Implications of Rice Variety Selection to Optimize Returns from Crop Insurance

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ABSTRACT

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Rice production is distinguished from most other field crops by distinct differences in yields across cultivars and producers being paid on production as a result of post-harvest milling into head rice and brokens.  In the ten years of Arkansas harvest data from performance trials in six different locations, hybrids are shown the have 19 percent higher paddy yields and head rice yield rates 1.8 percentage points lower than conventional varieties.  In crop insurance yield protection and revenue protection policies, no distinctions in premiums are made on the basis of variety.  Adjustments for adverse milling outcomes are made only in the most extreme cases.  Using a three-equation, econometric model to predict paddy yields, milled rice yields and head rice yields, the relative returns to yield protection and revenue protection crop insurance are estimated.  Additionally, a policy that is more sensitive to milling deficiencies is explored. Results indicate some advantage for hybrids compared with conventional cultivars as a ratio of indemnities to premiums.  A revenue protection policy that would cover adverse milling outcomes would lessen risk marginally.

Key words:  Rice, crop insurance, milling yields, cultivar differences, Arkansas

*JEL codes*:  Q18, Q12.

**Implications of Rice Variety Selection to Optimize Returns from Crop Insurance**

The passage of the Agricultural Act of 2014 (2014 Farm Bill) brought numerous changes for farmers across the country. Direct and counter-cyclical payments are gone and risk management is now more strongly focused around crop insurance. For crops in states such as Arkansas, which is largely characterized by operators who irrigate their crops, making decisions on crop insurance takes on added importance. As Karov et al. argue, crop insurance is not targeted to producers who irrigate. Energy costs to lift water reduce producer profits, and crop insurance does not offset increased lifting costs due to drought (Karov et al.). Arkansas' second most important crop in terms of revenue is rice, and in 2012 Arkansas was responsible for 42% of US rice revenues.[1] Rice has been treated favorably under the previous farm bill programs, but with the shift in emphasis to crop insurance, it is important to take a closer look at the current crop insurance program for rice and how it may be improved to more adequately control the risks associated with growing rice.

Unlike with other row crops, rice producers' revenues are based on both field yield and the outcome of post-harvest processing. Rice prices at the mill are directly affected by the milling quality of the paddy (rough rice) yield delivered. Rice milling is measured in two ways. The so-called milling rate yield (MRY) is the proportion of paddy rice that becomes either head rice or broken rice. The head rice yield (HRY) is the proportion of paddy rice resulting in kernels that are at least three-fourths whole (Hardke and Siebenmorgen). In current crop insurance programs there are minimal protections to offset losses due to adverse milling outcomes. Hence there is a gap between how revenues are insured and how revenues are actually realized by producers. It is the intent of this investigation to explore a potential policy to provide rice producers protection from adverse milling outcomes.

Over the past decade, the US rice industry has increased the proportion of rice acreage planted to hybrids increasing from less than ten percent in 2004 to over 20% in 2010 (Nalley et al.). In general, hybrids are characterized by higher paddy yields than conventional cultivars, but often less favorable

milling quality.  For the data used for this study, hybrids yielded a mean paddy yield 19% higher than conventional cultivars, but head rice yield rates were 1.8 percentage points lower for hybrid rice.  There are several explanations for poor milling in hybrid rice such as improper milling techniques, excessive chalkiness, etc., but generally hybrids mill lower (Hardke and Siebenmorgen).  According to the University of Arkansas, Division of Agriculture 2014 rice budgets (Dunn et al.), hybrid seed costs approximately $125 per acre compared to approximately $33 per acre for conventional rice seed. However, Dunn et al. project that total operating costs per acre of hybrids exceed those of conventional varieties by $43.  The more frequent use of hybrids in rice planting poses an interesting situation for both producers and crop insurance providers.  The only factors used in writing policies are four to ten years of actual production history (APH), location (county), and coverage level (50%-85%).  Producers may select the type of coverage.  Premium costs do not distinguish between hybrid and conventional cultivars. Studies have yet to examine the benefits of rice crop insurance programs as a function of cultivar.

There are several different crop insurance programs available for rice producers.  In 2014, the majority of Arkansas rice insured was insured in Revenue Protection (RP) with 45% of the policies. Yield Protection (YP) is also popular in Arkansas with 22% of the policies enrolled in YP, but it is not as widely used as RP.[2]  The remaining policies sold are primarily catastrophic (CAT) coverage - a premium-free, minimum protection policy.  Rice is flood irrigated in Arkansas and water is generally pumped.  As a consequence, it makes sense that rice producers value revenue protection since it provides direct protection due to revenue (price) variation and not solely on yield variation.  RP protects farmers according to a revenue guarantee which is determined by coverage level, APH, and a projected price based on futures contract price for paddy rice as well as a harvest price adjustment if harvest price exceeds the projected price.  After harvest, a producer can draw an indemnity on the difference between revenue guarantee and their actual revenue as defined by RMA.  For insurance purposes, actual revenue is actual paddy yield times the September mean of the November rough rice closing price.  Yield protection follows the same model except price stays constant between revenue guarantee and actual revenue.[3]

The "actual revenue" as computed for crop insurance purposes generally does not take milling quality into consideration unless there are extreme milling deficiencies. For most crops, realized revenue is simply yield times price which is how insurance programs model producer revenue. For rice, however, realized revenue is a function of yield, price, and milling quality. The price that producers are quoted for their rice is based on an industry standard milling rate of 55% HRY and 70% MRY. When a producer's rice mills greater than or less than this industry standard, an adjustment is made to the price received by the farmer. This adjusted price is used to compute a producer's realized revenue. Milling quality is affected by environmental conditions such as drought, high nighttime temperatures, low sunlight exposure, low or high harvest moisture content (HMC) and others (Hardke and Siebenmorgen). As stated earlier, milling quality can also vary as a function of cultivar differences. Rice producers are being protected using revenue estimates which do not equal their realized revenues. Because of this, a gap exists between producers' current indemnities and what their actual exposures are which increases basis risk although we do not pursue this aspect in our analysis. In cases of poor milling, this gap could be substantial for producers. Given the changed risk management structure of the new farm bill, producers are relying heavily on crop insurance to protect them against their losses and milling yields can be part of those losses.

In this study, two current crop insurance programs for Arkansas rice producers are analyzed relative to location and cultivar. Specifically, we ask what effect does location and cultivar have on loss-cost ratios and producer revenue under various crop insurance programs? We also investigate if a revenue protection program that more closely insures against adverse milling outcomes would be more suitable in terms of reducing revenue fluctuations. This study uses production data and weather data from six different research locations across Arkansas in order to predict producer revenues over 1000 stochastic simulations per scenario. With the results it is possible to measure the effectiveness of the various crop insurance programs for location and cultivar. For the sake of comparison, the outcome of a proposed policy that would more closely compensate for milling deficiencies is also examined.

**Data and Methods**

*Data*

Annual Arkansas Rice Performance Trial (ARPT) data were collected from six locations in Arkansas over ten years (2003-2013[4]).These locations are indicated on Figure 1.  The variables collected from these trials include paddy yield in bushels per acre dried to 12% ($Y_p$), milled rice yield percentage of paddy yield (MRY), head rice yield percentage of paddy yield (HRY), percent harvest moisture content (HMC), cultivar, and location.  The plots were harvested at various HMC levels, but all yields recorded were dried to 12% HMC (Frizzel[5]). Weather observations were collected for each location for each year using the aWhere data base.[6] Weather variables collected included vapor pressure difference[7] (VPD), solar radiation (SOLAR), hours during daylight when temperature is greater than thirty-three degrees Celsius (TD33), hours during nighttime when temperature is greater than twenty-two degrees Celsius (TN22), and mean daily temperature in Celsius (AvgT).  Weather variables were observed in two succeeding intervals.  Window one (w1) is the time frame from rice plant emergence to when the first signs of heading occurred.  This time period is referred to as the plant's vegetative stage. Window two (w2) is the grain filling stage which occurs from one day after heading to harvest of the plant.  AvgT is averaged over w1 and w2.  Numerous cultivars were planted at the six locations.  For the purposes of crop insurance where no distinction is made by cultivar, the cultivars were put into two broad categories:  conventional cultivars and hybrid cultivars.  In total there were 2058 observations on conventional cultivars and 460 observations on hybrids.

