Customizable Area Whole-Farm Insurance

(CAWFI)

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In discussions of alternative risk protection programs, policy makers and farmers are sometimes attracted to the whole-farm insurance concept because whole farm insurance can pool all risks of a farm into a single insurance policy and can provide insurance more cheaply as compared to commodity specific revenue insurance or any individual price and or yield insurance products. For example, last year the Chairman of the House Agriculture Committee, Collin Peterson, mentioned that a more flexible whole farm revenue concept might be considered a better farm program (Reuters, April 21, 2010). However, one should note that adjusted gross revenue (AGR) and AGR-lite are two whole farm insurance products already offered by RMA. Both are based on the income reported on Schedule F federal income tax forms which may not accurately represent the true farm income. The AGR and AGR-lite products are complex, in part due to the need to make accrual adjustments to the federal Schedule F which is based on cash accounting. Thus, the AGR and AGR-lite products balance the choice of very stringent underwriting rules to prevent fraud and moral hazard with an operationally simple program that may reward gamesmanship rather than good farming practices. Another issue with farm-level whole farm insurance is that the need to understand price variability, yield variability, and price-yield interactions for all the commodities grown on a farm makes developing insurance premium complex and opens up the potential for adverse selection due to inaccurate rating assumptions (Dismukes and Coble, 2006).

Adverse selection and moral hazard are two major insurability problems in crop insurance that can be minimized through area-based insurance products (Miranda, 1991). Group risk protection (GRP) is an area-yield based crop insurance product offered by the Risk Management Agency (RMA) of the U.S. Department of Agriculture. Group risk income protection (GRIP) is an area-revenue based product based on county average yields and futures market prices (Edwards, 2009). As the area (county) average yield is not perfectly correlated with the farm average yield, GRP and GRIP are subject to basis risk. An insured farmer may not experience an actual loss but still may receive an indemnity if the county experiences a yield or revenue shortfall. Alternatively, a policy holder may not receive an indemnity when they experience a farm level loss if there is no loss at the county level (Barnett et al., 2005).

This manuscript evaluates an alternative that could provide significant whole farm risk protection while avoiding the potential abuse of farm-level designs. Specifically, we analyze a customizable area whole farm insurance (CAWFI) design. This manuscript investigates the safeguards of combining area-revenue insurance with the risk reducing effectiveness of whole farm (multiple commodities) coverage. An important component of CAWFI is a weighting system that customizes the mix of area coverage to a particular farm's enterprise mix.

Area based insurance products are more prone to basis risk than farm level products but are less affected by moral hazard and adverse selection problems. Whole farm insurance can protect risks associated with multiple commodities at a lower premium cost than insuring each commodity separately. But whole farm insurance requires complex premium rating and indemnity calculations.

An important challenge for the CAWFI design is accounting for the fact that the crop mix on the farm may be quite different than that of the county. A weighting mechanism is necessary to customize the area coverage to the farm's crop mix. One could simply use the sum of aggregated commodity revenue by county. However, this implicitly weights all commodities by the crop mix of the county. A farm growing a different crop mix could potentially receive poor risk protection due to the lack of correlation between farm and county crop mix. This manuscript proposes a procedure for estimating optimal weights for each crop.

This manuscript develops a simulation model capable of modeling correlated prices and yields with mixed marginal distributions at both the farm and county level. CAWFI yield and revenue insurance designs are evaluated for a representative Delta farm in Mississippi.

History of Crop Insurance

The history of federal government involvement in offering crop insurance in the United States begins in the 1930s. Because of the correlated risks, adverse selection, and moral hazards problems, it is difficult to develop farm level agricultural insurance products. The US government initially offered only yield insurance but later began offering revenue insurance products as well.

