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ECONOMICS AND MARKETING

Simulating Net Returns Among Enterprise Selection and Farm Program Choice Under Risk

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ABSTRACT

Farm-level returns can provide a measure of a grower's conviction for crop choice and farm program preference among alternative enterprise and farm program choices across varying levels of risk aversion. The objectives of this study were to incorporate stochastic efficiency with respect to a function as a means of ranking alternative crop enterprise selections among corn, cotton, rice, and soybeans and to include farm program choice between the Agricultural Risk Coverage county option program and the Price Loss Coverage program (PLC) on two representative farms in Louisiana, one located in Rapides County/Parish (central) and one located in Tensas County/Parish (northeast), for grower profitability. Using certainty equivalent (CE) values as proxies for grower risk premium, farm analysis examined those CE values for enterprise and farm program selection on the basis of grower net returns. In the absence of farm program enrollment, a corn/soybean/cotton rotation was preferable for both farms. When farm program payments were considered, cotton/corn/rice rotation would be more profitable for both farms under PLC for the grower across multiple levels of risk aversion. Crop choice and program election have an important place in the farm management decision. As market conditions change, growers are more able to tailor their farm program choice to mitigate the type of risk they deem more imminent (revenue versus price).

Both the Red River Valley region of central Louisiana and the Mississippi River Delta region of northeastern Louisiana are perhaps the most diverse areas of the state in terms of agricultural crop production. Corn, cotton, rice, and soybeans (among others) are cultivated in both regions as these crops are particularly suited for the regions' agricultural production environment (e.g., soil type) and pair well with growers' ability to produce these crops under irrigation. Even though both regions possess the necessary environmental factors for large-scale enterprise cultivation (e.g., environment, soil type), those factors are not homogenous across both regions. These differences could impact a grower's final decision regarding enterprise selection. One of the primary factors impacting crop enterprise selection is economic in nature, with each commodity's expected market price and the resulting expected net economic return from the production of selected commodities serving as two fundamental factors driving enterprise selection.

The economic efficacy of enterprise selection has been investigated using both partial budget and whole-farm analyses by Deliberto (2015). Simulation analysis provides a basis for evaluating the variability in farm-level net returns associated with those production systems in both the Red River Valley of central Louisiana and the northeastern Mississippi River Delta region of Louisiana. Two representative farms, one located in the Red River Valley region of central Louisiana (Rapides County/Parish) and one in the Mississippi River Delta region of northeast Louisiana (Tensas County/Parish), were modeled for corn, cotton, rice, and soybean production as to accurately project annualized net returns resulting from price and yield risk as well as to evaluate alternative farm program selection across varying levels of risk aversion amongst growers using stochastic efficiency criterion. Additionally, because Farm Bill Title I safety net programs such as Agricultural Risk Coverage county option program (ARC-CO), which works to mitigate income risk, and the Price Loss Coverage program (PLC), which works to mitigate price risk, are different by design as to the type of risk they work to mitigate, the aim of this paper was to evaluate both programs simultaneously along with enterprise selection to more closely model the risk-management decisions producers face within the two

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regions. In addition to 2014 farm bill provisions for cotton, corn, rice, and soybean eligibility for participation in ARC and/or PLC, the Bipartisan Budget Act of 2018, signed into law 9 February 2019, included a provision amending the 2014 farm bill to include seed cotton as a covered commodity, making seed cotton eligible for participation in both PLC and/or ARC-CO. Results from different farming operations suggest that the preferred pairing of farm programs with enterprise selection varies.

Both ARC-CO and PLC are important in the overall farm management decision. The ARC-CO program provides income support tied to a farm's historical base acres and is decoupled from current production. ARC-CO program payments are triggered when the actual county crop revenue for a covered commodity is less than the ARC-CO guarantee for the crop. The actual county revenue and revenue guarantee are based on county/parish yield data for the physical location of the farm/tract's base acres. ARC-CO benchmark revenue is calculated by multiplying the five-year Olympic average marketing year average (MYA) price by the five-year Olympic average county yield. Benchmark yields and MYAs are calculated using the five years preceding the year prior to the program year. The ARC-CO guarantee is determined by multiplying the ARC-CO benchmark revenue by 86%. The ARC-CO actual crop revenue is determined by multiplying the applicable actual county/parish yield by the MYA price for the program year. The ARC-CO payment is equal to 85% of the base acres of the covered commodity multiplied by the difference between the county guarantee and the actual county crop revenue for the covered commodity (USDA-FSA, 2019).