Using the data collected, six different ordinary least squares (OLS) regressions were estimated (Appendix A).  Similarly to Lyman et al., yield models, HRY models and MRY models were estimated.  Lyman et al. used pooled data using cultivar as a variable to estimate

yield.  In this study, two models (one for hybrid cultivars and one for conventional cultivars) were used to estimate paddy yield.  Lyman et al. estimated separate MRY and HRY models for each cultivar in their study.  In similar manner we estimate one MRY model for hybrids and another for conventional cultivars.  Similarly two HRY models are estimated, one for hybrid cultivars and one for conventional cultivars.  Appendix A gives the estimated models.

*Paddy Yield Model*

Yield was observed as paddy yield harvested dried to 12% field before milling.  Yield was measured in bushels (forty-five pounds per bushel).  For the two yield regression models, the natural log of yield ($Y_p$) is specified as a function of location (Stuttgart, Corning, Keiser, Newport, Pine Tree and Rohwer) and seven different climate variables (w1TN22, w2TN22, w1SOLAR, w2SOLAR, w1VPD, w2VPD and AvgT).  In the estimated model, Stuttgart is the base location so this effect is captured in the intercept term.

This model is used to predict paddy yield for a given location and cultivar.  Using this model, $Y_p$ is simulated using @Risk via Microsoft Excel twelve times to predict yields for all possible location and cultivar combinations.  Each simulation had 1000 repetitions.

*MRY Model*

MRY is the observed mass percentage of whole and broken rice kernels remaining after milling a sample of paddy rice.  In the two MRY regression models (one for hybrids and one for conventional) the logit of MRY (log of (MRY/(1 − MRY))) was specified to be a function of the six locations, w1TD33, w2TD33, w1TN22, w2TN22 and HMC.[8]  These models were used to predict MRY for a given location for hybrid cultivars and conventional cultivars.  The same procedure for simulations was used as for the yield model.

*HRY Model*

HRY is the observed mass percentage of whole kernels remaining after a sample of paddy yield was milled. In the two HRY regression models (one for hybrids and one for conventional) the logit of HRY/MRY was specified to be a function of the six locations, w1TD33, w2TD33, w1TN22, w2TN22, HMC, and HMC squared (HMC2). For the simulation, the same procedure for MRY simulations was used for HRY simulations.

*Sources of Uncertainty*

Our ultimate goal was to simulate the revenues received by producers under various insurance policies. The simulations recognized four sources of uncertainty and were modeled by random draws according to the hypothesized distributions. The first source of uncertainty is due to uncertainty about the regression parameters since these estimates are based on sample data. In each of the 1000 simulations a vector of regression coefficients was drawn assuming normality and using the covariance matrix of the parameter estimates. The second source of uncertainty is due to weather variability. Random draws of the weather variables were used as values for the independent variables in the regressions and multiplied times the random draws of the parameter coefficients (the first source of uncertainty noted above.) The third source of uncertainty is the randomness due to the additive error terms of each regression model. For a given location and cultivar three error terms on the original regressions were drawn according to a multivariate normal distribution with means zero with the estimated three-by-three covariance matrix of the error terms. After the regression coefficient draws were multiplied times their random draws on the independent variables and the random draws on the error terms were added, all three

dependent variables were transformed back into their natural units so that head rice yields and brokens yields in pounds could be computed.

The fourth source of uncertainty was harvest price which is needed for computing the actual revenues that producers received. Harvest price was simulated using s Black-Scholes options approach (Hull). The February price for computing rice insurance policies by RMA is $0.1390/cwt. Using the RMA rice volatility factor of 0.10, the Black-Scholes process generated random draws on the harvest price.[9] In the interests of simplicity price correlations with yields in the harvest price are ignored although adopting a copula approach as in Vedenov and Power could be used to explore the sensitivity of results to this assumption.

**Crop Insurance Models**

The simulations for paddy yield ($Y_p$), MRY, and HRY were used to generate distributions of producer revenue to facilitate comparisons of current crop insurance programs available for rice producers. The two current crop insurance programs analyzed were Revenue Protection (RP) and Yield Protection (YP). We also propose and simulate an alternative crop insurance program that might better protect producers from losses related to milling quality. This program is referred to as Milling Revenue Protection (MRP).

Actual production histories (APH) were calculated for each cultivar and location by averaging paddy yield for the four most recent years of data. Projected price is the January mean of the November rough rice contract closing prices, and the projected price is published by RMA every February.[10] The projected price for 2014 is $0.139 per pound of rice, and this is the price used with a volatility factor of 0.10. Harvest price for the purposes of crop insurance is typically the September mean of the November rough rice contract closing prices. Harvest price had yet

to be observed at the time of this analysis; therefore, the simulation for harvest price as described above was used.

Quality adjustment factors (QAF) were applied to each observation based on the RMA guidelines for quality adjustment.[11] For any observation where MRY was less than 68% or HRY was less than 48%, the following $QAF_{48/68}$ was applied to paddy yield:

$$QAF_{48/68} = (P_{adj}/P_h) \tag{1}$$

$$Y_{adj} = Y_p \times QAF_{48/68} \tag{2}$$

where $QAF_{48/68}$ is a proportional adjustment; $P_{adj}$ is the realized price a producer receives after milling quality discounts are applied (explained below); $P_h$ is the harvest price simulated for producers and $Y_{adj}$ is the adjusted yield which a producer uses for crop insurance purposes.[12]

The revenues producers actually receive (realize) net of indemnities are determined by paddy yield, harvest price, and milling quality of the rice. Observed rice prices are based on the industry standard milling quality of 55% HRY and 70% MRY. Prices received by an individual producer vary based on deviations of a harvested crop from this industry standard. A producer's realized revenue (RR) not including indemnities is calculated as:

$$RR = Y_p \times P_{adj} \tag{3}$$

where:

$$P_{adj} = [P_h + (HRY/100 - 0.55)(P_w) + (BRY/100 - 0.15)(P_b)] \tag{4}$$

$P_h$ is the harvest price for 55/70 rice, $P_w$ is the national loan rate for whole kernels published annually by USDA, *BRY* is the percentage of broken kernels remaining after the milling of paddy rice (MRY – HRY); $P_b$ is the national loan rate for broken kernels published annually by USDA. For this analysis $P_w$ equals \$10.25/cwt and $P_b$ equals \$6.18/cwt.[13] Note that in (1) $QAF_{48/68}$ is truncated to one if it exceeds one and only is less than one for adjustment purposes if MRY is

less than 68% or HRY is less than 48% or both. But for the purposes of computing a producer's revenues received at a mill, price gets adjusted for any deviation from 55% HRY and 70% MRY.[14]

*Revenue Protection*

To analyze the impacts on rice farmers of the Revenue Protection (RP) crop insurance policy, the yield, MRY and HRY equations were used with the appropriate pricing mechanism to simulate realized producers' revenue under a RP policy. Realized producer revenues, producer revenues with indemnity payments, the frequency of an indemnity payment occurring, and mean indemnity payments are computed for every location and cultivar combination.[15] For RP, revenue guarantees $(R_g^{rp})$ are computed for each observation based on a given APH, coverage level proportion *(C),* $P^{rp}$ which is the larger value of projected price ($0.139 in all simulations) and the simulated harvest price $(P_h)$ as:

$$R_g^{rp} = APH \times C \times P^{rp}. \tag{5}$$

Coverage level (C) can range from 50%-85% depending on producer preference. For RP, a producer's revenue for insurance payment computations $(R_a^{rp})$ is estimated based on simulated, adjusted paddy yield $(Y_{adj})$ and harvest price $(P_h)$.

$$R_a^{rp} = Y_{adj} \times P_h.$$

Indemnity payments are triggered when $R_a^{rp}$ is less than the revenue guarantee $(R_g^{rp})$. Producers are paid the difference between the two. Simulations were performed for this policy over two scenarios with C ranging from 55% (0.55) to 70% (0.70) coverage levels.

