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**Stochastic Analysis of County and Multi County Yields for Agriculture Risk Coverage  
(ARC) payments for Arkansas Row Crop Producers**

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Abstract:

The Agricultural Risk Coverage (ARC-CO) program authorized by the 2014 Farm Bill provides revenue loss coverage at the county level. The ARC-CO payments are based on actual county crop revenue for a particular commodity. The county revenue is a function of county yield and national price. Since the inception of the ARC-CO program, there has been a wide disparity in crop revenue payment between two or more counties with a similar production environment. The variation in county yield has resulted in quite wide disparity of payments for Arkansas producers based on the location of their farm. This study compared ARC-CO program for corn and soybean and their respective average county yields and average multi county yields for selected eastern Arkansas counties. The study used simulation to evaluate stochastic ARC-CO payments generated by multicounty yield for 2014, 2015, and 2016 for four major corn and soybeans producing regions of Grand Prairie, White River, Upper Delta and Lower Delta regions in Arkansas. Multivariate empirical distributions of multi county yields, and prices were simulated. The likelihood of receiving ARC-CO payment under multicounty yield was more than 60, 27, and 29 percent for Corn, Irrigated Soybean and Non Irrigated Soybean based on our simulated results. The multicounty yield had an ARC-CO payment for all regions. However, individual county payment were less for corn in Grand Prairie and other regions. ARC-CO payment for irrigated soybeans and non-irrigated soybean fluctuated from year to year with highest payment at individual county level for 2014.

JEL Code(s) Q11, Q13, Q14, Q18.

## **Introduction**

The 2014 Farm Bill authorized two safety net programs; Agriculture Risk Coverage (ARC) & Price Loss Coverage (PLC). These two programs are delivered by the Farm Service Agency (FSA) of the United State Department of Agriculture (USDA) and have replaced pervious farm programs (USDA, 2014). The Agriculture Risk Coverage (ARC) has two options Agriculture Loss Coverage-County Coverage (ARC-CO) and Agriculture Loss Coverage-Individual Coverage (ARC-IC) and are based on county and individual yields respectively. The Price Loss Coverage (PLC) program has an option to purchase additional coverage with crop insurance through the federal crop insurance program called the Supplemental Coverage Option (SCO). Producers have to choose either PLC or ARC program and remain enrolled in the chosen program for the entire life of the 2014 Farm Bill (2014-2018) (USDA, 2014). The earlier programs prior to 2014 Farm bill had direct payments for past two decade and were based crop base acres and had a guaranteed payment irrespective of crop yield and prices (Theisse, 2017). However, the ARC-CO and PLC payment are different from the earlier programs. There is a PLC payment for a producer for a particular commodity when the effective price (which equals higher of market year average price (MYA) or the national average loan rate) is less than the respective reference price of that commodity (USDA, 2014). In case of ARC-CO payment a producer is expected to receive payment when actual county crop revenue for a particular commodity is less than the ARC-CO guarantee for that commodity (USDA, 2014).

The national concern with the 2014 Farm Bill is the difference in ARC-CO payment for adjacent countries in 2014 crop year was due to insufficient information on county yields outside the core production area provided by the USDA's National Agricultural Statistical Service (NASS) (Mercier, 2016). In Arkansas, majority of row crop producers are enrolled in either one

or other farm program. To be specific, majority of rice producer are enrolled in PLC whereas, corn and soybean producers are enrolled in ARC-CO program. The concern for row crop producers in Arkansas like any other producer in United States is the wide difference in ARC-CO payments across counties. The above-mentioned concerns of corn and soybean producers are highlighted by policymaker and politicians and are going to be address by a bill that would reform ARC-CO payments under the leadership of Senators Heidi Heitkamp and Joni Ernst. The proposed bill will have priority to use data from the Risk Management Agency (RMA) to calculate county yield. Second, ARC-Co payment calculation will be based on physical location of the farm and not the administrative unit (county). Third, the bill will reduce the wide variation in yield by adjusting yield between and along counties lines at the discretion of FSA state committee before they are finalized or published (Ernst, 2017).

However, there is another way to address the wide disparity in ARC-CO payments if we aggregate corn and soybean producing counties into a region and use a regional average yield instead of county yield to have an equitable ARC-CO payment across counties. In Arkansas major corn and soybean, producing counties can be grouped as follows. The Grand Prairie (Arkansas, Prairie, Lonoke) White River (Craighead, Clay, Jackson, Greene, Poinsett, Cross, Randolph, Woodruff, Lawrence, Independence, White), Upper Delta (Mississippi, Crittenden, Lee, Phillips, St. Francis, Monroe) and Lower Delta (Ashley, Drew, Lincoln, Jefferson, Desha and Chicot) regions these regions have similar soil, climate and crop management practices.