The PLC program works to mitigate downside price pressure for covered commodities. PLC program payments are issued when the effective price of a covered commodity is less than the respective effective reference price for that commodity. The effective price equals the higher of either the MYA or the national average loan rate for the covered commodity. The PLC program is also decoupled in nature. PLC payments, if triggered, will be paid on 85% of the farm's base acres of each covered commodity with a PLC election where the farm has been enrolled (USDA-FSA, 2019).

Given the national scope of both ARC and PLC, national MYA price data were simulated to establish ARC/PLC reference price thresholds. Parameters within current farm bill legislation maintain the principle of decoupling farm program payments from planting decisions. Although decoupling is an important premise of domestic farm policy, the representative farms (Tensas and Rapides) are assumed to have an established production history in the cultivation of corn, cotton, rice, and/or soybeans. Assuming that growers reallocated farm base acres under the 2014 Farm Bill (calculated from a proration of the farm's 2009-2012 planted or considered planted crop history), it was also assumed, based on the provisions of the farm update, that the enterprise selection for planted acres would mimic that of base acre enterprise allocation.

MATERIALS AND METHODS

Simulation analysis uses both farm level and aggregate data in analyzing various sectors of the U.S. agricultural economy. Stochastic analysis provides inferences about the drivers behind enterprise selection and their relationships along with any correlations amongst relevant variables (Flanders, 2008). Stochastic simulation models permit variations in variables and are interpreted as representing the random occurrences that correspond to risks associated with decision-making (Flanders and Wailes, 2010) while providing graphical inferences caused by relevant variables and correlations among the variables (Flanders, 2008). A multivariate empirical (MVE) distribution accounts for interrelationships occurring in the data and prevents the application of a specific distribution on the variables (Flanders and Wailes, 2010). An MVE distribution is viewed as being able to simulate random values from a frequency distribution composed of actual historical data and is considered a proper means of appropriately correlating random variables based on their historical correlation (Richardson et al., 2000).

By utilizing MVE simulation, simulated random variables that are generated are bounded by the historical minimums and maximums of the original data, rather than normal distributions, where it is possible to have random variables falling outside of historical bounds (Flanders, 2008). MVE distribution simulations use non-normal distributions, intra-temporal distribution across different commodities, and inter-temporal distribution across a time correlation matrix to generate correlated stochastic error terms that can be applied to any forecasted mean (Richardson et al., 2000). Using an MVE distribution is valuable when simulating commodity prices and yields because the distribution includes a correlation matrix that generates correlated stochastic variables (Richardson et al., 2000). Simulated stochastic commodity prices and yields involve the use of MVE distributions for generating random prices and yields that are employed as a means of deriving net returns that account for stochastic relationships extant amongst production systems. Therefore, implementing a simulation analysis with stochastic variables and assuming a baseline cost of production will provide sufficient results needed in comparing levels of farm net returns as market conditions change (Flanders, 2008).

Stochastic efficiency with respect to a function (SERF) uses the concept of certainty equivalents (CE) to evaluate a group of risky alternatives for a specified range of upper- and lower-bound absolute risk-aversion coefficients (Hardaker et al., 2004, Richardson et al., 2008). SERF has a stronger discriminating power over other conventional stochastic dominance techniques because it uses the concept of CEs for each alternative rather than the conventional approach of cumulative distribution functions (CDF) (Fathelrahman et al., 2011). CEs enable SERF to rank a set of risk-efficient alternatives instead of a subset of dominated alternatives (Hardaker et al., 2004). The risk alternatives are partitioned in terms of CEs for a specified range of attitudes to risk. Each alternative is compared simultaneously with the others, rather than a pairwise comparison of risky alternatives (Hardaker et al., 2004). The CE of a risky alterative is the dollar amount at which the producer is indifferent between the certain dollar value and the risky alternative (Fathelrahman et al., 2011, 2014; Williams et al., 2012). When calculating CEs, various types of utility functions can be applied to the individual's level of risk aversion, defined by the corresponding ranges of absolute, relative, or partial risk-aversion coefficients (Hardaker et al., 2004). Thus, the decision criterion for SERF is to rank risky alternatives from the highest valued (i.e., highest CEs at specified levels of risk aversion) to the lowest valued (i.e., lowest CEs at the specified levels of risk aversion) (Fathelrahman et al., 2011, 2014).