*Yield Protection*

The yield protection model was simulated in a similar fashion to the RP simulations to analyze producer revenues, mean indemnity payments, and the frequency of an indemnity

payment occurring for every location and cultivar combination. For YP, revenue guarantees $(R_g^{yp})$ are estimated for each observation based on a given APH, coverage level *(C)* and projected price $(P_p)$ as:

$$R_g^{yp} = APH \times C \times P_p.$$

Coverage level can range from 50%-85% (0.50-0.85) depending on producer preference. For RP, a producer's projected revenue $(R_a^{yp})$ for insurance purposes is based on adjusted paddy yield $(Y_{adj})$ and projected price $((P_p)$:

$$R_a^{yp} = Y_{adj} \times P_p.$$

Indemnity payments are triggered when $R_a^{yp}$ is less than the revenue guarantee $(R_g^{yp})$. Producers are paid the difference between the two. This model was simulated with C ranging from 55% (0.55) to 70% (0.70) coverage levels.

*Milling Revenue Protection*

As noted earlier there is a gap in revenue insurance for producers whose milling is above 48% HRY and 68% MRY but one or both of these rates is below 55% HRY and 70% MRY. Such a gap suggests exploring an insurance policy that would protect producers from losses due to such milling deficiencies. In this section we propose a policy much like RP, which we call milling revenue protection (MRP), with provisions to provide producers with coverage for milling deficiencies. In designing and simulating such a policy it is our intention to find the fair market value of such a policy (the mean indemnity) and compare the stability of actual producer revenues under such a policy. For MRP, revenue guarantees are equivalent to $R_g^{rp}$ in (5). For MRP, a producer's realized revenue (RR) which is (3) using the price adjustment due to milling yield deviations as in (4).

Indemnity payments are triggered when realized revenue RR is less than the revenue guarantee ($R_g^{rp}$). Producers are paid on the difference between the two. This model was simulated with C ranging from 55% (0.55) to 70% (0.70).

*USDA Cost Estimator*

In order to evaluate RP and YP programs, premium levels were needed for each location and cultivar. The USDA Cost Estimator program was used to estimate the producer paid premium[16] per acre for a given location and cultivar. It should be noted that even though simulations vary between hybrid and conventional, no distinction is made by the Cost Estimator on the basis of cultivar. For each research station, location was defined as the county in which the station resided. In addition to that, each location and cultivar's APH for the most recent four years of data was used as "Approved Yield" and "Rate Yield". Since there were no substitution yields or yield floors used, Approved Yield always equaled Rate Yield.[17] We also assumed complete ownership of the crop by producers, so "Insured Share Percent" always equaled 100%. The projected prices were left at the 100% published price level at $0.139/lbs. After all the information was inputted, the "Get Estimates" button was selected. "Producer Premium Amount" was selected and the premium values for RP and YP are given at various coverage levels.

**Results**

*Sample Characteristics and Estimation*

As indicated in Table 1 for all observations pooled, hybrid cultivars have 19% higher yields than conventional cultivars across all locations. This is consistent with the common beliefs about hybrid yield production versus conventional yield production. Note that hybrids also have larger yield variability than conventional cultivars with a hybrid standard deviation of

51.5 bushels compared with 38.2 bushels for conventional cultivars. Hybrid and conventional MRY are equal at the industry standard of 70%. Hybrid HRY averages two percentage points lower compared to conventional cultivars, somewhat offsetting the hybrid rough rice yield advantage. While hybrid cultivars exhibit lower HRY, hybrid cultivars also have lower milling variation than conventional cultivars by half a percentage point for MRY (3.2% for hybrid versus 3.7% for conventional) and 1.3 percentage points for HRY (8.8% for hybrid versus 10.1% for conventional).

The sample data from the six research locations over ten years give a baseline for the cultivar characteristics in Arkansas (Table 2). Location exhibits an important role in production variability, and the location differences on paddy yield, MRY, and HRY and their dispersions are shown in Table 2. Paddy yields were the lowest in Rohwer which is the southernmost of the six locations. Milling quality was also the worst in Rohwer. Newport and Corning posted the highest paddy yields, and Corning had higher MRY and HRY for both hybrid and conventional cultivars than any other location. In five of the six locations hybrids have a larger yield standard deviation than conventional cultivars.

As clear from Tables 3 and 4 that display premiums for RP and YP, Newport clearly has the highest premiums. This could be explained by high yields and large standard deviations, but Keiser has high standard deviations although lower mean yields but premiums roughly half that of Newport. This seeming anomaly may be explained by a claims history not evident in our data. This anomaly may also be an artifact that the six locales are at one specific point in each county. The premiums likely reflect actual claims histories from the entire county over many years which may exhibit variability not evident in our site-specific data.

*Revenue Protection and Yield Protection*

Location affects yield and milling quality due to differences such as soil type and climate.  This suggests different cultivars may be more suitable to some locations and insurance policy types.  Results from simulating production and revenue based on location, cultivar, and climate under RP and YP are displayed in Tables 3 and 4 for coverage at 55% and 70%.  The loss-cost ratio is the mean indemnity payment over 1000 iterations divided by producer paid premium.  The larger the ratio, the more valuable the crop insurance plan is to the producer and vice versa.  All locations except Newport and Corning showed RP and YP policies are more valuable to the producer for hybrid cultivars than conventional cultivars.  For RP and YP, hybrid cultivars grown in Stuttgart proved to have high loss-cost ratios at both 55% and 70% coverage levels.  This is undoubtedly due to the high Stuttgart APH for hybrids relative to the mean yield. In Newport and Corning a reverse situation appears where APH is lower for hybrids and mean yield.  The most neutral location is Pine Tree where APH and mean yield are nearly identical for both hybrid and conventional varieties.  For both RP and YP, hybrid has the higher loss-cost ratios.  While this finding suggests hybrids are a better choice from an insurance perspective, more testing should be done by setting APH equal to observed mean yields for all locations.

As to be expected, the returns to the insurance plans increase from 55% coverage level to 70% level for both RP and YP.  This can be seen by the increasing loss-cost ratios in going from the 55% column to the 70% column in Tables 3 and 4.  Revenue protection policies proved to have higher loss-cost ratios than YP policies for every location and cultivar except hybrid cultivars grown in Stuttgart.  Revenue protection policies also had higher indemnity frequencies and mean indemnity payments for every cultivar and location.  Revenue protection policies also have higher premium costs than YP policies to accommodate for increased protection against

price fluctuations.  The premiums between hybrid cultivars and conventional cultivars were almost equal across all locations.  Since crop insurance policies do not factor in cultivar variation in premium costs, hybrid cultivars benefit more from RP and YP policies given the increase in yield variation for hybrid cultivars over conventional cultivars.

*Milling Revenue Protection*

Our proposed MRP policy can only be evaluated on indemnity frequency and mean indemnity paid since the premium costs cannot be calculated with the USDA Cost Estimator. The mean indemnities and indemnity frequencies by cultivar and location are displayed in Table 5.  As to be expected, the mean indemnities and frequencies of indemnities for MRP exceed those for RP.  For 70% coverage level, the MRP increased mean indemnity payments a minimum of $0.11 per acre (Rohwer, hybrid) to a maximum of $1.07 per acre (Corning, hybrid). The gap between MRP and YP is greater with indemnity payments increasing from a minimum of $1.82 per acre (Newport, hybrid) to a maximum of $13.78 per acre (Stuttgart, hybrid) at a 70% coverage level from YP to MRP.  Figures 2 and 3 show that MRP provides producers with increased mean indemnity payments (Figure 2) and increased indemnity frequencies (Figure 3) although the margins between MRP and RP are narrow, they do expand as coverage level increases.  The increased indemnity payments and frequencies come from expanding the quality adjustment threshold.  As a consequence, premiums for MRP would likely be higher than for RP, but given the narrow margin between mean indemnity payments and indemnity frequencies between MRP and RP, the increase in premiums should be small.

