.27 | **135.71** | 132.53 | 132.61 | **136.33** |
| 55% | 136.58 | 134.36 | 139.00 | **139.48** | 136.12 | 135.70 | **140.34** |
| 60% | 140.84 | 138.01 | 143.20 | **144.81** | 140.59 | 139.90 | **144.95** |
| 65% | 146.71 | 141.57 | 147.60 | **150.23** | 143.97 | 142.96 | **149.95** |
| 70% | 151.87 | 147.11 | 153.15 | 154.96 | 147.96 | 147.14 | **155.42** |
| 75% | 156.22 | 151.60 | 157.81 | 159.22 | 152.16 | 152.42 | **159.51** |
| 80% | 163.60 | 155.64 | 161.95 | **164.62** | 157.00 | 158.07 | **165.48** |
| 85% | **171.88** | 160.66 | 168.23 | 171.49 | 163.20 | 163.52 | **171.61** |
| 90% | 180.11 | 168.22 | 175.21 | **181.14** | 171.01 | 171.98 | **180.62** |
| 95% | 193.74 | 178.45 | 188.81 | **193.77** | 185.57 | 192.85 | **194.09** |

Table A.5. Gross Revenue Per Acre for 65% IP Coverage with Selected Marketing Strategies

| Name | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 80.65 | 65.90 | 13.17 | 80.59 | 80.27 | 79.53 | 74.91 | 68.11 | 22.29 |
| Maximum = | 235.30 | 246.51 | 257.95 | 243.41 | 251.68 | 232.44 | 229.52 | 249.41 | 263.81 |
| **Mean =** | **137.68** | **134.89** | **132.00** | **139.67** | **141.65** | **134.89** | **131.99** | **137.72** | **137.71** |
| **Std Dev =** | **26.78** | **30.17** | **36.86** | **27.95** | **29.54** | **26.70** | **26.72** | **30.24** | **36.93** |
| Variance = | 716.93 | 910.43 | 1358.64 | 781.31 | 872.51 | 713.00 | 714.12 | 914.69 | 1364.05 |
| Mode = | 139.04 | 126.39 | 138.31 | 120.63 | 136.32 | 133.59 | 133.85 | 122.96 | 143.68 |
| | *Base* | *33% CFC* | *66% CFC* | *33% Min Price* | *66% Min Price* | *33% Basis Fixed* | *66% Basis Fixed* | *33% HTA* | *66% HTA* |
| 5% | **96.99** | 85.74 | 75.04 | **97.63** | **97.98** | 94.30 | 91.31 | 88.73 | 80.44 |
| 10% | 103.28 | 97.78 | 85.36 | **104.17** | **104.54** | 100.57 | 98.06 | 99.87 | 89.78 |
| 15% | **109.13** | 102.78 | 94.39 | **109.89** | **110.37** | 106.21 | 103.34 | 105.63 | 99.91 |
| 20% | 113.57 | 108.58 | 101.26 | **114.39** | **114.92** | 110.98 | 108.17 | 111.20 | 106.25 |
| 25% | 117.45 | 113.64 | 106.64 | **118.59** | **119.00** | 114.51 | 112.08 | 115.96 | 112.28 |
| 30% | 120.69 | 117.39 | 111.15 | **122.22** | **123.31** | 118.22 | 115.16 | 120.04 | 116.40 |
| 35% | 125.15 | 120.94 | 115.50 | **126.22** | **127.46** | 122.23 | 119.52 | 123.87 | 121.24 |
| 40% | 129.05 | 125.43 | 120.57 | 130.37 | **132.17** | 126.17 | 123.65 | 128.35 | 126.45 |
| 45% | 133.19 | 128.82 | 125.55 | **134.69** | **136.04** | 129.95 | 127.48 | 131.96 | 130.90 |
| 50% | 136.66 | 133.47 | 130.77 | **138.17** | **138.90** | 133.74 | 130.67 | 136.54 | 136.59 |
| 55% | 139.14 | 137.21 | 134.71 | **141.11** | **142.97** | 136.52 | 133.98 | 139.84 | 140.67 |
| 60% | 143.00 | 140.74 | 139.60 | 144.56 | **146.78** | 139.77 | 136.92 | 143.64 | 144.91 |
| 65% | 146.60 | 145.74 | 144.90 | 149.23 | **151.55** | 143.83 | 141.06 | 149.02 | 150.69 |
| 70% | 151.91 | 150.42 | 150.66 | 154.42 | **156.85** | 149.12 | 146.40 | 153.42 | **157.12** |
| 75% | 156.37 | 155.83 | 156.55 | 158.85 | **161.87** | 153.34 | 150.21 | 158.59 | **162.49** |
| 80% | 161.01 | 160.27 | 163.94 | 163.41 | 166.11 | 158.19 | 154.95 | 163.06 | **170.35** |
| 85% | 165.75 | 166.93 | 171.32 | 168.52 | 172.22 | 162.24 | 159.71 | 169.30 | **177.16** |
| 90% | 172.24 | 175.50 | 180.57 | 176.06 | 181.36 | 169.51 | 166.38 | 177.97 | **185.82** |
| 95% | 183.35 | 187.26 | 194.10 | 187.78 | 192.67 | 181.21 | 178.20 | 190.00 | **198.96** |

Table A.5. (Continued)