SERF is a variant of stochastic dominance with respect to a function (SDRF) that orders a set of risky alternatives in terms of CEs calculated for specified ranges of risk attitudes (Hardaker et al., 2004). The CE is typically less than the expected (mean) monetary value and greater than or equal to the minimum monetary value of a stream of monetary outcomes (Hardaker et al., 2004). SERF allows for simultaneous, rather than pairwise, comparison of risky alternatives and can produce a smaller efficient set than SDRF (Hardaker et al., 2004). Graphical presentation of SERF results facilitates the presentation of ordinal rankings for decision makers with different risk attitudes and provides a cardinal measure of a decision maker's conviction for preferences among risky alternatives at each risk-aversion level by interpreting differences in CE values for a given risk-aversion level as risk premiums (Hardaker et al., 2004).

SERF calculates CE values over a range of absolute risk-aversion coefficients (ARAC). The ARAC represents a decision maker's degree of risk aversion. Decision makers are risk averse if ARAC > 0; risk neutral if ARAC = 0, and risk preferring if ARAC < 0. ARAC values ranging from 0 (risk neutral) to 0.02 (strongly risk averse) were used in the SERF analysis to calculate corresponding CE values for each enterprise and farm program combination. ARAC values were calculated using the formula proposed by Hardaker et al., 2004 of

$$ARAC_w = \frac{r_r(w)}{w}$$

where

$r_r(w)$ is the relative risk-aversion coefficient with respect to wealth (w).

Using a representative farm approach, regional crop yields, commodity prices, and key energy related input prices were simulated using 10 years of historical data (2010-2019) from annual production statistics published by the Louisiana State University (LSU) Agricultural Center and U.S. Department of Agriculture, National Agricultural Statistics Service (USDA NASS). Regional yields (county/parish), commodity prices (state and national), nitrogen fertilizer price (state), and diesel fuel price (state) are considered stochastic variables in our model. Actual farm-level yields were set to correspond to county/parish yields. Historical yields were detrended using linear regression, and residuals from trend were used to estimate the parameters for the MVE yield distributions of 1,000 iterations. An MVE distribution was used as this approach has been shown to correlate random variables based on their historical correlation. By using detrended historical yield and price information specific to Louisiana, the expectation is that future yield and price distribution variability for each variable will center around historical patterns. Commodity price distributions were simulated using season average Louisiana farm price data and national MYA price data from the USDA NASS for the 10-year period (2010-2019). Louisiana farm-level price data were simulated to determine actual farm revenue. Simulated pricing data were used to determine gross farm revenues before accounting for simulated production costs. The variable costs of enterprise production, to include harvest costs, were obtained from the LSU Agricultural Center (Deliberto and Hilbun, 2020). For energy related inputs (i.e., nitrogen fertilizer price per unit and diesel price per gallon), MVE distributions were calculated so that future price distribution variability for these energy related inputs would also center around their historical behavior.

The total variable production costs per hectare for corn, cotton, rice, and soybeans were estimated using the per hectare stochastic nitrogen and diesel unit costs in addition to the non-stochastic unit costs (e.g., chemical and labor costs) associated with the irrigated production of those commodities for the same 10-year period for both Rapides and Tensas representative farms. These energy-related direct costs account for the majority of variable production costs. Based upon personal communication with grower cooperators, irrigated production systems were chosen as the production practice most commonly used. Simulated total variable production costs were used to calculate net returns to the grower by way of crop income and farm program payments given simulated yields and pricing data for each iteration. An 80/20 share rental arrangement was chosen as a proxy for land cost, with the grower receiving 80% of revenues and the landlord receiving 20%. In the case of a farm program payment, the payment would be split between the landowner and the grower in the same proportion as revenue is shared as stipulated in the land rental arrangement. PLC farm program yields were selected on the basis of conversations with LSU Agricultural Center county agents and project cooperators. The U.S. Department of Agriculture, Farm Service Agency reported historical county/parish yield information specific to Rapides and Tensas parishes served in establishing the relevant county/parish revenue guarantees (as a function of the five-year Olympic average for price and yield) specific to both county/parishes as defined in the ARC-CO program.

Having simulated yield, price, and direct cost data for the representative farms, grower net returns were calculated and used to measure grower's attitude towards risk across multiple risk coefficients that were calculated in SIMETAR©, a risk analysis management modeling software suite within Microsoft Excel®. Data used in this representative farm simulation model were originally reported in U.S. standard units (acres) and subsequently converted to metric units (SI) (hectares). All other factors (i.e., production costs) were scaled in proportion.