*Producer Revenue Risk Reduction*

In Tables 6-8, producer realized revenue is shown with and without mean indemnity payments from RP, YP, and MRP.  Comparing realized revenue between hybrid cultivars and

conventional cultivars, hybrids have higher revenues than conventional cultivars across all locations as would be expected given hybrid's higher mean yields. Conventional cultivars, however, have lower variation in realized revenue than hybrid cultivars, as shown by the standard deviations in Tables 6-8. The same holds true for realized revenue plus indemnity payments. Hybrid cultivars have higher variability than conventional cultivars in realized revenue. Although not shown in the tables, coefficients of variation (standard deviation divided by the mean) which are measures of relative risk, are lower for conventional cultivars.

When comparing crop insurance policies, Tables 6-8 show that RP and MRP decrease producer revenue variation more compared to YP. Producers selecting RP or MRP can expect to see higher realized revenues (with indemnities) than those who enroll in YP (Figure 4). Premiums are not deducted out of the mean revenues (because we have no premium for MRP), but in viewing Figure 4, even with premiums deducted, producer revenues will likely still be greater under RP and MRP given the generally small differences in RP and YP premiums displayed in Tables 3 and 4. There is minimal realized revenue variation difference between RP and MRP. Given that the margins are small between indemnity payments between RP and MRP, the differences in realized revenues (with indemnities) are also negligible.

*Cultivar Selection*

Producers make annual decisions on cultivar selection and crop insurance policy selection. As demonstrated in Tables 1 and 2, hybrids have higher yields variation in annual yields than conventional cultivars and this is reflected in the revenues in Tables 6-8. This variation carries over when indemnities are added to realized revenues. Hybrid cultivars have higher variation among realized revenues (with indemnities) than conventional cultivars. As

noted earlier, hybrid seed costs more than conventional seed and has higher overall operating costs so this must be considered adjusting expected net revenues.

As evident from the results in Tables 3 and 4, cultivar selection and the best loss-cost ratio is very much influenced by the difference between APH and mean yields over a longer period of time. The most neutral site for comparing hybrid versus conventional site is Pine Tree. For both RP and YP, hybrids have higher ratios than conventional cultivars. Moreover, the reduction in revenue standard deviations due to insurance is less for conventional cultivars.

**Conclusion**

The 2014 Farm Bill has made crop insurance a cornerstone for risk management in the rice industry. Our analysis shows that hybrid cultivars generate higher variability in producer realized revenues and higher total realized revenues compared to conventional cultivars. Producers must decide between selecting a less risky cultivar or a cultivar with the potential of higher revenues. Our analysis indicates that hybrids offered a better return on premiums than conventional cultivars when APH equaled long run expected yields for both yield protection and revenue protection. While this finding is certainly preliminary and requires further research, it suggests that because of different yield and milling characteristics, perhaps cultivar should become part of the computation of premiums.

Arkansas rice producers showed a clear preference for revenue protection policies over yield protection policies in 2014. However, revenue protection as currently sold does not provide protection against adverse milling yields except in extreme cases. Our proposed milling revenue protection policy, which covers all adverse milling yields at some coverage level, indicates that such coverage would further decrease revenue variability. To balance such protection higher premiums would likely be charged than current revenue protection premiums.

Our analysis focused on two existing policies and another with minor modification. As Karov et al. concluded in their study on crop insurance in the Southern United States, current crop insurance does not protect producers' profit margins in the South. High energy costs due to irrigation are the main source of variation in Arkansas production costs. An insurance policy based on cost and irrigation needs throughout the growing season is deserving of further consideration.

Our analysis is relevant for rice crop insurance but needs to be expanded to thoroughly understand all the changes pertaining to rice producers as mandated in the 2014 Farm Bill. In particular, the Supplemental Coverage Option (SCO) will need to be considered once its details for rice become known. Analyses could be done to see the effect that cultivar selection will have on increases in crop insurance coverage from the SCO.

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**Table 1. Mean Paddy Yield, MRY, and HRY by Cultivar 2003-2013**

| Cultivar | Variable | n | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|---|
| **Hybrid** | **Yield (bu/ac)** | 460 | 210 | 51.5 | 35 | 336 |
| | **MRY (%)** | 460 | 70 | 3.2 | 53 | 82 |
| | **HRY (%)** | 460 | 57 | 8.8 | 18 | 72 |
| **Conv** | **Yield (bu/ac)** | 2058 | 176 | 38.2 | 12 | 325 |
| | **MRY (%)** | 2058 | 70 | 3.7 | 42 | 98 |
| | **HRY (%)** | 2058 | 59 | 10.1 | 7 | 90 |

Note: Data does not inlcude 2011 because of insufficient observations

**Table 2.  Mean Paddy Yield, MRY, HRY and APH by Location and Cultivar (2003-2013)**

| Location | Variety | n | APH (bu/ac) | Yield (bu/ac) | MRY (%) | HRY (%) |
|---|---|---|---|---|---|---|
| Stuttgart | Hybrid | 83 | 222 | 202 | 70 | 58 |
| | Std. Dev. | | | 41.8 | 1.9 | 5.3 |
| | Conventional | 413 | 180 | 173 | 70 | 63 |
| | Std. Dev. | | | 27.8 | 2.4 | 5.7 |
| Keiser | Hybrid | 93 | 196 | 189 | 69 | 56 |
| | Std. Dev. | | | 59.7 | 4.0 | 8.3 |
| | Conventional | 425 | 185 | 172 | 69 | 57 |
| | Std. Dev. | | | 42.6 | 4.9 | 10.1 |
| Rohwer | Hybrid | 34 | 160 | 171 | 67 | 48 |
| | Std. Dev. | | | 33.0 | 6.7 | 19.2 |
| | Conventional | 158 | 150 | 151 | 69 | 52 |
| | Std. Dev. | | | 33.3 | 6.1 | 19.0 |
| Newport | Hybrid | 99 | 186 | 220 | 70 | 59 |
| | Std. Dev. | | | 50.7 | 2.2 | 5.7 |
| | Conventional | 426 | 161 | 177 | 70 | 59 |
| | Std. Dev. | | | 44.4 | 2.5 | 7.3 |
| Corning | Hybrid | 97 | 228 | 244 | 71 | 60 |
| | Std. Dev. | | | 40.8 | 1.6 | 7.6 |
| | Conventional | 395 | 204 | 193 | 71 | 60 |
| | Std. Dev. | | | 34.1 | 2.7 | 11.3 |
| Pine Tree | Hybrid | 54 | 206 | 206 | 70 | 57 |
| | Std. Dev. | | | 38.2 | 2.5 | 5.7 |
| | Conventional | 241 | 171 | 172 | 71 | 60 |
| | Std. Dev. | | | 30.1 | 3.0 | 6.3 |

Note: Data does not inlcude 2011 because of insufficient observations. APH is four-year average of 2009, 2010, 2012, 2013 paddy yield.

**Table 3: Revenue Protection Mean Indemnities, Frequencies and Returns to Premiums**

| Location | Variety | Producer Premium ($) Coverage Level | | Average Indemnity ($) Coverage Level | | Indemnity Frequency (%) Coverage Level | | Loss-Cost Ratio Coverage Level | |
|---|---|---|---|---|---|---|---|---|---|
| | | 55% | 70% | 55% | 70% | 55% | 70% | 55% | 70% |
| Stuttgart | Hybrid | 5.00 | 12.00 | 10.24 | 57.84 | 10.4 | 35.7 | 2.05 | 4.82 |
| | Conven | 5.00 | 10.00 | 2.85 | 22.74 | 4.5 | 21.2 | 0.57 | 2.27 |
| Keiser | Hybrid | 9.00 | 18.00 | 3.84 | 27.50 | 5.7 | 20.4 | 0.43 | 1.53 |
| | Conven | 9.00 | 17.00 | 3.38 | 21.90 | 4.6 | 19.1 | 0.38 | 1.29 |
| Rohwer | Hybrid | 6.00 | 13.00 | 1.48 | 10.66 | 2.3 | 10.1 | 0.25 | 0.82 |
| | Conven | 6.00 | 12.00 | 0.76 | 7.33 | 1.3 | 9.0 | 0.13 | 0.61 |
| Newport | Hybrid | 18.00 | 32.00 | 0.90 | 5.15 | 1.0 | 5.3 | 0.05 | 0.16 |
| | Conven | 17.00 | 30.00 | 0.77 | 6.14 | 1.3 | 7.3 | 0.05 | 0.20 |
| Corning | Hybrid | 10.00 | 21.00 | 5.12 | 28.80 | 4.5 | 19.8 | 0.51 | 1.37 |
| | Conven | 10.00 | 19.00 | 5.71 | 34.76 | 6.3 | 25.2 | 0.57 | 1.83 |
| Pine Tree | Hybrid | 10.00 | 19.00 | 3.34 | 23.55 | 4.3 | 16.9 | 0.33 | 1.24 |
| | Conven | 9.00 | 17.00 | 1.22 | 13.45 | 2.0 | 14.1 | 0.14 | 0.79 |

Note: Average indemnities are estimated over 1000 iterations.