The farm level yield insurance product offered in the United States is known as Actual Production History (APH) multiple peril crop insurance (MPCI). This product protects insured farmers against yield loss caused by multiple perils such as excessive rainfall, disease, and drought. MPCI benefits may vary sharply among farms, crops and regions (Knight and Coble, 1997). Some perils are also spatially correlated. As a result, if offered privately a private insurer would need large capital reserves and/or reinsurance to backstop the risk exposure of the insurers (Skees et al. 2008).

In an attempt to minimize adverse selection and moral hazards problems associated with crop insurance, RMA introduced an area-based insurance product, GRP, in 1993. For area based products, the higher the positive correlation between the farm yield and county yield, the lower the basis risk (Barnett et al., 2005). GRP has less moral hazard problem and lower transaction costs, as it avoids establishing APH yields and no on-farm loss adjustment is required. GRP basis risk is lower in relatively homogenous production regions. The area-based insurance products accounted for 9% of federal crop insurance program acres in 2005. Area insurance could become an available alternative insurance product instead of farm-level insurance even in heterogeneous geographical production regions when premium rates for farm level insurance contain large positive wedges (Deng et al., 2007). The wedge is simply the difference in the premium cost and expected indemnity for that particular insurance product where its positive values inform that premium cost is higher than indemnity expected and vice versa.

The Group Risk Income Protection (GRIP) is an area-revenue product, introduced in 2000 (Dismukes and Glauber, 2004). Futures market prices and county-level yields are used in GRIP revenue calculations and the indemnity is paid based on county revenue shortfalls. GRIP represented 3.5% of acres insured under revenue insurance in 2005 (Coble and Miller, 2006). Note also that Loan Deficiency Payments (LDPs) and Counter Cyclical Payments (CCPs) provide only price risk protection whereas GRIP provides revenue risk protection (Paulson and Babcock, 2008). Therefore there is some overlap of price and revenue protection programs.

In 1996, crop revenue insurance plans were added in FCIP for the first time. Assuming that farm decision makers seek to maximize utility from profits, separate price and yield risk protection programs provide risk protection at a higher cost than a single revenue insurance product. Crop Revenue Coverage (CRC), Revenue Assurance (RA), and Income Protection (IP) are existing revenue insurance programs. Initially, crop revenue insurance programs were introduced in limited areas for specific crops. However, crop revenue products rapidly became popular among farmers and now account for the vast majority of farm level insurance policies sold. To some extent, revenue insurance products substitute for other risk reducing strategies such as hedging using futures or options. This substitution effect increases rapidly for revenue insurance coverage levels greater than 70%. Yield insurance, on the other hand is complementary to hedging (Coble et al., 2000). Mishra and Goodwin (2006) point out that the revenue insurance can shift taxpayer's burdens to subsidize farmer's insurance premium more efficiently. Revenue variability occurs due to variation in price and yield, and the correlation between price and yield. Price is determined mostly by world markets while yield is based on micro climatic factors, so farm revenue tends to be highly responsive to fluctuations in farm yield. In general, the relation between price and yield is negative which makes revenue less variable than yield. A more negative correlation between price and yield reduces revenue risk. In 2000, whole farm insurance products such as AGR and AGR-lite were first introduced. These products had only a 3.53% market share in 2005 (Coble and Miller, 2006).

Price risk protection has been provided through the commodity title of the farm bill through loan programs, deficiency payments, and more recently the counter-cyclical program, SURE program, and the ACRE program. In the 2008 Farm Bill, the Average Crop Revenue Election (ACRE), and Supplemental revenue (SURE) programs were introduced as optional income support program. ACRE provides price as well as yield protection, and is based on 2-year national average price and 5-year state average yield. When state and farm revenue for the specific crop in the given crop year falls below bench mark revenue, an ACRE payment is made. The ACRE program may also substitute for crop insurance products because it protects against revenue shortfalls (Cooper, 2010, Zulauf et. al, 2008). The SURE program covers revenue losses with payments based on whole farm revenue shortfalls. Farmers are eligible for SURE payment when they buy at least the catastrophic level of federal crop insurance coverage. The optimal crop insurance coverage level is affected by SURE payments to some extent. SURE provides some incentive for farmers to move toward mid-level coverage (Anderson, Barnett, and Coble, 2009). Thus, these insurance products and Farm Bill programs have potential redundancies because they all protect against revenue risk.

