DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Agriculture and Natural Resources

FSA87

# Determining Expected Cost and Premium Rates in Margin Protection Crop Insurance

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## Introduction

Agricultural producers are susceptible to crop price and production risks resulting from the uncertainty of weather, pest pressure, and price volatility, which are beyond the producers' control. Additionally, the Russia-Ukraine conflict and low Mississippi River levels have highlighted the need to mitigate input price risk. This fact sheet aims to shed light on the technical aspects of Margin Protection (MP) crop insurance, emphasizing a unique component: Expected Costs. Expected Costs constitute the primary risk factor that MP Crop Insurance provides unique safeguards against.

## Yield, Revenue, and Margin Risk Protection

The evolution of crop insurance traces back to 1899 when a private company based in Minneapolis pioneered the first 'All Risk' crop insurance, initially designed as a pilot project (Biram and Coble, 2023). It aimed to protect against shortfalls in yield, addressing production risk exclusively. Today, this federal crop insurance product is known as Yield Protection (YP). YP covers yield losses based on the Actual Production History (APH) but doesn't extend to guaranteeing revenue losses (Biram and Rainey, 2023a). This gap was addressed by introducing Revenue Protection (RP) coverage, which safeguards against both price and production risks (Biram and Rainey, 2023b). RP does guarantee revenue but not the profit margin, which is a significant concern in any economic production activity. MP was introduced as a federally sponsored crop insurance product in May 2015 and made available in 2016 to respond to this gap in risk protection. Initially, MP was only available in select areas for select crops and has since emerged as a new product that offers county-level protection for corn, soybeans, spring wheat, and rice against the risk of less-than-expected margin, or the difference between Expected Revenue and Expected Costs (Biram and Stiles, 2022).

## Expected Margin

Profit margin is the main objective of any economic production activity and is measured under MP crop insurance by the MP Trigger Margin. It is measured as the Expected Margin because it is calculated based on Expected Yield, Projected Futures Prices, and Expected Costs. Expected Margin

provides a measure of the most likely profit margin at the county level. The coverage level, which ranges from 70-95%, is chosen by the producer and determines the Margin Guarantee. Expected Revenue and Expected Margin are calculated as:

**Expected Revenue = Expected Yield X Projected Futures Price**

**Expected Margin = Expected Revenue – Expected Cost**

Since MP is an area-based product, Expected Yield represents the county's average yield among insured producers in a specific county (Biram and Connor, 2023), and is determined by the Risk Management Agency (RMA). See Figure 1, 2 and 3 below for a geographic look at county yield averages of Arkansas used in the calculation of Expected Margin for soybeans, corn, and long-grain rice.

**Figure 1. Expected County Yields for Irrigated Soybeans.**

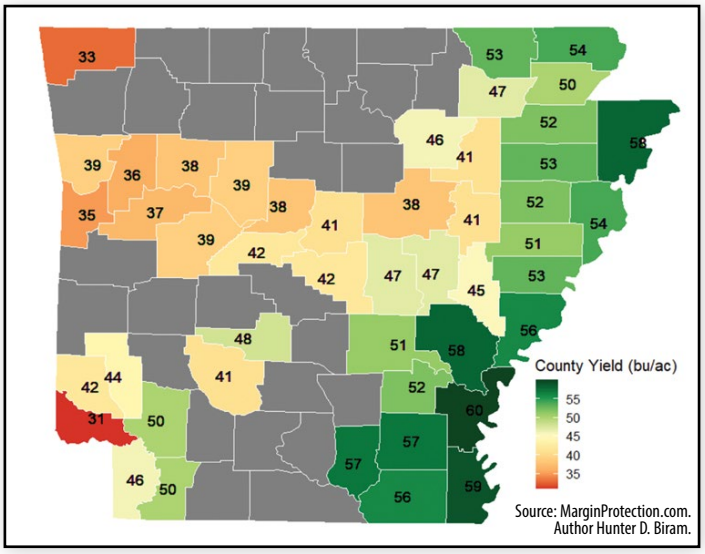
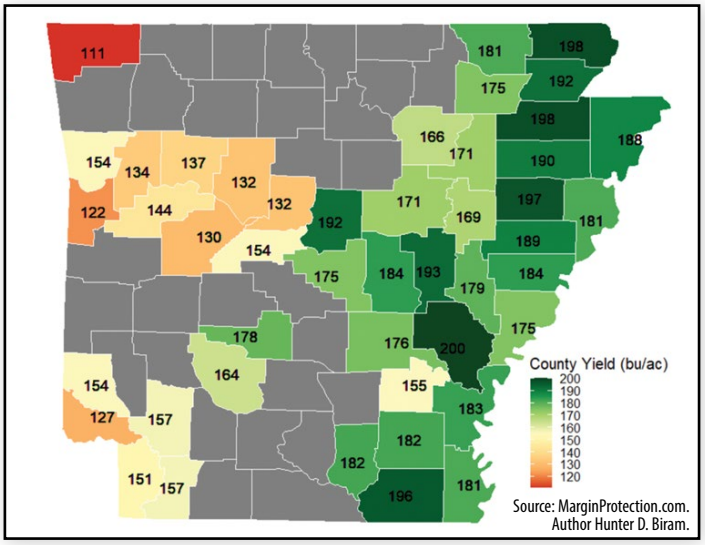