**Table 4: Yield Protection Mean Indemnities, Frequencies and Returns to Premiums**

| Location | Variety | Producer Premium ($) Coverage Level | | Average Indemnity ($) Coverage Level | | Indemnity Frequency (%) Coverage Level | | Loss-Cost Ratio Coverage Level | |
|---|---|---|---|---|---|---|---|---|---|
| | | 55% | 70% | 55% | 70% | 55% | 70% | 55% | 70% |
| Stuttgart | Hybrid | 4.00 | 9.00 | 7.39 | 45.00 | 8.5 | 30.5 | 1.85 | 5.00 |
| | Conven | 4.00 | 8.00 | 1.72 | 15.77 | 3.3 | 16.5 | 0.43 | 1.97 |
| Keiser | Hybrid | 8.00 | 15.00 | 2.44 | 19.89 | 3.7 | 16.9 | 0.31 | 1.33 |
| | Conven | 8.00 | 14.00 | 1.79 | 15.51 | 2.6 | 15.1 | 0.22 | 1.11 |
| Rohwer | Hybrid | 5.00 | 10.00 | 0.84 | 7.43 | 1.5 | 8.5 | 0.17 | 0.74 |
| | Conven | 5.00 | 10.00 | 0.34 | 4.59 | 0.9 | 6.3 | 0.07 | 0.46 |
| Newport | Hybrid | 17.00 | 29.00 | 0.49 | 3.46 | 0.7 | 3.8 | 0.03 | 0.12 |
| | Conven | 15.00 | 26.00 | 0.24 | 3.96 | 0.6 | 5.2 | 0.02 | 0.15 |
| Corning | Hybrid | 9.00 | 17.00 | 2.89 | 20.40 | 2.6 | 15.4 | 0.32 | 1.20 |
| | Conven | 9.00 | 16.00 | 3.66 | 25.74 | 4.6 | 20.7 | 0.41 | 1.61 |
| Pine Tree | Hybrid | 8.00 | 16.00 | 2.14 | 17.84 | 2.8 | 13.8 | 0.27 | 1.12 |
| | Conven | 8.00 | 14.00 | 0.68 | 9.15 | 1.2 | 11.5 | 0.08 | 0.65 |

Note: Average indemnities are estimated over 1000 iterations.

**Table 5. Milling Revenue Protection Mean Indemnities and Frequencies**

| Location | Variety | Mean Indemnity ($) Coverage Level | | Indemnity Frequency (%) Coverage Level | |
|---|---|---|---|---|---|
| | | 55% | 70% | 55% | 70% |
| Stuttgart | Hybrid | 10.52 | 58.78 | 10.8 | 36.0 |
| | Conven | 2.92 | 23.00 | 4.5 | 21.3 |
| Keiser | Hybrid | 4.13 | 28.10 | 5.8 | 20.6 |
| | Conven | 3.56 | 22.35 | 4.8 | 19.3 |
| Rohwer | Hybrid | 1.48 | 10.77 | 2.3 | 10.3 |
| | Conven | 0.85 | 7.57 | 1.5 | 9.1 |
| Newport | Hybrid | 0.91 | 5.29 | 1.0 | 5.5 |
| | Conven | 0.84 | 6.44 | 1.4 | 7.5 |
| Corning | Hybrid | 5.56 | 29.87 | 4.8 | 20.0 |
| | Conven | 5.97 | 35.55 | 6.4 | 25.4 |
| Pine Tree | Hybrid | 3.47 | 23.99 | 4.4 | 17.0 |
| | Conven | 1.24 | 13.77 | 2.1 | 14.6 |

Note: Average indemnities are estimated over 1000 iterations.

**Table 6. Mean Realized Producer Revenue by Location and Cultivar Under Revenue Protection ($/ac)**

| Location | Variety | Realized Revenue | Mean Indemnity | | Total Revenue | |
|---|---|---|---|---|---|---|
| | | | Coverage Level | | Coverage Level | |
| | | | 55% | 70% | 55% | 70% |
| Stuttgart | Hybrid | 1,219.91 | 10.24 | 57.84 | 1,230 | 1,277 |
| | Std. Dev. | *394* | *37* | *103* | *380* | *338* |
| | Conven | 1,108.78 | 2.85 | 22.74 | 1,112 | 1,132 |
| | Std. Dev. | *322* | *17* | *58* | *317* | *294* |
| Keiser | Hybrid | 1,201.91 | 3.84 | 27.50 | 1,206 | 1,229 |
| | Std. Dev. | *377* | *21* | *69* | *371* | *345* |
| | Conven | 1,128.17 | 3.38 | 21.90 | 1,132 | 1,150 |
| | Std. Dev. | *325* | *20* | *60* | *320* | *298* |
| Rohwer | Hybrid | 1,123.85 | 1.48 | 10.66 | 1,125 | 1,135 |
| | Std. Dev. | *366* | *13* | *40* | *363* | *351* |
| | Conven | 1,035.07 | 0.76 | 7.33 | 1,036 | 1,042 |
| | Std. Dev. | *315* | *9* | *31* | *314* | *305* |
| Newport | Hybrid | 1,397.38 | 0.90 | 5.15 | 1,398 | 1,403 |
| | Std. Dev. | *431* | *11* | *31* | *430* | *423* |
| | Conven | 1,129.73 | 0.77 | 6.14 | 1,131 | 1,136 |
| | Std. Dev. | *331* | *8* | *29* | *330* | *322* |
| Corning | Hybrid | 1,421.85 | 5.12 | 28.80 | 1,427 | 1,451 |
| | Std. Dev. | *461* | *30* | *79* | *454* | *427* |
| | Conven | 1,156.65 | 5.71 | 34.76 | 1,162 | 1,191 |
| | Std. Dev. | *334* | *28* | *80* | *325* | *294* |
| Pine Tree | Hybrid | 1,289.97 | 3.34 | 23.55 | 1,293 | 1,314 |
| | Std. Dev. | *396* | *21* | *66* | *391* | *368* |
| | Conven | 1,119.41 | 1.22 | 13.45 | 1,121 | 1,133 |
| | Std. Dev. | *320* | *11* | *42* | *318* | *303* |

Note: Average indemnities are estimated over 1000 iterations.

**Table 7. Mean Realized Producer Revenue by Location and Cultivar Under Yield Protection ($/ac)**

| Location | Variety | Realized Revenue | Mean Indemnity Coverage Level | | Total Revenue Coverage Level | |
|---|---|---|---|---|---|---|
| | | | 55% | 70% | 55% | 70% |
| **Stuttgart** | Hybrid | 1,219.91 | 7.39 | 45.00 | 1227 | 1265 |
| | Std. Dev. | *394* | *30* | *91* | *384* | *349* |
| | Conven | 1,108.78 | 1.72 | 15.77 | 1111 | 1125 |
| | Std. Dev. | *322* | *12* | *47* | *319* | *302* |
| **Keiser** | Hybrid | 1,201.91 | 2.44 | 19.89 | 1204 | 1222 |
| | Std. Dev. | *377* | *16* | *57* | *373* | *353* |
| | Conven | 1,128.17 | 1.79 | 15.51 | 1130 | 1144 |
| | Std. Dev. | *325* | *14* | *49* | *322* | *305* |
| **Rohwer** | Hybrid | 1,123.85 | 0.84 | 7.43 | 1125 | 1131 |
| | Std. Dev. | *366* | *9* | *32* | *364* | *355* |
| | Conven | 1,035.07 | 0.34 | 4.59 | 1035 | 1040 |
| | Std. Dev. | *315* | *4* | *23* | *314* | *308* |
| **Newport** | Hybrid | 1,397.38 | 0.49 | 3.46 | 1398 | 1401 |
| | Std. Dev. | *431* | *7* | *24* | *430* | *426* |
| | Conven | 1,129.73 | 0.24 | 3.96 | 1130 | 1134 |
| | Std. Dev. | *331* | *4* | *22* | *331* | *325* |
| **Corning** | Hybrid | 1,421.85 | 2.89 | 20.40 | 1425 | 1442 |
| | Std. Dev. | *461* | *21* | *63* | *457* | *436* |
| | Conven | 1,156.65 | 3.66 | 25.74 | 1160 | 1182 |
| | Std. Dev. | *334* | *21* | *66* | *328* | *303* |
| **Pine Tree** | Hybrid | 1,289.97 | 2.14 | 17.84 | 1292 | 1308 |
| | Std. Dev. | *396* | *16* | *56* | *393* | *374* |
| | Conven | 1,119.41 | 0.68 | 9.15 | 1120 | 1129 |
| | Std. Dev. | *320* | *8* | *33* | *319* | *308* |

Note: Average indemnities are estimated over 1000 iterations.

