8-2019

Assessing the Economic Viability of Arkansas Farms under the 2018 Farm Bill

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Assessing the Economic Viability of Arkansas Farms under the 2018 Farm Bill

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Agricultural Economics

by

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Arkansas State University
Bachelor of Science in Agricultural Business, 2017

August 2019
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

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Abstract

For over a century, the American agricultural industry has relied on federal government support to aid in the maintenance and expansion of farming operations. Since 1933, a series of 18 farm bills have shaped agricultural policy into what is commonly known as the agricultural safety net. The 2018 farm bill was passed on December 20, 2018 and is the most recent update of the agricultural safety net. Commodity programs and federal crop insurance are two key components of today's agricultural safety net, and many times, these programs may be the difference between a net loss and a positive net income for many producers. The objective of this study is to examine the safety net as it is designed in the 2018 farm bill, and assess its contribution to the economic viability of Arkansas farms. Using a set of representative Arkansas farms, this study simulates the production and financial characteristics of these farms over the life of the 2018 farm bill to quantify the effects of commodity program payments and crop insurance payments on overall financial health. The projected farm models generate large government support payments in all five-year life of the 2018 farm bill (2019-2023) leading to more financially sustainable farm performance across all five farms.

Acknowledgements

I would like to extend my sincerest thanks to the faculty and staff of the Department of Agricultural Economics and Agribusiness at the University of Arkansas. Your financial, technical and personal support has been essential in the completion of this thesis. I would especially like to thank my advisor Dr. Alvaro Durand-Morat. Without your dedication, encouragement and wisdom this undertaking would not have been possible. I would also like to thank the members of my committee, Dr. Eric Wailes, Dr. Lanier Nalley, and Dr. Steve Halbrook. Your guidance and assistance has been vital throughout this entire process.

In addition, I would like to thank my parents and family members whose love and support has allowed me to pursue all my goals. I would also like to thank all of my friends and colleagues that have been with me through this entire process, your kind words of encouragement and belief in my abilities has helped make this journey possible.

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Chapter 1: Introduction

The federal government has supported American agriculture since the mid-19th Century, and since the passage of the Agricultural Adjustment Act (AAA) more than 80 years ago, a robust system of government price and income support programs have been a cornerstone of agricultural policy. The importance of a safe and reliable food supply has been one of the driving forces behind the unparalleled support programs and is the basis for agricultural exceptionalism—the idea that the specific needs and interests of farmers require exceptional provisions by the federal government (Schneider, 2016). Other factors contributing to the federal government's continued support of agricultural producers is the complexity of global agricultural trade, the environmental risk associated with agricultural production, and the desire to stabilize farm incomes and reduce rural poverty (Novak, Pease, & Sanders, 2015).

U.S. agricultural policy today is passed almost entirely in omnibus legislation known as the Farm Bill. The farm bill plays a vital role in supporting American agriculture by supporting the research and development of new agricultural practices, facilitating trade both domestically and internationally, providing risk management tools for farmers, and advancing conservation and environmental protections. Like many producers around the country, Arkansas farmers benefit from the support provided by the farm bill, and it is important to understand how these benefits may vary with changes in commodity markets and policy support in the U.S. and around the world.

For years, economic analysis of farm programs and agricultural policy has been of major importance to the agricultural industry as a whole. Tweeten (2002) found that between 1933 and 2000, taxpayers spent $561 billion (in 2000 dollars) to support farm prices and incomes. He argues that the best public policies are those that benefit the entire society, not just a single segment, so a frequent and thorough analysis to ensure equitable spending by farm programs is essential. Tweeten, Heady and Mayer (1963) pointed out the efforts taken between 1933 and 1960 to improve the income position of farmers in the United States, but also noted that general agreement was not attained on the type of programs deemed acceptable.

Historically, many economists have argued that a farm safety net is essential because it helps support commodity prices and stabilize farm incomes. Gardner (2000) notes that many early studies of farm policy were aimed at reducing poverty among farm households. In 1960, 31 percent of all farm households were below the poverty line compared to only 15 percent of nonfarm households (Gardner, 2000). A key finding of Gardner's study is that household incomes for farm and nonfarm households have converged, but Gardner argues that commodity policy cannot be justified as the remedy for low incomes. Gardner asserts that many times commodity programs have been unfairly skewed towards larger farms and most of the reduction in urban-rural income inequality is associated with wage increases and emigration of rural poor to urban areas. Gundersen, et. al. (2000) analyzed four safety net alternatives to the 1996 farm bill. The authors echoed Gardner's findings that, as designed, the farm safety net disproportionally supported larger commercial farmers, and offered small benefit to low-income farming operations.

Many studies have focused on the effects of farm policies on various groups of stakeholders, but few have focused extensively on farmers in Arkansas. Agriculture is Arkansas's largest industry; it contributed around $21.4 billion of the state's value added in 2016, and one of every six jobs in the state (University of Arkansas, 2017). This study extends the current literature on farm policy by exploring how the major changes to safety net programs under the 2018 farm bill affect the economic situation of Arkansas farmers. It explores the programs that have been historically important to Arkansas producers, and seeks to determine which programs will be most beneficial for producers in the near future. Through simulation analysis, this study assesses the economic impact of commodity programs and crop insurance on representative Arkansas farms.

The representative farm approach stated here makes a few key assumptions that have the ability to affect the overall outcome of the simulations. First, each farm's crop mix is assumed to be fixed, and the proportion of acreage that is cash rented and share rented is also held constant throughout the analysis period. Yields on each of the representative farms are county yields, and not taken from actual farm data. Because of this, actual farm-level yield distributions are not known so they were specified using the county yields. This introduces the possibility of specifying distributions that produce a more muted stochastic output that does not reflect an actual farm yield.

Objectives and Hypotheses

The objective of this study is to assess the impact of farm safety net programs under the 2018 farm bill on the economic viability of Arkansas farms. The analysis will use five representative crop farms located across the state of Arkansas that include financial data, crop data, and government program calculations on each farm. Using these models, we simulate the impact of commodity programs and crop insurance on the economic situation of Arkansas farms.

We hypothesize that over the next 5 years, farmers will rely more on government support programs to maintain profitable farm operations in the face of unstable world commodity prices. We hypothesize that the Price Loss Coverage (PLC) commodity program will be the preferred commodity program to maximize payments for farmers in the state under the projected price scenarios currently available. We also hypothesize that crop insurance programs will be of less importance overall to Arkansas farmers than commodity programs. And finally, we hypothesize that the farm safety net will fall short for many Arkansas farms—specifically those that reach the payment limit for commodity program payments, and that the current dire situation of decreasing farm incomes and increasing farming debt will continue in the near future.

Chapter 2: Early Agricultural Policy and the Farm Safety Net

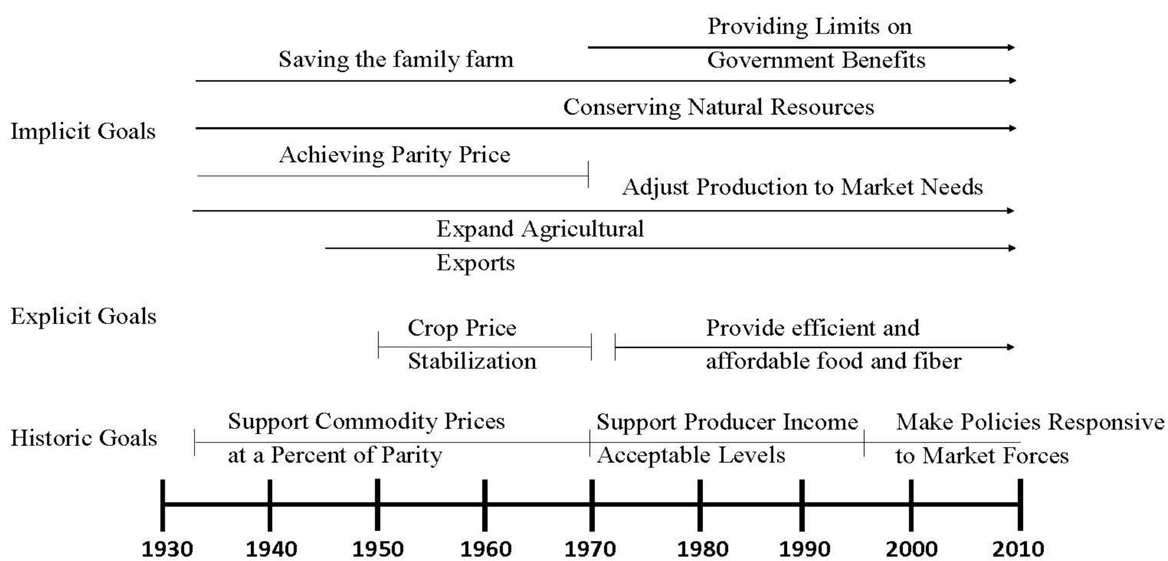
To understand how American agricultural policy came to its present state, a good understanding of historical farm policy is useful. Most early agricultural policy in the United States was aimed at expanding food and fiber production to new and unsettled territories and increasing total output. One of the most important early agricultural policies in America was the Homestead Act of 1862. This act allowed settlers who had lived and farmed a plot of land for five years to obtain the title to that land at no cost. Further direct support to U.S. agriculture in the 19th century included the Morrill Act of 1862, which granted states with federal land that could be sold to establish colleges of engineering, agriculture, and sciences with the objective of educating the states' working class and professionals, and the Hatch Act of 1887, which provided funding for agricultural research at the so-called land grant universities. The Smith-Lever Act of 1914 expanded funding to facilitate the creation of the modern-day extension service (Novak et al. 2015). Along with this direct support, the government subsidized many other projects that benefitted agriculture. The Pacific Railway Act of 1862 provided grants of public lands that were used to fund the construction of the transcontinental railway. Other government subsidies for road construction, canal construction and other infrastructure projects aided agriculture by creating easier access to markets for agricultural goods (Novak, et al. 2015).

American Agriculture prospered in the early 20th century during a period known as the Golden Age of Agriculture. However, a series of bad years for agriculture in the mid-1910s prompted the passage of the Federal Farm Loan Act of 1916, which created a system of land banks that eased access to inexpensive credit. The subsequent years saw prices and incomes rise again as World War I had wiped out a majority of European food production, and easy access to credit allowed for rapid expansion on many farms (Novak, et al. 2015). By 1920, World War I had ended and world commodity supplies increased again to more normal levels. U.S. export demand dropped drastically, and prices soon followed. Higher taxes on land, tightening of once-easy credit access and increased tariffs led to the agricultural depression in the 1920s.

The stock market crash of 1929 plunged the rest of the U.S. economy into the Great Depression, which exacerbated the already abysmal conditions faced by the agricultural community. The Secretary of Agriculture's report to the president in 1932 said that gross farm income declined more than 40 percent between 1929 and 1931. Corn prices had dropped from $0.77 per bushel in 1929 to $0.36 in 1931. Some farmers in the Corn Belt even resorted to burning their corn crop for heat as opposed to selling it to buy more expensive fuel to heat their homes (Novak, et al. 2015). To keep agriculture a viable lifestyle and ensure a plentiful food supply, the federal government decided that some type of intervention had to be taken to restore price and income levels to at least a significant portion of their historical highs, which led to the passage of the Agricultural Adjustment Act (AAA) in 1933. The overarching goal of the AAA was restoring farm purchasing power to the parity price farmers enjoyed during the Golden Age of Agriculture by means of voluntary reduction in commodity acreages in exchange for government support, and public purchase and storage of specific commodities by the newly created Commodity Credit Corporation (Rasmussen, Baker, & Ward, 1976).

A total of 18 farm bills have been passed since the AAA of 1933. Some have altered farm policy very little, while others have profoundly changed the make-up of agricultural support. For example, the federal crop insurance program was introduced in 1938 and significantly revamped in 1980, nutrition was introduced in 1973 and has since grown to be the largest title of the farm bill in terms of annual spending, and energy was included in 2002. All of these changes over the years have made the farm bill much more comprehensive and complex, and increased the numbers of stakeholders that actively participate in the agricultural policy process (Mercier, 2016).

Over the years, farm bills have had a variety of explicitly stated goals, as well as a number of implicit goals. As previously stated, early farm bill programs were designed to support prices and income as well as conservation efforts, and over time new goals have been added and others have evolved, including access to affordable food and fiber, expansion of exports markets, and development of new energy sources from agricultural products. Figure 1 shows the goals of agricultural policy from the passage of the AAA to present day (Doering & Outlaw, 2006).



Source: http://www.choicesmagazine.org/2006-4/resource/2006-4-03.htm

Figure 1: Agricultural Policy Goals 1933-Present

Modern Farm Safety Net Policy

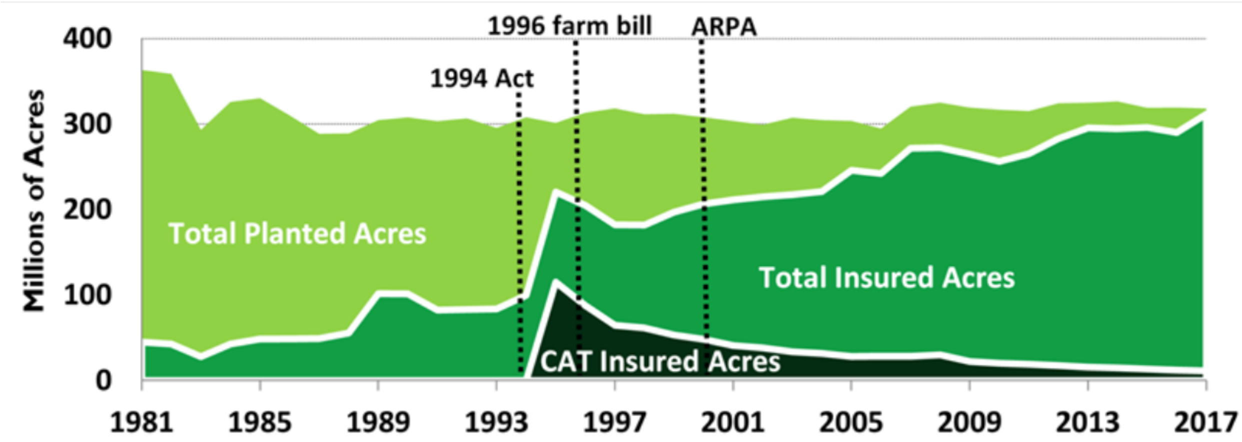
Today's farm safety net consists of commodity programs designed to support prices of major commodities, subsidized crop insurance programs, disaster assistance programs that benefit those who may not be covered by commodity or insurance programs, and marketing assistance loan programs. The two major commodity programs currently available to producers are the Price Loss Coverage (PLC) program and the Agricultural Risk Coverage (ARC) program, which provide price and revenue support to agriculture, respectively. PLC and ARC were introduced in the 2014 farm bill and replaced the Direct Payment and Countercyclical Payment programs. Since 2014, the commodity programs have average annual outlays of over $7 billion nationwide (United States Department of Agriculture, 2018), or 2.4 percent of all agricultural receipts. (Schnepf, 2017).

The disaster assistance program mainly covers livestock producers and fruit tree producers who generally do not have access to crop insurance or commodity program coverage. This program pays producers who have excessive livestock deaths, forage losses caused by drought, or losses of trees, bushes and vines from which annual production is taken. Participation is free for this program and has projected costs of $500 million annually under the 2014 farm bill. Producers affected by a federally declared disaster are also eligible to apply for emergency loans through the Farm Service Agency (FSA). These low-interest loans can be used to pay for crops, livestock and farm real-estate damages and have a life of 1 to 7 years (Shields, 2015c).

The 2014 farm bill also reauthorized nonrecourse marketing assistance loans (MALs) and loan deficiency payments (LDPs) for a number of commodities. These programs are available to producers beginning at harvest that help finance harvest-time costs. MALs help farmers meet their cash flow requirements using production as collateral. This allows producers to plan their sales and take advantage of market price movements, and facilitates spreading the supply throughout the year. These loans can be redeemed by repayment, or by delivery of the commodity pledged as collateral. LDPs are direct government payments made instead of an MAL if the marketing loan rate determined by the Commodity Credit Corporation (CCC) is below the county loan rate for the commodity in question (Farm Service Agency, 2016). The Congressional Research Service projects MAL annual outlays of $250 million under the 2014 farm bill (Shields, 2015c).

The last major part of the farm safety net is the federal crop insurance program. Since the passage of the Federal Crop Insurance Act of 1980, the government has spent over $80 billion on the program (Schnepf, 2017). In recent years, crop insurance's share of the safety net has been growing relative to commodity programs. Crop insurance declined costs reached their maximum in 2012 when government outlays reached $14.1 billion in value, subsided to $6.0 billion in 2013, and increased to $8.7 billion or 2.3 percent of the value of agricultural production in 2014 (Shields, 2015b). By 2015, 238 million acres—or 86 percent of all farm acres—across the country were enrolled in some type of crop insurance plan. Over the same period, the number of insurable commodities increased from 28 to 123 (Good, 2018). Figure 3 shows crop insurance program enrolled acres compared with planted acres from 1981 to 2017.[1]

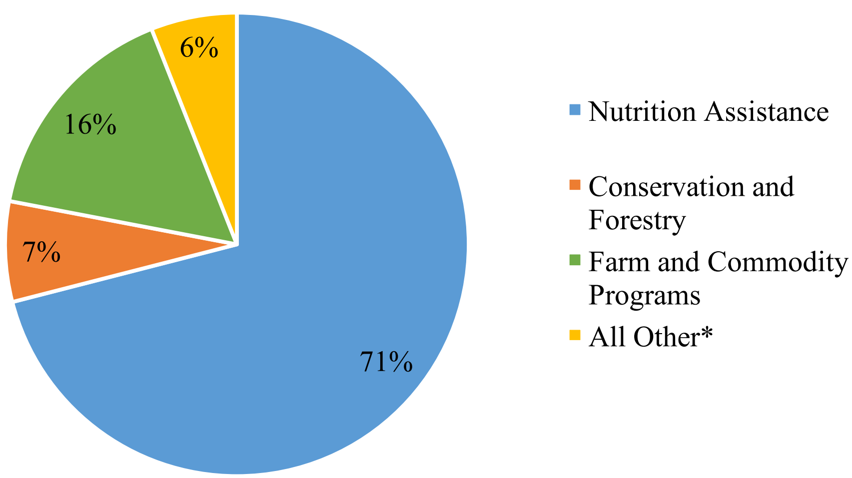
[1] Figure only includes insured acres on principal crops, not specialty crops. Specialty crops account for about 16% of all insured liability, but are not well-suited for measurement by acres.



Source: https://farmpolicynews.illinois.edu/2018/05/an-overview-of-crop-insurance-recent-congressional-research-service-report/

Figure 2: Crop Insurance Enrollment Acres 1981-2017

In 2017, the United States Department of Agriculture (USDA) monetary outlays totaled $151 billion, or nearly 3.8 percent of the entire federal government's $4 trillion 2017 expenditure (Angres & Salazar, 2018). Figure 2 shows the USDA's 2017 outlays, of which nutrition programs accounted for 71 percent, and farm and commodity programs for 16 percent (United States Department of Agriculture, 2018).



**Includes Rural Development, Research, Food Safety, Marketing and Regulatory, and Departmental Management* Source: https://www.obpa.usda.gov/budsum/fy17budsum.pdf

Figure 3: 2017 USDA Budget Outlays

To give some perspective on the size and scope of U.S. agricultural supports, it is beneficial to examine the agricultural safety net payments in some other countries. According to a 2011 study by the Organization for Economic Cooperation and Development (OECD), the government policies in 34 developed nations transferred more than $252 billion to farmers in the form of support payments annually. On average, 19 percent of cash receipts in these countries came from transfer payments, but there are large differences between many of the countries. Producers in Norway, Switzerland and Japan, for example, received more than 50 percent of their cash receipts from government payments. On the other hand, countries like Australia, New Zealand, and Chile subsidize producers below 5 percent of annual cash receipts. Government transfer payments to producers in the United States accounted for about 8 percent of total farm receipts on average in 2011 (Paarlberg, 2013).

The major issue with most farm safety net programs in many developed countries is the likelihood they have to distort international trade and violate WTO policies. In 2004, agriculture and trade policies accounted for 70 percent of global welfare costs of all trade distortions, yet the agricultural sector only accounts for 6 percent of global trade and 3 percent of global GDP (Anderson, Rausser, & Swinnen, 2013). To lower or remove any trade distorting effects, many developed countries have been implementing agricultural policies such as biofuel production mandates and crop insurance programs as opposed to the coupled-subsidy programs of the past. These more decoupled programs tend to depress world prices to a lesser degree and comply more closely with WTO standards (Anderson, et al. 2013).

The WTO Agreement on Agriculture states that for income supports to be decoupled “The amount of such payments in any given year shall not be related to, or based on, the prices, domestic or international, applying to any production undertaken in any year after the base period.” (World Trade Organization, 1994). The WTO categorizes domestic support programs in essentially one of two ways, as a “green box” policy that does not distort trade at all, or as an “amber box” policy that distorts production and trade. Currently, total amber box supports can equal as much as 5 percent of agricultural production in a developed county ($18.5 billion in the U.S. according to 2019 NASS data) (World Trade Organization, 2019) Both PLC and ARC use market prices to determine payment levels, making them amber box policies by WTO standards. It is unlikely that commodity supports will exceed the current $18.5 billion limit, leading many lawmakers and farm groups to support the PLC and ARC programs without fear of WTO disputes.