Multivariate Simulation

Historical multivariate simulation has been most easily performed by assuming multivariate normality. However, imposing normality on the marginal distribution of crop yields and prices is often not supported by empirical data. The entire marginal price distributions are correlated with each other and the marginal yield distribution are also typically correlated. The interaction between price and yield has also been noted. Only by using a procedure capable of modeling and simulating multivariate distributions can one analyze such complex combinations (Ramirez, 2000). Ramirez notes that, in general, both the mean and the variance of the marginal distributions of crop yield and price are found to be shifting over time. Marginal price distributions are typically correlated with each other because crop production is typically correlated and many crops also substitute for each other in output markets.

The Iman and Conover (IC) procedure (1982) is commonly used to simulate multivariate risks in agricultural economics research (Mildenhall, 2005). Another procedure by Phoon, Quek, and Huang (PQH) (2004) has also been used in agricultural economics. The PQH is a multivariate simulation technique for correlated stochastic variables from mixed marginal distribution based on Eigen decomposition of the rank correlation matrix. Comparing with the IC (1982) simulation technique, the PQH (2004) procedure is a straightforward and distribution free simulation technique. Anderson, Harri, and Coble (2009) find the PQH procedure results in more accurate relations between interdependent random variables, as the t-test for the rank correlation matrix from simulated data does not differ significantly to that of the original correlation. The PQH simulated data has relatively small bias. It is well suited for multi-crop insurance modeling.

Conceptual Framework

The farmer's portfolio is assumed to consist of multiple crops. The expected return on a portfolio of *n* different crops is expressed as,

(1.) $E(R_{portfolio})_t = \sum_i \varpi_i E(NR_i)$

Where, $E(NR_i)$ = expected net return for crop *i*, ϖ_i = the proportion of crop *i*, and $\sum_i \varpi_i = 1$ or 100%.

Assuming two crops 1 and 2 in a portfolio, and $\rho_{1,2}$ is the correlation between them, then the variance in portfolio return would be expressed as;

(2.) $\sigma^2{}_{portfolio} = \varpi_1^2 \sigma_1^2 + \varpi_2^2 \sigma_2^2 + 2\varpi_1 \varpi_2 \sigma_1 \sigma_2 \rho_{1,2}$

Risk averse farmers will have a decreasing marginal utility over ending wealth. This study assumes that decision makers maximize a constant relative risk aversion (CRRA) utility function of wealth. Designating the weighted probability of possible outcome *t* as ϖ_t then,

(3.) $NR_t = \varpi_1 NR_{1t} + \varpi_2 NR_{2t}$

Where,

$W_t = W_o + NR_t$

W_o = initial wealth and NR_t = net return from different scenarios which are stochastic. Given a risk aversion coefficient r,

(4.) $U = \frac{W_t^{1-r}}{1-r}$ if r≠ 1 and $U = \ln(W_t)$ if r =1.

The farmer's expected utility is

(5.) $E(U) = \sum_{t=1}^{n} \eta_t \frac{W_t^{1-r}}{1-r}$ if r≠1 and $E(U) = \sum_{t=1}^{n} \eta_t \ln(W_t)$ if r=1.

Where, η is the weight assigned based on the probability of possible outcome t.

The CAWFI revenue to count is calculated as,

(6.) $CAWFI_{RC} = \sum_i A_{i,f} \times P_i \times Y_{i,c}$

Where, $CAWFI_{RC}$ is revenue to count, $A_{i,f}$ is planted acres of crop *i*, on farm *f*, P_i is output price of crop *i*, and $Y_{i,c}$ is yield for crop *i* in county *c*.