### **Literature Review**

The rational for use of multi county yield is that demarcation of county is for administrative purposes whereas yields can be similar or different between and across counties.

In this section of the paper a brief review of previous research on application of yield data for actuarial purpose in estimating crop insurance premium and government farm payments is presented. Crop insurance premium and farm program payments are based on county crop combinations that provide empirical assessment of yield distribution (Gerlt et al., 2014). Many economic studies have used county level yield data to represent farm level outcomes (Zulauf et al., 2008). But, Miranda (1991) studied disaggregated farm level yield variability concluding that regional yield deviations from regional mean was reflected in any particular farm's yield deviation from its own mean. However, Barnett et al. (2005) using farm level yield data on multiple sugar and corn farms concluded that regional and individual insurance program was unable to estimate beta as specified by Miranda. However, Goodwin (2009) determined the extra variability at farm level by shocking state yields. The most interesting study was presented by Deng et al., (2007) using selected RMA and NASS county data that estimated kernel function for farm level yield to find that regional level insurance was preferred over individual when premium were low. Some of the above-mentioned studies have used regional yields to determine insurance payment and other have used county yields to determine farm level yields. However, in absence of good reliable data from NASS for some counties. An argument can be made in favor for use of multicounty yield based on the soil type, climate and crop management practices. The multicounty yields can aggregate yield in a particular geographic area. These yields can be used to represent a geographic area instead of county yield, which may or may not represent the actual yield. The national price for corn and soybean and other commodities remain same irrespective of state or county. The only value in ARC-Revenue calculation is the yield that can be re-estimated using multicounty yield. Therefore, use of multicounty yield would be another way to calculate ARC-CO payments. Which are expected to provide more equitable

payments when compared to county yields. The present study differs from the other previous studies in that we do not focus on a multi-year framework. We simulate 500 iterations of corn and soybean regional yield for five regions in Arkansas for expected ARC-CO revenue. We evaluate the likelihood of receiving an ARC- CO payment across 500 simulated outcomes. We look at the role of MYA prices and regional yields contributing to ARC-CO payments. The objective of the paper is to address the disparity in ARC-CO payment by moving from county yield to average multicounty yield or regional yield.

### **Data and Methodology**

Arkansas counties in statistical district 30, 60, and 90 are grouped into Grand Prairie, White River, Upper Delta, and Lower Delta regions. The multicounty or regional classification is based on soil type, weather, planting season (early or late planting), and total area of a particular county under row crop production (J. Hardke, Personal Communication, October 15, 2017). County yields and National Market Year Average (MYA) crop prices are obtained from USDAs' National Agricultural Statistics Service and ARC-CO payments are based FSA. The procedure to estimate or calculate ARC-CO payments for corn and soybean is based on guidelines set forth by the USDA's Farm Service Agency available online. ARC-CO payment for 2014 are calculated using following steps

1. 2014 Benchmark Revenue = 2014 Benchmark Yield (Olympic Average 2009-2013) \* 2014 Benchmark Price (Olympic Average 2009-2013)
2. 2014 Guarantee Revenue = 86 % of 2014 Benchmark Revenue
3. 2014 Maximum Payment Rate = 10% of 2014 Guarantee Revenue
4. 2014 Actual Revenue = 2014 Actual Yield \* 2014 National Price
5. 2014 Payment Formula Rate = 2014 Guarantee Revenue – 2014 Actual Revenue

6. 2014 Payment Rate = Lesser of 2014 Maximum Payment Rate or 2014 Payment Formula Rate (payment is capped at 10 % of Benchmark). Similar procedure is used to estimate ARC-CO payments for 2015 and 2016.

## **Results and Discussion**

There is wide discrepancy in ARC-CO payments for corn and soybean producers in Arkansas as presented in Table 1. In order to address the difference in ARC-CO payments across counties we use of multicounty yield or regional yield and expect an equity in ARC-CO payment for counties within the same region as stated above.

The results of simulated multicounty ARC-CO payments are divided into three sections; corn, irrigated soybean and non-irrigated soybean.

### ***Corn:***

In Arkansas, majority of corn production is irrigated; therefore, our results are for irrigated corn.

In the Grand Prairie region, corn ARC-CO payment from 2014 to 2016 would be reduced by \$21.00 for Arkansas county with the simulated multicounty yield. The multicounty simulated ARC-CO payment for Grand Prairie in 2014 is \$70.19 with 2016 payment reduced to \$67.33.