**Figure 2. Expected County Yields for Irrigated Corn.**



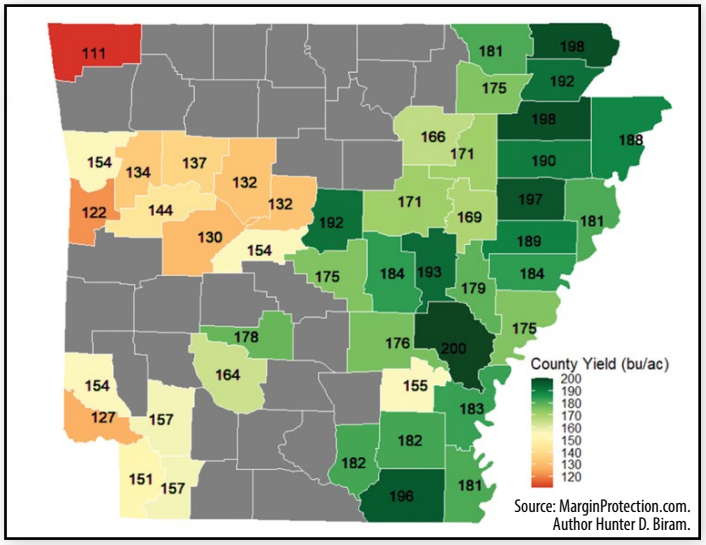

The Projected Futures Price is a measure of the expected price at harvest and is calculated as the 30-day average of the harvest-month futures contract for a specific crop and county, commonly referred to as the price discovery period. Corn (ZCZ) and soybeans (ZSX) have the same Projected Price discovery period of August 15 through September 14. Long Grain Rice (ZRX) has a Projected Futures Price discovery period from January 15 through February 14. While the inputs used to determine the Expected Margin and Trigger Margin for corn and

**Table 1. Price Discovery Periods for Arkansas (USDA-RMA)**

| CROP & INPUT | FUTURES CONTRACT | PROJECTED PRICE | HARVEST PRICE |
|---|---|---|---|
| CORN | DEC (ZCZ) | 8/15 - 9/14 | 8/15 - 9/14 |
| Urea (Corn) | MAY (UFVK) | 8/15 - 9/14 | 4/1 - 4/30 |
| DAP (Corn) | MAY (DFNK) | 8/15 - 9/14 | 4/1 - 4/30 |
| Potash (Corn) | USDA-AMS | 8/15 - 9/14 | Same as Projected Price |
| Diesel (Corn) | AUG (HOQ) | 8/15 - 9/14 | 4/1 - 4/30 |
| Interest Rate (Corn) | OCT (ZQV) | 8/15 - 9/14 | 8/15 - 9/14 |
| LONG GRAIN RICE | NOV (ZRX) | 1/15 - 2/14 | 9/1 - 9/30 |
| Urea (LG Rice) | JUL (UFVN) | 1/15 - 2/14 | 5/1 - 6/30 |
| DAP (LG Rice) | JUL (DFNN) | 1/15 - 2/14 | 3/15 - 5/14 |
| Potash (LG Rice) | USDA-AMS | 1/15 - 2/14 | Same as Projected Price |
| Diesel (LG Rice) | AUG (HOQ) | 1/15 – 2/14 | 5/15 – 7/14 |
| Interest Rate (LG Rice) | OCT (ZQV) | 1/15 – 2/14 | 9/1 – 9/30 |
| SOYBEANS | NOV (ZSX) | 8/15 - 9/14 | 10/1 - 10/31 |
| DAP (Soybeans) | MAY (DFNK) | 8/15 - 9/14 | 4/1 - 4/30 |
| Potash (Soybeans) | USDA-AMS | 8/15 - 9/14 | Same as Projected Price |
| Diesel (Soybeans) | MAY (HOQ) | 8/15 - 9/14 | 4/1 - 4/30 |
| Interest Rate (Soybeans) | NOV (ZQX) | 8/15 – 9/14 | 10/1 – 10/31 |