The guaranteed revenue under CAWFI customizing with appropriate weights is as follows,

(7.) $CAWFI_{Guar} = \sum_i \mu_{i,f} \times E(P_i) \times E(Y_{i,c}) \times CL$

Where,

$CAWFI_{Guar}$ = guaranteed revenue under CAWFI, $\mu_{i,f}$ = appropriate weight for the planted acres of crop *i* in the farm f, CL = coverage level, $E(P_i)$ = expected output price for crop *i*, $E(Y_{i,c})$ = expected yield for crop *i* in county *c*.

(8.) $CAWFI_{INDEMNITY} = Max[0, \{CAWFI_{Guar} - CAWFI_{RC}\}]$

To pay indemnities, revenue to count should be lower than guaranteed revenue. Net revenue for a farm that purchases CAWFI is the sum of net revenue without CAWFI plus any CAWFI indemnity minus the CAWFI premium.

(9.). $CAWFI_{NETREV} = (NOPROG_{NETREV} + CAWFI_{INDEMNITY} - CAWFI_{PREMIUM})$

Ending wealth for the farm will be the sum of beginning wealth and $CAWFI_{NETREV}$.

For purposes of comparison, similar calculations are performed for a hypothetical farm level whole farm insurance product. Certainty equivalents are calculated as

(10). $CE_j = e^{E\,Uj} - W_o$ if r=1,

$CE_j = EU_j(1-r)^{\frac{1}{1-r}} - W_o$ if r≠1.

Where, EU_j is expected utility for scenario *j*, W_o is initial wealth, and CEj is certainty equivalent of scenario *j*.

Data

Our analysis is based on a representative cotton-soybean-corn farm in Yazoo County, Mississippi. Historical county yield data from 1975 to 2009 were obtained from the National Agricultural Statistics Services (NASS). For the same years, the US national marketing year average (MYA) prices were collected from the Economic Research Service (ERS). The within-year future price changes for the same year were also collected. Farm-yield was simulated from the county yield according to Miranda's formulations as described in Coble and Dismukes (2008) as follows;

(11.) $Y_{f,t} = \mu_f + \beta_f (y_{c,t} - \mu_c) + \varepsilon_{f,t}$

Where, $Y_{f\,t}$ and y_{ct} are random farm yield and county yield respectively at period t, μ_f and μ_c are the expected farm and county yield, β_f is the responsiveness of farm yield to deviations from expected county yield, and ε_{ft} is the idiosyncratic risk.

Developing the CAWFI Model

Monte Carlo simulation is one of the most popular sampling methods that can generate thousands of data of having same properties as of original set of data. The multivariate stochastic simulation technique proposed by Anderson, Harri, and Coble (2009) was used to generate correlated samples and used to evaluate the CAWFI design.

To use the PQH simulation technique, first, the yield trend was estimated and removed from the data before fitting parametric distributions. Several studies in agricultural economics support the use of beta distribution for yield data, and log normal distribution for price data (Roberts, Goodwin, and Coble, 1998). Crop yield is non-negative, and the beta distribution ranges from 0 to 1, but can be scaled to any interval. However, one must define the upper and lower bound for scaling. Price and yield are both non-negatives having lower bound value zero. These parametric assumptions were imposed on the historical data. The marginal probability distribution and correlation matrix for the original data set were obtained. Using Eigen values decompositions of the correlation matrix, 100,000 sample data for prices and yields were generated through PQH simulation technique to stabilize the results. The rank correlation as well as descriptive statistics of original data and simulated data was tested using t-test whether the simulated data match the original set of data.

Assuming farmers are risk-averse, returns from CAWFI was computed and converted to utility values using the constant relative risk aversion (CRRA) function as mentioned above. A CRRA risk aversion coefficient of 1 indicates somewhat risk averse; 2.0 indicate moderately risk averse; 3.0 indicate risk averse; and 4.0 indicates extremely risk averse (Hardaker et al., 2004: pp92-120). The expected utility under no insurance program, CAWFI, and farm level whole farm Insurance (CFWFI) were converted into certainty equivalents. The certainty equivalent for differing expected utility risk aversion values were compared to measure the benefit of CAWFI to producers of varying risk aversion levels under different coverage level. Sensitivity analysis was conducted on the risk aversion coefficient assuming CRRA utility function of wealth.