The simulated ARC payment for Corn in Grand Prairie region for 2014 increases from \$70.19 to \$75.62 in 2015 with increase in probability of payment from 70.19 percent in 2014 to 75.62 in 2015. However, the ARC-CO payment decreases in 2016 and so does the probability of payment when compared with 2014 and 2015 payments. In White River region simulated multicounty payment increases from \$59.50 in 2014 to \$61.77 in 2016 (Table 2). . In Upper Delta and Lower Delta, regions would have a lower ARC-CO payment with the use of multicounty yield for 2015 and 2016 as presented in (Table 3). These two regions would expect ARC-CO payment for all counties in 2014 with ARC-CO payment of \$63.87 in Upper Delta region and \$68.04 in Lower



Delta. However, majority of counties in White River region will have decrease in ARC-CO payments due to the use of multicounty yields in ARC-CO payment estimation. While, White, Independence and Randolph counties have a positive ARC-CO payment (Table 3). It is important to note that the above-mentioned counties have one of the lowest corn yield in that region. In other words, there would be a small payment for a county with lower yield at the expense of county that has higher yield and lower payment.

### ***Irrigated Soybean***

Soybean is the largest cultivated row crop in Arkansas with majority of soybean production system irrigated. In 2014, Grand Prairie region will have payment for \$32.21. There is no payment for Arkansas, Prairie and Lonoke counties in Grand Prairie region when county yield is used for ARC-CO payment estimation. In White River region there is ARC-CO payment for irrigated soybeans in 2014 and 2015. A regional payment of minimum of \$28.78 and maximum of \$33.92 is expected for 2014 and 2015. However, In 2016 ARC-CO payment will be reduce for Craighead and Clay counties by \$10.28 and \$19.07 respectively. We do expected reduced ARC-CO payment due to multicounty yield for Randolph, Woodruff and Lawrence and White counties. The simulated regional yield has a higher probability of ARC-CO payment for all regions from 2014 to 2016. To add further the Irrigated soybeans have an increase in ARC-CO payment when compared to corn and non-irrigated soybeans.

### ***Non Irrigated Soybeans***

The ARC-CO payments for non-irrigated soybeans are only available two regions; White River and Upper Delta regions. There is an increase in ARC-CO payment from \$16.12 to \$19.69 for White River region from 2014 to 2016. However, ARC-CO payments will decrease from \$26.35

to \$25.68 for Upper Delta during the same time. In 2015, both White River and Upper Delta have decrease in ARC-CO payments. Non Irrigated Soybean have the highest ARC-CO payment of when compared to corn and soybean. There is a decrease in ARC-CO payment for 2015, which is the highest of all. The multi county yield may have more impact on ARC-CO payment for non-irrigated soybean when compared to other crops.

## **Conclusion**

The 2014 Farm Bill, instituted ARC-CO program as one of the two program to replaced previous farm payment programs and protect farmer against unexpected decreases in yield and prices. The resulting outcome was unexpected variation in ARC-CO payment based on county yield. Based on our simulated results, ARC-CO payment provides an equitable payments for Corn and Soybean for all 3 years. When multicounty yields or regional yields are used instead of county yield. We also found that the likelihood of payment increases for all regions with respect to Irrigated soybeans and Non Irrigated Soybeans from 2014 to 2016. However, for Corn all regions have decrease in ARC-CO payments in 2016 and its associated probability. A couple of things need to be noted about in our stochastic analysis of the multicounty or regional yield. First, all regions (Grand Prairie, White River, Upper Delta and Lower Delta) have an ARC-CO payment for Corn and Soybeans. These payments may be less or more that the current ARC-CO payment based on county yield, a farmer in a particular county may experience much lower ARC-CO payment rather than no payment. Second, unlike other studies evaluating impact of county yield on farm level insurance premium or farm payment, we did not investigate if ARC-

CO payment should be based on accurate yield estimation at county level rather we focus our research focused on agro-ecological classification of a region to have a uniform equitable payment for region based on multicounty or regional yield. There is a need to have more studies that estimate ARC-CO payment based on yield that is more representative

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Table 1. Corn and Soybean ARC-CO Payment for Selected Counties in Arkansas (2014-2016).