Note: Price Discovery periods for all covered program crops and inputs can be found under "Show Price Discovery" at MarginProtection.com (https://www.marginprotection.com/).

**Figure 3. Expected County Yields for Long Grain Rice.**



soybeans have the same Projected Price discovery periods and largely the same Harvest Price discovery periods, the Harvest Price discovery period for soybeans (ZSX) and Interest Rate (ZQX) for soybean coverage differ slightly from corn. This is likely to reflect the later harvest window and later loan repayment period for soybeans. Interestingly, Long Grain Rice has vastly different Projected Price and Harvest Price discovery periods. Projected Price and Harvest Price discovery periods are given in Table 1.

## Expected Cost

Expected Yield and Revenue are common factors among most federal crop insurance products, but what sets MP apart from others is the consideration of Expected Cost. MP is primarily concerned with protecting the profit margin, which is vulnerable to input price volatility in addition to price and yield risk. To calculate Expected Cost, we must estimate the prices of inputs subject to price fluctuations, such as Urea, DAP, Potash, Diesel, and Interest Rates. Importantly, MP is not designed to provide protection against input price volatility at the farm or county-level but rather provides price protection using futures prices and recommended usage rates determined at the Cost Region level (Biram and Stiles, 2022).

All input prices, with the exception of Potash, are determined based on futures contracts from the Chicago Mercantile Exchange (CME). The price of Potash is derived from the static price published in the USDA-AMS Illinois Production Cost Report[1]. The futures contract for DAP is the DAP FOB