| Name | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
|---|---|---|---|---|---|---|---|
| Minimum = | 62.56 | 79.94 | 77.31 | 75.30 | 76.19 | 71.08 | 77.25 |
| Maximum = | 258.94 | 231.91 | 247.73 | 255.91 | 262.07 | 291.87 | 255.84 |
| **Mean =** | **136.60** | **134.64** | **139.39** | **140.57** | **137.43** | **137.26** | **141.38** |
| **Std Dev =** | **33.78** | **26.61** | **28.98** | **30.93** | **28.06** | **31.27** | **30.70** |
| Variance = | 1141.29 | 707.95 | 839.71 | 956.52 | 787.32 | 977.96 | 942.22 |
| Mode = | 122.85 | 135.65 | 115.63 | 130.54 | 127.00 | 147.10 | 133.86 |
| | *33% CFC 33% Puts* | *33% CFC 33% Futures* | *33% Puts* | *66% Puts* | *33% Futures* | *66% Futures* | *33% Min Price 33% Puts* |
| 5% | 83.01 | 94.11 | 95.27 | 93.75 | 97.05 | 93.38 | 95.19 |
| 10% | 95.12 | 100.67 | 103.25 | 102.62 | 103.28 | 99.90 | **103.43** |
| 15% | 101.55 | 106.47 | 108.69 | 107.46 | 107.40 | 106.26 | 108.98 |
| 20% | 107.19 | 111.12 | 113.40 | 113.22 | 112.40 | 109.93 | **113.88** |
| 25% | 112.30 | 113.81 | 117.41 | 117.59 | 116.91 | 114.43 | **118.21** |
| 30% | 117.15 | 118.12 | 121.53 | 121.41 | 121.09 | 118.84 | **122.39** |
| 35% | 120.65 | 121.92 | 125.83 | 125.77 | 124.99 | 122.24 | **126.70** |
| 40% | 124.50 | 125.94 | 130.28 | **130.71** | 127.96 | 126.55 | **131.35** |
| 45% | 130.12 | 129.49 | 133.80 | 134.51 | 130.82 | 130.74 | **135.49** |
| 50% | 133.83 | 133.60 | 137.25 | 137.35 | 135.50 | 134.66 | **138.15** |
| 55% | 138.01 | 136.41 | 140.71 | 141.05 | 138.76 | 137.66 | **141.85** |
| 60% | 142.29 | 139.67 | 144.94 | **145.92** | 142.81 | 142.14 | **146.46** |
| 65% | 147.70 | 143.29 | 149.15 | **151.84** | 146.23 | 146.27 | **151.63** |
| 70% | 153.24 | 148.46 | 154.72 | **156.31** | 149.98 | 149.57 | **157.10** |
| 75% | 157.63 | 153.19 | 159.36 | **161.01** | 154.16 | 154.90 | **161.85** |
| 80% | 165.38 | 157.26 | 163.50 | **166.25** | 159.40 | 161.16 | **166.89** |
| 85% | **173.43** | 162.46 | 169.92 | 173.12 | 165.00 | 165.69 | **173.70** |
| 90% | **181.66** | 168.68 | 178.13 | 182.69 | 172.44 | 174.91 | **182.17** |
| 95% | **195.29** | 180.29 | 190.28 | 195.32 | 187.12 | 193.06 | **195.65** |

# APPENDIX B

# SINGLE CROP SIMULATION OUTPUT

Table B.1. Gross Revenue Per Acre for Single Crop Analysis, Wheat with CAT Insurance Coverage

| | | *33%* | *33% CFC* | *33% Min Price* | *33%* | *66%* | *66%* | *33%* | *33%* | *33%* |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | ***Base*** | ***CFC*** | ***33% Puts*** | ***33% Puts*** | ***Min Price*** | ***Min Price*** | ***Puts*** | ***Puts*** | ***Futures*** | ***HTA*** |
| Minimum = | 39.24 | 17.07 | 14.72 | 36.39 | 38.74 | 38.13 | 34.54 | 36.89 | 40.41 | 21.20 |
| Maximum = | 225.95 | 213.89 | 227.72 | 225.21 | 225.95 | 225.95 | 226.62 | 223.60 | 240.96 | 216.06 |
| **Mean =** | **119.34** | **116.68** | **118.33** | **123.00** | **121.35** | **123.31** | **122.65** | **120.99** | **119.07** | **119.46** |
| **Std Dev =** | **33.27** | **35.93** | **38.18** | **35.68** | **34.06** | **35.29** | **36.29** | **34.45** | **33.60** | **36.13** |
| Variance = | 1106.94 | 1290.89 | 1457.48 | 1272.73 | 1160.34 | 1245.14 | 1317.20 | 1186.67 | 1128.91 | 1305.26 |
| Mode = | 105.45 | 99.52 | 109.10 | 126.32 | 122.78 | 127.75 | 167.84 | 134.10 | 127.59 | 98.30 |
| 5% | **64.39** | 56.80 | 54.60 | 62.10 | **64.44** | 64.13 | 59.75 | 62.10 | **66.90** | 58.93 |
| 10% | **77.52** | 67.28 | 65.62 | 76.71 | **78.23** | **78.28** | 75.24 | 76.17 | 76.62 | 70.18 |
| 15% | 84.34 | 79.11 | 76.97 | **85.39** | **85.45** | **86.15** | 83.71 | 84.80 | 84.80 | 80.41 |
| 20% | 90.57 | 86.47 | 86.75 | **92.91** | 91.69 | **92.40** | **92.07** | 91.81 | 89.67 | 88.45 |
| 25% | 95.96 | 92.27 | 92.73 | **97.15** | **96.87** | **98.34** | 96.55 | 95.90 | 95.13 | 95.34 |
| 30% | 101.25 | 97.09 | 97.16 | **103.40** | **102.94** | **103.26** | 102.55 | 102.68 | 100.18 | 98.65 |
| 35% | 105.54 | 101.40 | 101.71 | **107.88** | **107.49** | **108.54** | 107.27 | 107.32 | 105.67 | 104.61 |
| 40% | 109.85 | 108.80 | 107.88 | **112.76** | 111.31 | **113.05** | **112.34** | 111.20 | 108.88 | 110.84 |
| 45% | 113.44 | 111.94 | 114.53 | **117.18** | 115.93 | **117.45** | **117.55** | 115.23 | 112.70 | 115.47 |
| 50% | 117.69 | 117.59 | 120.43 | **121.29** | 119.64 | **121.68** | **122.58** | 119.94 | 116.28 | 119.81 |
| 55% | 122.31 | 122.49 | 123.57 | **126.37** | 124.89 | **126.94** | 126.15 | 125.08 | 120.16 | 124.16 |
| 60% | 126.85 | 127.12 | 128.81 | **130.91** | 129.40 | **131.53** | **131.75** | 128.96 | 125.55 | 129.58 |
| 65% | 131.09 | 131.08 | 132.82 | **136.36** | 133.88 | **136.77** | **136.36** | 134.19 | 129.40 | 133.84 |
| 70% | 136.44 | 135.34 | 138.87 | **142.42** | 138.63 | **141.87** | **142.49** | 139.35 | 135.89 | 138.67 |
| 75% | 142.30 | 140.79 | 143.59 | **147.33** | 145.43 | **148.15** | **146.59** | 144.88 | 140.89 | 143.65 |
| 80% | 148.22 | 147.32 | 148.65 | **153.36** | 151.09 | **154.64** | **152.75** | 151.21 | 146.38 | 151.03 |
| 85% | 153.73 | 154.40 | 157.88 | **161.07** | 155.84 | **159.60** | **161.30** | 156.86 | 152.65 | 156.76 |
| 90% | 160.45 | 160.06 | 165.68 | **167.39** | 162.77 | **166.61** | **167.94** | 162.84 | 163.13 | 163.64 |
| 95% | 172.88 | 177.25 | 183.21 | **183.71** | 179.93 | **182.17** | **185.05** | 179.18 | 176.53 | 179.76 |