The Farm Safety Net in Arkansas

The farm safety net has been a boon for Arkansas farmers. Arkansas ranked number four in the nation in total subsidy payments and fourteenth in terms of agricultural sales in 2017 (National Agricultural Statistics Service, 2019). According to the Environmental Working Group (2018), Arkansas agriculture received $492.9 million or 7 percent of the total nationwide farm support in 2017, but accounted for only 2.4 percent of total receipts (National Agricultural Statistics Service, 2019).

Many farmers in Arkansas rely on government programs to free up cash flow and continue expanding and improving their operations. According to the USDA National Agricultural Statistics Service (NASS, 2012) Census of Agriculture, total net cash farm income for all Arkansas operations was $2.5 billion. Considering that Arkansas had combined commodity program payments of $213.2 million in 2014 (Farm Service Agency, 2016), we estimate that 8.5 percent of total net cash farm income in Arkansas comes from government program payments—not including crop insurance indemnity payments.

2018 Farm Bill Title I Commodity Program Descriptions

The most recent farm bill was authorized on December 20th 2018 after months of debate in the U.S. House of Representatives and the U.S. Senate. There was large bipartisan support for the 2018 farm bill in both Houses of Congress, with The House of Representatives passing the final conference report by a vote of 369 to 47, and the Senate passing it with a vote of 87 to 13 (Newton, 2018). This farm bill does not introduce any major changes to federal farm policy, but instead makes minor updates to many of the programs put in place by the 2014 farm bill (Agricultural Improvement Act of 2018).

Beginning in 2015 under the 2014 farm bill, farmers who grew one or more of 22 covered commodities could make a one-time choice as to which program (PLC or ARC) each commodity on their farm was enrolled. The PLC and ARC programs differ substantially, and a crop that generates large payments under one program may not receive payments as large or at all under the other (Orden & Zulauf, 2015). Since payments under both programs are decoupled from actual planted acres, enrollment in either should not effect on-farm production decisions. Total support payments are not expected to exceed WTO amber box policy payment limits, so the programs should be shielded from WTO disputes for the time being (Schnepf, 2019a). The 2018 farm bill changes the commodity program decision-making process by allowing producers to re-select which program to enroll their crops in for the 2019 and 2020 crop years, and beginning with the 2021 crop, producers can choose to enroll each commodity into the PLC or ARC program on an annual basis. Those who do not enroll in a program will be defaulted into the PLC program (Coppess, Schnitkey, & Paulson, 2018).

Today's safety net allows each person or legal entity with an interest in a farming operation to receive up to $125,000 in combined program payments annually. (Coppess, et al. 2018). Peanuts are subject to their own payment limit, so qualifying entities on farms growing peanuts have a $125,000 limit for peanuts alone, and a second $125,000 payment limit for other commodities. A single farm can have multiple entities receiving payments as long as they are considered "actively engaged in farming operations," but persons or legal entities with an adjusted gross income over $900,000 are ineligible for payments at all (Schnepf, 2019a). In recent farm bill debates, many groups, including prominent Iowa Senator Chuck Grassley, have called for stricter limits on the amount of commodity program payments an operation can receive, while others have argued that the number of entities eligible for payments be expanded. Depending on the characteristics of the farm and the program selection, payment limits can constrain the ability of the safety net to provide support in times of dire market conditions.

Price Loss Coverage

The PLC program makes payments to farmers based on the national price level of the commodity in question. Each of the covered commodities has a reference price that is statutorily defined by the 2014 farm bill. Table 2 shows the crops grown on our representative farms and lists the reference price for each. PLC payment rates for a farm are calculated as the difference between the reference price and the current year's actual price, defined as the higher of the national average market price and the national average loan rate. If the actual price is higher than the reference price, no payments are made. If the reference price exceeds the actual price, the calculated payment rate (reference price minus national average market price) is multiplied by a fixed, farm-specific, historical payment yield, then by 85 percent of historical base acres on a given farm (Lubben, 2015). The 2018 farm bill incorporates an elevator mechanism that will allow PLC reference prices to rise as high as 115 percent of their statutory level (Agricultural Improvement Act of 2018). This new price, known as the effective reference price, is the larger of the 5-year Olympic average of national prices and the statutory reference price, capped at 115 percent of the statutory price. (Coppess, et al. 2018).

Table 1: PLC Reference Prices

Commodity	Reference Price	115% of Reference Price
Long Grain Rice ($/cwt.)	14.00	16.10
Medium Grain Rice ($/cwt.)	14.00	16.10
Soybeans ($/bu.)	8.40	9.66
Cotton ($/lbs.)	0.367	0.422
Peanuts ($/ton)	535.00	615.25
Corn ($/bu.)	3.70	4.26

Source: https://agecon.unl.edu/cornhusker-economics/2015/economics-of-arc-vs.-plc

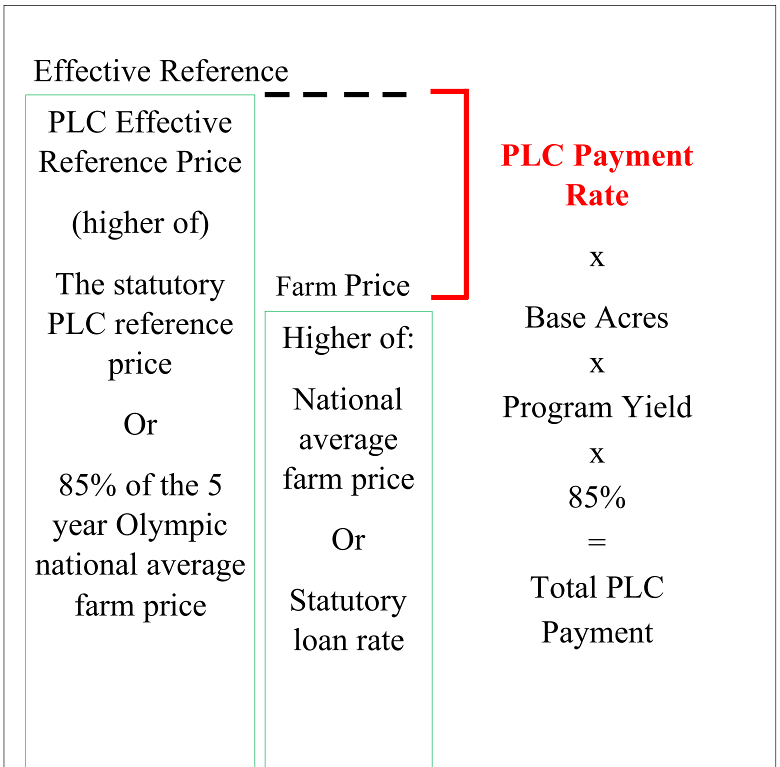
Under the 2014 farm bill producers were able to do a one-time update of their program payment yields. The 2014 program yield was determined by taking 90 percent of the simple average of a crop's Farm Service Agency (FSA) certified yield between 2008 and 2012. If a farm's yield was below 75 percent of the county average, 75 percent of the county average yield is substituted. The 2018 farm bill allows producers to update this PLC payment yield again, using the following formula.

$$\frac{2008-12 \text{ National Average yield on planted acres}}{2013-17 \text{ National Average yield on planted acres}} \times 0.90 \times \text{Avg farm yield on planted acres } 2013-17$$

Figure 4: PLC Payment Yield Update Formula

The ratio of national averages must be between 0.9 and 1.0, and farm yields below 75 percent of the county average are replaced with that number, similar to the 2014 PLC payment yield formula (Farm Service Agency, 2014).

Base acres are used in calculating program payments as to not tie current planting decisions to potential commodity payments. Under the 2014 farm bill, producers had the one-time choice to update their base acres by taking a proportion of the 4-year average of acres planted or considered planted to a specific commodity to the 4-year average of acres planted to all covered commodities from 2009-2012. Base acres could be reallocated, but overall base acres could not increase under the 2014 farm bill. The 2018 farm bill retains base acres as defined under the 2014 farm bill, but removes any that were continuously planted to grass or pasture or left fallow between 2009 and 2017 (Schnepf, 2019b). Figure 4 shows how PLC payments are calculated.



Source: https://crsreports.congress.gov/product/pdf/IF/IF11161

Figure 5: PLC Payment Formula

Agricultural Risk Coverage

The ARC program as two separate programs—ARC-CO, or county coverage option and ARC-IC, or individual coverage option. Less than 1 percent of nationwide commodity program acres are enrolled in the ARC-IC option, so this study will focus only on the ARC-CO option (simply called ARC henceforth) (Angadjivand, 2018). The ARC program makes payments based on a guaranteed revenue, estimated as 86% of the benchmark revenue. The benchmark revenue ($/acre) is estimated as the product of the five-year Olympic average of county yields and the five-year Olympic average national average market prices. In the 2014 farm bill, if actual county yields are below 70 percent of a specified transitional yield[2] (t-yield) estimated by the Risk Management Agency (RMA), 70 percent of the t-yield is used to replace county yield. Under 2018 farm bill provisions, this replacement yield is updated to 80% of the RMA-specified t-yield. The actual crop revenue ($/acre) is estimated as the product of the county average yield times the national average market price. The ARC payment rate is then estimated as the difference between the benchmark and the actual revenue if the benchmark revenue is greater than the actual revenue, and zero otherwise. The per-acre payment that is generated is multiplied by 85 percent of on-farm base acres for the commodity in question to generate total payments. In contrast to the PLC program, ARC payments are capped at 10 percent of the benchmark revenue for a farm (Angadjivand, 2018). Figure 5 shows how ARC payments are calculated.

[2] Transitional Yields county-specific yields generated by USDA RMA based on 10-year historical county average yields.

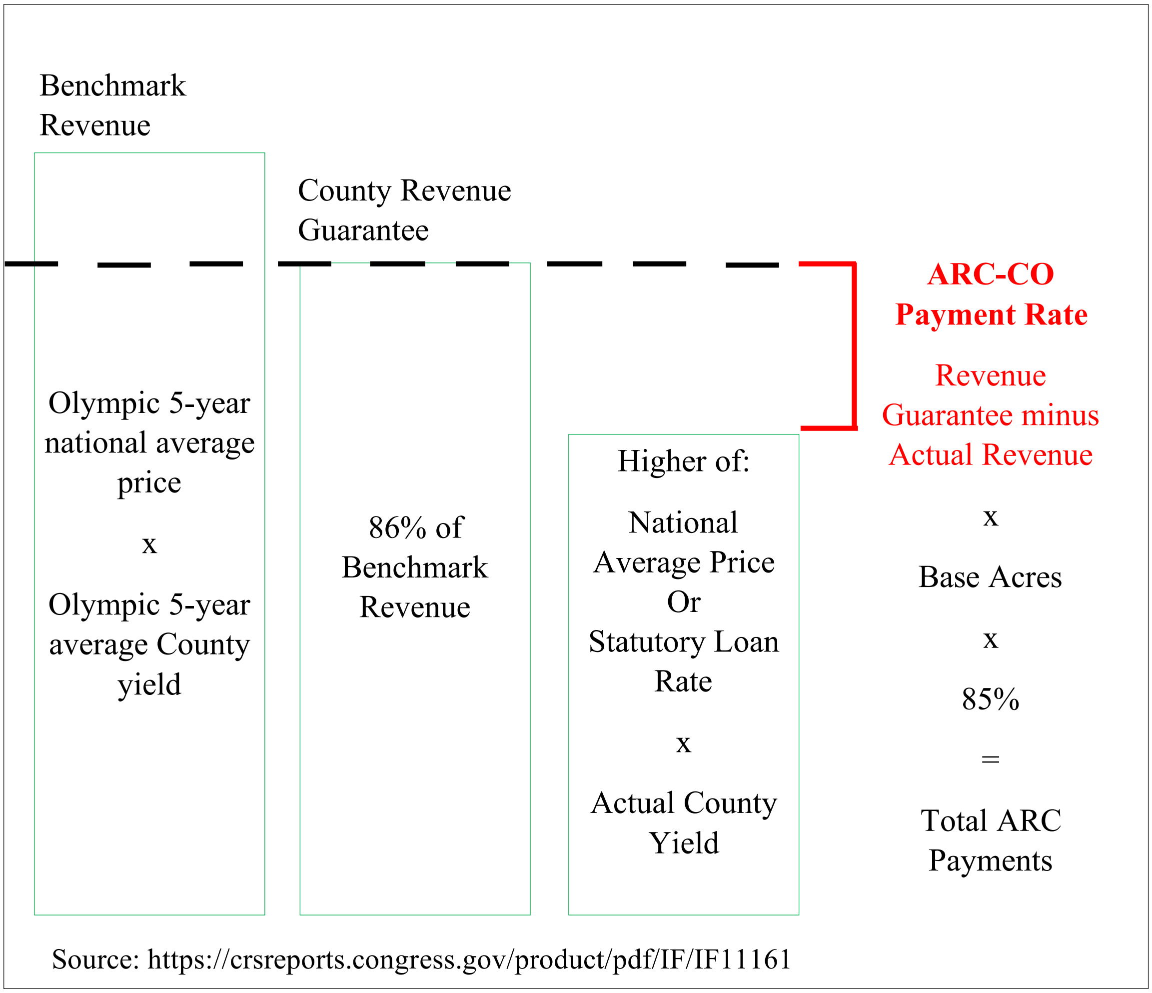


Figure 6: ARC Payment Formula

If county revenue is low enough, ARC payments are triggered for everyone enrolled, not just the producers whose personal farm revenues are below the benchmark revenue. However, if a county is not far enough below average to generate a payment, those producers who are below average do not receive payments since the entire county is not below benchmark. Corn and soybeans were almost entirely enrolled in the ARC program under the 2014 farm bill, and the lion's share of ARC payments were made to these two crops. In the 2014-2016 crop years, ARC payments made to corn totaled $10.6 billion and soybeans received $1.6 billion. Added together, corn and soybeans averaged 86.1 percent of all ARC payments made during this period (Angadjivand, 2018).

The biggest change to the commodity title in the 2018 farm bill is the ability to switch between ARC and PLC on an annual basis beginning in 2021. The 2014 farm bill gave producers a one-time choice as to which program each commodity would be enrolled. The 2018 farm bill allows producers to select one program for the 2019 and 2020 crop years, and beginning in 2021, they can choose either program at planting each year.

Arkansas has received payments under both the PLC and ARC commodity programs since the passage of the 2014 farm bill. Table 3 shows total PLC and ARC payments Arkansas producers received over the 2014-2017 period (Farm Service Agency, 2019).

Table 2: Arkansas Total PLC and ARC Payments 2014-2017

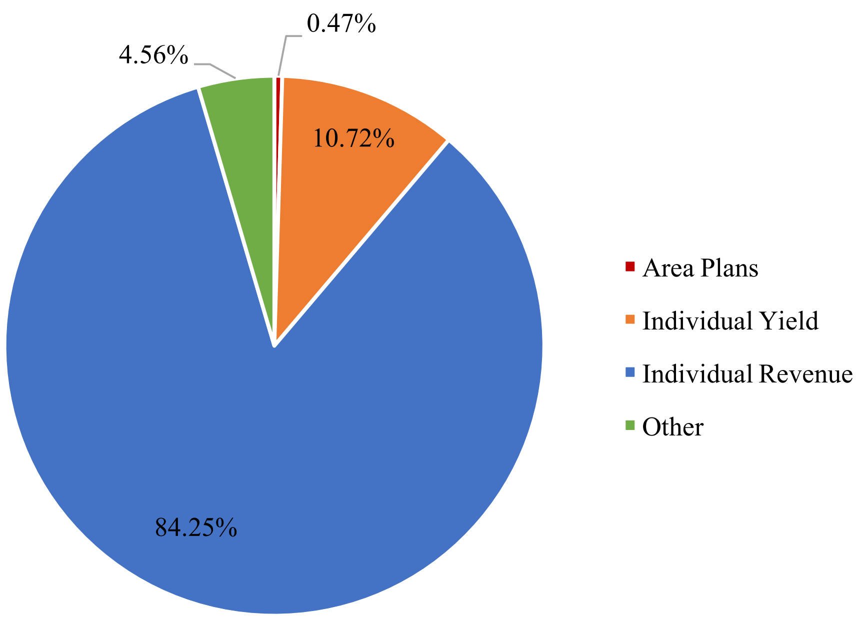
Year	PLC Payments	ARC Payments
2014	$196.3	$16.9
2015	$291	$75.4
2016	$411.9	$79.1
2017	$260.3	$19.7

Source: https://www.fsa.usda.gov/programs-and-services/arcplc_program/arcplc-program-data/index

PLC payments have been much larger than ARC payments since the passage of the 2014 bill as a result of the prevalence of rice production in the state. Arkansas is the largest rice producing state in the nation, accounting for over 49 percent of the entire U.S. rice crop (Hardke, 2019), and almost all rice base acres were enrolled in PLC.

The Federal Crop Insurance Program

Another part of the farm safety net for producers across the country and in Arkansas is the federal crop insurance program. The federal crop insurance program offers myriad different products to farmers. Eligibility varies by commodity and by region, but the major commodities generally have coverage availability nationwide. Some of the available insurance plans include individual revenue protection plans, individual yield protection plans, area yield and area revenue protection plans, and whole farm revenue protection plans. The vast majority of insurance plans sold are individual revenue protection plans (Good, 2017). Figure 7 shows the percentage of premiums coming from each type of insurance plan for the 2016 crop year. This study focuses on individual revenue protection plans and individual yield protection plans since the two of them account for the vast majority of policies sold.



Source: https://farmpolicynews.illinois.edu/2017/09/usda-rma-report-analysis-federal-crop-insurance-portfolio

Figure 7: U.S. Crop Insurance Premium Payments by Policy Type, 2016

Yield Protection Insurance

Yield protection (YP) crop insurance plans, as the name implies, pay producers if their actual crop yield in a year falls below a producer specific "normal" yield. This normal yield is based on a producer's actual production history (APH) which is the simple average of a producer's unit-per-acre yield for the last 4 to 10 years. If a producer doesn't have sufficient yield data, he or she will be assigned an RMA generate transitional yield (t-yield) that is county and crop specific. Every commodity is also assigned a price at planting time, called the projected price, based on the Chicago Board of Trade (CBOT) contract prices during an RMA-specified period (Shields, 2015b). For example, long grain rice is assigned a price based on the average price of the November contract during the January 15th – February 14th period (Risk Management Agency, 2019).

Yield protection insurance plans offer different levels of coverage. Protection plans start at 50 percent coverage and increase in 5 percent increments up to 85 percent. Thus, a farm with an APH of 180 bushels of corn per acre and a 75 percent YP plan is guaranteed 135 bushels per acre. If the actual yield is below 135 bushels, producers receive a payment (indemnity) estimated as the difference between the actual yield and the guarantee, multiplied by the projected price and the number of acres insured. Along with the option to choose an APH yield coverage level, producers can choose a price coverage level as well, beginning at 55 percent of the projected price and increasing in increments of 5 percent to 100. (Shields, 2015b).

Revenue Protection Insurance

Since 2003, revenue protection (RP) policies have been the most purchased insurance policies in the country, and currently make up over 80 percent of all policies sold (Figure 5). RP policies combine the production guarantees of YP insurance with an added protection against price risks.

The same method of calculating APH yield used for yield protection insurance is used to calculate the yield for RP plans. Essentially, RP guarantees a target revenue, and if a producer fails to reach the chosen percentage of this guarantee, they receive payments (indemnities) equal to the difference. Similar to the YP policies, revenue protection coverage levels start at 50 percent and increase in 5 percent increments to 85 percent coverage (Shields, 2015b).

The price calculations are also the same, except instead of calculating the price a single time, it is calculated twice. The first price for every commodity is called the projected price and is the same projected price calculated under the YP plan. The second price is referred to as the harvest price (Shields, 2015a). This price uses the same contract as the projected price, but takes the average over a 4-week period at the end of the growing season. For long grain rice, the harvest price is determined by taking the average November contract price over the September 1 – September 30 period (Risk Management Agency, 2019). At harvest time, a final revenue guarantee is determined for a producer by multiplying the higher of the projected price and the harvest price with the specified APH coverage level chosen by a producer. Actual revenue is calculated by multiplying on-farm yield with the price received by the producer. If the actual revenue generated by these calculations is below the guarantee, a payment rate is generated by taking the difference. This is then multiplied by covered acres to calculate total revenue protection payments (Edwards & Plastina, 2014).

Another type of revenue protection policy that exists is revenue protection with harvest price exclusion (RP-HPE). This policy is similar to the regular RP policy in most ways, but it offers less protection by only determining a single price. Under a regular RP insurance policy, if harvest prices taken from the futures market are higher than projected prices, the revenue guarantee is recalculated with the harvest price. The RP-HPE plan does not update the revenue guarantee with the new price. Both RP and RP-HPE protect against yield losses and price declines, but the revenue protection with harvest price exclusion limits the potential benefits generated by price increases over the growing season. Farmers that do not forward price would benefit much the same under the harvest price exclusion option, with the added benefit of lower premium costs compared with traditional RP plans (Edwards & Plastina, 2014).