To estimate the grower's share of net returns per hectare ($GRWNR_{ij}$) for crop i, iteration j, it was assumed that three crops (corn, cotton, and rice and/or soybeans) were produced on one-third of that representative farm's area and averaged across all iterations of j (1,000 iterations). For representative farms in Rapides and Tensas, it was assumed that the area of production corresponded to that farm's historical base. To estimate the grower's share of net returns per hectare ($GRWNR_{ij}$) for crop i, iteration j, it is necessary to estimate total farm revenue, using the equation

$$GRWNR_{ij} = 0.333 * \sum_{i=1}^{3} \{[0.80 * (Y_{ij} * P_{ij}) + 0.80 * \left(ZARC_{ij} + \left(1 - Z\right) * PLC_{ij}\right)] - SVC_{ij} - NSVC_{ij}\}$$

where

$$SVC_{ij} = \left(N_{ij} * NFERT_{ij}\right) + \left(DIESEL_{ij} * DFUEL_{ij}\right)$$

$$NSVC_{ij} = \left(CHEM_{ij} + LABOR_{ij} + REPAIR_{ij} + SEED_{ij} + HAUL_{ij} + CUSTOM_{ij} + DRY_{ij} + INTEREST_{ij} + MISC_{ij}\right)$$

The grower's share of net returns ($GRWNR_{ij}$) was simulated using state-level commodity prices for crop i, iteration j (P_{ij}) and county/parish yields (Y_{ij}). Here Z is a binary variable denoting participation in a particular farm program (to the exclusion of the other farm program) for crop i, iteration j. ARC_{ij} and PLC_{ij} denote payment rates under ARC and PLC, respectively. In addition to stochastic prices and yields, the price of nitrogen fertilizer (N_{ij}) and the price of diesel fuel ($DIESEL_{ij}$) were simulated based on the 10-year data set to capture input price volatility expressed as SVC_{ij}. Individual unit prices are multiplied by the amount of fertilizer applied ($NFERT_{ij}$) and total units of diesel fuel ($DFUEL_{ij}$) used in the production process for each alternative enterprise. Non-stochastic production expense variables ($NSVC_{ij}$) include chemicals ($CHEM_{ij}$), labor ($LABOR_{ij}$), repair ($REPAIR_{ij}$), seed ($SEED_{ij}$), hauling ($HAUL_{ij}$), custom applications ($CUSTOM_{ij}$), drying (DRY_{ij}), interest on operating capital ($INTEREST_{ij}$), and miscellaneous ($MISC_{ij}$) for each alternative enterprise. Because some non-stochastic variable costs [e.g., drying (DRY_{ij}) and hauling ($HAUL_{ij}$)] are functions of simulated yields, those non-stochastic variable costs vary in proportion to gross production amount.

The utility function (U) of a grower with the performance criterion (w) represents wealth or, more specifically, the grower's share of net returns per hectare ($GRWNR_{ij}$) across each representative farming location is expressed as

$$U(w)$$

Following Hardaker et al. (2004), this research considers different levels of alternative farm program choices paired with enterprise selection that will compare uncertain outcomes, so values of w are stochastic. Utility functions are then converted into CE values by taking the inverse of the utility function stated above and resulting in

$$CE\left(w, r\left(w\right)\right) = U^{-1}\left(w, r\left(w\right)\right)$$

Using output from the SERF procedure in SIMETAR, CE graphs were constructed to display ordinal rankings of enterprise selection and farm program choice across specified ranges of ARAC values. ARAC values ranging from 0 (risk neutral) to 0.02 (strongly risk averse) were used in the SERF analysis to calculate corresponding CE values for each enterprise and farm program combination. The mappings of CEs across ARAC values were used to rank from most dominant to least dominant combinations of enterprise and farm program selection for both Rapides and Tensas. Higher CE values are risk preferred to lower CE values.

RESULTS AND DISCUSSION

Net returns were analyzed based on three possible enterprise production options: 1) rice, soybeans, and corn; 2) corn, soybeans, and cotton; and 3) cotton, corn, and rice for both representative farm locations (Table 1). Net returns for each crop within an option is expressed as one-third of a hectare. Subsequently, each alternative production scheme is the sum of the net return of the three crops produced for each representative farm location.

Table 1. Crop mix composition (evenly distributed) imposed on two representative Louisiana farms

Crop Mix Composition (33.3% each)	Option Identifier No.
Rice/Soybean/Corn	1
Corn/Soybean/Cotton	2
Cotton/Corn/Rice	3

To estimate the net return effect that farm program choice has on the covered enterprises, PLC and ARC-CO participation was subsequently incorporated into the grower's share of mean net returns per iteration, which were varied over risk. To capture this farm program income effect, an economic comparison between Rapides and Tensas was modeled for each enterprise production option (Table 2). The mean net returns estimates (dollars per hectare) contained in Tables 2 through 5 express the CEs of net returns for a risk neutral grower. In the absence of farm program payments for either Rapides or Tensas, highest net returns were associated with option 2 (corn/soybean/cotton) for both farms, followed by option 3 (cotton/corn/rice) and option 1 (rice/soybean/corn). One notable observation is that the difference in mean net returns across risk suggest that the difference between options 3 and 1 for Rapides is less significant than for Tensas (Figs. 1 and 2).