Table B.2. Gross Revenue Per Acre for Single Crop Analysis, Wheat with 65% MPC Insurance Coverage

| | | ***33%*** | ***33% CFC*** | ***33% Min Price*** | ***33%*** | ***66%*** | ***66%*** | ***33%*** | ***33%*** | ***33%*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | ***Base*** | ***CFC*** | ***33% Puts*** | ***33% Puts*** | ***Min Price*** | ***Min Price*** | ***Puts*** | ***Puts*** | ***Futures*** | ***HTA*** |
| Minimum = | 62.53 | 52.54 | 50.20 | 61.81 | 64.01 | 64.16 | 59.39 | 61.74 | 55.42 | 56.67 |
| Maximum = | 222.70 | 210.65 | 224.48 | 221.96 | 222.70 | 222.70 | 223.37 | 220.35 | 237.72 | 212.82 |
| **Mean =** | **118.68** | **116.01** | **117.66** | **122.34** | **120.68** | **122.65** | **121.98** | **120.33** | **118.41** | **118.79** |
| **Std Dev =** | **30.05** | **31.87** | **34.10** | **32.24** | **30.76** | **31.92** | **32.78** | **31.04** | **31.51** | **32.08** |
| Variance = | 903.12 | 1015.46 | 1162.71 | 1039.31 | 946.27 | 1019.15 | 1074.69 | 963.50 | 992.99 | 1029.41 |
| Mode = | 119.60 | 96.28 | 105.85 | 123.10 | 119.61 | 124.52 | 119.79 | 108.35 | 124.34 | 95.14 |
| 5% | 75.19 | 71.64 | 70.10 | **75.55** | **76.71** | **76.17** | 74.06 | **75.55** | 72.83 | 73.62 |
| 10% | **81.92** | 75.65 | 73.55 | 81.57 | **82.71** | **82.96** | 80.17 | 81.38 | 80.34 | 78.14 |
| 15% | 86.03 | 79.06 | 77.85 | **88.56** | 86.85 | **88.29** | **87.62** | 86.64 | 85.94 | 82.46 |
| 20% | 90.69 | 85.34 | 84.52 | **92.38** | **91.74** | **93.21** | 91.62 | 91.46 | 90.90 | 86.72 |
| 25% | 95.64 | 89.79 | 89.58 | **97.12** | **96.86** | **98.51** | 96.06 | 96.57 | 96.03 | 93.04 |
| 30% | 100.34 | 93.84 | 93.92 | **101.65** | **101.69** | **101.91** | 100.42 | 100.63 | 101.06 | 95.52 |
| 35% | 104.00 | 98.15 | 98.47 | **105.71** | **105.04** | **105.96** | 104.84 | 105.11 | 104.38 | 101.37 |
| 40% | 107.57 | 105.55 | 104.63 | **110.06** | 108.89 | **110.71** | **109.73** | 108.46 | 107.54 | 107.60 |
| 45% | 110.87 | 108.70 | 111.28 | **115.12** | 113.14 | **114.45** | **114.76** | 112.68 | 110.47 | 112.22 |
| 50% | 115.22 | 114.34 | 117.18 | **118.28** | 116.97 | **118.88** | **119.47** | 117.11 | 114.43 | 116.56 |
| 55% | 119.46 | 119.25 | 120.33 | **123.13** | 121.69 | **124.47** | **122.97** | 121.86 | 119.08 | 120.92 |
| 60% | 123.66 | 123.88 | 125.57 | **127.78** | 126.16 | **128.54** | **128.60** | 125.79 | 123.46 | 126.34 |
| 65% | 128.29 | 127.84 | 129.58 | **133.12** | 130.94 | **133.53** | **133.42** | 131.18 | 126.98 | 130.60 |
| 70% | 133.29 | 132.10 | 135.63 | **139.19** | 136.15 | **138.82** | **139.24** | 136.20 | 133.46 | 135.43 |
| 75% | 139.55 | 137.55 | 140.35 | **144.08** | 142.22 | **144.90** | **143.35** | 141.64 | 138.84 | 140.40 |
| 80% | 144.97 | 144.08 | 145.41 | **150.12** | 147.85 | **151.40** | **149.50** | 147.97 | 143.44 | 147.78 |
| 85% | 150.48 | 151.16 | 154.63 | **157.83** | 152.60 | **156.35** | **158.06** | 153.61 | 149.68 | 153.51 |
| 90% | 157.21 | 156.82 | 162.44 | **164.15** | 159.53 | **163.36** | **164.69** | 159.60 | 159.89 | 160.40 |
| 95% | 169.64 | 174.00 | **179.96** | **180.47** | 176.68 | 178.93 | **181.80** | 175.94 | 174.56 | 176.52 |