Insurable Units and Premium Rates

All crop insurance plans cover commodities on a per unit basis, but producers can choose which unit type they prefer to insure their crop. The four main types of insurable units are basic, optional, enterprise, and whole farm units, and each structure has the potential to affect indemnity payments. Basic units insure each crop a producer grows in each county as a separate unit. A farmer who grows corn on owned or cash rented land in one county can insure his crops under basic units. If the farmer grows more corn in another county or under a share-lease operation, it would have to be insured under a separate basic unit. Optional units are similar to basic units, but they allow farmers to insure the same crop in the same county under different plans. If a farmer grows corn on one farm in the northwest corner of the county, and more corn on another farm in the southwest part of the county, he or she can insure each farm as separate optional units (Johnson, 2010). Enterprise units are more complex than basic and optional units, but can offer better risk protection than other units in some scenarios. An enterprise unit is made up of all insurable acres of any crop in a county, regardless of ownership of the land, section of the county, or legal structure of the farm (Smith, 2001). Figure 6 shows insurable units in a pyramid structure. Whole farm units allow a producer to combine all of his or her crop acres in a single county together and insure them as a single unit.

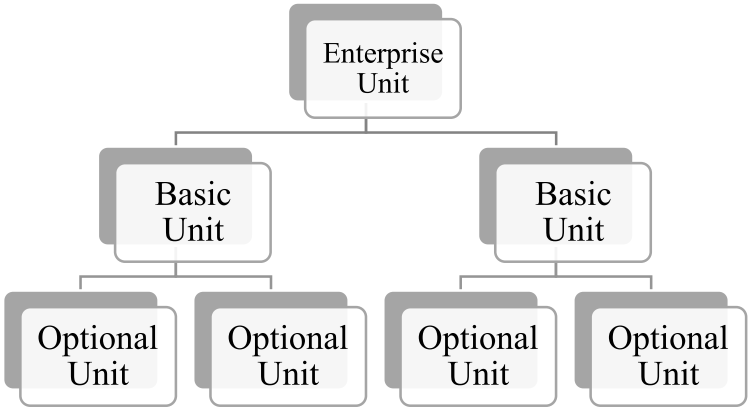


Figure 8: Hierarchy of Insurable Units

Premium rates vary not only by coverage levels but also by type of insurance policy, location, crop, and management system (e.g., irrigated versus non-irrigated). In general, crop insurance premiums increase with coverage levels, and RP policies tend to have higher premium rates than YP policies since the RP plans offer a broader range of protection. The federal government subsidizes at a 62 percent rate on average all crop insurance premiums, and producers pick up the remaining 38 percent. Table 4 shows the government paid percentage of premiums for each coverage level under various insurable units. The subsidy rate decreases with the level of coverage, and across coverage levels, enterprise and whole farm units are subject to higher premium subsidies than basic and optional units. The government fully subsidizes catastrophic (CAT) insurance, for which producers pay a one-time $500 fee for each crop in each county (Shields, 2015b).

Table 3: Government Paid Portion of Crop Insurance Premium by Unit Type

Coverage Level (%)	CAT	50	55	60	65	70	75	80	85
Basic and Optional	100	67	64	64	59	59	55	48	38
Enterprise Units	n/a	80	80	80	80	80	77	68	53
Area Plans (yield)	n/a	n/a	n/a	n/a	n/a	59	59	55	55
Area Plans (Revenue)	n/a	n/a	n/a	n/a	n/a	59	59	55	49
Whole Farm Units	n/a	80	80	80	80	80	80	71	56

Source: https://fas.org/sgp/crs/misc/R40532.pdf

Crop Insurance Statistics

The American crop insurance industry is a multibillion-dollar sector, and every year insurance companies across the nation sell millions of crop insurance policies of all types. Table 5 shows some major nationwide crop insurance statistics for the 2014-2017 crop years including number of policies sold, total liability, producer paid liability, government subsidies, total premiums paid, indemnity payments and loss ratio (Risk Managment Agency, 2019).

Table 4: Nationwide Crop Insurance Statistics 2014-2017

Crop Year	Policies Sold (no.)	Liabilities ($B.)	Total Premium ($B.)	Producer Paid Premium ($B.)	Government Subsidies ($B.)	Indemnity Payments ($B.)	Loss Ratio (unit)
2014	2,211,651	109.90	10.07	3.86	6.22	9.14	0.91
2015	2,237,420	102.53	9.77	3.68	6.09	6.31	0.65
2016	2,206,863	100.62	9.33	3.46	5.87	3.91	0.42
2017	2,183,064	106.08	10.07	3.72	6.36	5.42	0.54

Source: https://www.rma.usda.gov/SummaryOfBusiness/StateCountyCrop

Table 6 shows the same set of statistics on a state level and shows how Arkansas' crop insurance sector compares to the nation as a whole (Risk Managment Agency, 2019).

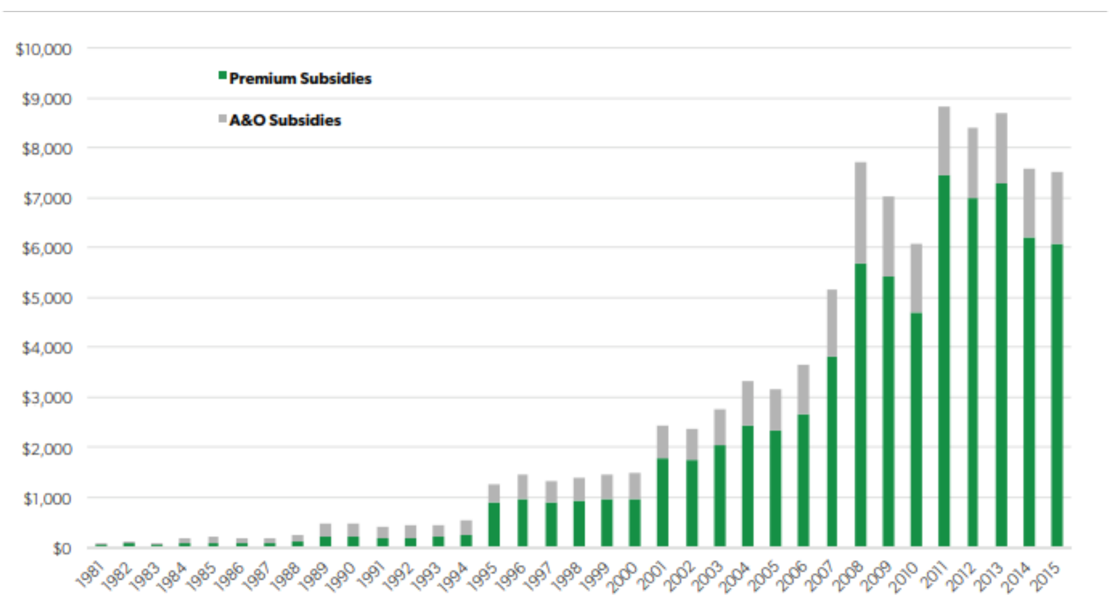
Table 5: Arkansas Crop Insurance Statistics

Crop Year	Policies Sold (no.)	Liabilities ($M.)	Total Premium ($M.)	Producer Paid Premium ($M.)	Government Subsidies ($M.)	Indemnity Payments ($M.)	Loss Ratio (unit)
2014	35,803	1,614.63	126.67	34.94	91.72	103.87	0.82
2015	38,820	1,498.61	113.38	34.16	79.23	154.81	1.37
2016	38,405	1,570.45	123.08	37.14	85.94	140.29	1.14
2017	38,611	1,591.94	134.26	40.41	93.85	155.20	1.16

Source: https://www.rma.usda.gov/SummaryOfBusiness/StateCountyCrop

Based on the information presented in the tables above, it appears that Arkansas enjoys a strong position in terms of government subsidies received relative to the average state. In every year except 2014, Arkansas had a loss ratio that was greater than 1, meaning indemnity payments received by producers in the state were larger than total premium payments that were made. Over this same period, Arkansas producers also received larger subsidy payments than the national average. On average, producers across the nation received federal subsidy payments at around 62 percent of premiums, but in Arkansas, those subsidies averaged 70.5 percent of total premiums.

The federal crop insurance program has been growing relative to all other farm safety net programs over the past few years, and it is now the largest farm support program in terms of annual dollars spent. There has been resistance to budget cuts in the crop insurance program from both Democrats and Republicans in Congress, and the program was actually expanded to add supplemental coverage options and a special cotton-specific program call the stacked income protection plan. Producers and lawmakers alike support a strong crop insurance program, and the trend of moving away from a commodity program-heavy safety net to an insurance-heavy safety net is expected to continue (Smith, Glauber, & Goodwin, 2017). Figure 7 shows the growth in government expenditures on premium subsidies and operating expenses from 1981 to 2015.



Source: http://www.aei.org/publication/time-to-reform-the-us-federal-agricultural-insurance-program/

Figure 9: Government Expenditure on Crop Insurance Premium Subsidies 1981-2015

Chapter 3: Methodology

Farm Policy Simulations

The large majority of farm policy analysis today is conducted using simulation modeling. Tyner and Tweeten (1968) developed an early simulation model to examine the effects of government intervention on agriculture. Their study found that under a free-market scenario with no government payments, no commodity diversions, and no acreage limitations, net returns to family labor were 32 percent lower than the scenarios with government programs in place. This early simulation model has been extended to a wide range of agricultural policy studies focusing on all parts of the farm safety net. Woodard, Sherrick and Schnitkey (2010) used simulation analysis to test the impact of popular crop insurance plans on corn and soybean farms in McClean County Illinois, and Hauser, Sherrick and Schnitkey (2004) used a similar simulation analysis to examine the interaction between counter-cyclical payments and crop insurance payments across the entire state of Illinois.

A number of studies have employed various simulation programs to study the effects of farm programs. Taylor and Koo (2006) used Palisade's @RISK Excel add-on to conduct simulation analysis testing the overall efficiency of the 2002 farm bill against proposed farm bill alternatives. Their model developed stochastic yield and price distributions for eight major commodities grown in North Dakota. Commodity program payments and federal crop insurance payments were separated to test the importance of each to North Dakota farmers, and total net farm income under each proposal was examined as well to determine the overall effectiveness of the policy. Wilson, Gustafson, and Dahl (2009) also employed @RISK to study the crop insurance decisions of North Dakota Barley growers with different risk preferences.

Representative Farm Models

A common extension of simulation analysis for many farm policy studies is the use of representative farm models. Plaxico and Tweeten (1963) were among the first to suggest the application of representative farms to policy studies. At the time, previous literature had used representative models to analyze farm management decisions, but little had been done in the field of policy analysis and projection. The authors note representative farms are a good tool for agricultural policy evaluation and formulation, and discuss how they can be used both in short and long-term projections.

Today, representative farm models are used extensively to analyze policy effects on a wide variety of metrics. For example, the Agricultural and Food Policy Center (AFPC) at Texas A&M maintains a portfolio of 94 representative farms in 30 states across the nation, and are used primarily to ascertain the economic viability of farming. These farm models are designed by panels of actual farmers in the area with the assistance of research extension economists in the state. (Richardson, et al., 2017). North Dakota State University also maintains a portfolio of representative farm models based on records from the North Dakota Farm and Ranch Business Management Education Program with the stated purpose of analyzing the impact of agricultural policy changes on farm income (Taylor, Koo, & Swenson, 2005).

Numerous studies have used representative farm models to analyze a wide range of agricultural policies. Higgins, Richardson, Outlaw, and Raulston (2007) used representative farms to test the impact altering farm payment programs to be revenue-based as opposed to price-based. Likewise, Vedenov and Power (2008) used a representative farm model to test how government payments affect producers' decisions to enroll in yield or revenue insurance protection plans, and

Gray, Boehlje, Gloy, and Slinksy (2004) used a representative corn and soybean farm in Indiana to analyze the risk-reducing effects of government commodity programs and crop insurance.

The five representative farm models used in this study are based on financial data files made available by the Texas A&M AFPC developed with assistance of the Arkansas Research and Extension Service. The representative Arkansas farms are located in Stuttgart, Wynne, McGehee, Hoxie, and Mississippi County, and were last updated in February 2017, April 2017, February 2017, April 2016, and March 2017, respectively. They range in size from 2500 acres on the Wynne farm to 6500 acres on the McGehee farm. Figure 10 shows the planted acres of each commodity on the five farm models.

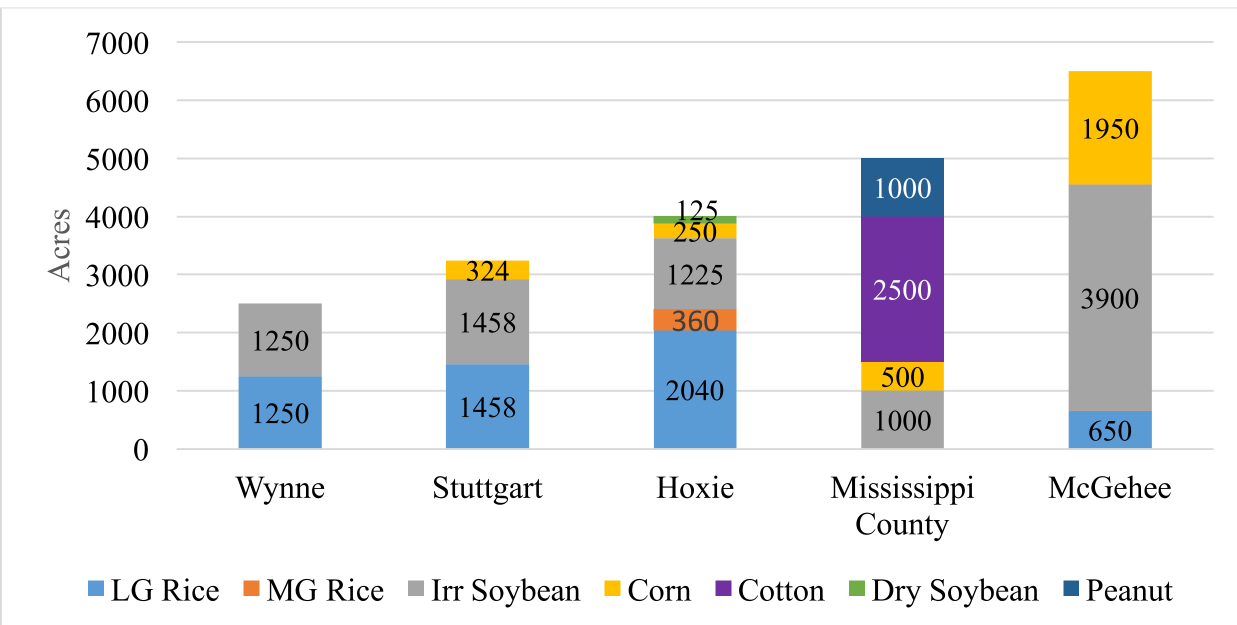


Figure 10: Planted acres by crop and representative farm

The representative farm models provide income and cash flow statement projections up to 2021. I expanded the projection horizon up to 2023 to cover the 5-year period under the 2018 Farm Bill cycle, and updated the projected costs and returns using more recent cost indexes and market prices from The University of Missouri's Food and Agricultural Policy Research Institute (FAPRI)'s August 2018 baseline (FAPRI, 2019).

The models were run stochastically based on yield and price variability using @RISK© (Palisade Corporation, 2016). I estimated the probability distribution functions for commodity yields and prices using county yield data and national price data from USDA NASS.

Each farm model was modified to incorporate the changes to the safety net programs under the 2018 farm bill; more specifically, the PLC program was updated to include the new reference prices and the elevator mechanism to estimate the effective price. The ARC program was also updated to include a yield trend-adjustment factor determined by USDA RMA, and the use of the higher percentage of transitional yields producers can use as a substitute for low yields in the estimation of the 5-year Olympic average yield. I included the specification of crop insurance provisions given its growing importance among safety net programs. In particular, the modification allows for the assessment of changes to yield protection (YP), revenue protection with harvest price exclusion (RP-HPE), and catastrophic (CAT) coverage payments.

This analysis assumes that each farm has a two-entity payment limit of $250,000 that will be factored into the cash receipts and net cash farm income output variables. We assume this payment limit structure because a single farmer and his or her spouse are eligible to enroll as two entities. We do not know the legal structure or the makeup up the five representative farms so this simplification allows for what may represent a typical family farm. We also assume that neither entity has an adjusted gross income higher than $900,000. Total commodity payments without limits will be included in the results to show the full payment potential each farm would have, but cash receipt and net income figures presented in the results will only account for up to $250,000.

Yield and Price Distributions

One of the biggest issues in studying farm policy—especially crop insurance programs—is determining farm-level yield distributions. Coble, Knight, Pope and Williams. (1996) used farm-level data from Kansas State University's Farm Management Whole Farm Data Bank to estimate yield distributions, while Cooper, Langemeir, Schnitkey and Zulauf (2009) and Woodard, Sherrick and Schnitkey (2010) utilized farm-level yield data from the Illinois Farm Business Farm Management Program. Another approach commonly used is to collect primary yield data via surveys. For instance, Sherrick, Barry, Ellinger and Schnitkey (2004) conducted a survey of three thousand producers who operated at least 160 acres or more in Illinois, Iowa and Indiana. Smith and Baquet (1996) conducted a similar survey of about 2,000 wheat and barley farmers across Montana.

Unfortunately, long series of reliable farm-level data does not exist for large portions of the country, and methods of obtaining or eliciting data are time consuming and costly. To circumvent this problem, a number of studies concerning crop insurance simulation have found ways to determine farm-level yield distributions using more aggregated data at county or state levels. Coble and Dismukes (2008) use historical county-level premium rates from the federal crop insurance program to infer farm-level yield variability. This method assumes actuarially fair premiums and that difference between farm and county yields are normally distributed with a mean of zero. Cooper et al. (2009) used farm-level datasets from Kansas and Illinois in conjunction with county level data to determine the average differences in yield distributions between the two, and found that a good rule of thumb is that farm-level deviations are 1.3 times larger than county level deviations. Goodwin (2010) used state data from NASS and assumed crop yields follow a beta distribution. To incorporate individual farm variability, he added normally-distributed random shocks with a mean of 0 deviation equal to 75 percent of the standard deviation of detrended state yields.

Before I could analyze farm safety net programs, stochastic distributions of farm yields and national prices for each crop on our representative farms had to be defined. Using USDA NASS's national average crop prices for the 2002-2016 (2005-2016 for medium grain rice) period, I ran an OLS regression model to detrend them and used @RISK® to estimate the best distribution fit for the standard errors based on the Akaike Information Criteria (AIC). The estimated probability distribution functions were applied to the projected 2019-2023 mean prices collected from FAPRI (2019).

Similarly, USDA NASS's county yield data by crop for the period 2002-2016 were used to estimate the yield distribution functions. As described by Coble and Dismukes (2008), projected, trend-adjusted county-level yields were estimated using an OLS regression model. This study assumed yields to be normally distributed with a standard deviation equal to 1.3 times the standard deviation of the detrended yields as specified by Cooper et al. (2009). The simulation accounts also for yield and price correlations across crops and farms.

Each of the representative farms used in this analysis use two separate yields. The first yield, called the normal yield, uses county-wide yields to determine distributions and predict future means. This fact means that exceptionally low yields and exceptionally high yields on a single farm may not be reflected fully by the county averages, which may bias the yield distributions. This narrower distribution means lower-end yields that would normally generate the largest payments to crop insurance aren't realized, so our mean crop insurance benefits may be smaller than some producers receive on average. To analyze the crop insurance program more appropriately, a second series of below-average yields are calculated by reducing the mean of the normal yields by 25 percent while holding distributions constant. Crop insurance analyses conducted using these below average yields are referred to as low-yield scenarios.

Commodity Program Simulation

Given that commodity programs are crop specific, and also given that farmers will be able to switch programs annually starting in 2021, I estimated the combination of commodity program-crop that will maximize program payments under the 2018 farm bill as follows. First, I use 1,000 simulations to estimate the mean and standard deviation of program payments by crop and year under both PLC and ARC, and second I choose the combination of program by year and crop that maximizes mean program payments. Since producers cannot change programs between 2019 and 2020, the mean PLC and ARC payments in those years were added together to facilitate the selection. To analyze the risk-reduction potential associated with commodity program enrollment, a coefficient of variation (CV) is calculated for cash receipts under a no program scenario and the payment-maximizing scenario. The coefficient of variation is the standard deviation of a variable divided by the mean of the same variable. Knapek (2013) uses CV's as a simple way to compare variability risk between different scenarios. This analysis will use CV values on cash receipts and not net income values because, according to Knapek (2013), a major drawback to using CV values is that if mean values are close to zero, or go from a positive to a negative value CV's can be misleading.

Crop Insurance Simulation

Crop insurance programs have been studied extensively using the representative farm framework, and consistent changes and updates to the federal crop insurance program require continual analysis and study. A multitude of insurance policies exist; some are widely used among major commodities, while others are only used by very few crops. Many policies are designed to work in combinations with others to offer sufficient protection. Devadoss and Luckstead (2018) examine the interaction of deep loss revenue protection and yield protection plans with shallow loss stacked income and supplemental coverage plans for representative cotton farmers. The study uses expected utility theory to find the profit-maximizing mix of deep and shallow loss crop insurance policies for risk-averse farmers. In a similar study, Luckstead and Devadoss (forthcoming) examine the interaction of revenue protection crop insurance with the 2014 farm bill commodity programs ARC and PLC for a representative Kansas wheat farm.