**Table 8. Mean Realized Producer Revenue by Location and Cultivar Under Milling Revenue Protection ($/ac)**

| Location | Variety | Realized Revenue | Mean Indemnity | | Total Revenue | |
|---|---|---|---|---|---|---|
| | | | Coverage Level | | Coverage Level | |
| | | | 55% | 70% | 55% | 70% |
| Stuttgart | Hybrid | 1,219.91 | 10.52 | 58.78 | 1230 | 1279 |
| | Std. Dev. | 394 | 38 | 104 | 380 | 338 |
| | Conven | 1,108.78 | 2.92 | 23.00 | 1112 | 1132 |
| | Std. Dev. | 322 | 17 | 58 | 317 | 294 |
| Keiser | Hybrid | 1,201.91 | 4.13 | 28.10 | 1206 | 1230 |
| | Std. Dev. | 377 | 22 | 70 | 371 | 344 |
| | Conven | 1,128.17 | 3.56 | 22.35 | 1132 | 1151 |
| | Std. Dev. | 325 | 21 | 61 | 320 | 298 |
| Rohwer | Hybrid | 1,123.85 | 1.48 | 10.77 | 1125 | 1135 |
| | Std. Dev. | 366 | 13 | 40 | 363 | 351 |
| | Conven | 1,035.07 | 0.85 | 7.57 | 1036 | 1043 |
| | Std. Dev. | 315 | 9 | 31 | 313 | 305 |
| Newport | Hybrid | 1,397.38 | 0.91 | 5.29 | 1398 | 1403 |
| | Std. Dev. | 431 | 11 | 31 | 430 | 423 |
| | Conven | 1,129.73 | 0.84 | 6.44 | 1131 | 1136 |
| | Std. Dev. | 331 | 9 | 30 | 330 | 322 |
| Corning | Hybrid | 1,421.85 | 5.56 | 29.87 | 1427 | 1452 |
| | Std. Dev. | 461 | 31 | 82 | 453 | 426 |
| | Conven | 1,156.65 | 5.97 | 35.55 | 1163 | 1192 |
| | Std. Dev. | 334 | 29 | 81 | 325 | 294 |
| Pine Tree | Hybrid | 1,289.97 | 3.47 | 23.99 | 1293 | 1314 |
| | Std. Dev. | 396 | 21 | 67 | 391 | 367 |
| | Conven | 1,119.41 | 1.24 | 13.77 | 1121 | 1133 |
| | Std. Dev. | 320 | 11 | 43 | 318 | 302 |

Note: Average indemnities are estimated over 1000 iterations.

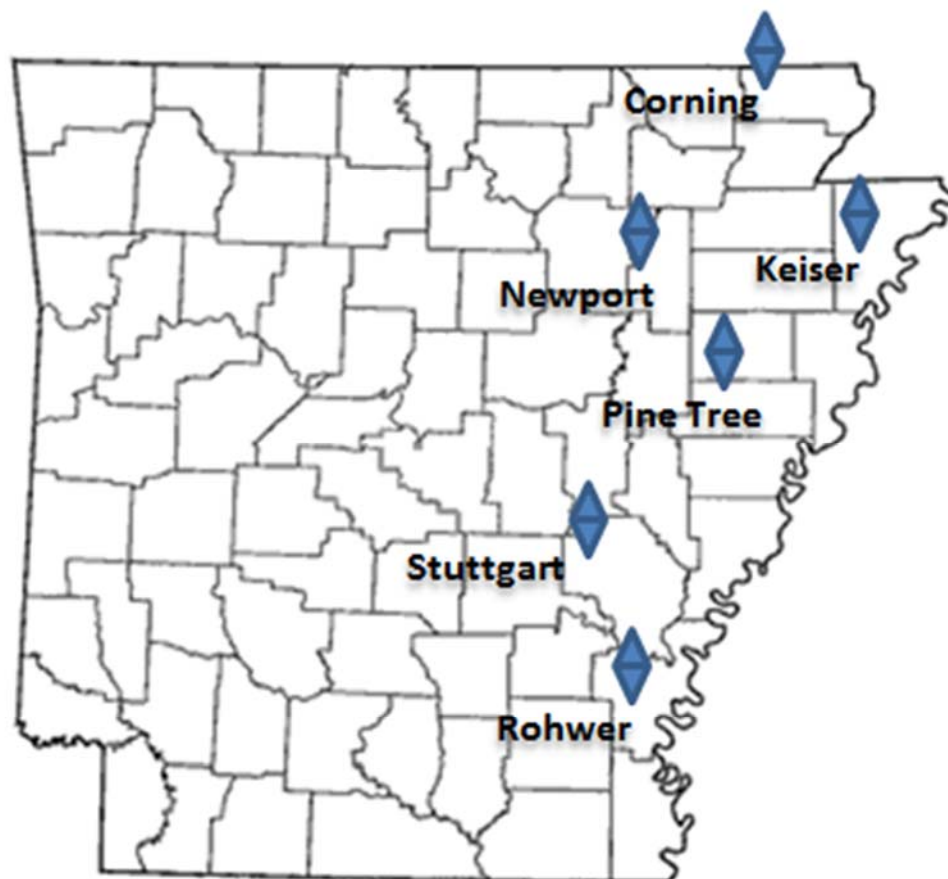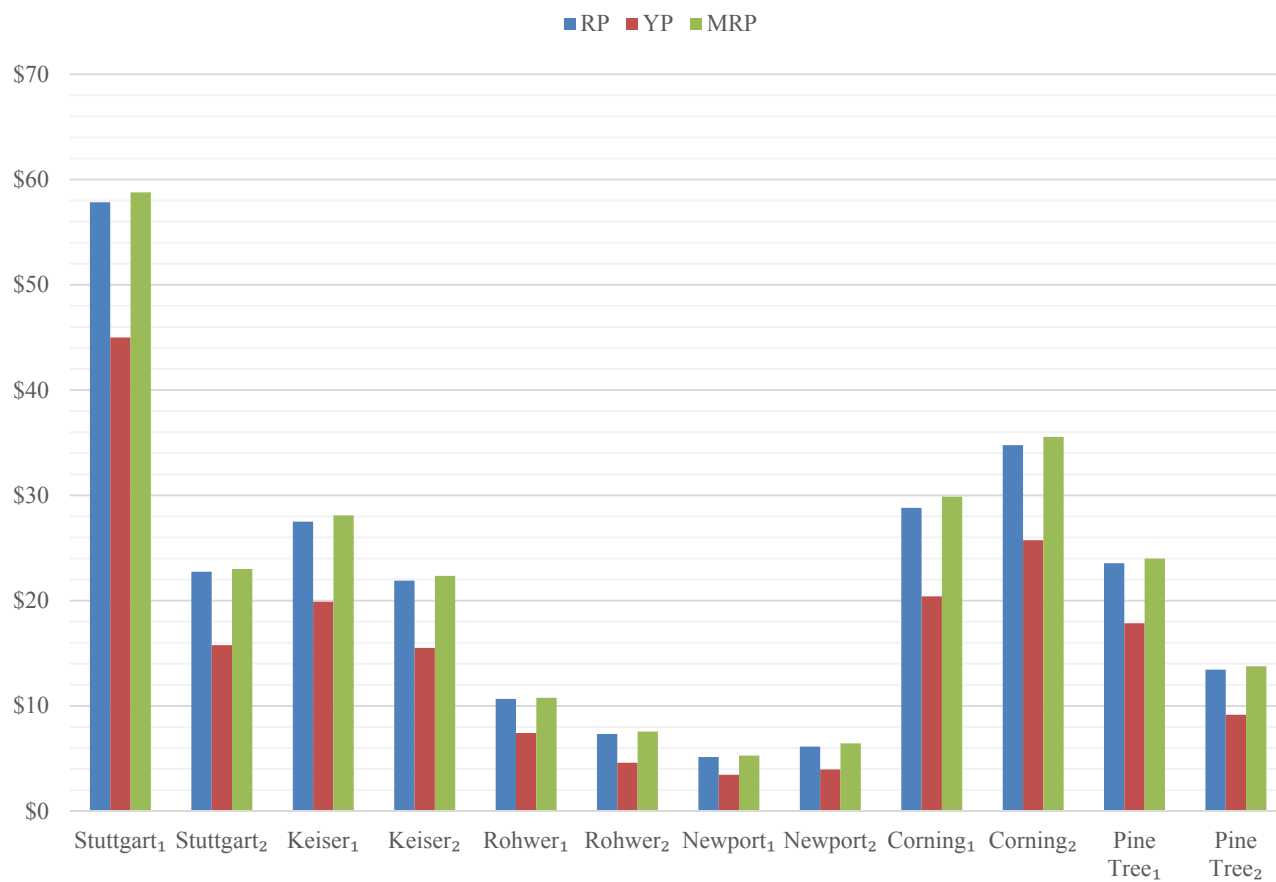**Figure 1. Research Locations in Arkansas**