Table B.3. Gross Revenue Per Acre for Single Crop Analysis, Wheat with 65% CRC Insurance Coverage

| | | *33%* | *33% CFC* | *33% Min Price* | *33%* | *66%* | *66%* | *33%* | *33%* | *33%* |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | ***Base*** | ***CFC*** | ***33% Puts*** | ***33% Puts*** | ***Min Price*** | ***Min Price*** | ***Puts*** | ***Puts*** | ***Futures*** | ***HTA*** |
| Minimum = | 63.24 | 65.84 | 63.49 | 60.97 | 63.32 | 63.32 | 58.55 | 60.90 | 64.34 | 61.92 |
| Maximum = | 221.20 | 209.15 | 222.98 | 220.46 | 221.20 | 221.20 | 221.87 | 218.85 | 236.22 | 211.32 |
| **Mean =** | **118.94** | **116.28** | **117.93** | **122.60** | **120.95** | **122.91** | **122.24** | **120.59** | **118.67** | **119.06** |
| **Std Dev =** | **28.74** | **30.01** | **32.32** | **30.95** | **29.47** | **30.65** | **31.48** | **29.71** | **30.84** | **30.24** |
| Variance = | 825.91 | 900.52 | 1044.41 | 957.89 | 868.21 | 939.41 | 990.77 | 882.94 | 951.22 | 914.53 |
| Mode = | 106.03 | 105.88 | 85.10 | 121.60 | 123.06 | 123.06 | 115.52 | 124.76 | 141.91 | 93.60 |
| 5% | **78.35** | 75.36 | 73.64 | 78.07 | **79.44** | **79.39** | 76.00 | 78.07 | 75.22 | 78.13 |
| 10% | 82.18 | 80.02 | 78.58 | **84.80** | **84.09** | **84.28** | 83.86 | 82.80 | 80.37 | 82.91 |
| 15% | 87.80 | 84.33 | 83.30 | **89.67** | 88.76 | **89.83** | **89.58** | 88.77 | 85.06 | 87.17 |
| 20% | 92.91 | 87.60 | 87.05 | **93.83** | **94.50** | **95.00** | 92.90 | 93.54 | 90.79 | 90.57 |
| 25% | 97.63 | 90.87 | 91.15 | **98.95** | **98.51** | **99.23** | 97.95 | 98.40 | 95.66 | 93.68 |
| 30% | 101.01 | 94.73 | 94.05 | **102.76** | **102.60** | **103.79** | 102.06 | 102.28 | 100.85 | 97.25 |
| 35% | 104.85 | 97.34 | 98.14 | **106.90** | 106.05 | **107.48** | **106.12** | 105.81 | 104.09 | 100.99 |
| 40% | 107.81 | 104.48 | 104.40 | **110.60** | 109.87 | **110.74** | **110.66** | 108.94 | 107.29 | 106.25 |
| 45% | 111.04 | 107.48 | 110.19 | **115.61** | 112.92 | **114.89** | **115.39** | 113.01 | 111.21 | 111.15 |
| 50% | 115.45 | 113.10 | 115.87 | **119.32** | 117.59 | **118.22** | **119.25** | 116.93 | 114.02 | 115.40 |
| 55% | 119.10 | 117.99 | 119.01 | **122.99** | **122.97** | **123.77** | 122.52 | 121.60 | 119.31 | 119.72 |
| 60% | 123.69 | 122.40 | 124.11 | **127.27** | 125.41 | **127.70** | **127.30** | 124.87 | 123.05 | 125.10 |
| 65% | 127.44 | 126.59 | 128.46 | **132.28** | 130.73 | **133.13** | **132.38** | 130.01 | 127.00 | 129.63 |
| 70% | 131.86 | 131.14 | 134.22 | **137.79** | 134.94 | **138.43** | **137.79** | 134.97 | 133.47 | 134.30 |
| 75% | 138.24 | 136.39 | 139.30 | **142.82** | 141.16 | **143.68** | **142.32** | 140.66 | 138.11 | 138.98 |
| 80% | 143.68 | 142.98 | 144.93 | **148.81** | 146.54 | **150.15** | **148.56** | 147.34 | 143.20 | 146.28 |
| 85% | 149.51 | 149.66 | 153.54 | **156.35** | 151.16 | **155.10** | **157.17** | 152.20 | 150.52 | 152.01 |
| 90% | 155.72 | 155.32 | 161.18 | **162.65** | 158.52 | **161.86** | **163.19** | 158.10 | 158.67 | 158.90 |
| 95% | 168.14 | 172.50 | **178.46** | **178.97** | 175.18 | 177.43 | **180.30** | 174.44 | 173.19 | 175.02 |

Table B.4. Gross Revenue Per Acre for Single Crop Analysis, Corn with CAT Insurance Coverage