**Figure 4. MP Input Price Cost Regions for LG Rice.**

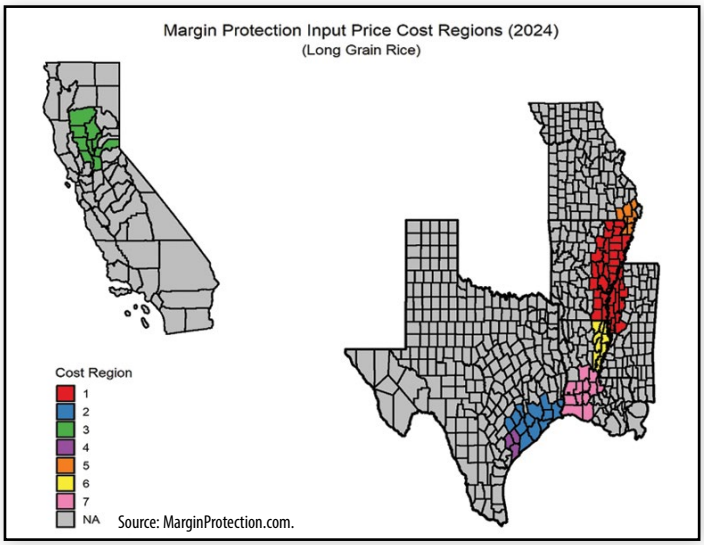



**Figure 5. MP Input Price Cost Regions for Corn.**

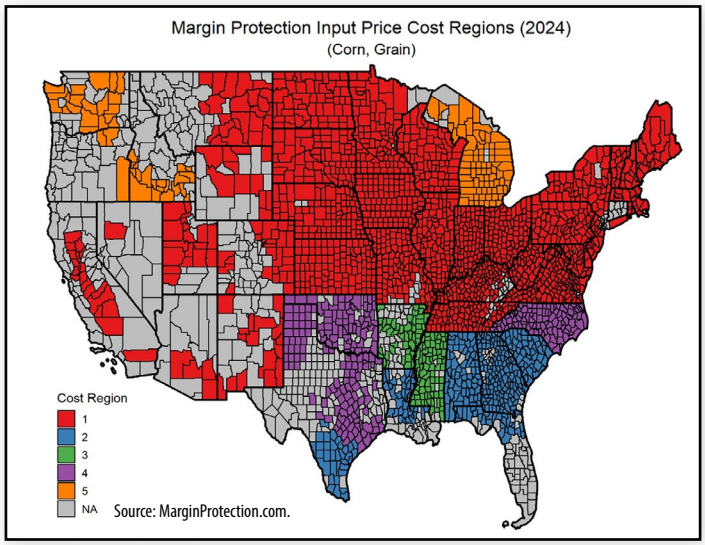
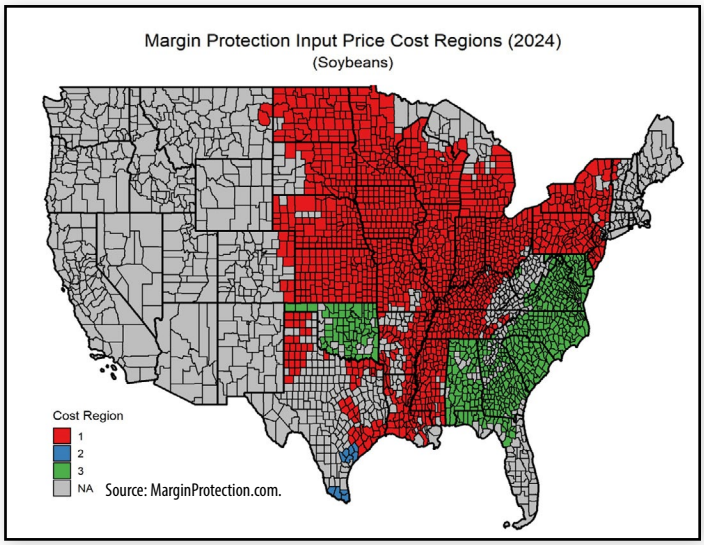



**Figure 6. MP Input Price Cost Regions for Soybeans**




NOLA futures contract (DFN), and the Urea futures price is Urea (Granular) FOB US Gulf futures contract (UFV). Diesel prices are established through the NY Harbor Ultra Low Sulfur Diesel futures contract, or Heating Oil futures (HO). Since Expected Cost exhibits no variation across counties under MP, the cost region drives variability in price discovery across the U.S. Cost regions for long grain rice, corn and sobyeans are depicted in Figures 4-6, respectively. A producer may determine their cost region by viewing the maps below or by visiting MarginProtection.com.

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[1] https://mymarketnews.ams.usda.gov/viewReport/3195.

[2] All fixed input costs and input quantities for the input prices subject to price change are from marginprotection.com.

[3] We convert input futures prices from $/short ton to $/lb by dividing each price by 2000 in this and subsequent examples.

## Expected Cost Calculation Examples

Here are examples of the Expected Cost calculation for Long Grain Rice, Corn and Soybeans:

**Example 1. Long Grain Rice**
**Determine the Expected Cost of Long Grain Rice for Arkansas County, Arkansas.**

Arkansas County, Arkansas is located in MP cost region 1. Therefore, we need fixed[2] input costs for region 1:

| | |
|---|---|
| Maintenance Cost ($/ac) | = $ 28.10 |
| Chemicals ($/ac) | = $ 83.64 |
| Application Costs ($/ac) | = $ 43.39 |
| **Total Fixed Input Costs ($/ac)** | **= $ 155.13** |

Input quantity for inputs subject to price change are retrieved from MarginProtection.com:

| | |
|---|---|
| Urea (lb./ac) | = 350 |
| DAP (lb./ac) | = 100 |
| Potash (lb./ac) | = 51.90 |
| Tractor Diesel (gal/ac) | = 13 |
| Irrigation Diesel (gal/ac) | = 22 |

In this example, we use Projected and Harvest Prices for the 2023 growing season since all prices have been determined for 2023. These prices are given below:

| | |
|---|---|
| Urea (UFV) | = $ 303.13/short ton |
| DAP (DFN) | = $ 593.79/short ton |
| Potash (USDA-AMS) | = $ 681.25/short ton |
| Diesel (HOQ) | = $ 2.80/gallon |