Counties	Corn			Irrigated Soybeans			Non Irrigated Soybeans		
Year	2014	2015	2016	2014	2015	2016	2014	2015	2016
<b>Grand Prairie</b>									
Arkansas	\$92.05	\$96.81	\$90.53	\$(80.20)	\$23.21	\$17.83			
Prairie	\$92.58	\$95.22	\$89.09	\$(121.96)	\$45.25	\$4.79			
Lonoke	\$73.49	\$98.92	\$91.97	\$(103.56)	\$20.94	\$12.16			
<b>White River</b>									
Craighead	\$93.10	\$96.28	\$88.62	\$(82.01)	\$9.45	\$44.20			
Clay	\$78.95	\$92.05	\$87.66	\$(10.86)	\$27.35	\$52.99			
Jackson	\$55.96	\$85.70	\$79.04	\$(87.43)	\$11.33	\$17.41			
Greene	\$0.76	\$84.64	\$79.04	\$(63.16)	\$22.54	\$12.87	\$(71.30)	\$107.67	\$(78.00)
Poinsett	\$39.16	\$66.63	\$86.70	\$(73.26)	\$(22.21)	\$(14.92)			
Cross	\$70.46	\$34.93	\$86.22	\$(72.81)	\$34.70	\$23.79			
Randolph	\$0.00	\$84.11	\$80.47	\$(23.67)	\$8.79	\$48.67			
Woodruff	\$60.51	\$86.76	\$79.99	\$(5.73)	\$2.38	\$35.00			
Lawrence	\$77.31	\$87.29	\$79.51	\$(56.68)	\$18.67	\$42.73			
Independence	\$0.00	\$77.76	\$72.33	\$6.18	\$3.98	\$(1.59)	\$(41.91)	\$109.77	\$28.49
White	\$0.00	\$78.82	\$49.68	\$(87.43)	\$(17.13)	\$45.11	\$(1.51)	\$111.87	\$(12.92)
<b>Upper Delta</b>									
Mississippi	\$2.40	\$93.10	\$85.74	\$(101.30)	\$(5.25)	\$(1.88)	\$(148.03)	\$174.81	\$35.00
Crittenden	\$82.65	\$92.05	\$84.78	\$(60.90)	\$55.22	\$13.58	\$(76.88)	\$186.84	\$(4.42)
Lee	\$14.71	\$83.58	\$80.95	\$(70.55)	\$30.55	\$34.70	\$(110.35)	\$135.05	\$(28.38)
Phillips	37.39)	\$87.35	\$88.62	\$(170.65)	\$32.16	\$(12.09)	\$(199.44)	\$160.36	\$(36.46)
St. Francis	\$79.25	\$89.93	\$82.39	\$48.84	\$19.34	\$(7.55)	\$(16.73)	\$183.74	\$23.37
Monroe	\$19.81	\$87.81	\$86.22	\$(42.96)	\$31.49	\$30.45			
<b>Lower Delta</b>									
Ashley	\$68.40	\$95.22	\$90.05	\$(101.30)	\$24.81	\$(9.97)			
Drew	\$33.94	\$97.87	\$91.49	\$(110.95)	\$(24.75)	\$6.91			
Lincoln	\$61.00	\$96.28	\$91.97	\$(80.20)	\$(12.59)	\$(1.17)			
Jefferson	\$52.44	\$97.34	\$93.41	\$(102.66)	\$(65.36)	\$(24.42)			
Desha	\$86.84	\$102.10	\$94.36	\$(130.25)	\$(28.89)	\$19.24			
Chicot	\$51.35	\$93.63	\$89.57	\$(59.09)	\$56.46	\$38.95			

Source: Farm Service Agency (FSA) Actuarial Data as of on 12/8/2018.

Table 2. Simulated ARC-CO Payment for Grand Prairie, White River, Upper Delta and Lower Delta Regions

	Average <sup>1</sup> ARC-CO Payment			ARC-CO Payment in Percent		
	2014	2015	2016	2014	2015	2016
<b>Corn</b>						
Grand Prairie	\$70.19	\$75.62	\$67.33	62%	69%	59%
White River	\$59.50	\$66.72	\$61.77	58%	67%	60%
Upper Delta	\$63.87	\$70.23	\$65.27	60%	66%	61%
<b>Soybean Irrigated</b>						
Grand Prairie	\$32.21	\$35.53	\$38.41	34%	44%	50%
White River	\$28.78	\$32.09	\$33.92	27%	53%	56%
Upper Delta	\$32.40	\$35.79	\$37.50	41%	46%	47%
Lower Delta	\$33.67	\$38.41	\$40.66	31%	43%	55%
<b>Soybean Non Irrigated</b>						
White River	\$16.12	\$19.48	\$19.69	30%	43%	45%
Upper Delta	\$26.35	\$26.35	\$25.68	29%	29%	41%

<sup>1</sup>Indemnity statistics are based on 500 simulated iterations.

Table 3. Difference between Actual and Simulated ARC-CO Payment for Grand Prairie, White River, Upper Delta and Lower Delta Regions.

[illegible]