| | | *33%* | *33% CFC* | *33% Min Price* | *33%* | *66%* | *66%* | *33%* | *33%* | *33%* |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | ***Base*** | ***CFC*** | ***33% Puts*** | ***33% Puts*** | ***Min Price*** | ***Min Price*** | ***Puts*** | ***Puts*** | ***Futures*** | ***HTA*** |
| Minimum = | 35.62 | 9.07 | 3.93 | 29.48 | 34.62 | 33.60 | 30.48 | 30.48 | 8.62 | 11.27 |
| Maximum = | 394.23 | 377.50 | 385.43 | 389.09 | 394.23 | 394.23 | 389.09 | 389.09 | 410.15 | 383.48 |
| **Mean =** | **139.75** | **134.77** | **136.34** | **143.06** | **141.49** | **143.09** | **141.32** | **141.32** | **139.33** | **139.60** |
| **Std Dev =** | **66.99** | **68.97** | **71.92** | **69.79** | **67.63** | **68.62** | **68.74** | **68.74** | **68.50** | **69.03** |
| Variance = | 4487.59 | 4756.92 | 5172.48 | 4870.76 | 4574.17 | 4708.85 | 4725.02 | 4725.02 | 4692.68 | 4765.25 |
| Mode = | 52.41 | 163.57 | 121.98 | 128.74 | 52.19 | 187.22 | 169.19 | 169.19 | 125.50 | 57.86 |
| 5% | **47.28** | 37.34 | 33.31 | 44.15 | **47.94** | **47.29** | 44.31 | 44.31 | 46.02 | 41.90 |
| 10% | 54.73 | 48.96 | 44.31 | 54.25 | **55.23** | **55.26** | 53.50 | 53.50 | **57.41** | 53.40 |
| 15% | **65.64** | 56.44 | 54.03 | 63.89 | **65.88** | **65.98** | 63.36 | 63.36 | **70.83** | 61.73 |
| 20% | **76.04** | 67.15 | 65.49 | 74.74 | **76.15** | 76.66 | 73.61 | 73.61 | **79.15** | 72.47 |
| 25% | 86.36 | 83.22 | 80.31 | 85.88 | **89.02** | **90.15** | 85.88 | 85.88 | 85.44 | **87.11** |
| 30% | 99.13 | 93.82 | 92.01 | **100.80** | 100.28 | **101.78** | 99.56 | 99.56 | 94.94 | 96.55 |
| 35% | 107.02 | 101.56 | 102.45 | **109.27** | **108.26** | **109.09** | 106.82 | 106.82 | 103.95 | 107.18 |
| 40% | 114.54 | 109.88 | 111.85 | **119.00** | 115.01 | **117.58** | **116.62** | **116.62** | 112.67 | 116.36 |
| 45% | 122.72 | 117.97 | 122.18 | **128.56** | 125.55 | **126.07** | **126.31** | **126.31** | 120.90 | 123.76 |
| 50% | 133.70 | 129.52 | 131.21 | **136.67** | **135.41** | **136.51** | 134.94 | 134.94 | 128.64 | 133.13 |
| 55% | 141.54 | 138.89 | 141.49 | **147.47** | 142.45 | **144.85** | **144.77** | **144.77** | 138.95 | 143.88 |
| 60% | 152.09 | 147.03 | 151.46 | **157.43** | 154.30 | **156.75** | **154.82** | **154.82** | 147.67 | 152.07 |
| 65% | 160.71 | 157.38 | 162.70 | **166.12** | 162.86 | **164.23** | **163.88** | **163.88** | 159.17 | 162.17 |
| 70% | 172.43 | 167.51 | 171.40 | **176.65** | 174.37 | **177.07** | **174.36** | **174.36** | 169.98 | 171.99 |
| 75% | 185.46 | 180.69 | 182.85 | **187.86** | **187.13** | **187.35** | 186.47 | 186.47 | 180.79 | 186.58 |
| 80% | 196.14 | 194.18 | 196.66 | **202.46** | 199.86 | **201.03** | 199.06 | 199.06 | 197.98 | **199.08** |
| 85% | 209.52 | 208.42 | **213.27** | **218.87** | 212.63 | **214.33** | **212.75** | **212.75** | 210.88 | 211.73 |
| 90% | 230.90 | 227.42 | 229.98 | **234.72** | 230.98 | **233.36** | 229.85 | 229.85 | 229.27 | **232.18** |
| 95% | 259.38 | 253.40 | 254.48 | **268.00** | 262.90 | **263.80** | **263.06** | **263.06** | 262.93 | 260.18 |

Table B.5. Gross Revenue Per Acre for Single Crop Analysis, Corn with 65% MPC Insurance Coverage

| Name | Base | 33% CFC | 33% CFC 33% Puts | 33% Min Price 33% Puts | 33% Min Price | 66% Min Price | 66% Puts | 33% Puts | 33% Futures | 33% HTA |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 61.62 | 44.50 | 39.36 | 61.63 | 63.48 | 63.68 | 61.63 | 61.63 | 29.12 | 48.56 |
| Maximum = | 386.23 | 369.50 | 377.43 | 381.09 | 386.23 | 386.23 | 381.09 | 381.09 | 402.15 | 375.48 |
| **Mean =** | **137.97** | **132.99** | **134.57** | **141.29** | **139.71** | **141.32** | **139.55** | **139.55** | **137.56** | **137.82** |
| **Std Dev =** | **60.04** | **61.46** | **64.31** | **62.55** | **60.60** | **61.50** | **61.53** | **61.53** | **62.87** | **61.53** |
| Variance = | 3604.84 | 3776.76 | 4135.60 | 3912.06 | 3672.20 | 3782.24 | 3785.54 | 3785.54 | 3952.74 | 3786.21 |
| Mode = | 73.42 | 67.65 | 62.52 | 67.39 | 81.58 | 179.22 | 73.71 | 73.71 | 110.20 | 71.78 |
| 5% | 69.03 | 65.27 | 60.80 | 68.05 | **70.81** | **70.52** | 68.29 | 68.29 | 58.27 | **69.27** |
| 10% | **73.48** | 67.72 | 63.54 | 72.20 | **74.34** | **74.16** | 72.54 | 72.54 | 68.67 | 71.88 |
| 15% | **78.06** | 69.30 | 65.87 | 75.39 | **78.50** | **78.23** | 75.39 | 75.39 | 75.22 | 74.54 |
| 20% | **81.71** | 71.56 | 69.93 | 80.22 | **82.78** | **83.36** | 79.17 | 79.17 | 84.93 | 77.28 |
| 25% | 86.57 | 76.23 | 76.43 | 89.16 | 87.03 | **88.79** | **87.32** | **87.32** | **90.31** | 82.04 |
| 30% | 94.53 | 86.20 | 86.51 | 94.66 | **94.93** | **96.45** | 93.87 | 93.87 | **95.75** | 89.98 |
| 35% | 99.85 | 93.95 | 94.82 | **101.87** | 101.24 | **101.35** | 101.05 | 101.05 | **101.33** | 99.36 |
| 40% | 106.63 | 103.48 | 105.18 | **111.22** | 107.55 | **110.32** | **109.32** | **109.32** | **110.03** | 108.49 |
| 45% | 115.71 | 109.97 | 114.18 | **120.56** | **118.07** | **118.54** | **118.31** | **118.31** | 115.79 | 115.76 |
| 50% | 125.70 | 121.52 | 123.21 | **129.31** | 127.41 | **128.51** | **127.20** | **127.20** | 123.26 | 125.13 |
| 55% | 133.69 | 130.89 | 133.49 | **139.47** | 134.82 | **136.95** | **136.77** | **136.77** | 132.87 | 135.88 |
| 60% | 144.09 | 139.03 | 143.46 | **149.43** | 146.30 | **148.75** | **146.82** | **146.82** | 141.96 | 144.07 |
| 65% | 152.71 | 149.38 | 154.70 | **159.06** | 154.86 | **156.23** | **155.88** | **155.88** | 152.88 | 154.17 |
| 70% | 164.65 | 159.51 | 163.40 | **168.65** | **166.48** | **169.25** | **166.61** | **166.61** | 162.73 | 163.99 |
| 75% | 177.46 | 172.69 | 174.85 | **179.86** | **179.13** | **179.35** | 178.47 | 178.47 | 172.79 | 178.58 |
| 80% | 188.14 | 186.18 | 188.66 | **194.46** | 191.86 | **193.03** | 191.06 | 191.06 | 190.68 | **191.08** |
| 85% | 201.52 | 200.42 | **205.27** | **210.87** | 204.63 | **206.33** | **204.75** | **204.75** | 202.88 | 203.73 |
| 90% | 222.90 | 219.42 | 221.98 | **226.72** | 222.98 | **225.36** | 221.85 | 221.85 | 221.27 | **224.18** |
| 95% | 251.38 | 245.40 | 246.48 | **260.00** | 254.90 | **255.80** | **255.06** | **255.06** | **255.12** | 252.18 |