Results and Discussion

Table 1 presents the descriptive statistics of data used in representative farm modeling. This analysis has constructed four different types of crop mix in the representative corn-cotton-soybean farm in Mississippi based on acres percentage of the crop in the farm. All three crops sharing one third of acres in the farm would be called as evenly distributed acres in the farm. The farm where one crop is assumed to share 70% of total acres is major crop and remaining two shares 15% each allows specification of three different farm type; corn major, soybean major, and cotton major farms. Insurance coverage level at 70%, 80%, and 90% have taken to compare the three different scenarios; no insurance program, CAWFI program, and CFWFI program based on their certainty equivalents and indemnities paid values under various risk levels and farm types.

<u>Comparison across Coverage Levels</u>

The certainty equivalents and indemnities paid for different crop mix with various coverage level for the highly risk averse decision makers (risk aversion coefficient r= 3), are presented in table 2. Here, the certainty equivalents for CAWFI are slightly higher than no insurance program. The cotton major Mississippi farm at 90% coverage level, CAWFI produces 1.07% higher certainty equivalents than no insurance program for the same farm type at the same coverage level. The ordering of certainty equivalents under CAWFI relative to no program are cotton farm, evenly distributed acres in the farm, corn farm, and soybean major Mississippi farm for all coverage levels in descending order. The CFWFI program has substantially higher certainty equivalents relative to CAWFI for all type of farm and all coverage levels in Mississippi. The lowest difference is for the evenly distributed acres in the farm at 70% coverage level which is 2.70%, and the highest difference is 13.63% which is in cotton major farm at 90% coverage level- others are in between.

An evaluation of indemnity paid levels shows CAWFI has sharply lower rate than CFWFI for all types of farm and all coverage levels. The CFWFI indemnities differences relative to CAWFI are higher in lower coverage level as compared to higher coverage levels. For example, the Mississippi cotton farm with 70% coverage level has $23342 indemnity in CFWFI and $77 indemnity in CAWFI. For the same type of farm at 90% coverage level, CFWFI indemnity is $66679 and CAWFI indemnity is $7870. On the other side, cotton major Mississippi farm has highest indemnities for CFWFI over CAWFI and then Soybean major, corn major, and evenly distributed acres farm in the descending order for the various coverage levels. The indemnities under CAWFI are seems more or less similar under different crop mix at the same coverage levels. It is clear the county based program is cheaper and higher coverages may be obtained from CAWFI than from CFWFI. For example for the evenly distributed acres farm a 90% CAWFI policy would cost roughly the same as a 70% CFWFI policy. However, it is also apparent that the 70% CFWFI provides greater risk reduction.

Comparison across Risk Aversion Levels and Farm Types

Table 3 summarizes the certainty equivalents and indemnities paid under different farm types having varying risk aversion levels at 80% coverage level. At 80% coverage level, for all four different types of crop mix and four different risk aversion levels of decision makers, CAWFI produced slightly higher certainty equivalents over no insurance program in Mississippi. Though it is not that big difference, CAWFI has produced higher percentage difference over no insurance program as the risk aversion level of decision makers increases. For all four risk level, extremely risk averse decision makers(r=4) have highest difference of CAWFI over no insurance program as compared to very risk averse(r=3), moderately risk averse(r=2), and some what risk averse(r=1) in descending order. The other product, CFWFI, produces higher certainty equivalent values as compared to CAWFI regardless of farm type and coverage levels. The differences are bigger in higher level of risk aversion as compared with lower level of risk aversion. For example, extremely risk averse decision maker in cotton major Mississippi farm can produce 15.97% higher certainty equivalents under CFWFI as compared with the same farm type with somewhat risk averse decision makers.