To calculate the costs producers face when purchasing crop insurance, premium rates for every policy option must be calculated. Following Luitel, Hudson and Knight (2018), the USDA RMA's cost estimator tool was used to determine individual premium rates for each policy (YP and RP-HPE), crop, and farm. Since future premium rate estimates do not exist, I assume that the 2019 rates remain constant through 2023. Although the representative farm models were modified to account for the different types of insurable units (basic, optional, enterprise, and whole farm), I conducted the simulations assuming a basic unit arrangement as this is the most common unit type, and requires no additional information about farm location or legal structure. Net insurance benefit, defined as total indemnity payments minus total producer paid premiums, was simulated stochastically for different policies, crops, and farms, to ascertain the effectiveness of crop insurance as a safety net program for Arkansas farms. Two scenarios are run to test the crop insurance program. The first uses the normal yields and the second is conducted using the below-average yields.

Revenue Protection with Harvest Price Exclusion

The next phase of the simulation analysis was to simulate insurance benefits under RP-HPE policies. To avoid an excessive amount of results, only the revenue policies that have been most popular in Arkansas historically were analyzed under the normal yield scenario. RMA summary of business data lists the number of each revenue and yield protection policies sold in Arkansas since 1980. In 2015, 2016 and 2017 the most frequently sold revenue protection policy for every commodity in this analysis, with the exception of soybeans, was the 75 percent coverage option. The most frequently sold coverage level for soybeans was the 70 percent option, but 75 percent coverage was a close second. To reflect the most typical insurance situation, RP-HPE policies were simulated at 75 percent coverage levels on all farms. Commodities that performed positively were examined at other levels to determine which coverage option maximized payments (Risk Managment Agency, 2019).

RP-HPE indemnity payments to each commodity were simulated, and the results were aggregated by farm to show the total amount of indemnities each farm would receive. The premium costs for each commodity were also aggregated by farm and compared with indemnity payments to test the overall insurance benefit. The potential of receiving insurance benefits larger than $0.00 was also calculated at every RP-HPE coverage level possible.

The low-yield scenario analyzed the average net benefit at every YP and RP-HPE coverage level. The best policy and coverage level for each commodity was chosen based on which one generated the largest net insurance benefit per acre. Once the optimal policy had been selected, cash receipts and net income were simulated and net crop insurance benefit and commodity program payments were compared to assess the overall strength of the safety net.

Chapter 4: Results and Discussion

The farm safety net is designed to protect farmers' income from downturns in the farm economy, and as such, it supplements the revenue generated through the marketing of agricultural commodities. The five Arkansas representative farms used in this study vary greatly in their production and cost structures, which to a large extend drive their economic viability, as we will see in the following sections. To illustrate, Hoxie and Mississippi County have relatively low average cash expenses of $557 and $592 per acre, respectively, while the McGehee and Stuttgart farms have average cash expenses that average $723 and $720 per acre, respectively. Total cash receipts are also important in explaining the financial health of each farm, and the variation among receipts on each farm explains the large differences in average net cash income. The Hoxie farm has the lowest cash receipts on average over the period, bringing in only $492 per acre on average. The Mississippi County farm has the largest cash receipts, averaging $975 per acre on average. Figure 11 shows average cash receipts and cash expenses on each of the five farms for the period 2019-2023.

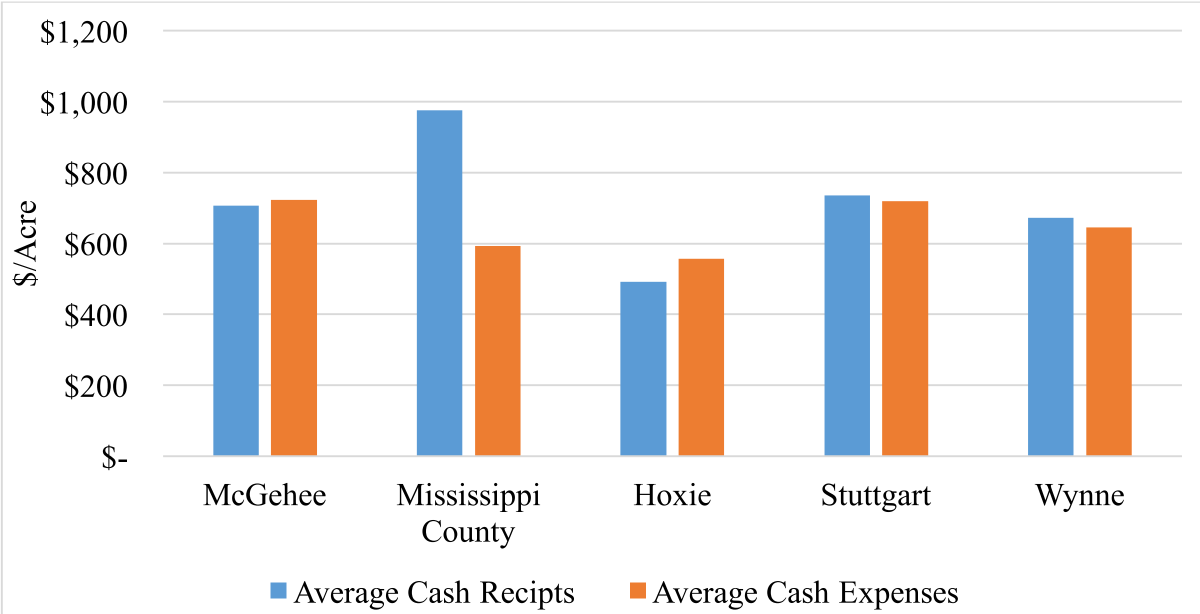


Figure 11: Average Cash Receipts and Cash Expenses by Farm for the period 2019-2023.

Along with cash expenses and receipts, yield variability among the commodities on the farms plays an important role in the overall financial health of the farm. For example, irrigated soybeans on the McGehee farm have average yields of 67.3 bushels per acre, while irrigated soybeans on the Hoxie farm only have an average yield of 37.2 bushels per acre over the 2019-2023 period. Most of the farm revenue comes from crop sales, so a smaller yield per acre converts to smaller cash receipts. The other commodities in the analysis vary as well. Long grain rice yields are as low as 68.1 cwt. per acre on the Hoxie farm and as high as 81.4 cwt. per acre on the Stuttgart farm. Corn yields are largest on the McGehee farm, averaging of 213.2 bushels per acre and lowest on the Stuttgart farm at 186.4 bushels per acre. Figure 12 shows the yield variability of irrigated soybeans on all five farms.

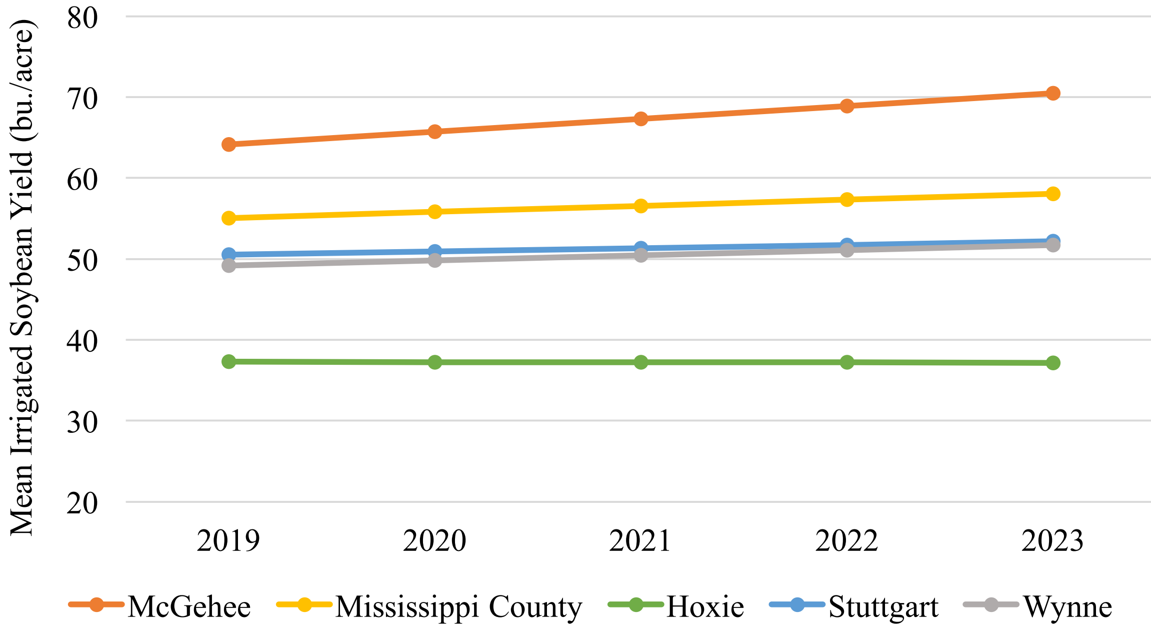


Figure 12: Irrigated Soybean Yield variability

With the variability in cost and productivity across farms highlighted above, we now turn to discuss the main findings on the impact of commodity programs and the federal crop insurance program on the viability of Arkansas farms.

<u>Title I Commodity Program Analysis</u>

Table 6 shows the stochastic mean annual commodity program payments received by commodity and farm for the span of the 2018 farm bill. The green (yellow) cells indicate that PLC (ARC) generates more program payments than ARC (PLC) for that specific farm, crop, and year combination. The first important finding to notice is that under the projected conditions commodity programs will generate payments in the next 5 years and thus contribute to improve the economic conditions of Arkansas farms. The reason why corn on the Stuttgart farm does not generate program payments is that it has no allocated base acres. It is also important to notice the dominance of PLC (over ARC) from the point of view of generating high payments for most crops and farms. As hypothesized, the PLC program is projected to be of much greater importance to Arkansas farmers than the ARC program in the coming years. There are 68 possible farm/crop/year enrollment choices between PLC and ARC as shown in table 7, and 65 times PLC is the payment-maximizing choice. Only non-irrigated soybeans on the Hoxie farm benefit more under the ARC program. Dry soybeans generate higher payments on the Hoxie farm under the ARC program in the 2019-2021 period, but PLC offers better prospects during 2022 and 2023. The remainder of the analysis assumes the program enrollment arrangements presented in Table 6. Table 7 shows the PLC payment rate on a per unit basis for each commodity and ARC payments on a per acre basis for non-irrigated soybeans.

Table 6: Average PLC and ARC Payments by Crop and Farm 2019-2023 No Limits†

Farm	Crop	2019	2020	2021	2022	2023	Average
McGehee	Lg Rice	$212,501	$213,151	$211,820	$202,024	$198,180	$207,535
	Soybean	$46,593	$37,688	$35,392	$40,735	$41,677	$40,417
	Corn	$8,082	$7,755	$7,461	$8,066	$9,828	$8,238
Mississippi	Cotton	$66,673	$67,376	$78,021	$75,492	$77,021	$72,917
	Soybean	$12,781	$10,440	$10,736	$12,667	$13,318	$11,988
	Peanuts	$110,418	$105,240	$88,422	$88,422	$89,177	$96,336
	Corn	$7,436	$7,270	$7,640	$9,200	$10,459	$11,338
Hoxie	Lg Rice	$244,029	$244,741	$243,254	$231,908	$227,344	$238,255
	Mg Rice	$33,577	$34,319	$39,502	$39,619	$40,661	$37,536
	Irr. Soybean	$16,563	$13,729	$14,080	$16,521	$17,649	$15,708
	Dry Soybean	$2,534	$2,205	$1,706	$1,686	$1,801	$1,603
	Corn	$2,729	$2,658	$2,693	$3,279	$3,718	$3,015
Stuttgart	Lg Rice	$192,551	$193,184	$191,942	$183,090	$179,560	$188,065
	Soybean	$22,002	$17,789	$16,538	$18,541	$19,668	$18,908
	Corn	$0	$0	$0	$0	$0	$0
Wynne	Lg Rice	$156,543	$157,011	$156,036	$148,816	$145,989	$152,879
	Soybean	$16,967	$13,713	$13,015	$15,195	$17,595	$15,297

† Cells in green (yellow) mean that PLC (ARC) is the program payment maximizing option for the crop/year combination.

Table 7: Average PLC and ARC Payment Rates by Crop and Farm 2019-2023 ($/unit) †

Farm	Crop	2019	2020	2021	2022	2023
McGehee	Lg Rice (lbs.)	$2.54	$2.55	$2.54	$2.42	$2.37
	Soybean (bu.)	$0.50	$0.41	$0.38	$0.44	$0.45
	Corn (bu.)	$0.15	$0.15	$0.14	$0.15	$0.19
Mississippi	Cotton (lbs.)	$0.015	$0.016	$0.018	$0.017	$0.018
	Soybean (bu.)	$0.53	$0.43	$0.44	$0.52	$0.55
	Peanuts (ton)	$118.54	$112.98	$94.92	$94.92	$95.73
	Corn (bu.)	$0.16	$0.15	$0.16	$0.19	$0.22
Hoxie	Lg Rice (lbs.)	$2.56	$2.56	$2.55	$2.43	$2.38
	Mg Rice (lbs.)	$1.99	$2.04	$2.35	$2.35	$2.41
	Irr. Soybean (bu.)	$0.53	$0.44	$0.45	$0.53	$0.56
	Dry Soybean (bu.)	$29.23*	$25.44*	$19.68*	$0.53	$0.56
	Corn (bu.)	$0.16	$0.15	$0.15	$0.19	$0.21
Stuttgart	Lg Rice (lbs.)	$2.54	$2.55	$2.54	$2.42	$2.37
	Soybean (bu.)	$0.50	$0.41	$0.38	$0.42	$0.45
	Corn (bu.)	$0.00	$0.00	$0.00	$0.00	$0.00
Wynne	Lg Rice (lbs.)	$2.54	$2.55	$2.54	$2.42	$2.37
	Soybean (bu.)	$0.50	$0.41	$0.39	$0.45	$0.52

† Cells in green (yellow) mean that PLC (ARC) is the program payment maximizing option for the crop/year combination.
* ARC payments rates are listed as $/Acre values

This mix of program enrollment not only maximizes the amount of government support payments a farm receives, but also provides the lowest level or program payment risk in nearly all scenarios. Programs payments under PLC for both long and medium grain rice, corn, cotton, and peanuts have a lower variability (risk) in every farm and year relative to ARC. Soybeans on the Stuttgart and Hoxie are the only commodities offering lower program payment risks under ARC. On the Stuttgart farm, the variability of PLC program payments for soybeans are slightly higher than for ARC in 2019, 2020 and 2021, but lower for 2022 and 2023. On the Hoxie farm, both irrigated and non-irrigated soybeans have lower CV values under the ARC program in every year of the analysis, even though payments are only maximized under ARC for dry soybeans in the 2019-2021 period.

Tables 8 – 12 compare each farm's financial health, as measured by the total cash receipts and net cash farm income, under a no government program scenario and the payment-maximizing program enrollment scenario. These results demonstrate first the dire economic situation of most farms in Arkansas, and the importance of government programs to the overall financial health of Arkansas farms. Of the five farms, only Mississippi County has a positive net income throughout the analysis period when government program payments are not included. The Wynne and Stuttgart farms have positive net incomes in 2019 without commodity payments, but every other year they have negative net income. The McGehee and Hoxie farms both have negative incomes for the entirety of the analysis period without program payments. The Hoxie farm suffers the most from no government payments, as the farm has an average annual net loss of over $500,000.

Table 8: McGehee Farm Mean and Distribution of Total Cash Receipts and Net Cash Farm Income by Year With and Without Commodity Program Payments

	2019	2020	2021	2022	2023	Average
			No Commodity Program Payments			
Total Cash Receipts ($)	4,193,063	4,350,992	4,459,883	4,504,301	4,545,672	4,410,782
CV	0.153	0.157	0.152	0.154	0.156	0.154
Net Cash Farm Income ($)	-119,107	-194,242	-274,305	-368,285	-474,210	-286,960
Standard Deviation	(637,785)	(677,112)	(674,662)	(685,832)	(703,545)	(329,274)
			With Commodity Program Payments			
Program Payments ($)	267,180	258,582	254,426	251,043	249,983	256,193
Total Cash Receipts ($)	4,373,311	4,528,338	4,637,625	4,676,977	4,717,549	4,586,760
CV	0.140	0.143	0.141	0.144	0.145	0.143
Net Cash Farm Income ($)	61,142	-16,900	-96,566	-195,613	-302,337	-110,055
Standard Deviation	(602,204)	(643,041)	(649,482)	(670,291)	(678,931)	(324,542)

Table 9: Mississippi County Farm Mean and Distribution of Total Cash Receipts and Net Cash Farm Income by Year With and Without Commodity Program Payments

	2019	2020	2021	2022	2023	Average
			No Commodity Program Payments			
Total Cash Receipts ($)	4,635,035	4,714,678	4,799,150	4,839,217	4,870,714	4,771,759
CV	0.106	0.103	0.103	.0102	0.103	0.104
Net Cash Farm Income ($)	1,845,943	1,823,551	1,831,196	1,797,178	1,750,100	1,809,594
Standard Deviation	(475,357)	(468,878)	(478,202)	(473,365)	(483,953)	(353,067)
			With Commodity Program Payments			
Program Payments ($)	196,488	190,766	184,608	185,020	187,835	188,943
Total Cash Receipts ($)	4,812,834	4,888,779	4,963,571	5,005,704	5,040,857	4,942,349
CV	0.096	0.094	0.093	0.094	0.093	0.094
Net Cash Farm Income ($)	2,023,746	1,997,657	1,995,623	1,963,670	1,920,249	1,980,189
Standard Deviation	(442,683)	(442,801)	(443,413)	(451,033)	(449,313)	(346,193)

Table 10: Hoxie Farm Mean and Distribution of Total Cash Receipts and Net Cash Farm Income by Year With and Without Commodity Program Payments

	2019	**2020**	**2021**	**2022**	**2023**	**Average**
			No Commodity Program Payments			
Total Cash Receipts ($)	2,180,655	2,203,358	2,211,729	2,232,644	2,243,503	2,214,378
CV	0.155	0.160	0.161	0.153	0.157	0.157
Net Cash Farm Income ($)	-360,149	-490,560	-594,670	-667,411	-738,976	-570,353
Standard Deviation	(336,839)	(350,514)	(352,260)	(338,649)	(350,046)	(175,420)
			With Commodity Program Payments			
Program Payments ($)	297,409	295,768	299,240	291,334	289,960	294,844
Total Cash Receipts ($)	2,369,155	2,391,479	2,401,582	2,421,417	2,429,286	2,402,584
CV	0.121	0.122	0.121	0.119	0.119	0.120
Net Cash Farm Income ($)	-171,639	-302,429	-404,806	-478,626	-$553,180	-382,136
Standard Deviation	(284,103)	(287,846)	(287,536)	(283,627)	(285,347)	(154,190)

Table 11: Stuttgart Farm Mean and Distribution of Total Cash Receipts and Net Cash Farm Income by Year With and Without Commodity Program Payments

	2019	**2020**	**2021**	**2022**	**2023**	**Average**
			No Commodity Program Payments			
Total Cash Receipts ($)	2,153,110	2,191,988	2,220,796	2,243,929	2,258919	2,213,748
CV	0.152	0.144	0.147	0.149	0.147	0.148
Net Cash Farm Income ($)	19,952	-62,378	-124,756	-180,224	-242,894	-118,179
Standard Deviation	(318,743)	(332,937)	(321,626)	(333,003)	(337,392)	(162,153)
			With Commodity Program Payments			
Program Payments ($)	214,550	210,930	208,505	201,608	199,237	206,951
Total Cash Receipts ($)	2,313,650	2,354,078	2,379,240	2,399,518	2,412,944	2,371,886
CV	0.111	0.110	0.109	0.108	0.107	0.109
Net Cash Farm Income ($)	181,440	98,640	33,334	-23,816	-89,190	40,497
Standard Deviation	(254,106)	(255,392)	(255,928)	(256,373)	(255,059)	(133,855)

Table 12: Wynne Farm Mean and Distribution of Total Cash Receipts and Net Cash Farm Income by Year With and Without Commodity Program Payments

	2019	**2020**	**2021**	**2022**	**2023**	**Average**
			No Commodity Program Payments			
Total Cash Receipts ($)	1,492,836	1,524,786	1,548,759	1,566,893	1,581,459	1,542,947
CV	0.176	0.173	0.174	0.170	0.175	0.174
Net Cash Farm Income ($)	18,290	-39,554	-85,934	-106,176	-145,768	-71,828
Standard Deviation	(260,945)	(261,642)	(266,683)	(264,812)	(273,874)	(132.472)
			With Commodity Program Payments			
Program Payments ($)	168,205	173,493	170,729	169,077	164,408	168,153
Total Cash Receipts ($)	1,640,163	1,670,989	1,692,907	1,708,616	1,721,795	1,686,894
CV	0.120	0.120	0.117	0.120	.0120	0.120
Net Cash Farm Income ($)	165,622	106,654	58,220	35,554	-5,425	72,125
Standard Deviation	(194,321)	(198,393)	(195,774)	(200,874)	(203,778)	(113,856)

When government support payments are included, all farms are substantially better off. Program payments bring the average net cash farm income of the Stuttgart and Wynne farms into the positive territory, despite the fact that net cash farm income for both farms remains negative even with program payments in the out years (2022-2023 for Stuttgart, and 2023 for Wynne). Hoxie and McGehee still average annual net income losses over the analysis period even with government payments, but program payments help lower the risk of having income losses. The results show that commodity program payments reduce cash receipt risks on all farms. The Mississippi County farm sees the lowest level of risk reduction, going from an average CV of 0.104 to 0.094. Since the Mississippi County farm has large cash receipts already, the relatively small amount of risk reduction is expected. The McGehee farm also has a relatively low level of risk reduction going from a CV of 0.154 when not enrolled in a commodity program to 0.143 when it is enrolled. Like Mississippi County, the McGehee farm has larger cash receipts so a smaller CV is expected. Recall that the McGehee and Mississippi county farms are the largest operations considered in this study (Figure 9).The Wynne farm, the smallest of the 5 farms, has the largest amount of risk reduction, and the average CV drops from 0.174 with no government programs to 0.12 when completely enrolled in the PLC program.