Table B.6. Gross Revenue Per Acre for Single Crop Analysis, Corn with 65% CRC Insurance Coverage

| Name | Base | 33% CFC | 33% CFC 33% Puts | 33% Min Price 33% Puts | 33% Min Price | 66% Min Price | 66% Puts | 33% Puts | 33% Futures | 33% HTA |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 64.20 | 61.44 | 56.30 | 59.06 | 64.20 | 64.16 | 59.06 | 59.06 | 53.93 | 63.89 |
| Maximum = | 381.22 | 364.49 | 372.42 | 376.08 | 381.22 | 381.22 | 376.08 | 376.08 | 397.14 | 370.47 |
| **Mean =** | **137.10** | **132.12** | **133.69** | **140.41** | **138.83** | **140.44** | **138.67** | **138.67** | **136.68** | **136.94** |
| **Std Dev =** | **56.69** | **57.64** | **60.60** | **59.25** | **57.26** | **58.18** | **58.18** | **58.18** | **60.45** | **57.72** |
| Variance = | 3213.20 | 3322.59 | 3672.64 | 3510.25 | 3279.18 | 3385.17 | 3385.11 | 3385.11 | 3654.73 | 3331.48 |
| Mode = | 77.45 | 150.56 | 74.29 | 115.70 | 77.45 | 73.15 | 109.67 | 109.67 | 73.48 | 78.51 |
| 5% | **73.80** | 70.47 | 65.36 | 71.81 | **73.94** | 73.32 | 71.81 | 71.81 | 63.87 | **74.63** |
| 10% | **78.02** | 72.54 | 68.50 | 75.77 | **78.45** | 77.81 | 75.77 | 75.77 | 69.36 | **78.39** |
| 15% | **81.05** | 75.75 | 72.05 | 81.07 | **82.40** | **83.15** | 80.70 | 80.70 | 74.75 | 80.41 |
| 20% | **86.63** | 79.36 | 76.08 | 86.65 | **88.77** | **88.88** | 86.46 | 86.46 | 82.04 | 83.77 |
| 25% | **91.44** | 83.64 | 81.91 | 91.64 | **92.39** | **93.11** | 90.58 | 90.58 | 88.16 | 88.39 |
| 30% | 96.15 | 88.75 | 87.65 | **96.86** | **97.93** | **98.19** | 96.71 | 96.71 | 95.29 | 93.73 |
| 35% | 101.53 | 94.54 | 93.91 | **104.31** | 102.65 | **104.87** | **103.61** | **103.61** | **102.45** | 98.60 |
| 40% | 107.38 | 100.71 | 104.28 | **113.30** | **110.24** | **111.28** | **109.74** | **109.74** | 108.03 | 105.81 |
| 45% | 115.63 | 107.41 | 113.35 | **118.99** | **117.64** | **119.72** | **117.33** | **117.33** | 116.10 | 113.25 |
| 50% | 122.90 | 116.70 | 119.79 | **126.22** | **124.88** | **126.88** | 123.56 | 123.56 | 122.74 | 121.07 |
| 55% | 129.96 | 126.11 | 129.29 | **136.39** | 131.58 | **135.85** | **133.05** | **133.05** | **132.05** | 131.06 |
| 60% | 139.96 | 135.46 | 138.67 | **145.00** | 141.55 | **144.02** | **142.92** | **142.92** | 141.42 | 139.43 |
| 65% | 147.70 | 144.37 | 149.78 | **154.10** | 149.85 | 151.84 | **151.09** | **151.09** | **151.87** | 149.16 |
| 70% | 159.64 | 154.50 | 158.40 | **164.77** | **161.47** | **164.24** | **161.60** | **161.60** | 160.61 | 158.98 |
| 75% | 172.74 | 167.68 | 172.24 | **174.85** | **174.16** | **174.75** | 173.46 | 173.46 | 169.43 | 173.57 |
| 80% | 183.13 | 181.17 | 183.65 | **189.45** | 186.85 | **188.02** | 186.05 | 186.05 | **187.83** | 186.07 |
| 85% | 196.51 | 195.41 | **200.26** | **205.86** | 199.62 | **201.32** | 199.74 | 199.74 | **200.53** | 198.72 |
| 90% | 217.89 | 214.41 | 216.97 | **221.71** | 217.97 | **220.35** | 216.84 | 216.84 | 216.26 | **219.17** |
| 95% | 246.37 | 240.39 | 241.47 | **254.99** | 249.89 | **250.79** | **250.05** | **250.05** | **250.11** | 247.17 |

Table B.7. Gross Revenue Per Acre for Single Crop Analysis, Soybeans with CAT Insurance Coverage