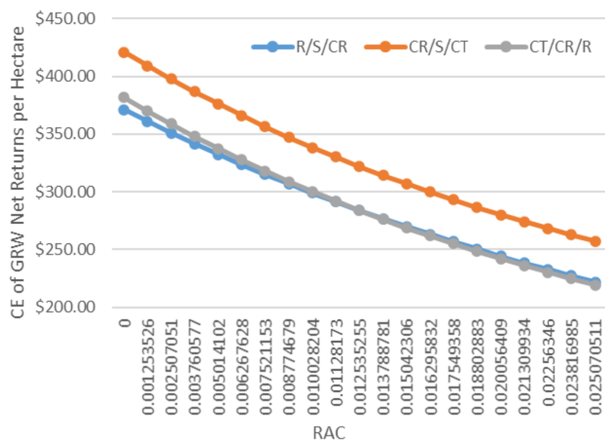

Figure 1. SERF rankings of cropping alternatives on a representative central Louisiana farm (Rapides Parish).

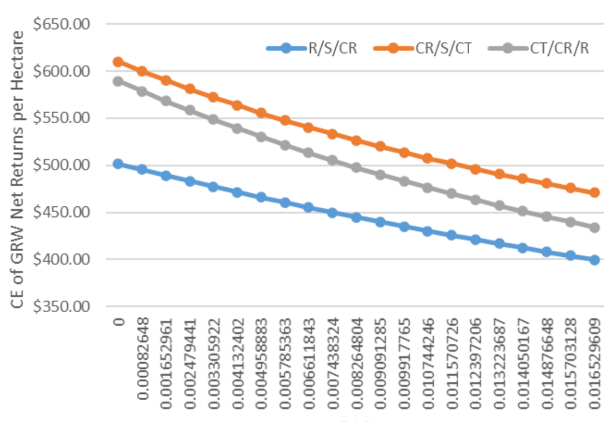

Figure 2. SERF rankings of cropping alternatives on a representative northeastern Louisiana farm (Tensas Parish).

Table 2. Mean net returns per hectare for imposed crop mixes on a representative Louisiana farm with no farm program enrollment

Rep. Farm Location	Option 1	Option 2	Option 3
Rapides Parish	$280.26	$318.90	$281.79
Tensas Parish	$434.38	$516.57	$488.73

Table 3. Mean net returns per hectare for imposed crop mixes on a representative Louisiana farm with ARC-CO farm program enrollment (all crops)

Rep. Farm Location	Option 1	Option 2	Option 3
Rapides Parish	$302.01	$347.56	$321.75
Tensas Parish	$466.73	$550.10	$549.58

Table 4. Mean net returns per hectare for imposed crop mixes on a representative Louisiana farm with PLC farm program enrollment (all crops)

Rep. Farm Location	Option 1	Option 2	Option 3
Rapides Parish	$337.25	$367.97	$371.84
Tensas Parish	$489.76	$569.49	$594.52

Table 5. Mean net returns per hectare for imposed crop mixes on a representative Louisiana farm with ARC-CO and PLC farm program enrollment (PLC choice for corn, seed cotton, and rice and ARC-CO for soybeans)

Rep. Farm Location	Option 1	Option 2	Option 3
Rapides Parish	$339.56	$370.29	$371.96
Tensas Parish	$494.71	$574.47	$594.72

Results in Fig. 1 for Rapides indicate that as the level of risk aversion increases, the rice/soybean/corn enterprise option (option 1) dominates or, alternatively stated, increases the grower's share of net returns as compared to the cotton/corn/rice crop option (option 3). However, grower net returns from both options 1 and 3 are less than the corn/soybean/cotton (option 2). Results in Fig. 2 for Tensas indicate that the corn/soybean/cotton enterprise option (option 2) dominates all other alternatives across all levels of implied risk. One observation is that cotton yields are historically greater in Tensas (northeast) than in Rapides (central) due to favorable agronomic production conditions and the proximity/frequency of cotton ginning infrastructure present in northeastern Louisiana.