Figures 13-17 show, for each farm, the probability of having a positive net cash farm income under the no program scenario and the payment-maximizing scenario.

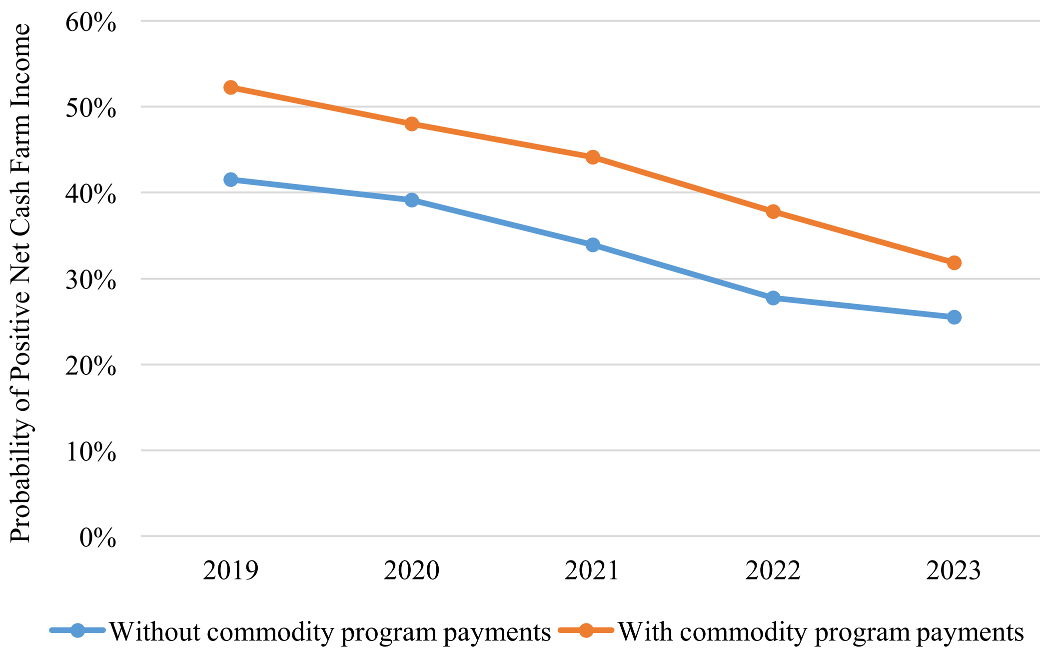


Figure 13: McGehee Farm Probability of Positive Net Income

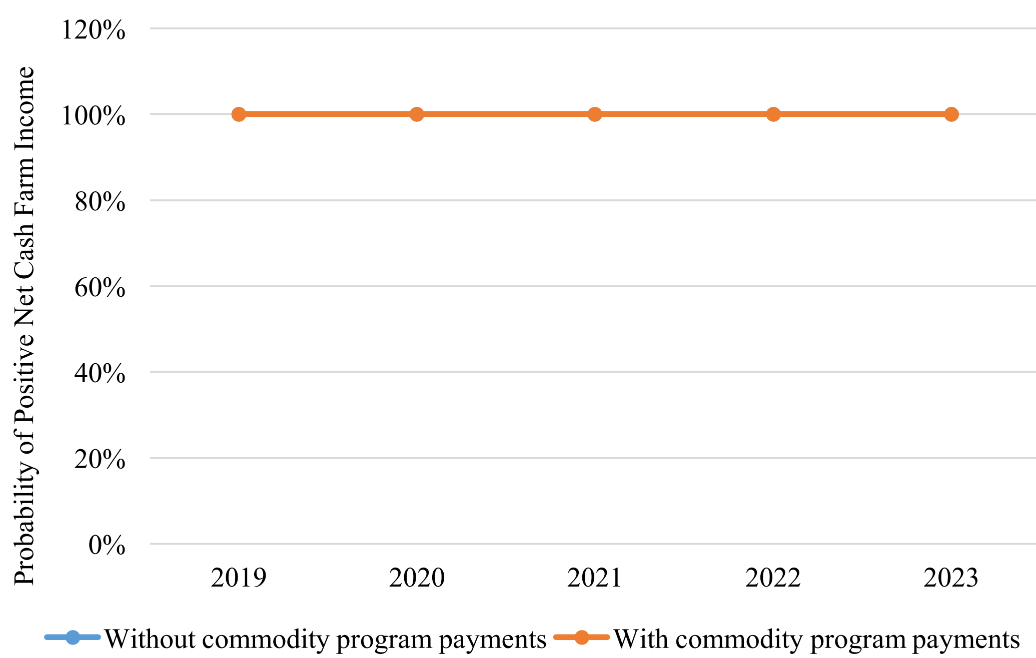


Figure 14: Mississippi County Farm Probability of Positive Net Income

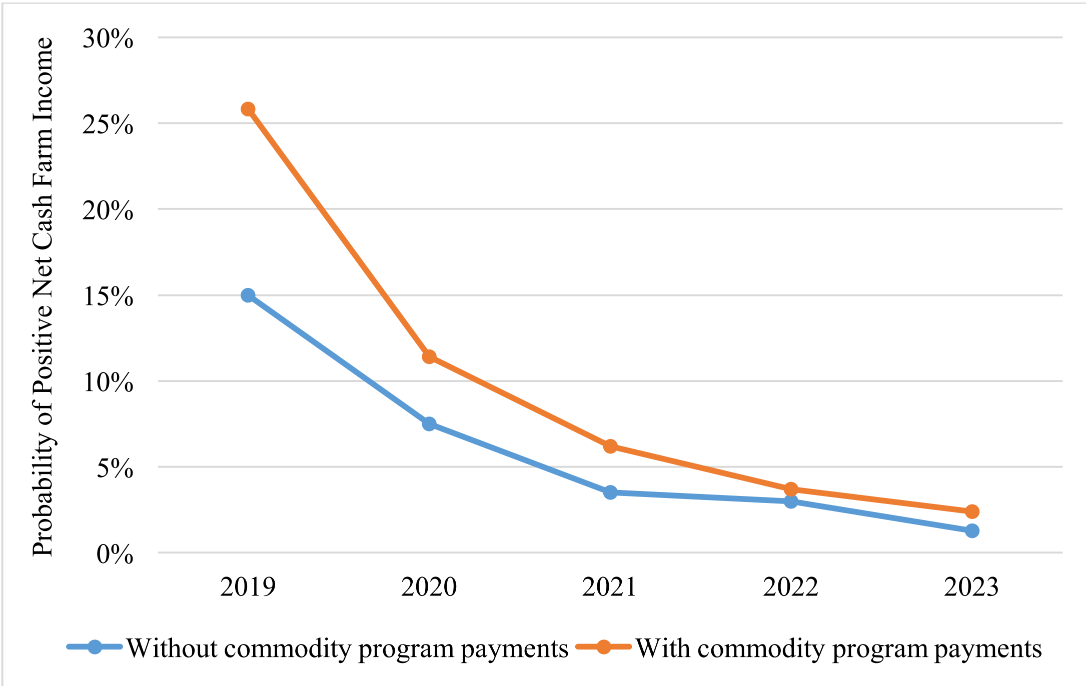


Figure 15: Hoxie Farm Probability of Positive Net Income

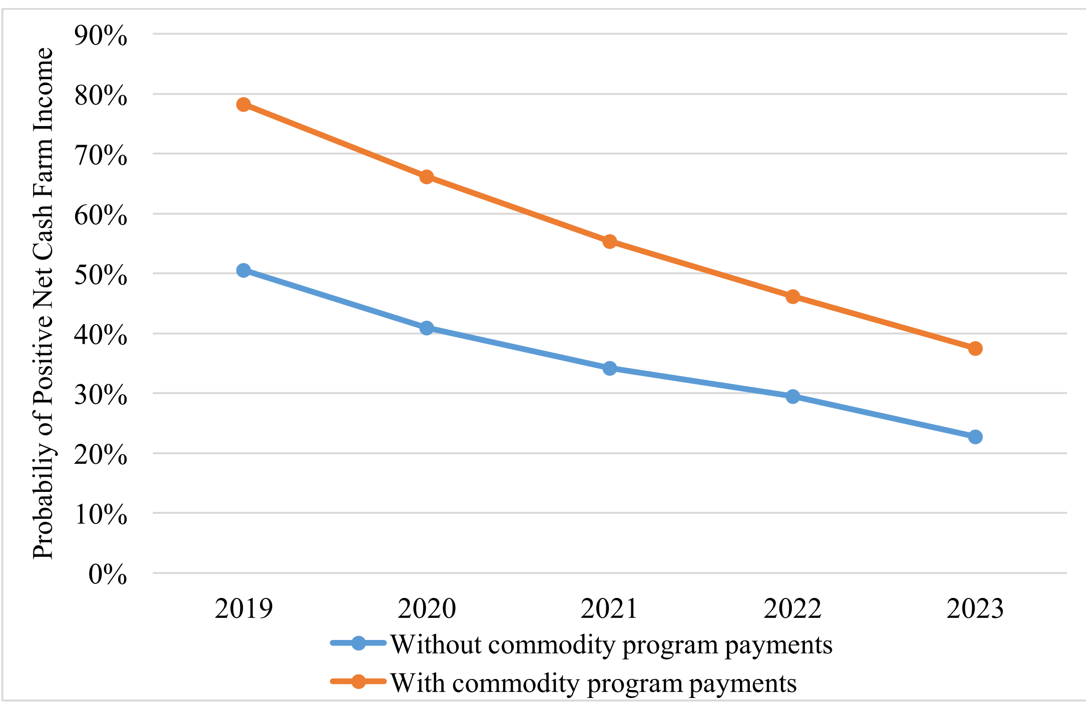


Figure 16: Stuttgart Farm Probability of Positive Net Income

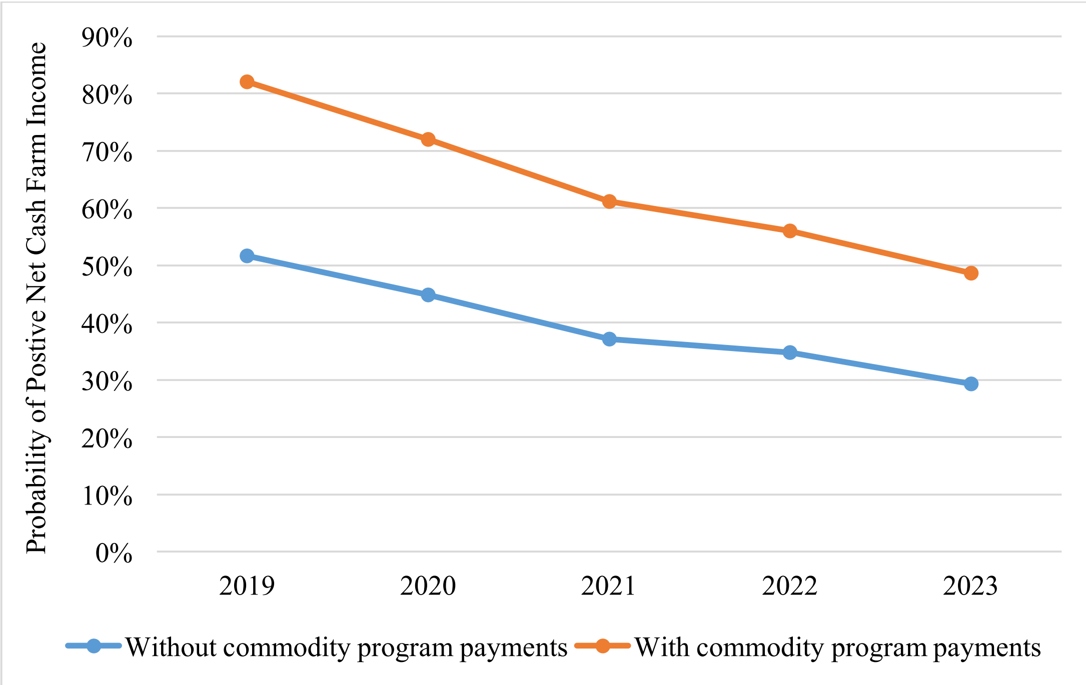


Figure 17: Wynne Farm Probability of Positive Net Income

On every farm except the Mississippi County operation, the probability of generating a positive net income decreases consistently from 2019-2023. The main reason for the declining percentage of positive incomes is large increases in total costs relative to the increase in total revenue across the five farms. Total cash expenses on the Stuttgart farm, for example, increases by $368,000 from 2019 to 2023. Total cash receipts on the other hand only increase by $80,000 over the same period. Without program payments, the Stuttgart farm has just over a 50 percent chance of having a positive income in 2019, but the probability decreases to 23 percent by 2023. When enrolled in the payment-maximizing commodity program mix, the Stuttgart farm has nearly an 80 percent chance of generating positive income in 2019, and a 38 percent chance in 2023. A similar pattern is observed for the McGehee farm where probabilities go from 42 percent in 2019 to 26 percent in 2023 and 52 to 32 percent over the same period for the no program and payment maximizing program scenarios, respectively. The Hoxie farm has a very small chance of generating payments throughout the entire period: Without program enrollment, it goes from a

15 percent chance of generating payments in 2019 to a 1 percent chance in 2023. With program payments, the farm has a 26 percent chance of having positive income in 2019, but by 2023, the probability is only 2 percent—nearly identical to the no program scenario. The Mississippi County farm always has a positive net income, regardless of program enrollment or not. The Wynne farm, much like the Stuttgart and McGehee farms, has more than an 80 percent chance of generating a positive income in 2019 when enrolled in government programs. The probability of having a positive net income drops less sharply than the Stuttgart farm's through the period, and Wynne still has nearly a 50 percent chance to generate a positive income in 2023. Without commodity program payments, the probability of a positive net cash farm income for the Wynne farm is 52 percent in 2019 and decreases to 29 percent by 2023.

An important facet of the government commodity program is the use of payment limitations. Since our analysis assumes a two-entity rule, farms can receive a maximum of $250,000 in commodity payments each year. Figure 18 shows the probability that program payments for each farm exceed the payment limit. Hoxie has the highest probability of exceeding the $250,000 limit due to the fact that it has such a large proportion of base acres allocated to rice. Long and medium grain rice combine to account for 2,400 of the farms 5,000 acres, or 48 percent of total base acres. McGehee has over 2,200 base acres allotted to rice, but it only accounts for 35 percent of the farms total base acres causing its likelihood of exceeding limits to be lower than the Hoxie farm's.

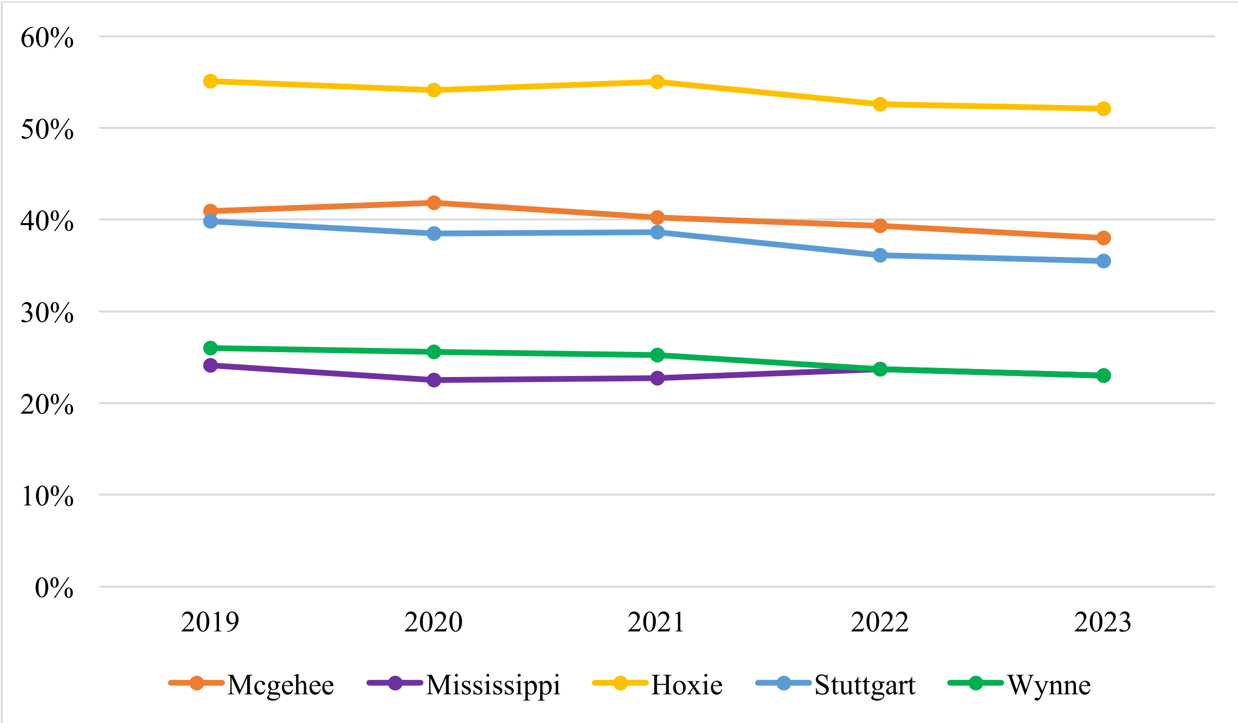


Figure 18: Probability of Commodity Program Payments above $250,000 by Farm

The probability of reaching the payment limit decreases only slightly for all five farms by 2023. The Wynne and Mississippi County farms both have relatively few payments above $250,000, hovering around 25 percent during the period. The Stuttgart farm also has very similar probabilities, starting with 40 percent of payments above the limit in 2019 and decreasing slightly to around 36 percent by 2023. The McGehee farm follows the same pattern as the Stuttgart farm with 41 percent of payments over the limit in 2019 and 38 percent by 2023. The Hoxie farm has the highest amount of payments above the $250,000 limit with more than half of their payments in each year being above the limit. The Hoxie farm also has the lowest net income on a yearly basis, and could benefit from an increase in annual payments. The Hoxie farm would have the most to gain from restructuring the operation or bringing in additional operators to increase their payment limits.

Federal Crop Insurance Analysis

The crop insurance portion of the simulation analysis had two major components—YP (including CAT) and RP. Table 13 lists the minimum yields by crop and farm generated by the estimated normal yield distribution functions. YP payments are due only if minimum yields fall below the guaranteed percentage of a producer's APH. Table 14 lists the APH of each commodity on every farm

Yield Protection

To determine whether indemnity payments will be issued, the YP coverage level is set to 85 percent, and yield guarantees (APH x 0.85) for each crop are compared with the minimum yield listed in Table 13. Results in Table 15 show that some of the commodities do not generate any YP payments at all because their actual yields do not drop below the guaranteed yields. Indemnities are possible in 65 out of the 85 possible farm-crop-year combinations.