Figure 2.  Mean Indemnity Per Acre by RP, YP, and MRP at 70% Coverage Level

1 Hybrid cultivars
2 Conventional cultivars

Figure 3. Probability of Indemnity Payment for RP, YP, and MRP at 70% Coverage Level

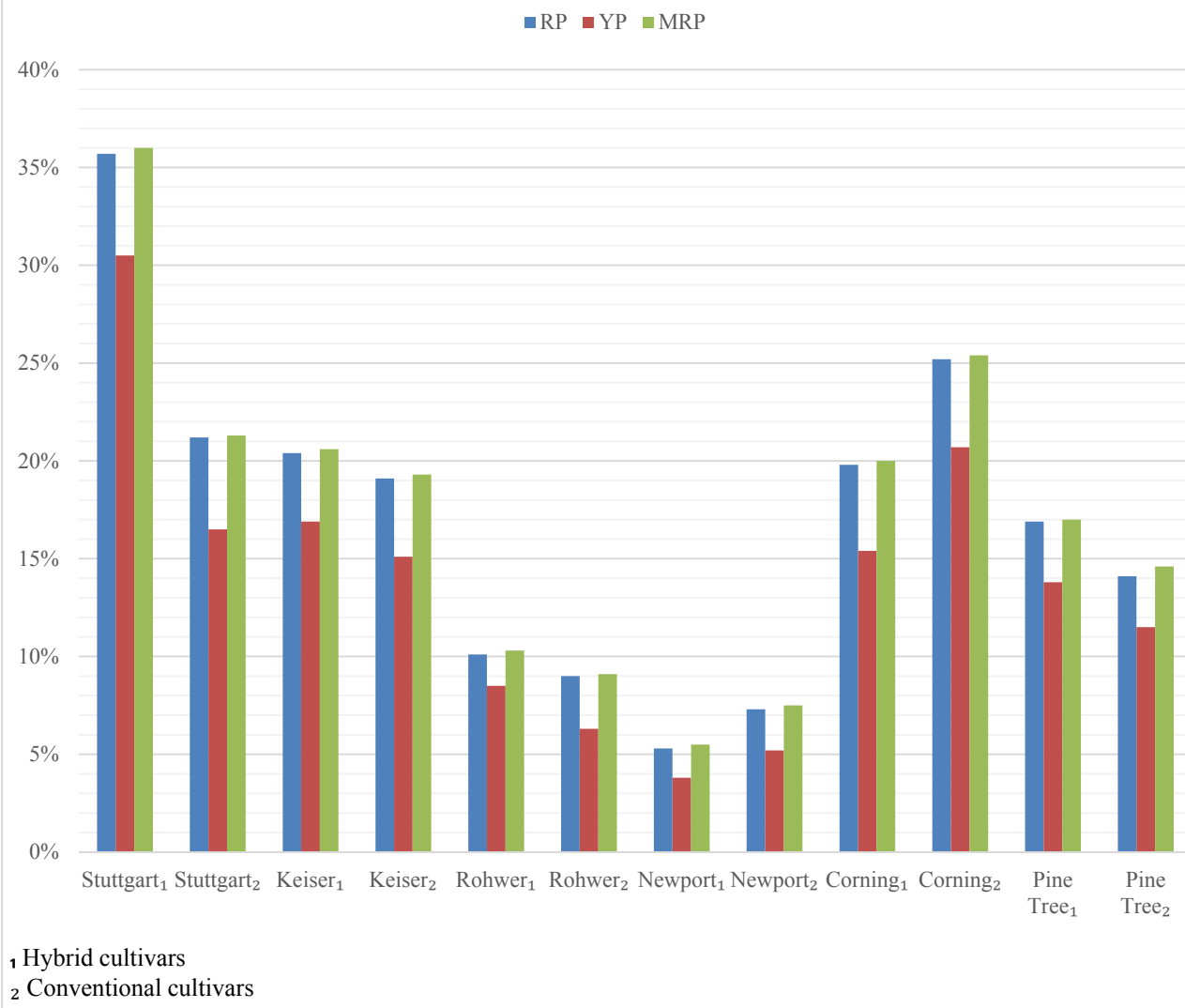1 Hybrid cultivars
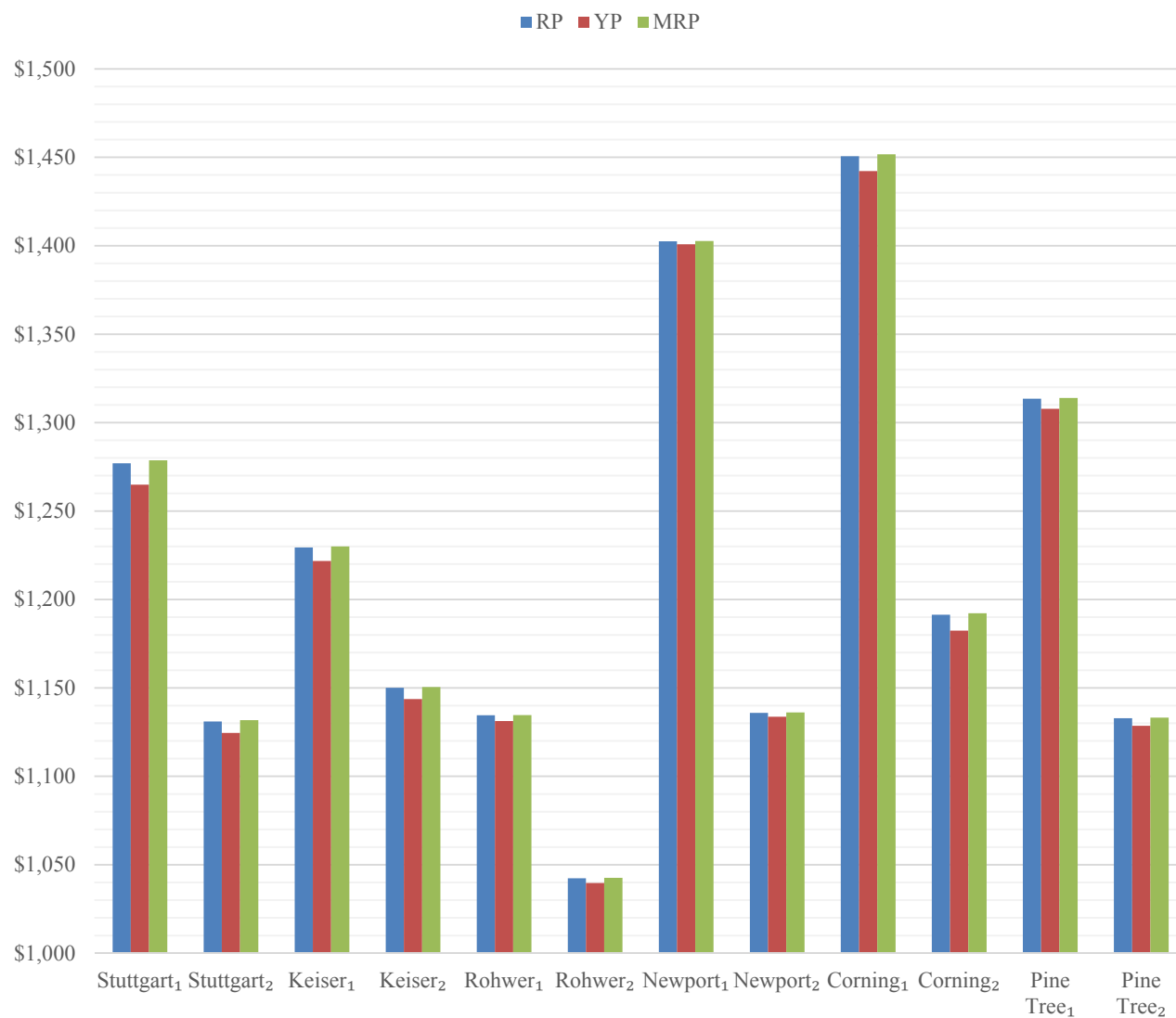2 Conventional cultivars