Table 3 imposes the ARC-CO program election for all covered commodities for both Rapides and Tensas, respectively. Similar to the results in Table 1, the corn/soybean/cotton enterprise option (option 2) maximizes the grower's share of net returns per hectare for both farms ($439.85 and $630.43 per hectare, respectively).

In Fig. 3, the corn/soybean/cotton enterprise option (option 2) dominates all alternatives across all risk levels. However, results from Fig. 4 suggest that for Tensas, a grower's CE of net returns between options 2 and 3 is $5.50 per hectare. When comparing the impact of farm program choice, the election of ARC-CO generates a difference of approximately $29.64 per hectare between enterprise options 2 and 3 (Table 2). Therefore, the economic intuition here is that ARC-CO program payments for seed cotton and rice could possibly offset lower returns across risk versus no farm program participation.

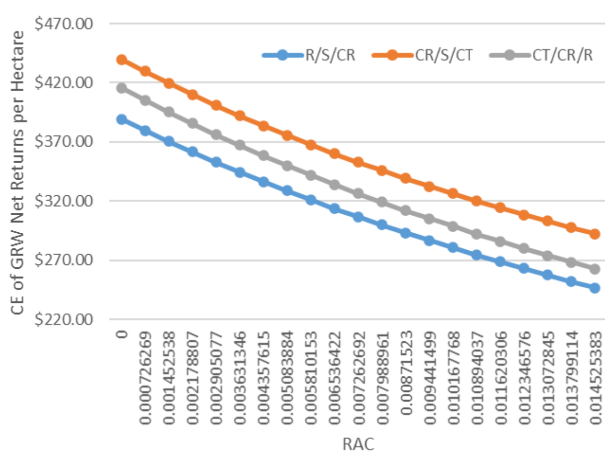

Figure 3. SERF rankings of cropping alternatives on a representative central Louisiana farm (Rapides Parish), with ARC-CO farm program selection across all covered commodities.

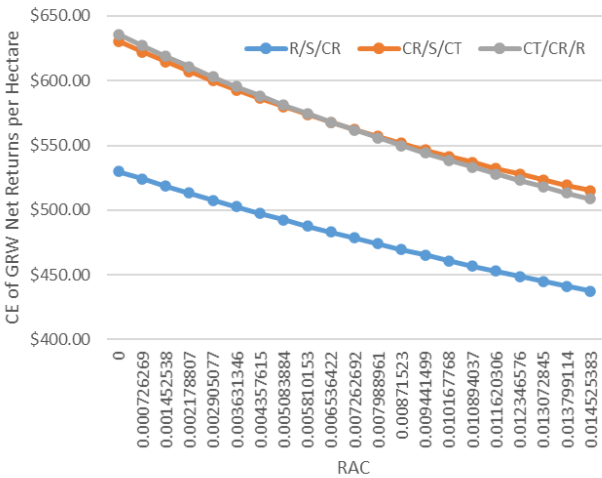

Figure 4. SERF rankings of cropping alternatives on a representative northeastern Louisiana farm (Tensas Parish), with ARC-CO farm program selection across all covered commodities.

Table 4 imposes the election of PLC program participation for all covered commodities for both Rapides and Tensas. Results indicate that the cotton/corn/rice crop option (option 3) generates the highest level of net returns per hectare for both locations. For Rapides, the difference between options 2 and 3 is approximately $13.44 per hectare for a risk-neutral producer. Hence, participation in PLC renders option 3 more appealing as compared to the corn/soybean/cotton (option 2) under the assumption of no government program participation as listed in Table 2. The $39.11 premium in option 2 over option 3 is eroded when PLC program payments are considered. As such, option 3 is the preferred crop choice (Fig. 5). The cotton/corn/rice enterprise option (option 3) for Tensas dominates all alternatives across all levels of risk appearing in Fig. 6.

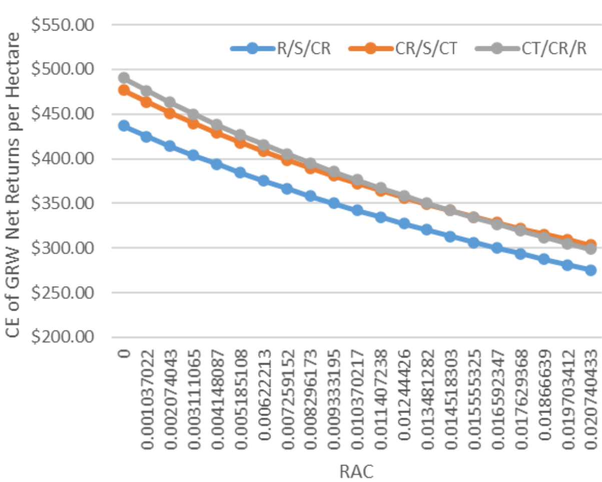

Figure 5. SERF rankings of cropping alternatives on a representative central Louisiana farm (Rapides Parish), with PLC farm program selection across all covered commodities.