Table 13: Minimum Commodity Yields by Farm and Year

Farm	Crop	2019	2020	2021	2022	2023
Stuttgart	Lg Rice (lbs.)	6,774	6,926	6,999	7,073	7,147
	Soybeans (bu.)	38.75	39.16	39.57	39.98	40.39
	Corn (bu.)	133.42	134.3	135.19	136.07	136.96
McGehee	Lg Rice (lbs.)	5,140	5,480	5,556	5,632	5,708
	Soybeans (bu.)	49.63	50.78	52.36	53.93	55.51
	Corn (bu.)	167.4	170.2	172.9	175.8	178.6
Hoxie	Lg Rice (lbs.)	5,554	5,587	5,619	5,652	5,685
	Mg Rice (lbs.)	5,312	5,343	5,373	5,404	5,434
	Irr. Soybeans (bu.)	21.53	21.5	21.48	21.46	21.43
	Dry Soybeans (bu.)	0	0	0	0	0
	Corn (bu.)	135.31	138.61	141.91	145.21	148.51
Mississippi	Cotton (lbs.)	728.6	738.1	747.6	757.1	766.6
	Soybeans (bu.)	38.41	39.16	39.91	40.65	41.4
	Peanuts (tons)	1.407	1.447	1.487	1.517	1.557
	Corn (bu.)	128.7	131.1	133.5	135.9	138.3
Wynne	Lg Rice (lbs.)	5,358	5,417	5,477	5,537	5,596
	Soybeans (bu.)	35.69	36.32	36.96	37.59	38.12

Table 14: Average Production History by Farm and Year

Farm	Crop	2019	2020	2021	2022	2023
Stuttgart	Lg Rice (lbs.)	7,552	7,660	7,793	7,867	7,885
	Soybeans (bu.)	50.1	50.6	51.4	52.2	52.3
	Corn (bu.)	182.3	185.2	187.0	190.1	190.4
McGehee	Lg Rice (lbs.)	7,031	7,168	7,271	7,330	7,319
	Soybeans (bu.)	55.1	57.1	58.6	60.5	62.4
	Corn (bu.)	190.5	194.3	197.2	200.9	202.4
Hoxie	Lg Rice (lbs.)	6,370	6,467	6,569	6,628	6,616
	Mg Rice (lbs.)	6,571	6,598	6,684	6,725	6,695
	Irr. Soybeans (bu.)	37.6	38.1	38.6	38.7	37.8
	Dry Soybeans (bu.)	26.1	26.1	26.1	26.0	26.0
	Corn (bu.)	162.7	165.3	167.6	173.9	175.3
Mississippi	Cotton (lbs.)	1,062	1,086	1,095	1,118	1,124
	Soybeans (bu.)	50.2	51.0	52.4	53.6	54.1
	Peanuts (tons)	3.7	3.7	3.7	3.7	3.7
	Corn (bu.)	175.1	177.2	179.9	185.8	188.5
Wynne	Lg Rice (lbs.)	6,929	6,974	7,087	7,216	7,257
	Soybeans (bu.)	45.6	46.9	48.0	48.8	49.3

Table 15: Probability of Actual Yields Lower than 85 Percent Guarantee

Farm	Crop	2019	2020	2021	2022	2023
Stuttgart	Lg Rice (lbs.)	0%	0%	0%	0%	0%
	Soybeans (bu.)	0.5%	0.5%	0.7%	0.7%	0.6%
	Corn (bu.)	1.0%	1.3%	1.4%	1.9%	1.8%
McGehee	Lg Rice (lbs.)	1.5%	1.7%	1.8%	1.6%	1.8%
	Soybeans (bu.)	0%	0%	0%	0%	0%
	Corn (bu.)	0%	0%	0%	0%	0%
Hoxie	Lg Rice (lbs.)	0%	0%	0%	0%	0%
	Mg Rice (lbs.)	0.6%	0.6%	0.8%	0.8%	0.6%
	Irr. Soybeans (bu.)	13.9%	16.4%	19.1%	19.2%	15.3%
	Dry Soybeans (bu.)	57.6%	59.5%	61.3%	62.2%	64.1%
	Corn (bu.)	0.2%	0.1%	0.1%	0.1%	0.1%
Mississippi	Cotton (lbs.)	3.1%	3.9%	3.8%	4.5%	4.1%
	Soybeans (bu.)	0.4%	0.4%	0.5%	0.6%	0.5%
	Peanuts (tons)	10.9%	8.7%	6.9%	5.5%	3.4%
	Corn (bu.)	0.9%	0.8%	0.8%	1.2%	1.1%
Wynne	Lg Rice (lbs.)	0.8%	0.7%	0.8%	1.1%	1.0%
	Soybeans (bu.)	0.8%	1.1%	1.3%	1.3%	1.3%

The 65 combinations with probabilities of generating indemnity payments with an YP policy with 85 percent coverage were simulated to determine the effect of the YP policy on indemnity payments and net insurance benefit. The stochastic results show that none of the farm-crop-year combinations generates indemnities that are large enough to cover the costs of premium payments. The only substantial indemnity payment is received by non-irrigated soybeans on the Hoxie farm. Under an YP 85 percent coverage plan, dry soybeans receive average indemnity payments between $37 and $38 per acre, relative to average producer premium costs that range between $40 and $42 per acre. The other commodities with low enough yields generate indemnity payments that are much lower on average than non-irrigated soybeans. Irrigated soybeans have the next highest average payments per acre ranging from $2.71 per acre in 2019 to $0.57 per acre in 2023. The rest of the commodities generate payments per acre that are all less than $1.00. Premium rates per acre for the remaining commodities range from a low of $26 per acre for irrigated soybeans to a high of $69 per acre for peanuts. Since indemnity payments for most commodities are so low at 85 percent coverage, only non-irrigated soybeans in Hoxie are considered further.

At a coverage level of 85 percent, no commodity generates any positive insurance benefit. However, premium rates are very high under YP 85 plans, and premiums are not subsidized as heavily. Lowering the coverage level reduces the probability and size of indemnities and the premium costs, and may lead to a higher probability of benefits. Since non-irrigated soybeans in the Hoxie farm is the only commodity that generates substantial payments under the YP 85 plan, it is the only commodity that is considered under lower coverage levels. What we find is that as coverage levels decrease, premium rates decrease and the government subsidy covering premium payments increase. These two factors combined make non-irrigated soybean benefits positive at every level of coverage apart from YP 85. Figure 19 shows average insurance benefit for dry soybeans under all 8 coverage levels.

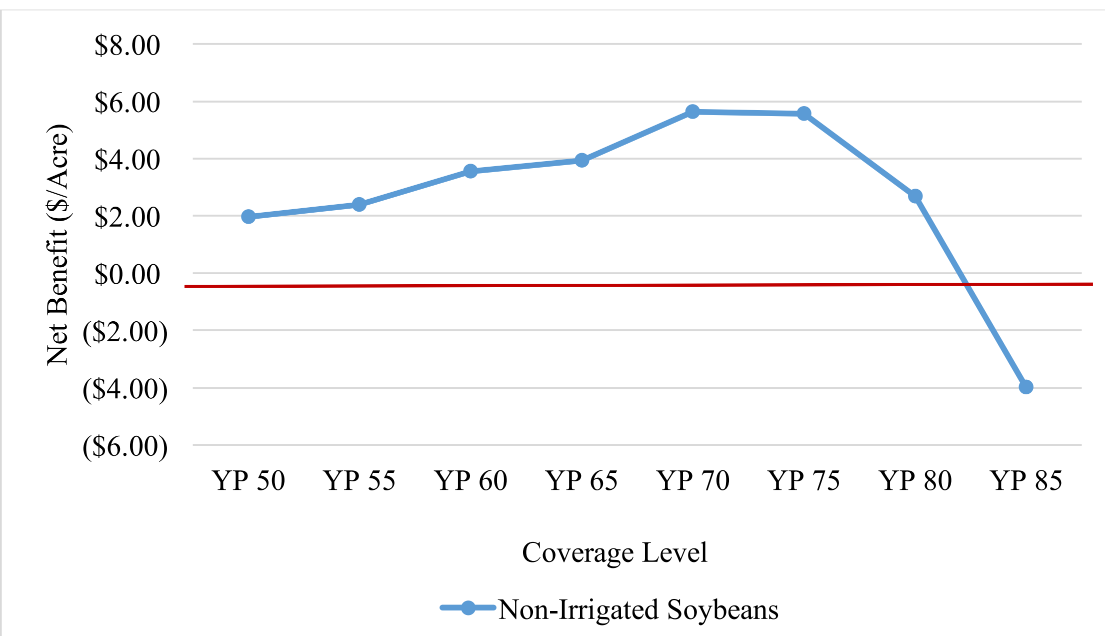


Figure 19. Hoxie farm: Average Dry Soybean Insurance Benefit by YP Coverage Level

Catastrophic Coverage

Like YP policies, CAT coverage also protects producers only against yield loss. The downside to using only CAT coverage however, is that it only protects a maximum of 50 percent of the yield at a 55 percent price coverage level. Only major losses that are likely only experienced by few farmers in a given year are covered by CAT plans, so instead of paying premiums rates that fluctuate, producers only pay a $500 fee for each crop in the program. In this simulation, dry soybeans on the Hoxie farm are the only commodity that ever generates any indemnity payments under the CAT program. Since the CAT program is set up as a 50/55 coverage plan, the average total indemnity payments that it does generate are rather small. For dry soybeans, total indemnity payments are right at $500 in the early years, and drop to just under $400 by 2023.

Revenue Protection with Harvest Price Exclusion

Unlike YP and CAT policies that fail to generate positive benefits for many of the commodities in this analysis, revenue protection plans generate a small percentage of positive payments at most coverage levels for nearly all crops on every farm when using normal yields. Figure 20 shows each farm's average total indemnity payments under a 75 percent RP-HPE policy for the 2019-2023 period.

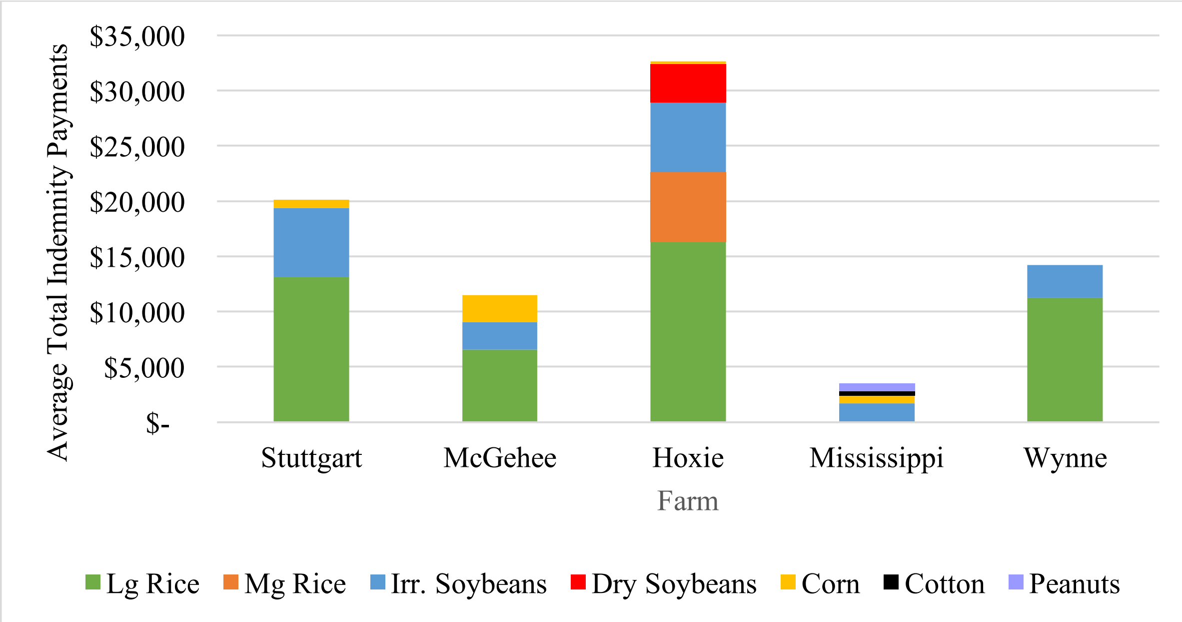


Figure 20: Average Total Indemnity Payments at 75% RP-HPE Coverage

At 75 percent coverage, the Hoxie farm receives the largest amount of indemnity payments totaling just over $32,000 on average. The Mississippi County farm receives the fewest indemnity payments totaling only $3,503. Rice receives the majority of payments on most of the farms, but this is due to the fact that long grain rice constitutes the greatest number of planted acres. To compare indemnity payments between commodities, figure, 21 breaks total payments down into average indemnity payments per acre.

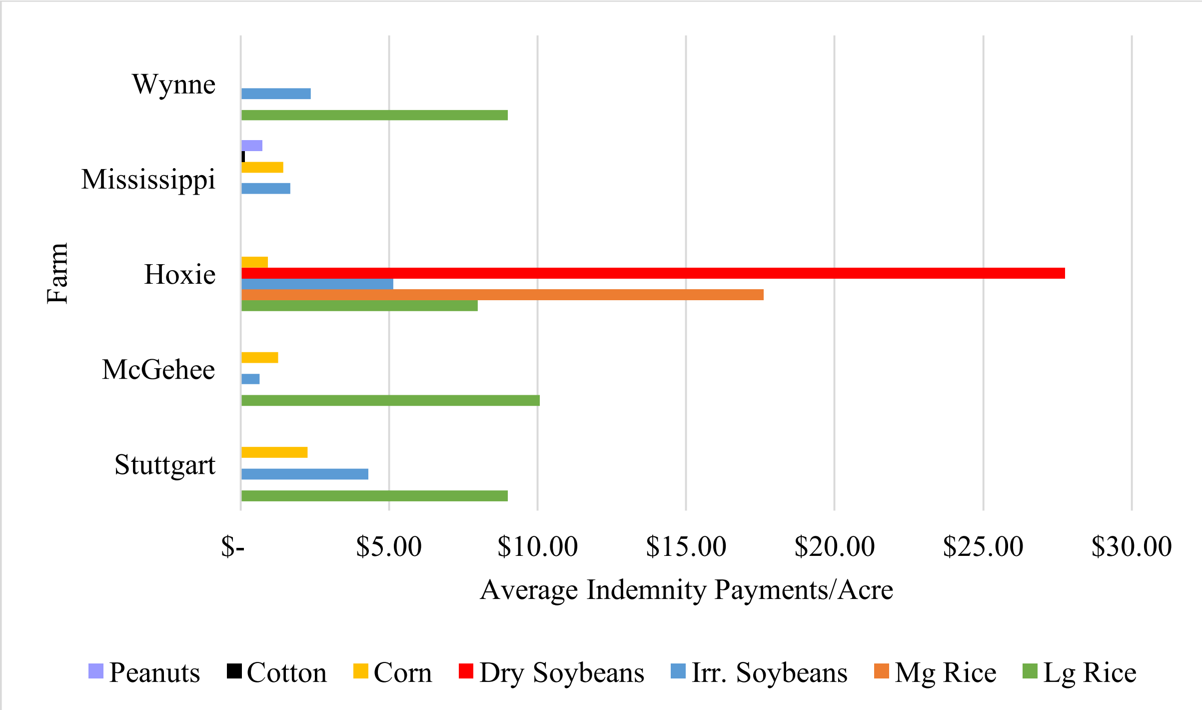


Figure 21: Indemnity Payments per Acre at 75% RP-HPE Coverage

Comparing indemnity payments on a per acre basis, it is clear that non-irrigated soybeans and medium grain rice on the Hoxie farm receive substantially larger payments than any other commodity. Across farms, indemnity payments range from $8 to $10 per acre for long grain rice, and at or below $5 per acre for all other crops.

To determine the economic impact of enrolling commodities in 75 percent RP-HPE policies, total premium costs to producers as well as premium costs per acre are calculated and compared against indemnity payments. Figure 22 shows average total premiums costs on each farm and figure 23 lists the average premium costs per acre by each commodity.

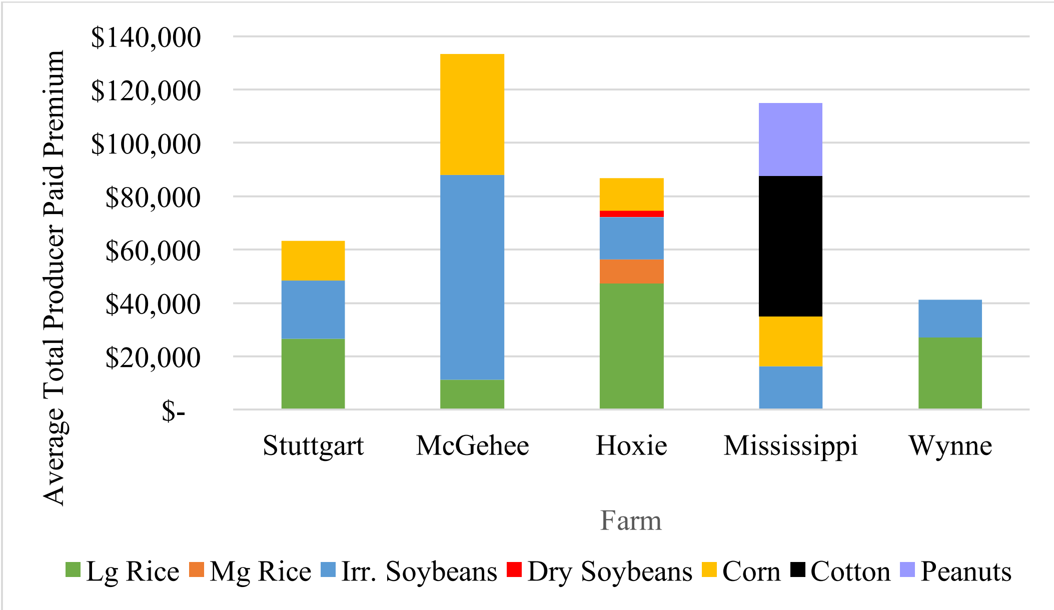


Figure 22: Average Total Producer Premium Costs at 75% RP-HPE Coverage

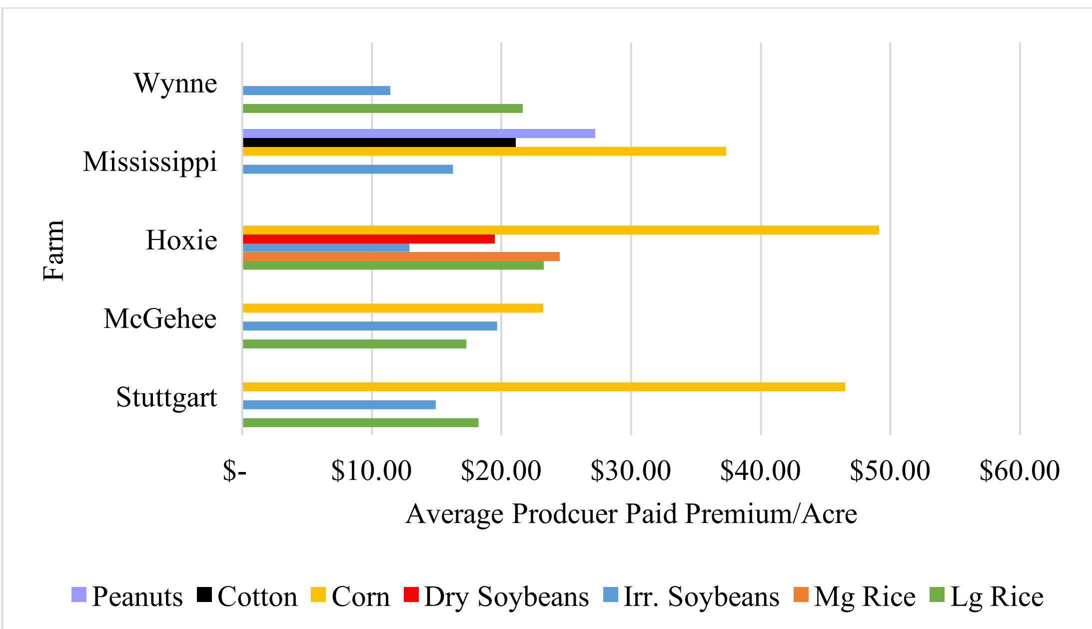


Figure 23: Average Producer Premium Costs per Acre at 75% RP-HPE Coverage

Comparing figure 22 and with figure 20 shows that none of the farms have total indemnity payments that are larger than the premiums costs associated with the 75 percent RP-HPE plan. The Mississippi County farm is worst off in relative terms, and average indemnity payments only cover 3 percent of total premium costs. Only 8.6 percent of premium costs are covered by the

McGehee farm’s indemnity payments and the Stuttgart, Wynne and Hoxie farms indemnity payments cover 31.7, 34.3 and 37.6 percent of premium costs, respectively. The loss ratios generated by these indemnity and premium levels are not consistent with what has been seen by Arkansas producers in the previous farm years (table 5). To generate more accurate loss ratios, indemnity payments must increase (meaning yield or prices must be lower) or premium rates need to be reduced.

Comparing figure 20 with figure 18 shows that non-irrigated soybeans on the Hoxie farm have average indemnities per acre that are larger than their associated premium cost. Non-irrigated soybeans earn an average indemnity of over \$27 per acre, and they only cost the producer \$19.44 per acre. This means that for every acre of soybeans grown, a producer benefits \$8.31 on average. No other policies garner any net benefit at 75 percent coverage. Medium grain rice generates substantial indemnity payments of \$17.60, but premium payments on medium grain rice are over \$24.

Since dry soybeans generate positive benefit at 75 percent coverage, it is considered a viable crop to insure. To further analyze the potential for payments to dry soybeans, indemnity payments and premium rates, as well as net benefit are presented at all coverage rates between 50 and 85 percent. Figure 24 shows average net benefit for dry soybeans at all coverage levels.