The prices of inputs are in different units; therefore, we need to convert[3] these prices into the same units and then multiply by the input quantities to calculate total input price:

| Input | Quantity | Prices | Total |
|---|---|---|---|
| Urea (lb/ac) | 350 lb/ac | $0.1750/lb | $ 61.25 |
| DAP (lb/ac | 100 lb/ac | $0.2969/lb | $ 29.69 |
| Potash (lb/ac) | 51.90 lb/ac | $0.3406/lb | $ 17.68 |
| Tractor Diesel (gal/ac) | 13 gallons | $2.80/gal | $ 36.40 |
| Irrigation Diesel (gal/ac) | 22 gallons | $2.80/gal | $61.60 |
| **Total Cost Subject to Price change =** | | | **$ 206.62** |

| | |
|---|---|
| Fixed input costs = | $ 155.13 |
| Costs subject to price change = | $ 206.62 |
| **Total Cost =** | **$ 361.75** |

The 2024 Projected Interest Rate is 10.39%, therefore, Interest Cost is,

| | |
|---|---|
| Interest Expense | = Total Cost x Interest Rate |
| Interest Expense | = 354.11 x 10.39% |
| **Interest Expense** | **= $ 36.79** |

Now, we have all the needed information to calculate the Expected Cost,

| | |
|---|---|
| Expected Cost | = Total Cost + Interest Expense |
| Expected Cost | = $ 354.11 + $ 36.79 |
| **Expected Cost** | **= $ 390.90** |

**Example 2. Corn**
**Determine the Expected Cost of Irrigated Corn for Jefferson County, Arkansas.**

First, we need to find out the fixed input costs for irrigated corn:

**Total Fixed Input Costs ($/ac)= $ 206.90**

The quantity for all inputs subject to price change are a function of Expected County Yield. The Expected County Yield for corn grown in Jefferson County, Arkansas is 176 bushels/acre which results in the following input quantities:

| | |
|---|---|
| Urea (lb/ac) | = (176 bu/acre * 0.83)/0.46 = 317.57 |
| DAP (lb/ac) | = (176 bu/acre * 0.35)/0.46 = 133.91 |
| Potash (lb/ac) | = (176 bu/acre * 0.25)/0.60 = 73.33 |
| Diesel (gal/ac) | = (176 bu/acre * 0.10) + 2.5 = 20.10 |

We will use Projected Prices for the 2024 growing season since corn and soybeans were first made available to Arkansas producers in this period. We will use prices which have been determined and may be in the process of being determined as of this writing. The Projected Prices for corn are:

| | |
|---|---|
| Urea (UFV) | = $ 353.41/short ton |
| DAP (DFN) | = $ 485.68/short ton |
| Potash (USDA-AMS) | = $ 492.80/short ton |
| Diesel (HOQ) | = $ 2.74/gallon |

Again, the prices of inputs are in different units, therefore, we need to convert these prices into the same units and then multiply by the input quantities to calculate total input price:

| Input | Quantity | Prices | Total |
|---|---|---|---|
| Urea (lb/ac) | 317.57 lb/ac | $0.1767/lb | $ 56.12 |
| DAP (lb/ac) | 133.91 lb/ac | $0.2428/lb | $ 32.51 |
| Potash (lb/ac) | 73.33 lb/ac | $0.2464/lb | $ 18.05 |
| Diesel (gal/ac) | 20.10 gallons | $2.74/gal | $ 55.07 |
| **Total Cost Subject to Price change =** | | | **$ 161.75** |

| | |
|---|---|
| Fixed input costs = | $ 206.90 |
| Costs subject to price change = | $ 161.75 |
| **Total Cost =** | **$ 368.65** |

According to MarginProtection.com, the projected interest rate is 10.68%, and the interest cost is:

| | |
|---|---|
| Interest Expense | = Total Cost x Interest Rate |
| Interest Expense | = 368.65 x 10.68% |
| **Interest Expense** | **= $ 39.37** |

Now, we have all the needed information to calculate the expected cost:

| | |
|---|---|
| Expected Cost | = Total Cost + Interest Expense |
| Expected Cost | = $ 368.65 + $ 39.37 |
| **Expected Cost** | **= $ 408.02** |

**Example 3. Soybeans**
**Determine the Expected Cost of Irrigated Soybeans for Craighead County, Arkansas.**

The fixed input costs for irrigated soybeans is given below:

**Total Fixed Input Costs ($/ac)= $ 111.50**

The quantity for all inputs subject to price change are a function of Expected County Yield. The Expected County Yield for soybeans grown in Craighead County, Arkansas is 52 bushels/acre which results in the following input quantities:

| | |
|---|---|
| Urea (lb/ac) | = 0 |
| DAP (lb/ac) | = (52 bu/acre * 0.73)/0.46 = 82.52 |
| Potash (lb/ac) | = (52 bu/acre * 1.1)/0.6 = 95.33 |
| Diesel (gal/ac) | = (52 bu/acre * 0.30) + 2.5 = 18.10 |

Input futures prices for soybeans are given below:

| | |
|---|---|
| DAP (DFN) | = $ 485.68/short ton |
| Potash (USDA-AMS) | = $ 492.80/short ton |
| Diesel (HOQ) | = $ 2.74/gallon |

Again, the prices of inputs are in different units; therefore, we need to convert these prices into the same units and then multiply by the input quantities to calculate total input price:

| Input | Quantity | Prices | Total |
|---|---|---|---|
| DAP (lb/ac) | 83.3 lb/ac | $0.2428/lb | $ 20.23 |
| Potash (lb/ac) | 96.25 lb/ac | $0.2464/lb | $ 23.70 |
| Diesel (gal/ac) | 18.25 gallons | $2.74/gal | $ 50.00 |
| **Total Cost Subject to Price change =** | | | **$ 93.94** |
| | Fixed input costs = | | $ 111.50 |
| | Costs subject to price change = | | $ 93.94 |
| | **Total Cost =** | | **$ 205.44** |

According to MarginProtection.com, the projected interest rate is 10.54%, and the interest cost is:

| | |
|---|---|
| Interest Expense | = Total Cost x Interest Rate |
| Interest Expense | = 205.44 x 10.54% |
| **Interest Expense** | **= $ 21.65** |

Now, we have all the needed information to calculate the expected cost:

| | |
|---|---|
| Expected Cost | = Total Cost + Interest Expense |
| Expected Cost | = $ 205.44 + $ 21.65 |
| **Expected Cost** | **= $ 227.09** |

The MP Trigger Margin is calculated based on the Projected Futures Price and Expected Revenue. However, under Margin Protection Harvest Price Option (MP-HPO), if the harvest price exceeds the Projected Futures Price, the Expected Revenue used to determine Trigger Margins is found using the Harvest Price. For a detailed explanation of how Margin Losses, or MP indemnities, are determined, see Biram and Stiles (2022).

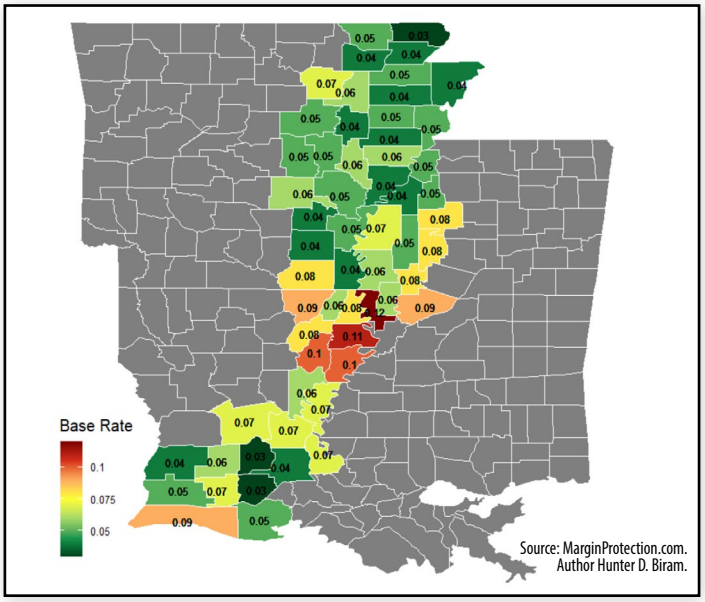
## How is the premium rate determined?

We will now briefly discuss how the premium rate is determined. RMA employs a historical Loss Cost Ratio (LCR) methodology to determine insurance rates and premiums (Coble, et al., 2010). This approach involves the computation of LCRs for insured producers at the county level. Initially, a liability is established for each policy in the following way:

**Liability = Expected County Yield X Projected Price X Coverage Level X Protection Factor**

The Protection Factor is a value between 80% and 120% which allows a producer to increase or decrease the dollar amount of their protection (i.e., liability). The Protection Factor provides a producer the option to account for any basis risk in their protection (Biram and Connor, 2023). If a producer believes their farm-level yield to be relatively higher than the county average, they should choose a Protection Factor greater than 100%. If a producer believes their farm yield to be less than the county average, they should choose a Protection Factor less than 100%. Since more coverage is being purchased, the producer-paid premium will be higher if a Protection Factor greater than 100% is chosen. Conversely, the producer-paid premium will be less if a Protection Factor less than 100% is chosen. The indemnity for each policy is then calculated as:

**Figure 7. MP Premium Rates for LG Rice at 85% Coverage.**



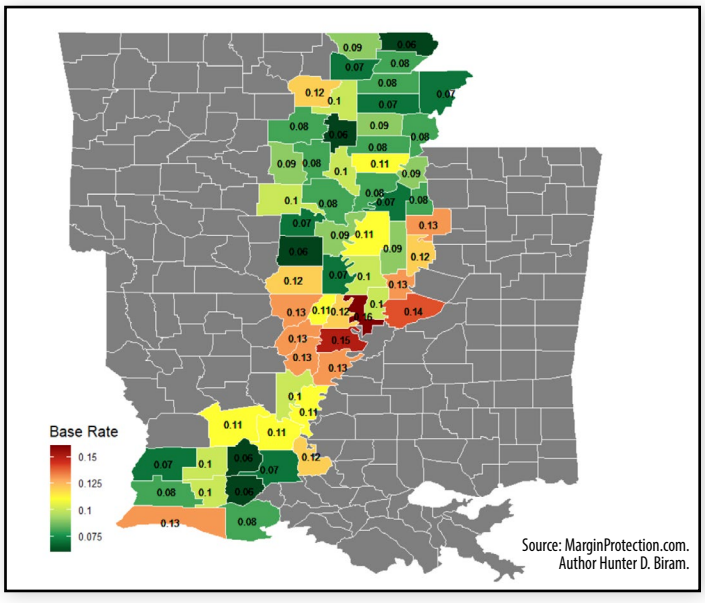

**Indemnity = Margin Loss X Protection Factor**

A county-level loss cost ratio is calculated for each county since MP has an area yield trigger. The county-level LCR is the ratio of indemnity to liability, and is expressed as:

**LCR = Indemnity / Liability**

RMA implements the LCR ratemaking method to determine an actuarially fair premium rate for each county-crop-coverage level combination. County-level LCRs will be determined each year, and RMA will take a 20-year moving average of county-level LCRs to determine the base premium rate (Coble, et al., 2010). Therefore, we write the base premium rate as the Expected LCR or E(LCR), the average of all 20 LCRs for a given county and coverage level.

**Figure 8. MP Premium Rates for LG Rice at 95% Coverage.**




**20-year average of LCRs = E(LCR)**
**E(LCR) = E(Indemnity/Liability)**
**E(LCR) = E(Indemnity)/Liability**
**Actuarily Fair Rate: Premium = E(Indemnity)**

MarginProtection.com provides data on per acre premiums and liabilities which allow us to calculate actuarially fair base premium rates. The MP base premium rate is found by taking the ratio of Total Premium to the MP Liability which are both provided by MarginProtection.com.

**Base Premium Rate = Premium/Liability**

Consider the scenario in which the Base Premium Rate equals 0.10. In this context, a base premium rate of 0.10 implies that, on average, a producer has experienced losses amounting to 10% of their liability. For instance, if the producer had purchased $1,000 in liability, their actuarially fair (i.e., unsubsidized) premium would amount to $100. This could also be interpreted to mean a producer is likely to incur 10% of their purchased liability on average since the premium is the same as the expected indemnity in actuarially fair insurance.

The MP base premium rates for long grain rice at 85% and 95% are shown in figure 7 and 8.

## Conclusion and Takeaways

During periods of heightened input price volatility, enrolling in MP is one strategy for shielding operating margins on the farm. MP provides another layer of risk protection against input price volatility and a buffer against fluctuations in input costs. Further, MP may provide additional protection by locking in crop prices with a different Projected Price Discovery Period. For example, the Projected Price Discovery Period for corn is January 15 through February 14 under traditional YP and RP plans of insurance, while the Projected Price Discovery Period for corn under MP is August 15 through September 14. This gives producers another opportunity to lock in futures price guarantees in the fall in addition to locking in futures price guarantees in the winter.

## References: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Margin Protection Payment Estimator (2024 Crop Year) https://hunterbiram.shinyapps.io/MarginProtection2024/.

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FSA87-PD-4-2024