| Name | Base | 33% CFC | 33% CFC 33% Puts | 33% Min Price 33% Puts | 33% Min Price | 66% Min Price | 66% Puts | 33% Puts | 33% Futures | 33% HTA |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 59.79 | 43.38 | 39.32 | 55.74 | 45.71 | 59.12 | 58.12 | 58.68 | 56.05 | 25.10 |
| Maximum = | 312.33 | 286.88 | 314.38 | 308.27 | 308.67 | 312.33 | 306.23 | 308.26 | 349.43 | 315.02 |
| **Mean =** | **161.93** | **159.39** | **161.19** | **163.29** | **164.07** | **166.22** | **164.62** | **163.72** | **161.72** | **161.91** |
| **Std Dev =** | **41.42** | **43.86** | **47.61** | **45.27** | **45.63** | **43.89** | **45.18** | **43.63** | **43.55** | **49.59** |
| Variance = | 1715.34 | 1923.95 | 2266.36 | 2049.51 | 2081.85 | 1926.02 | 2041.29 | 1903.27 | 1896.90 | 2459.04 |
| Mode = | 180.30 | 155.73 | 195.16 | 101.02 | 177.52 | 205.37 | 194.86 | 145.79 | 150.24 | 162.62 |
| 5% | **91.42** | 85.90 | 82.16 | 86.90 | 88.34 | **91.29** | 87.39 | 89.15 | **91.21** | 74.15 |
| 10% | **106.40** | 101.92 | 100.80 | 104.18 | 105.58 | **107.35** | 104.61 | 105.67 | **105.98** | 96.94 |
| 15% | **120.87** | 113.76 | 110.44 | 117.10 | 116.23 | **121.23** | 118.35 | **118.49** | 118.04 | 111.16 |
| 20% | **127.36** | 120.61 | 120.23 | 124.31 | 124.63 | **129.23** | 125.72 | **127.03** | 126.15 | 119.08 |
| 25% | **132.85** | 130.31 | 128.58 | 132.03 | 133.64 | **135.06** | **132.77** | 132.09 | 132.01 | 127.15 |
| 30% | 139.49 | 137.77 | 137.13 | 139.46 | **140.99** | **142.13** | 140.22 | **140.75** | 138.11 | 136.24 |
| 35% | 144.82 | 143.64 | 142.29 | 144.67 | **146.96** | **148.62** | **146.50** | 145.81 | 143.60 | 143.64 |
| 40% | 149.83 | 149.02 | 150.40 | 151.88 | 152.80 | **154.32** | **152.96** | **153.63** | 149.31 | 150.53 |
| 45% | 155.78 | 155.18 | 157.19 | 157.80 | **160.08** | **160.06** | **159.93** | 158.66 | 154.11 | 156.88 |
| 50% | 161.26 | 160.75 | 162.10 | 163.81 | **165.57** | **165.52** | **165.83** | 163.72 | 158.86 | 162.70 |
| 55% | 168.01 | 164.65 | 167.62 | 168.84 | **169.69** | **171.73** | **169.94** | 169.42 | 164.88 | 168.77 |
| 60% | 173.48 | 170.97 | 171.85 | 172.76 | **174.57** | **176.02** | **174.23** | 173.22 | 169.67 | 173.98 |
| 65% | 178.20 | 175.22 | 176.10 | 179.11 | 178.73 | **181.60** | **180.91** | 179.61 | 174.41 | **179.86** |
| 70% | 183.93 | 181.79 | 183.62 | 186.13 | 186.16 | **189.56** | **187.63** | **186.64** | 181.78 | 184.50 |
| 75% | 189.73 | 189.32 | 191.41 | 192.59 | 193.47 | **194.52** | **194.26** | 192.43 | 188.11 | **194.50** |
| 80% | 195.65 | 195.87 | 198.74 | 199.13 | **200.81** | **201.22** | 200.77 | 197.97 | 195.13 | **202.34** |
| 85% | 203.06 | 201.03 | 208.29 | 207.83 | **209.44** | 208.77 | 209.13 | 205.92 | 204.72 | **210.88** |
| 90% | 213.04 | 213.31 | 219.87 | **222.84** | 220.73 | 222.66 | 224.19 | 219.55 | 216.70 | **224.78** |
| 95% | 232.02 | 229.57 | 239.42 | 237.79 | **238.37** | 237.02 | 239.19 | 235.01 | 231.91 | **242.39** |

Table B.8. Gross Revenue Per Acre for Single Crop Analysis, Soybeans with 65% MPC Insurance Coverage

| Name | Base | 33% CFC | 33% CFC 33% Puts | 33% Min Price 33% Puts | 33% Min Price | 66% Min Price | 66% Puts | 33% Puts | 33% Futures | 33% HTA |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 95.61 | 86.47 | 82.40 | 88.78 | 88.79 | 95.82 | 89.94 | 91.97 | 74.95 | 65.51 |
| Maximum = | 308.42 | 282.97 | 310.48 | 304.36 | 304.76 | 308.42 | 302.32 | 304.35 | 345.52 | 311.11 |
| **Mean =** | **159.78** | **157.24** | **159.04** | **161.14** | **161.92** | **164.07** | **162.47** | **161.57** | **159.57** | **159.76** |
| **Std Dev =** | **38.65** | **40.78** | **44.59** | **42.45** | **42.58** | **41.10** | **42.34** | **40.79** | **41.52** | **46.45** |
| Variance = | 1493.66 | 1663.40 | 1987.99 | 1802.11 | 1813.16 | 1688.90 | 1792.89 | 1663.78 | 1723.87 | 2157.97 |
| Mode = | 176.40 | 151.82 | 191.25 | 96.53 | 95.42 | 201.46 | 190.96 | 191.88 | 165.68 | 87.41 |
| 5% | **99.40** | 94.32 | 90.25 | 96.65 | 96.15 | **101.07** | 97.61 | **99.36** | 97.37 | 87.50 |
| 10% | **107.74** | 101.57 | 99.82 | 105.05 | 104.60 | **110.40** | **107.32** | 106.34 | 109.17 | 98.60 |
| 15% | **118.86** | 110.08 | 107.25 | 115.07 | 112.43 | **119.96** | 115.98 | 116.42 | 118.22 | 107.68 |
| 20% | **124.79** | 116.70 | 116.32 | 121.92 | 120.72 | **127.03** | 122.57 | **124.47** | 124.00 | 115.95 |
| 25% | **129.60** | 126.40 | 124.67 | 128.12 | **129.73** | **132.03** | 129.59 | 128.59 | **129.73** | 123.24 |
| 30% | 135.91 | 133.87 | 133.22 | 135.85 | **137.08** | **138.80** | 136.72 | **136.93** | 134.88 | 132.33 |
| 35% | 140.94 | 139.73 | 138.38 | 140.80 | **143.05** | **144.75** | **142.67** | 142.38 | 141.05 | 139.73 |
| 40% | 145.96 | 145.11 | 146.49 | 148.05 | 148.89 | **151.02** | **149.57** | **149.75** | 146.05 | 146.63 |
| 45% | 152.08 | 151.27 | 153.28 | 153.89 | **156.17** | **156.28** | **156.02** | 154.75 | 151.42 | 152.97 |
| 50% | 157.64 | 156.84 | 158.19 | 159.90 | **161.66** | **161.61** | **161.92** | 159.81 | 156.10 | 158.79 |
| 55% | 164.10 | 160.75 | 163.71 | 164.93 | **165.78** | **167.82** | **166.03** | 165.51 | 161.36 | 164.86 |
| 60% | 169.57 | 167.06 | 167.94 | 168.85 | **170.66** | **172.11** | **170.32** | 169.32 | 165.78 | 170.08 |
| 65% | 174.29 | 171.31 | 172.19 | 175.20 | 174.83 | **177.70** | **177.00** | 175.70 | 170.50 | **175.95** |
| 70% | 180.02 | 177.88 | 179.71 | 182.23 | 182.26 | **185.65** | **183.72** | **182.73** | 177.87 | 180.59 |
| 75% | 185.82 | 185.41 | 187.50 | 188.68 | 189.56 | **190.61** | **190.36** | 188.52 | 184.20 | **190.59** |
| 80% | 191.74 | 191.96 | 194.83 | 195.22 | **196.91** | **197.31** | 196.86 | 194.06 | 191.30 | **198.43** |
| 85% | 199.15 | 197.13 | 204.38 | 203.92 | **205.53** | 204.87 | **205.22** | 202.01 | 201.30 | **206.97** |
| 90% | 209.14 | 209.40 | 215.96 | **218.93** | 216.82 | **218.75** | **220.29** | 215.64 | 212.79 | **220.87** |
| 95% | 228.12 | 225.66 | **235.51** | 233.88 | 234.46 | 233.11 | **235.28** | 231.10 | 228.01 | **238.48** |