Conclusions

The CAWFI model is able to produce at least slightly higher certainty equivalents as compared to no insurance program. However, these certainty equivalent values are lower while comparing with CFWFI. Keep in mind that there is reason to doubt that CFWFI is a workable insurance plan. In this study it used as a benchmark for comparison. CAWFI has lower indemnity paid as compared to CFWFI regardless of risk aversion levels, coverage levels, and farm types. Thus, a comparison of products with equal cost would involve higher coverages for the CAWFI product. Note also that if federal subsidies were applied as is the case with GRP/GRIP, then the higher priced product would also receive more subsidies.

There are several areas where this study could be extended. First, the replication of this study in other geographical locations with different crop mix would be useful to see if these results are robust. Further, the weights used for the CAWFI product were proportion of farm revenue. Other weights could be examined to see if they produce more risk reduction. Finally it is unlikely that CAWFI would become the sole farm program or that it would be unsubsidized. Thus, an examination of how CAWFI may be integrated with other program may be a relevant practical application.

References

Abbott, Charles. 2010. US Farm Supports may Need Change-Key Lawmaker. *Reuters*, Apr 21. http://www.reuters.com/article/idUSN2120298720100421(accessed September 13, 2010).

Anderson, J., A. Harri, and K. Coble. 2009. Techniques for Multivariate Simulation from Mixed Marginal Distributions with Application to Whole-Farm Revenue Simulation. *Journal of Agricultural and Resource Economics* 34(1):53-67.

Anderson, J., B. Barnett, and K. Coble. 2009. Impacts of the SURE Standing Disaster Assistance Program on Producer Risk Management and Crop Insurance Programs. Selected Paper for American Agricultural Economics Association Annual Meeting, Milwaukee, WI. July 26-28.

Barnett, B.J., J.R.Black, Y. Hu, and J.R. Skees. 2005. Is Area Yield Insurance Competitive with Farm Yield Insurance? *Journal of Agricultural and Resource Economics* 30(2):285-301.

Coble, K. and R. Dismukes. 2008. Distributional and Risk Reduction Effects of Commodity Revenue Program Design. *Review of Agricultural Economics* 30(2):543-553.

Coble, K. and J. Miller. 2006. The Devil's in the Details: Why a Revenue-Based Farm Program is No Panacea. https://ageconsearch.umn.edu/bitstream/15806/1/sp060001.pdf (accessed September 13, 2010).

Coble, K.H., R.G. Heifner, and M. Zuniga. 2000. Implications of Crop Yield and Revenue Insurance for Producer Hedging. *Journal of Agriculture and resource Economics* 25(2):432-452.

Cooper, J. 2010. Average Crop revenue election: A Revenue-Based Alternative to Price-Based Commodity Payment Programs. *American Journal of Agricultural Economics* 92(4):1214-1228.

Deng, X., B.J. Barnett, and D.V. Vedenov. 2007. Is There a Viable Market for Area-Based Crop Insurance? *American Journal of Agricultural Economics* 89(2) : 508-519.

Dismukes, R. and J. Glauber. 2004. Why Hasn't Crop Insurance Eliminated Disaster Assistance? *Amber waves*, USDA/ERS. http://www.ers.usda.gov/AmberWaves/June05/Features/WhyHasntCropInsurance.htm (accessed September 26, 2010).

Dismukes, R. and K.H. Coble. 2006. Managing Risk with Revenue Insurance. *Amber Waves*, USDA/ERS. http://www.ers.usda.gov/AmberWaves/November06/Features/Managing.htm (accessed September 26, 2010).

Edwards, W. 2009. Crop Revenue Insurance. *Ag Decision Maker*. Iowa state University, University Extension, and Revised February 2009.

Hardaker, J.B., R.B.M.Huirne, J.R. Anderson, and G. Lien. 2004. *Coping with Risk in Agriculture*. 2nd ed. CAB International, Cambridge USA. Pp 92-120.