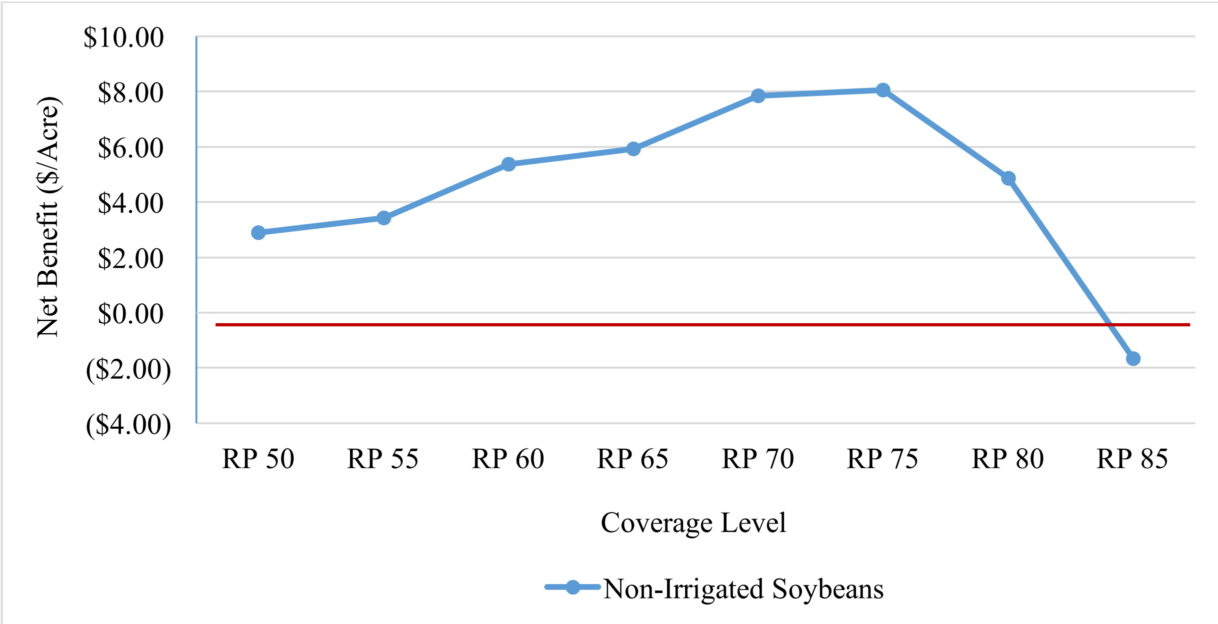


Figure 24: Average Dry Soybean Insurance Benefit by RP-HPE Coverage Levels

An important consideration when examining the crop insurance program is the probability of a policy generating positive benefits. Even if average benefits are negative, large upside potential and a fair percentage of positive benefits can make a policy worth purchasing. Figures 25-28 show the probability that each commodity will generate positive net benefits on each farm.

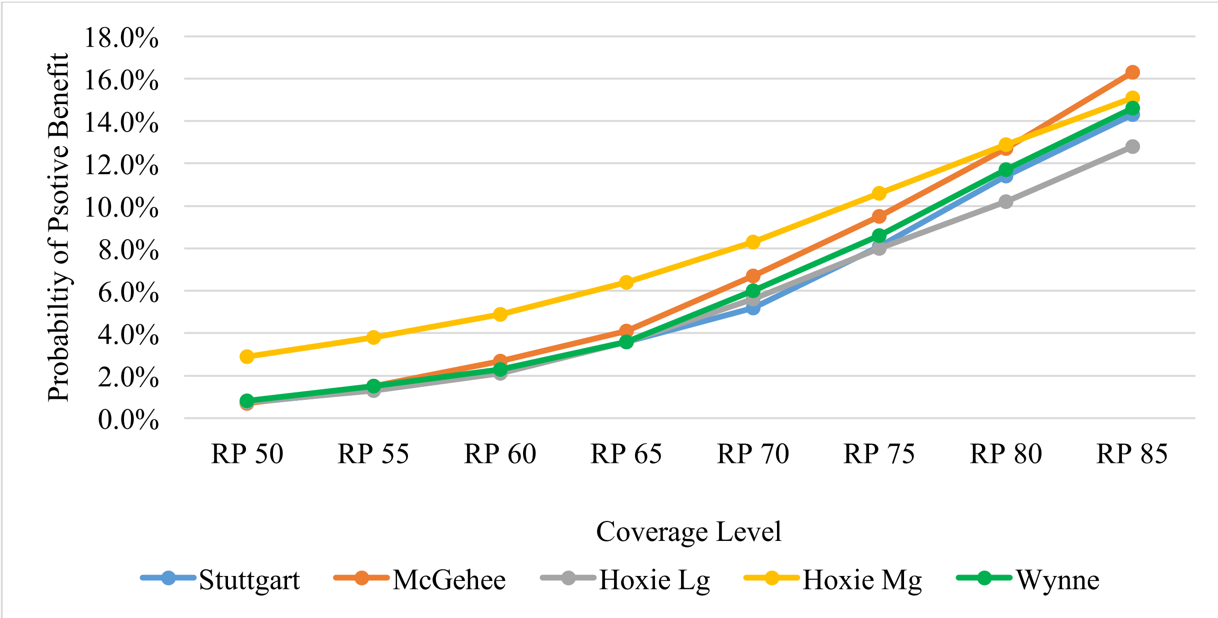


Figure 25: Probability of Positive Rice Benefits by Farm

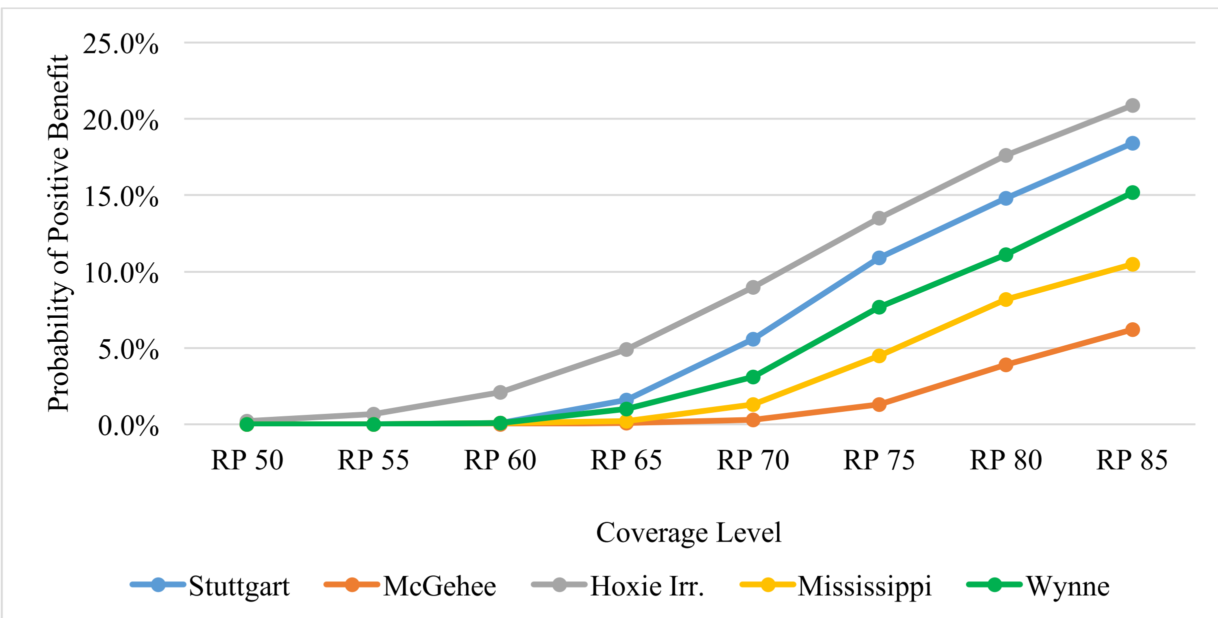


Figure 26: Probability of Positive Irrigated Soybean Benefits by Farm

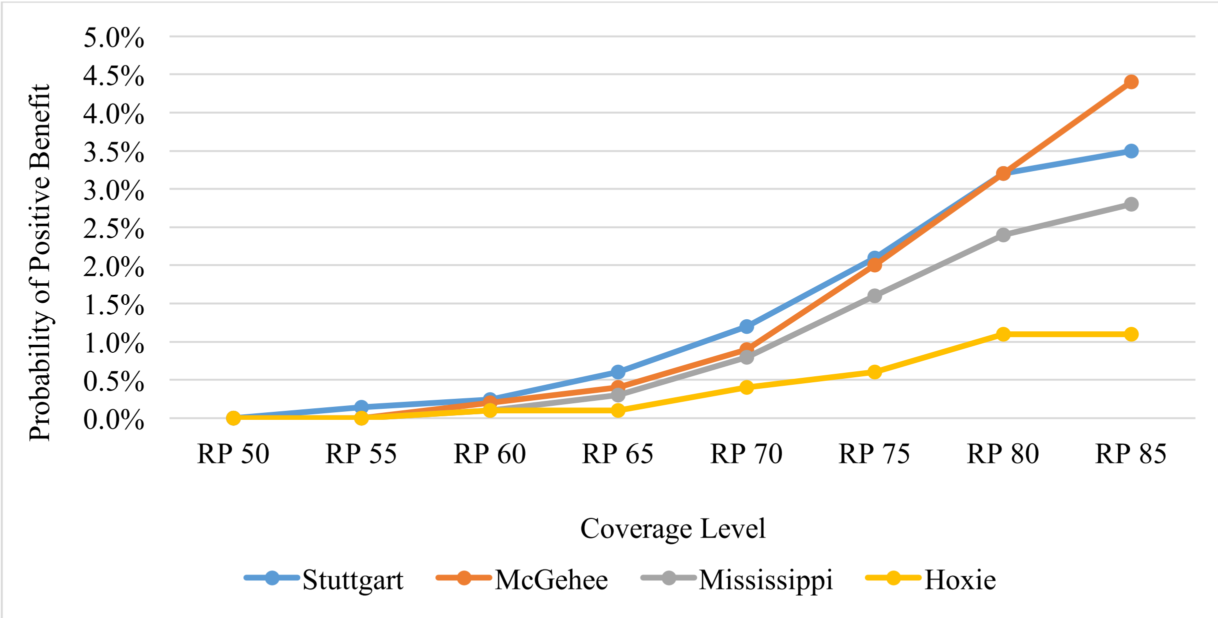


Figure 27: Probability of Positive Corn Benefits by Farm

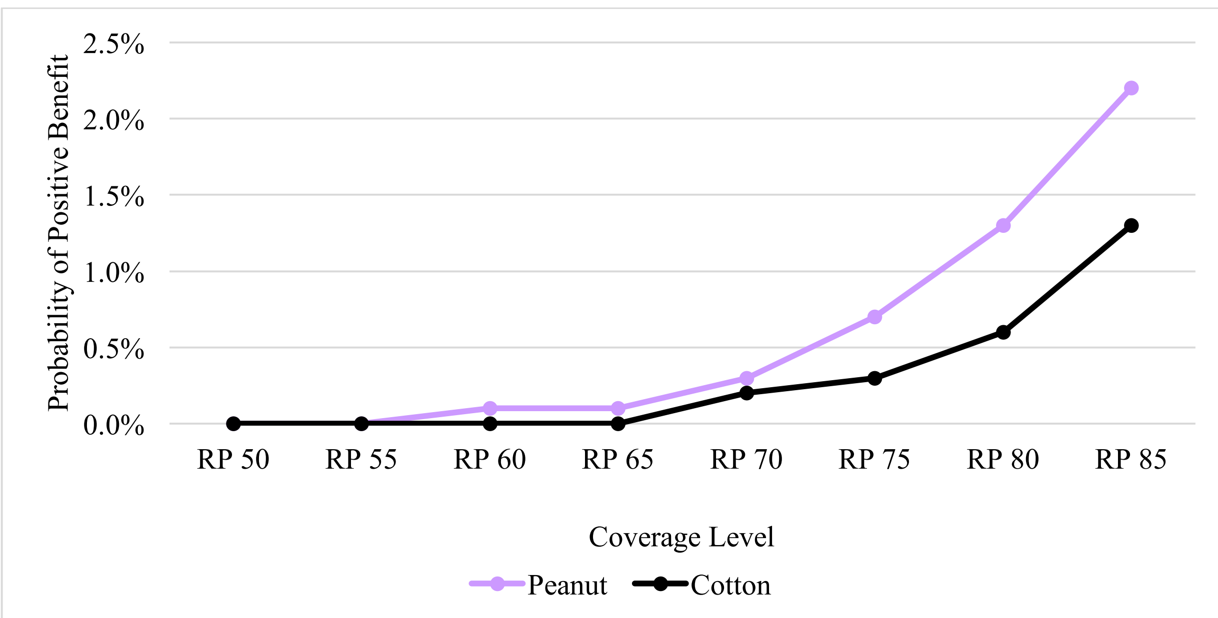


Figure 28: Probability of Positive Cotton and Peanut Benefits on Mississippi County

The probability of having positive rice benefits is fairly consistent among all four of the farms that produce it. Only 1 percent of insurance benefits are positive at 50 percent RP-HPE coverage levels. This percentage increases steadily and at 85 percent coverage between 12 and 16 percent of benefits are positive at 85 percent coverage. The historically most purchased coverage level of

75 percent has between 8 and 10 percent probability of positive benefits. Medium grain rice shows greater likelihood of positive payments at lower coverage levels, but is similar to long grain rice by 80 percent coverage.

Irrigated soybeans perform worse than rice at most coverage levels. On all of the farms except Hoxie, soybeans do not ever generate a positive benefit until 65 percent coverage. At the highest possible coverage level, McGehee has the lowest odds of generating benefits at only 6.2 percent. The Hoxie farm generates benefits nearly 21 percent of the time followed by Stuttgart and Wynne that produce payments 18.4 and 15.2 percent of the time, respectively. At 75 percent coverage levels, The Hoxie and Stuttgart farms produce benefits over 10 percent of the time, and the Mississippi County and McGehee farms produce at less than 5 percent.

Corn performs worse than irrigated soybeans and rice consistently across all the farms that grow it. At 85 percent coverage, not a single farm has greater than a 5 percent chance of generating positive insurance benefits. At 75 percent coverage, no benefits are greater than 2 percent. Cotton and peanuts on the Mississippi County farm show a similar situation. At 85 percent coverage, just over 2 percent of the payments generate by peanuts are positive, and just over 1 percent of cotton payments are positive.

In contrast to the other commodities, dry soybeans generate a substantial percentage of positive benefit at all coverage levels under both YP and RP-HPE policies. Figure 29 compares YP and RP-HPE policies for non-irrigated soybeans.

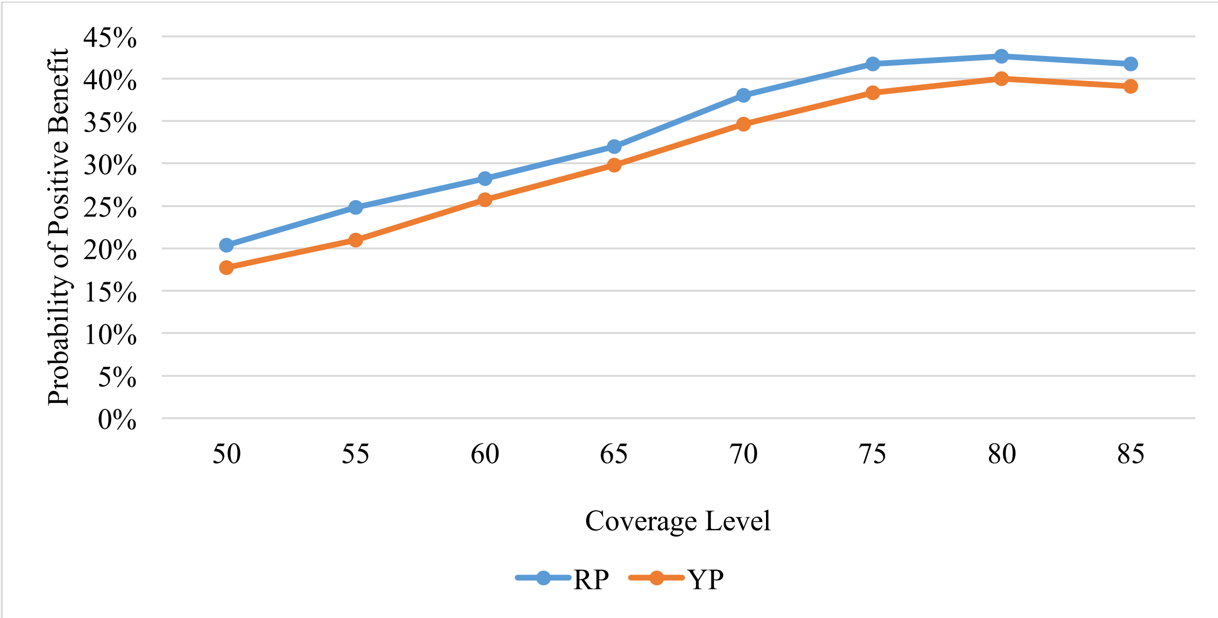


Figure 29: Dry Soybeans: Probability of Having Positive Benefits from a revenue Protection (RP) and Yield protection (YP) Policy

At every coverage level RP-HPE plans have slightly more positive benefits. The percentage of positive benefits increase steadily as insurance coverage rises, but after 80 percent coverage, the percentage of positive benefits begins to decline as premium rate increases outpace increases in indemnity payments.

Summary

These results highlight the importance of the PLC and ARC commodity programs to farmers in Arkansas who have commodity yields close to the county average. Every farm experienced commodity program payments in excess of $150,000 on average, and two farms went from average net losses over the period without commodity payments to average net incomes with payments. Reductions in CV values across all five farms also show the importance of commodity programs in reducing income risk on the farm.

Unlike the commodity programs, the results here show that for producers in Arkansas, both YP and RP insurance plans on almost all commodities offer little to no protection when yields are close to the county average. Only non-irrigated soybeans had positive payments on average under any policy, and many of the other commodities experienced large losses under all types of crop insurance policies. Rice farmers on all five farms had probabilities of generating positive benefits ranging from 13 to 17 percent at higher levels of RP-HPE protection, and soybean crops on all of the farms except McGehee had probabilities of generating positive benefits higher than 10 percent at RP-HPE 85. Using net cash income and cash receipts to measure risk, the only farm that has the possibility to improve net income and overall financial health on average under the crop insurance program is the Hoxie farm.

Low Yield Scenario

As expected, crop insurance generates substantially larger payments under the low-yield scenario relative to the "average/normal" yield scenario. RP-HPE policies generate higher net benefits overall, but many commodities generate positive average net benefits under both policies at high coverage levels. Under YP protection, corn does not generate positive average net benefits on any of the farms analyzed. Irrigated soybeans on the McGehee farm and the Mississippi County farm also fail to generate positive average net benefits even at 85 percent coverage. Every other commodity has positive average net benefits, but only at the highest coverage levels. Most of the lower coverage levels yield average losses (negative net benefits). The exception is dry soybeans on the Hoxie farm that generates positive average net benefits at all YP coverage levels, similar to the normal yield scenario.

RP-HPE policies generate larger net benefits on average for almost every commodity. All commodities generate positive average net benefits at most coverage levels between 50 and 85 except for corn, which generates losses on average on any farm at any coverage level. Figures 30-34 show the net benefit per acre received by each commodity at all coverage levels.