Table B.9. Gross Revenue Per Acre for Single Crop Analysis, Soybeans with 65% CRC Insurance Coverage

| Name | Base | 33% CFC | 33% CFC 33% Puts | 33% Min Price 33% Puts | 33% Min Price | 66% Min Price | 66% Puts | 33% Puts | 33% Futures | 33% HTA |
|---|---|---|---|---|---|---|---|---|---|---|
| Minimum = | 94.47 | 88.35 | 84.29 | 87.18 | 89.80 | 94.35 | 88.38 | 90.41 | 94.82 | 82.25 |
| Maximum = | 306.74 | 281.29 | 308.80 | 302.68 | 303.08 | 306.74 | 300.64 | 302.67 | 343.84 | 309.43 |
| **Mean =** | **159.34** | **156.81** | **158.61** | **160.71** | **161.48** | **163.64** | **162.04** | **161.14** | **159.13** | **159.33** |
| **Std Dev =** | **37.37** | **39.66** | **43.72** | **41.55** | **41.59** | **40.08** | **41.43** | **39.76** | **40.23** | **45.54** |
| Variance = | 1396.65 | 1572.73 | 1911.07 | 1726.05 | 1729.81 | 1606.75 | 1716.50 | 1580.52 | 1618.85 | 2073.53 |
| Mode = | 174.72 | 157.87 | 189.66 | 164.76 | 163.45 | 126.87 | 175.41 | 140.20 | 164.00 | 181.18 |
| 5% | **102.08** | 97.17 | 93.10 | 96.43 | 100.09 | **102.05** | 97.56 | 99.28 | **100.60** | 88.46 |
| 10% | **112.45** | 105.06 | 101.92 | 109.05 | 108.19 | **113.39** | 111.34 | **112.19** | 109.94 | 96.92 |
| 15% | **119.82** | 112.25 | 108.33 | 116.45 | 114.20 | 121.12 | **117.45** | **118.87** | 117.08 | 106.68 |
| 20% | **125.47** | 118.92 | 117.34 | 122.79 | 121.77 | **126.99** | 124.10 | **124.71** | 123.60 | 117.08 |
| 25% | **130.97** | 125.50 | 125.50 | 128.32 | 129.03 | **133.29** | 129.33 | **131.13** | 128.33 | 124.54 |
| 30% | 135.95 | 133.70 | 132.27 | 135.28 | 136.69 | **139.43** | **136.94** | **137.38** | 133.31 | 132.44 |
| 35% | 140.73 | 138.58 | 138.39 | 141.77 | **142.19** | **143.67** | **142.63** | 141.92 | 139.69 | 139.92 |
| 40% | 145.48 | 143.72 | 146.11 | 147.21 | **148.60** | **150.29** | **149.29** | 148.25 | 144.75 | 146.07 |
| 45% | 150.77 | 150.18 | 151.94 | 152.97 | **155.35** | **155.04** | **155.04** | 153.44 | 150.21 | 152.24 |
| 50% | 156.63 | 155.92 | 157.57 | 158.41 | **160.19** | **160.75** | **160.40** | 158.87 | 155.16 | 158.36 |
| 55% | 163.18 | 159.76 | 162.20 | 163.68 | **164.32** | **166.88** | **164.70** | 164.28 | 160.08 | 163.57 |
| 60% | 167.96 | 165.85 | 166.45 | 167.26 | **169.47** | **170.92** | 169.00 | 168.18 | 164.62 | **169.44** |
| 65% | 172.61 | 170.18 | 170.81 | 174.45 | 174.44 | **177.25** | **175.56** | **174.77** | 169.98 | 174.27 |
| 70% | 178.34 | 176.94 | 178.84 | 181.51 | 180.97 | **184.27** | **182.66** | **181.75** | 176.26 | 180.49 |
| 75% | 184.14 | 183.80 | 187.27 | 187.36 | 189.13 | **189.50** | **189.27** | 186.97 | 182.52 | **189.99** |
| 80% | 190.06 | 190.28 | 193.68 | 193.83 | **195.74** | **195.66** | 195.37 | 192.38 | 189.62 | **197.89** |
| 85% | 197.47 | 195.45 | **203.65** | 202.30 | **204.06** | 203.19 | 203.54 | 200.33 | 199.62 | **205.81** |
| 90% | 207.46 | 207.72 | 214.28 | **217.25** | 215.14 | 217.07 | **218.61** | 213.96 | 212.92 | **219.19** |
| 95% | 226.44 | 223.98 | **233.83** | 232.20 | 232.78 | 231.43 | **233.60** | 229.42 | 226.33 | **236.80** |