Knight, T.O. and K.H.Coble. 1997. Survey of U.S. Multiple peril Crop Insurance Literature since 1980. *Review of Agricultural Economics* 19:128-156.

Miranda, M.J. 1991. Area Yield Crop Insurance reconsidered. *American Journal of Agricultural economics* 73(2): 233-242.

Mildenhall, S.J. 2005. Correlation and Aggregate Loss Distribution with an Emphasis on the Iman-Conover Method. Report of the Research Working Party on Correlations and Dependencies Among All Risk Sources, Casualty Actuarial Society. http://scholar.google.com/scholar?q=correlation+and+aggregated+loss+distributions+with+an+emphasis+on+the+Iman-Conover+method&hl=en&btnG=Search&as_sdt=200000001&as_sdtp=on (accessed on January 2, 2011).

Mishra, A.K. and B.K. Goodwin. 2006. Revenue Insurance Purchase Decisions of Farmers. *Applied Economics*, 38: 149-159.

Paulson, N.D. and B.A. Babcock. 2008. Get a GRIP: Should Area Revenue Coverage be Offered Through the Farm Bill or as a Crop Insurance Program*? Journal of Agricultural and Resource Economics* 33(2):137-153.

Ramirez, O.A. 2000. Parametric Modeling and Simulation of Joint Price-Production Distributions under Non-Normality, Autocorrelation and Heteroscedasticity: A Tool for Assessing Risk in Agriculture. *Journal of Agricultural and Applied Economics*, 32:283-297.

Risk Management Agency (2004). *National Summary of business Report*, US Department of Agriculture, Washington DC.

Roberts, M., B.K. Goodwin., and K. Coble. 1998. Measurement of Price Risk in Revenue Insurance: Implications of Distributional Assumptions, Paper for AAEA Summer Meeting, Salt Lake City, May 1998.

Skees, J.R., B.J.Barnett, and B. Collier. 2008. Agricultural Insurance background and Context for Climate Adaptation Discussions. Developed for the OECD "Expert Workshop on Economic Aspects of Adaptation", Paris, France, April 7-8.

Zulauf, C.R., M.R. Dicks, and J.D.Vitale. 2008. ACRE (Average Crop Revenue Election) Farm Program: Provisions, Policy Background, and Farm Decision Analysis. *CHOICES*, 3rd Quarter -23(3). http://www.choicesmagazine.org/magazine/pdf/article_33.pdf (accessed September 15, 2010).

Table 1. Descriptive Statistics of Data Used in Representative Farm Models

Variable	Mean	Std Dev	Minimum	Maximum
End Future Price of Corn	5.190	0.524	2.822	7.607
End Future Price of soybean	9.802	1.538	3.380	16.291
End Marketing year average price of Corn	5.017	0.492	3.097	7.121
End marketing year average Price of soybean	10.086	1.285	4.810	15.818
End future Price of Cotton	0.808	0.120	0.288	1.416
End Marketing year average price of Cotton	0.806	0.106	0.336	1.241
Corn Farm Yield	149.667	45.268	34.034	250.878
Corn county yield	148.702	12.588	109.275	188.892
Corn State yield	139.575	11.034	106.290	171.626
Soybean Farm Yield	36.109	21.903	1.855	118.271
Soybean County Yield	32.782	6.367	18.437	48.847
Soybean State Yield	34.620	5.014	22.893	47.397
Cotton farm Yield	831.205	419.871	110.671	1947.110
Cotton County Yield	836.069	124.934	503.372	1175.410
Cotton State Yield	891.719	112.973	605.173	1223.330

Table 2: (r=3). Certainty equivalents ,CE (after subtracting indemnities) and Indemnities in No program, CAWFI, and CFWFI in the given condition: Initial wealth=$100,000., Risk aversion coefficient= 3.