Table 5 imposes the election of PLC program participation for corn, seed cotton, and rice and ARC-CO for soybeans. Results indicate that the cotton/corn/rice crop option (option 3) generates higher grower net returns for both Rapides and Tensas at $490.35 and $698.27 per hectare, respectively, at a risk coefficient of 0. Similarly, for Rapides, graphical analysis as presented in Fig. 7 coincide with the results in Fig. 5. This suggests the possibility that an ARC-CO election for soybeans (in lieu of PLC) has a null effect on grower whole-farm net returns. Results in Fig. 8 for Tensas seem to arrive at the same conclusion as the election of ARC-CO for soybeans as opposed to PLC also having a null effect ($698.27 per hectare as shown in Fig. 6).

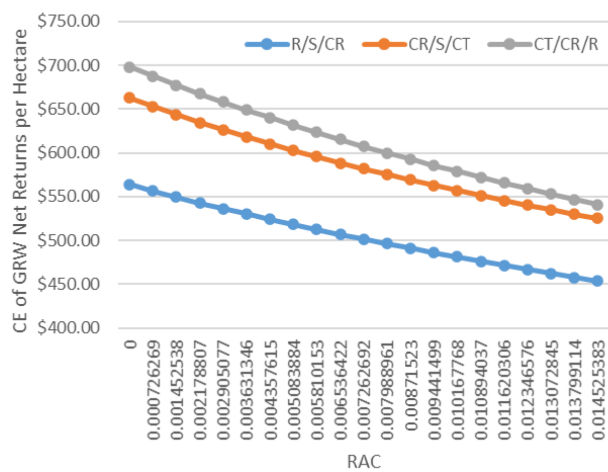

Figure 6. SERF rankings of cropping alternatives on a representative northeastern Louisiana farm (Tensas Parish), with PLC farm program selection across all covered commodities.

At a risk-aversion coefficient of 0 (risk neutral), grower net returns (CE) for production option 1 are $437.59 per hectare, $477.85 per hectare for option 2, and $490.34 per hectare for option 3. This implies greater grower net returns for option 3 are preferred to options 2 and 1 in that order (Fig. 7). Thus, returns from the cotton/corn/rice rotation are preferred for Rapides. Albeit, the level of variability mirrors that of Tensas for identical cropping options, the range of variability is narrower for Rapides. As the level of risk aversion increases, options 3 and 2 approach parity but then diverge from one another as option 2 becomes the preferred enterprise selection at higher levels of risk. At higher levels of risk, soybeans will be substituted for rice in enterprise selection for Rapides parish as soybeans have a propensity to contribute more to net returns than rice does.

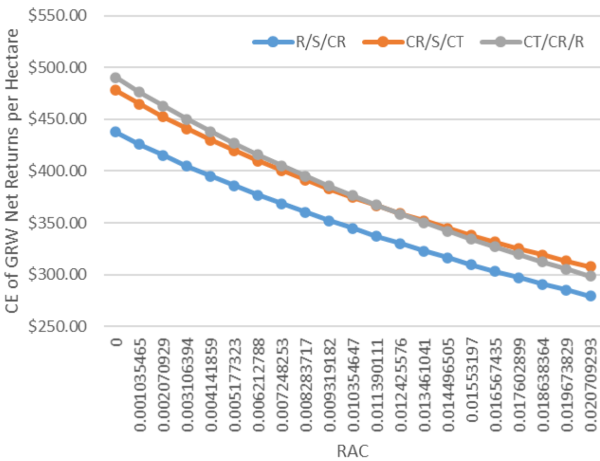

Figure 7. SERF rankings of cropping alternatives on a representative central Louisiana farm (Rapides Parish), with PLC farm program selection for corn, seed cotton and rice with ARC-CO selection for soybeans.