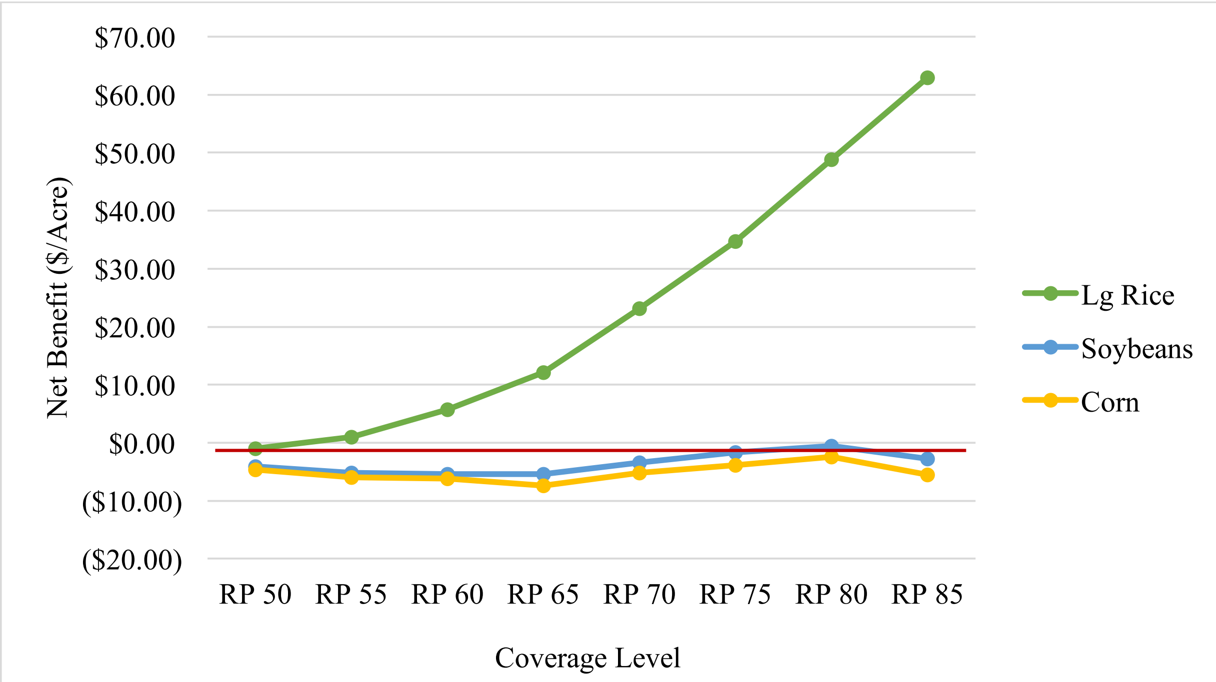


Figure 30: McGehee Net Benefit/Acre under All RP-HPE Coverage Levels Low Yield Scenario

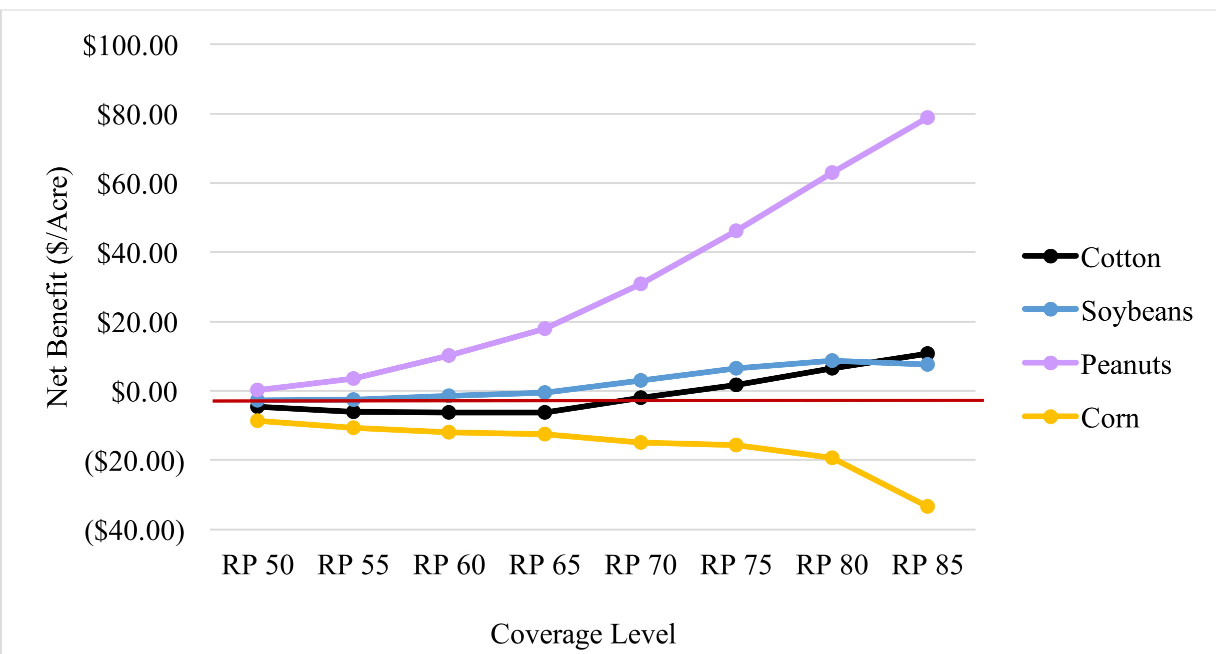


Figure 31: Mississippi County Net Benefit/Acre under All RP-HPE Coverage Levels Low Yield Scenario

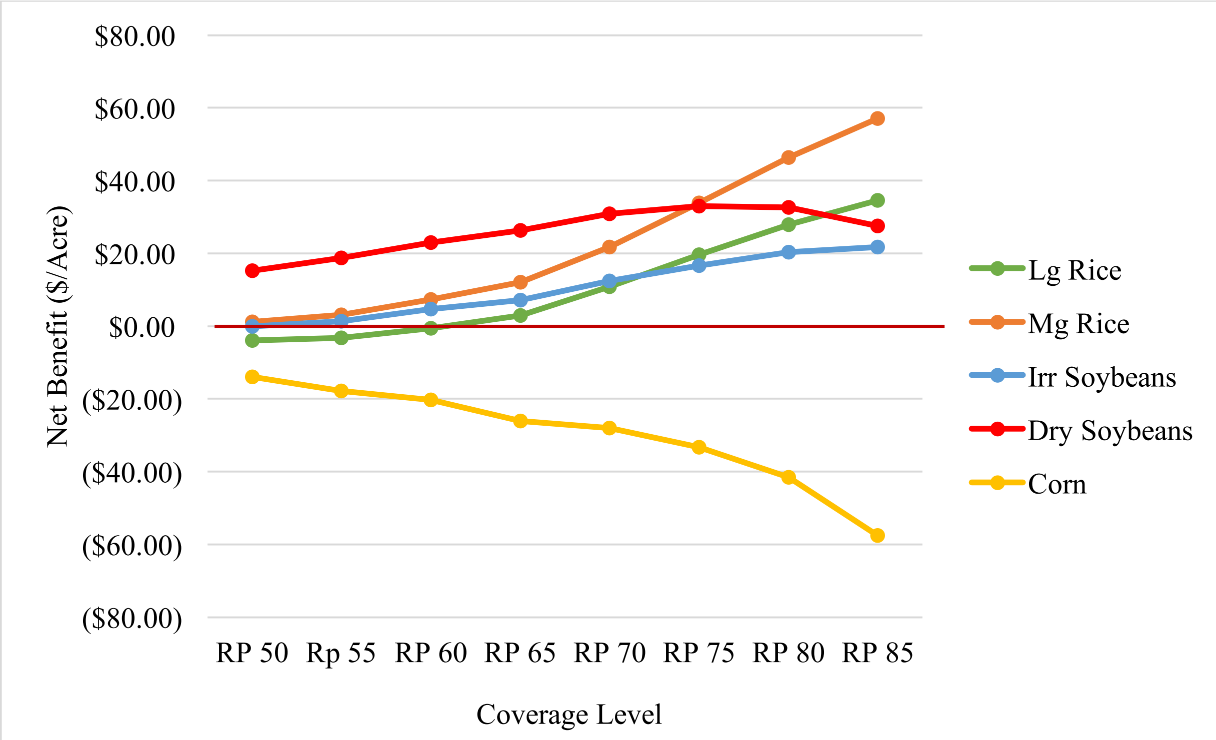


Figure 32: Hoxie Net Benefit/Acre under All RP-HPE Coverage Levels Low Yield Scenario

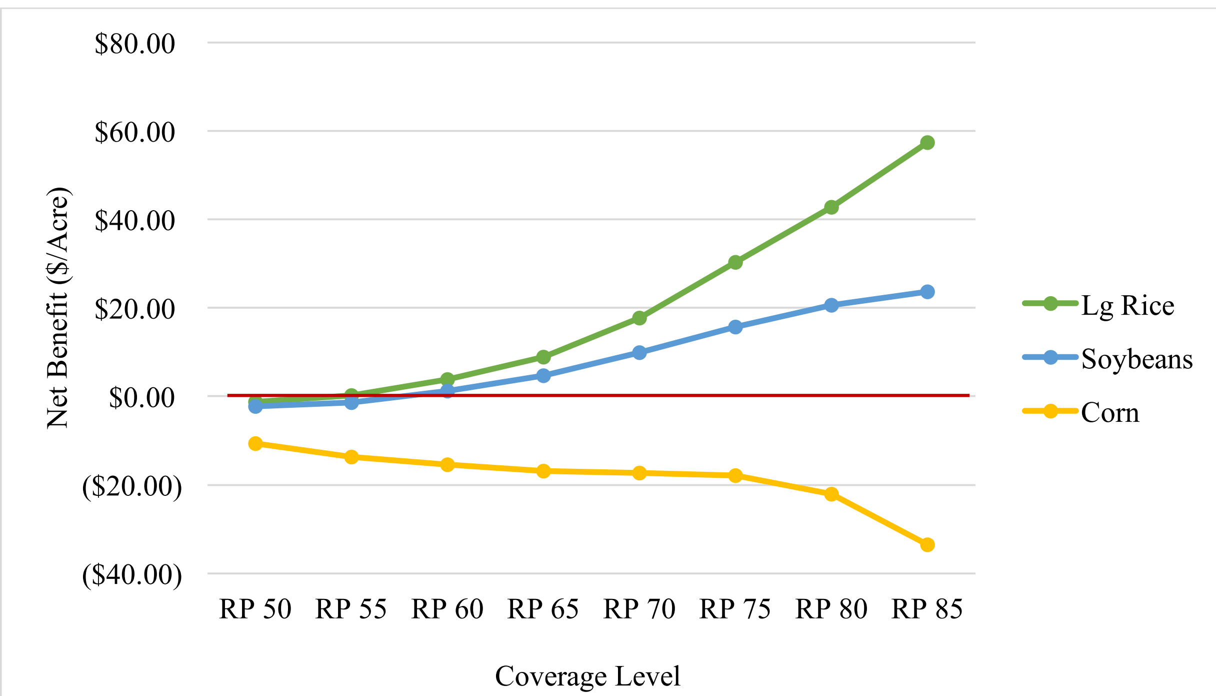


Figure 33: Stuttgart Net Benefit/Acre under All RP-HPE Coverage Levels Low Yield Scenario

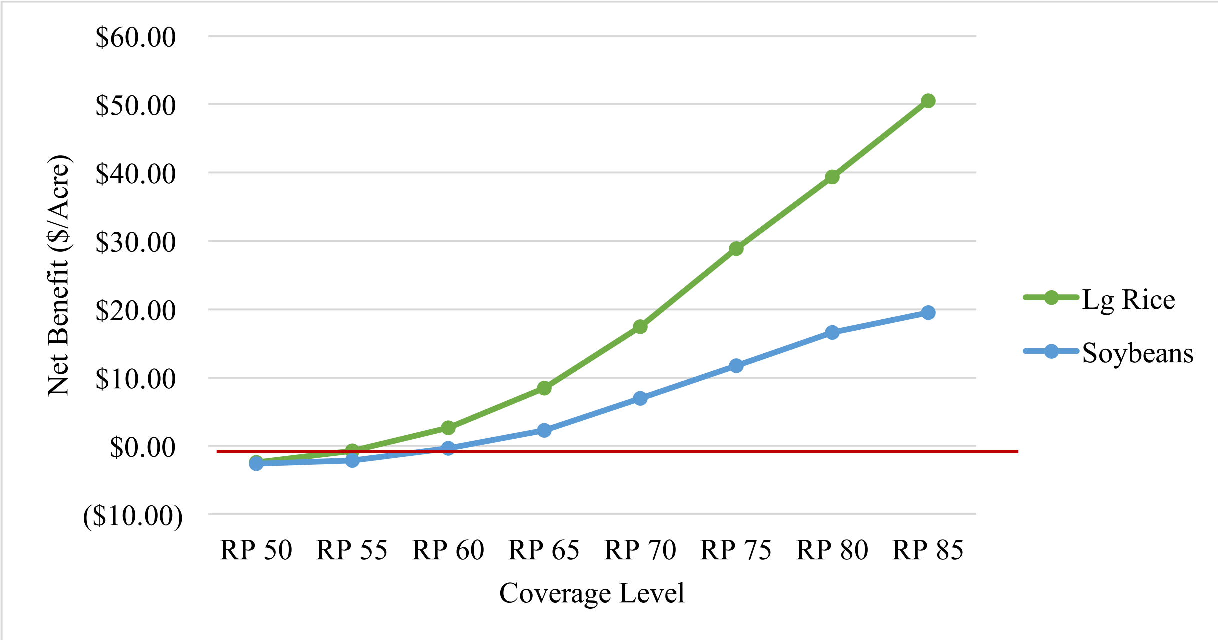


Figure 34: Wynne Net Benefit/Acre under All RP-HPE Coverage Levels Low Yield Scenario

As coverage levels increase, the average net benefit increases for most of the commodities. Non-irrigated soybeans on the Hoxie farm increase until RP-HPE 75, then begin to decrease, as was seen when normal yields were used. Soybeans on the Mississippi County farm had the largest average net benefits at 80 percent coverage. Average corn net benefits were never positive on any farm under RP-HPE plans, and therefore they were not enrolled in any policy. Cotton on the Mississippi County farm was the only commodity that performed better under YP policies. Under RP-HPE 85, net benefits averaged $10.62/acre, but under YP 85, net benefits were $22.46/acre on average. To quantify the effects of crop insurance purchasing decisions on financial health, each commodity was enrolled in the program that generated the largest average net benefits. Table 16 shows each farm's financial health, as measured by the total cash receipts and net cash farm income when each commodity is covered by the most beneficial crop insurance policy and each crops is enrolled in the payment maximizing commodity program.

Table 16: All Farms Low-Yield Scenario Cash Receipt and Net Cash Farm Income with Insurance and Commodity Program Payments

	2019	2020	2021	2022	2023	Average
McGehee						
Commodity Program Payments ($)	267,180	258,582	254,426	251,043	249,983	256,193
Net Insurance Benefit ($)	39,240	41,112	42,161	42,506	39,602	40,924
Total Cash Receipts ($)	3,384,999	3,505,210	3,589,083	3,618,543	3,649,363	3,549,440
Net Cash Farm Income ($)	-870,733	-973,222	-1,070,547	-1,172,189	-1,281,418	-1,073,622
Mississippi County						
Commodity Program Payments ($)	196,488	190,766	184,608	185,020	187,835	188,943
Net Insurance Benefit ($)	131,119	144,150	146,175	160,541	138,103	144,018
Total Cash Receipts ($)	4,097,724	4,165,594	4,228,481	4,280,452	4,286,102	4,211,671
Net Cash Farm Income ($)	1,209,164	1,176,342	1,164,020	1,142,943	1,075,795	1,153,653
Hoxie						
Commodity Program Payments ($)	297,409	295,768	299,240	291,334	289,960	294,844
Net Insurance Benefit ($)	106,295	118,429	129,823	134,917	124,360	122,765
Total Cash Receipts ($)	2,079,451	2,117,470	2,139,533	2,161,950	2,152,917	2,130,264
Net Cash Farm Income ($)	-570,854	-683,238	-771,732	-840,737	-927,415	-758,795
Stuttgart						
Commodity Program Payments ($)	214,550	210,930	208,505	201,608	199,237	206,951
Net Insurance Benefit ($)	107,693	114,453	112,581	125,068	120,976	116,154
Total Cash Receipts ($)	1,983,711	2,022,951	2,049,920	2,070,667	2,073,007	2,040,051
Net Cash Farm Income ($)	-204,982	-286,321	-348,109	-402,002	-475,127	-343,308
Wynne						
Commodity Program Payments ($)	168,205	173,493	170,729	169,077	164,408	168,153
Net Insurance Benefit ($)	78,926	80,789	89,115	97,265	92,788	87,777
Total Cash Receipts ($)	1,429,047	1,458,349	1,485,469	1,504,247	1,513,796	1,478,182
Net Cash Farm Income ($)	-104,376	-165,600	-206,410	-225,286	-268,353	-194,005

When the low-yield scenario is run, each of the farms suffer large income losses due to the decreased crop sales revenues. Only the Mississippi County farm has a positive net income when yields are low and the insurance plan with the largest net benefit is purchased. The other four farms have large net losses, even reaching over $1 million on average on the McGehee farm.

Chapter 5: Conclusions

The importance of agriculture to the state of Arkansas cannot be overstated. Agriculture is Arkansas's largest industry and contributes around 17 percent of the state value-added and employs one out of every six working Arkansans (University of Arkansas, 2017). Agricultural policy at a federal level is critical in keeping farming economically viable in the wake of low commodity prices. Therefore, thorough and continuous studies of new and developing policies is imperative to keep agriculture thriving in Arkansas. This study evaluates the impact of commodity and crop insurance programs, two key components of the agricultural safety net, on the economic viability of Arkansas farms using five representative farm models for the state.

The results support the position that commodity programs under the 2018 farm bill will be of great importance to Arkansas producers. Each of the representative farms is expected to receive commodity program payments each year that will help improve the probability of making a profit and reducing income risks. Without commodity payments, four of the five farms have average net income losses in the 2019-2023 period, and two remain in the red even when commodity payments are considered.

As expected, on average crop insurance offers little potential for economic benefits as historical yields and projected prices remain close to the mean distribution values. Yield protection, catastrophic coverage, and revenue protection plans all three failed to provide positive economic benefits on average for every commodity on every farm in this analysis except non-irrigated soybeans under the normal yield scenario. Under every coverage level, indemnity payments received by a farm were lower than the producer premium costs. The majority of commodities failed to receive any indemnity payments at all under all but the largest YP plans. RP-HPE plans generated indemnity payments at almost every coverage level, but even at the highest level, a fairly small percentage of payments were larger than what premium costs were.

Non-irrigated soybeans produced positive insurance benefits on average under both YP and RP insurance policies under the average yield scenario. A big reason for dry soybean's relatively good performance is the fact that its normal yield distribution goes as low as 0 bushels per acre. Including a zero yield scenario allows for an analysis of how crop insurance policies function in a worst case scenario. The other commodities analyzed had normal yield distributions that did not drop to zero. If the normal yield distributions of the other commodities were larger, a similar YP and RP payment scenario to non-irrigated soybeans could potentially occur.

The estimation of the yield distribution functions is one of the biggest issues in the majority of crop insurance studies. Most of the current literature on crop insurance use beta distributions with varied shape parameters to set stochastic yields. In this study I assume that all of the commodities have a normally distributed yield. This specification may cause average yields to be larger than they would under a beta distribution, which could account for the lack of positive insurance benefits for many commodities. A study by Just and Weninger (1998) on yield distribution influence on crop insurance found that different specifications of distributions can have large impacts on crop insurance effects. Based on their results, they assert that it is not unreasonable to use normal distributions when studying crop insurance and the results produced by these studies may be useful in evaluating the crop insurance program more fully. A good avenue for future research would be to specify beta distributions for the commodities on these five farms and compare the insurance results with those of normal distributions.

The results presented in this study lead to the conclusion that when using county averages to determine yield, premium rates are excessively high. Even when mean yields are reduced by 25 percent, premium rates are still too high to generate positive net benefit at most YP coverage levels and low RP-HPE coverage levels. The premium rates used in this study are taken directly from USDA RMA using actual farm-specific data, so it reflects what a producer would pay in reality. Instead of using premium rates supplied by RMA, a number of crop insurance studies in the past have determined premium rates by forcing the loss ratio to equal 1, since actuarial soundness is statutorily mandated by crop insurance legislation. The loss ratio is total indemnity payments divided by total premiums—both the producer paid portion and the government subsidized portion. If the yield distributions are not large enough to generate sufficient indemnity payments, the 1.0 loss ratio requirement would force premium rates to be much lower than is seen in reality. This requirement almost certainly generates positive insurance benefit since government subsidies are included as part of the total premium when calculating loss ratio. This situation is useful when comparing insurance products against one another, but can potentially overstate the importance and value of the crop insurance program for many producers.

The 20-year nationwide average loss ratio is 0.85, but since 2015, the loss ratio has been 0.6 or under. The loss ratios generated by the normal yield scenario of this study are well under the national 20-year average. At 75 percent RP coverage, long grain rice has an average loss ratio of only 0.12 on the Hoxie farm, and a high of 0.29 on the Wynne farm. Corn loss ratios never climb higher than 0.05 and irrigated soybean loss ratios range between 0.1 and 0.2. Even non-irrigated soybeans that generate positive net benefit under nearly every coverage level only have a loss ratio of 0.64 under RP 75 protection.

The loss ratio results generated by the low yield scenario tell a much different story than those found when using normal yields. The net-benefit-maximizing crop insurance policies for almost every commodity generate loss ratios that greater than 1. Cotton and soybeans on the Mississippi

County farm are the only commodities with ratios under 1 at 0.94 and 0.71, respectively. These loss ratios are much closer to recent years' observed Arkansas ratios as seen in table 5.

Total government safety net payments are substantial on all of the farms and risk is reduced through enrolling in many of these programs, but overall the safety net still falls short for many producers. In the normal yield scenario, two of the farms still have an average net loss when enrolled in commodity programs and when purchasing crop insurance policies of any level. Furthermore, three of the five farms have average commodity program payments that exceeded the payment limit. To improve economic standing further, the majority of the representative farms would need to restructure in some way or change planting or other management decisions in the coming years.

The low yield scenario shows that the crop insurance program generates fairly large payments on the five representative farms. However, yield or revenue has to drop low enough to generate these payments, and in our scenario the loss of income due to yield reductions vastly outweighs the benefits gained from crop insurance indemnity payments. With no insurance and normal yields, three of the five farms had positive net income on average. When yields were reduced and insurance benefits were positive, only one of the five farms maintained a positive income.

A large part of the negative net income could be the structure of the underlying representative farm models. On all farms except the Mississippi County farm, total cash receipts per acre and total cash expenses per acre are very similar in 2019, but costs increase at a much faster pace than revenues. By 2023, the Mississippi County farm is the only one that has cash receipts larger than cash expenses. A logical producer would change planting decisions, refinance debt, alter input decisions or any number of other strategies to stop costs from increasing so quickly or increase revenue to levels that can offset some of these costs. Our model can accurately show the level of government support a producer may receive, but may fall short in projecting actual revenue and income situations one would expect to see on a standard operation.

Aside from specifying different yield distributions or updating some structural pieces of the model, future studies using these representative farm models could update the price forecasting method used to determine crop insurance prices. The way it is designed now, only one future price exists for the crop insurance program, so standard RP policies cannot be analyzed, only RP-HPE policies. RP policies are by far the most purchased crop insurance policy, so incorporating them into the model would allow for useful analysis. The RP-HPE program is very similar and results would most likely on differ slightly, but differentiating between the two could be useful for decision-making purposes.

The farm safety net has been studied extensively for many years, but few have analyzed its impact on Arkansas farms specifically. Commodity programs and federal crop insurance policies are continually evolving and expanding, and producers in the state and across the nation need to be aware of the most up-to-date programs. From this research, it is clear that government programs play a huge role in supplementing farm incomes and keeping farming as a viable livelihood for millions of people across the country.

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