Figure 4. Mean Producer Realized Revenue Plus Mean Indemnity Payments for RP, YP, and MRP at 70% Coverage Level

1 Hybrid cultivars
2 Conventional cultivars

**Appendix A**

Table A1. Estimated Paddy Yield Models for
Conventional and Hybrid Cultivars

| Model | Ind. Variable | (1) | (2) |
|---|---|---|---|
| | Intercept | 3.4766*** | 2.9080*** |
| | w1TDN | -0.0003*** | -0.0002 |
| | w2TDN | 0.0001* | 0.0005*** |
| | w1VPD | 0.2771*** | 0.2522 |
| | w2VPD | -0.5649*** | -1.3816*** |
| | W1SOLAR | -0.0001** | -0.0002** |
| Paddy Yield | W2solar | 0.0001*** | 0.0003*** |
| | w1w2AvgT | 0.0791*** | 0.1167*** |
| | Corning | 0.0826*** | 0.1799*** |
| | Keiser | 0.0447** | 0.0036 |
| | Newport | 0.0542*** | 0.1645*** |
| | PineTree | 0.0190 | 0.0672 |
| | Rohwer | -0.0261 | -0.0346 |
| | R-Square | 0.1131 | 0.2919 |
| | F Value | 21.74 | 15.35 |
| | n | 2058 | 460 |

Note: Ordinary Least Squares (OLS) regression results for
conventional model (1) and hybrid model (2). Values in
columns (1) and (2) are the coefficient estimates of the
independent variables in column "Ind. Variable". For this
model, Stuttgart was the base location, and *, **, and ***
represent statistical significance at the 0.10, 0.05, and 0.01
levels, respectively. Standard errors are heteroscedasticity
robust.

Table A2.  Estimated  MRY Models for
Conventional and Hybrid Cultivars

| Model | Ind. Variable | (1) | (2) |
|---|---|---|---|
| MRY | Intercept | 1.6042*** | 1.6249*** |
| | w1TD33 | 0.0004*** | 0.0006*** |
| | w2TD33 | 0.0000 | 0.0000 |
| | w1TN22 | -0.0009*** | -0.0012*** |
| | w2TN22 | -0.0007*** | -0.0007*** |
| | HMC | -0.0021*** | 0.0005 |
| | Corning | -0.1352*** | -0.1387*** |
| | Keiser | -0.1159*** | -0.0609*** |
| | Newport | -0.1283*** | -0.1200*** |
| | PineTree | 0.0004 | -0.0033 |
| | Rohwer | -0.1306*** | -0.1457*** |
| | R-Square | 0.2528 | 0.3467 |
| | F Value | 69.26 | 23.83 |
| | n | 2058 | 460 |

Note: Ordinary Least Squares (OLS) regression results
for convetional model (1) and hybrid model (2). Values
in columns (1) and (2) are the coefficient estimates of
the independent variables in column "Ind. Variable".
For this model, Stuttgart was the base location, and *,
**, and *** represent statistical significance at the
0.10, 0.05, and 0.01 levels, respectively.  Standard
errors are heteroscedasticity robust.

Table A3. Estimated HRY Models for
Conventional and Hybrid Cultivars

| Model | Ind. Variable | (1) | (2) |
|-------|---------------|------|------|
| HRY | Intercept | 4.1242*** | 3.6030*** |
| | w1TD33 | 0.0014*** | 0.0002 |
| | w2TD33 | -0.0012** | 0.0000 |
| | w1TN22 | -0.0039*** | -0.0023*** |
| | w2TN22 | -0.0028*** | -0.0031*** |
| | HMC | 0.0913*** | 0.0339 |
| | HMC2 | -0.0015*** | -0.0005 |
| | Corning | -0.8783*** | -0.3493*** |
| | Keiser | -0.4662*** | -0.3427*** |
| | Newport | -0.7504*** | -0.3352*** |
| | PineTree | -0.4140*** | -0.2439** |
| | Rohwer | -1.0445*** | -0.9195*** |
| | R-Square | 0.2731 | 0.3235 |
| | F Value | 69.88 | 19.48 |
| | n | 2058 | 460 |

Note: Ordinary Least Squares (OLS) regression results
for conventional model (1) and hybrid model (2).
Values in columns (1) and (2) are the coefficient
estimates of the independent variables in column "Ind.
Variable". For this model, Stuttgart was the base
location, and *, **, and *** represent statistical
significance at the 0.10, 0.05, and 0.01 levels,
respectively. Standard errors are heteroscedasticity
robust.

**Endnotes**

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[1] http://www.ers.usda.gov/data-products/state-fact-sheets.aspx

[2] http://www3.rma.usda.gov/apps/sob/current_week/stcrop2014.pdf

[3] http://www.rma.usda.gov/fields/ms_rso/2014/ricearkmstn.pdf

[4] Usable observations were not available for 2011.  Data were obtained from:
University of Arkansas Cooperative Extension Service (UACES). Various Years. Arkansas rice
performance trials (ARPT). Available at: http://www.aragriculture.org/crops/rice/PerfTrials/default.htm

[5] Personal communication, Donna Frizzel, June 25, 2014.

[6] http://www.awhere.com/en-us/weather-details

[7] VPD is a measure of humidity.

[8] The logit transformation was used to avoid getting predicted MRY greater than one or less than zero.

[9] The exact formula is: $EXP(\ln(0.139)-(0.5*(.10)^2)*(0.75)+(\varepsilon)*(0.10)*(0.75)^{0.5})$ where $\varepsilon$ is a randomly
generated standard normal random variable.

[10] http://www.rma.usda.gov/bulletins/pm/2014/14-007.pdf

[11] http://www.rma.usda.gov/handbooks/25000/2014/14_25410-2.pdf

[12] Marvin Dearien, Rain and Hail, LLC. Personal communication, August 27, 2014

[13] http://www.fsa.usda.gov/FSA/webapp?area=home&subject=prsu&topic=col-nl-cr

[14] If $P_{adj}$ in (4) is divided by $P_h$ we get $QAF_{55/70}$ for adjusting yields for realized revenues.

[15] Mean indemnities are computed over all simulations including those for which no indemnity was paid.

[16] Crop insurance premiums are subsidized by the federal government.

[17] Travis Johnson, Risk Management Agency. Personal communication, August 27, 2014.