Coverage level	CE in No program($)	CE in CAWFI (% higher to no program)	CE in CFWFI (% higher to no program)	Indemnity in CAWFI ($)	Indemnity in CFWFI ($)
Evenly Distribution of acres in the farm					
CLf=0.7, Cla=0.9	545834	0.44	2.70	7870	7949
CLf=0.8, CLa=0.9	545834	0.46	4.35	7806	17628
CLf=0.9, CLa=0.9	545834	0.45	5.94	7832	34336
CLf=0.8, CLa=0.8	545834	0.12	4.26	1256	17336
CLf=0.7, CLa=0.7	545834	0.01	2.70	78	7534
Corn is major crop in the farm					
CLf=0.7, Cla=0.9	626883	0.27	2.99	7796	9002
CLf=0.8, CLa=0.9	626883	0.28	4.84	7899	20619
CLf=0.9, CLa=0.9	626883	0.28	6.46	7947	38990
CLf=0.8, CLa=0.8	626883	0.09	4.82	1256	20703
CLf=0.7, CLa=0.7	626883	0.01	3.04	88	9132
Soybean is major crop in the farm					
CLf=0.7, Cla=0.9	394035	0.06	6.01	7851	14251
CLf=0.8, CLa=0.9	394035	0.04	8.36	7879	27043
CLf=0.9, CLa=0.9	394035	0.08	10.73	7770	45431
CLf=0.8, CLa=0.8	394035	0.04	8.44	1266	27175
CLf=0.7, CLa=0.7	394035	0.00	6.00	88	14299
23617					
CLf=0.7, Cla=0.9	520154	1.06	8.20	7912	23617
CLf=0.8, CLa=0.9	520154	0.46	10.30	7723	41655
CLf=0.9, CLa=0.9	520154	1.07	13.63	7870	66679
CLf=0.8, CLa=0.8	520154	0.29	11.06	1277	42143
CLf=0.7, CLa=0.7	520154	0.02	8.10	77	23342

*CLa and CLf are Coverage level at area and farm level programs.

**corn-soybean-cotton acres ratio 34:33:33 is evenly distribution.

*** Major crop occupies 70% acres and rest 2 crops occupy 15% of total acres in the farm.

****CAWFI is customizable area whole farm
insurance

*****CFWFI is whole farm insurance based on farm level yield.

Table 3: Certainty equivalents ,CE (after subtracting indemnities) and Indemnities in No program, CAWFI, and CFWFI in varying risk aversion coefficient in the given condition: Initial wealth=$100,000., coverage Level 0.80 under various risk aversion coefficients.

Risk aversion Coefficient	CE in No program($)	CE in CAWFI (% higher to no program)	CE in CFWFI (% higher to no program)	Indemnity in CAWFI ($)	Indemnity in CFWFI ($)
Evenly Distribution of acres in the farm					
1	584236	0.033	1.061	1245	17256
2	565670	0.07	2.52	1277	17540
3	545834	0.12	4.26	1256	17336
4	525880	0.19	6.53	1276	17461
Corn is major crop in the farm					
1	675164	0.02	1.16	1213	20414
2	651485	0.05	2.70	1240	20270
3	626883	0.09	4.82	1256	20703
4	602168	0.12	7.34	1251	20512
Soybean is major crop in the farm					
1	442104	0.00	2.16	1287	26907
2	417550	0.02	5.00	1244	27085
3	394035	0.04	8.44	1266	27175
4	371777	0.06	12.37	1256	27251
Cotton is major crop in the farm					
1	597609	0.07	2.80	1253	41749
2	557538	0.20	6.65	1244	42320
3	520154	0.29	11.06	1277	42143
4	485615	0.39	15.97	1249	41891

*CLa and CLf are Coverage level at area and farm level programs.

**corn-soybean-cotton acres ratio 34:33:33 is evenly distribution.

*** Major crop occupies 70% acres and rest 2 crops occupy 15% of total acres in the farm.

****CAWFI is customizable area whole farm insurance

*****CFWFI is whole farm insurance based on farm level yield.