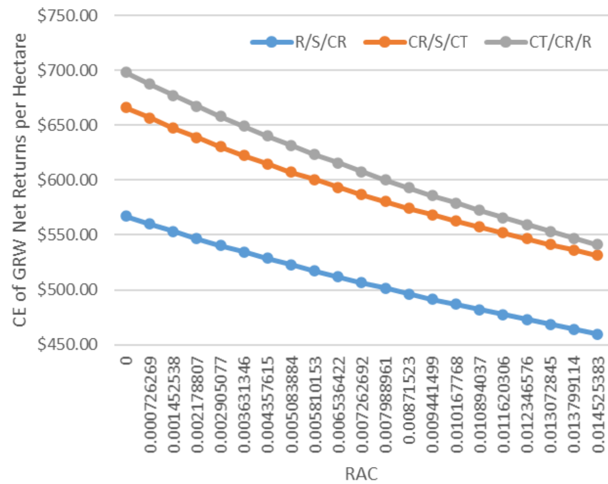

Figure 8. SERF rankings of cropping alternatives on a representative northeastern Louisiana farm (Tensas Parish), with PLC farm program selection for corn, seed cotton and rice with ARC-CO selection for soybeans.

Results in Fig. 8 suggest that at a risk-aversion coefficient of 0 (risk neutral), grower net returns (CE) for option 1 are $567.34 per hectare, $662.07 per hectare for option 2, and $698.27 per hectare for option 3. This implies that greater returns for option 3 are preferred to options 2 and 1 in that order. Returns from the cotton/corn/rice rotation are preferred for Tensas. Across increasing levels of risk aversion, option 3 dominates but as risk aversion increases, option 3 approaches option 2 denoting a reduction in the risk premium between enterprise options (Fig. 8). When the level of risk aversion is increased, the tradeoff between enterprise selection decreases between options 3 and 2. Those enterprise options are synonymous to Tensas as the production environment and managerial efficiency is directed towards the production of cotton and corn. Thus, it is postulated that both cotton and corn produced in Tensas under irrigation have worked to mitigate yield variability and find support in historical yield data for the 10-year observation period.

Risk premiums for Rapides and Tensas were associated with their participation in either ARC, PLC, or absence from participation in either ARC or PLC are presented in Table 6. Here, risk premiums are interpreted as the average increase in grower's share of net returns across varying levels of risk subject to farm program payment (if any) for a given enterprise selection as compared to representative farm analysis with no imposed program participation.

In Rapides, under a rice/soybean/corn rotation (option 1), corn/soybean/cotton rotation (option 2), and a cotton/corn/rice rotation (option 3), optimal mean net returns per hectare would come under option 3 with PLC election for corn, seed cotton, and rice and ARC-CO program election for soybeans. The impact that farm program payments have on grower net returns per hectare range between $21.75 to $90.17 per hectare. In Tensas, under a rice/soybean/corn rotation (option1), corn/soybean/cotton rotation (option 2), and a cotton/corn/rice rotation (option 3), optimal mean net returns per hectare would also come under option 3 with a PLC election for corn, seed cotton, and rice and an ARC-CO election for soybeans. The impact that farm program payments have on grower net returns per hectare range between $32.36 to $106.00 per hectare.

From these results, one can conclude that both enterprise production and program election choice play an important role in the farm's risk management decision. This is especially true for the 2021 crop year as growers make annual farm program elections. In the

Table. 6. Difference in mean net returns per hectare for imposed crop mixes on a representative Louisiana farm with ARC-CO and PLC farm program enrollment (PLC choice for corn, seed cotton, and rice and ARC-CO for soybeans).

Farm Location	All ARC-CO			All PLC			All PLC but ARC-CO SY		
	1	2	3	1	2	3	1	2	3
Rapides Parish	$21.75	$28.66	$39.96	$56.99	$49.07	$90.05	$59.30	$51.38	$90.17
Tensas Parish	$32.36	$33.52	$60.86	$55.39	$52.92	$105.79	$60.34	$57.90	$106.00

absence of farm program enrollment, a corn/soybean/cotton rotation was preferable for both representative farms. When farm program payments were considered, a cotton/corn/rice rotation with universal PLC election would be more profitable for both representative farms across multiple risk-aversion levels. As market prices for both cotton and rice have historically fallen below statutorily mandated reference prices for the PLC program, the PLC program addresses price risk more directly as opposed to ARC, which addresses revenue risk. An important caveat to this analysis is that each representative farm's base acres were assumed to model actual planted acres. Because the decoupled nature of farm policy acts to grant producers flexibility in their annual planting decisions, future research could be expanded to alter the base acreage characteristics of these farms to better isolate the effect of farm program choice. As growers are not homogenous in their attitudes towards risk and as market conditions change, growers are now more able to tailor farm program choice to mitigate the type of risk they deem more imminent (revenue versus price).

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DISCLAIMER

Research herein does not constitute or is intended to be seen as economic advice but is for educational purposes only.

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