The Effect of Changing Government Subsidy Programs:

An Analysis of Revenue at the Farm level

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Abstract

Producer revenue is simultaneously simulated for several hundred county-specific representative farms. The effects of current and alternative commodity programs are analyzed. In particular, two variations of revenue-triggered programs similar to plans proposed by the National Corn Growers Association are evaluated.

Keywords: Risk, commodity policy, simulation, **JEL codes**: Q180

Introduction

The nature of farming presents producers with management challenges that include endemic risks. These risks include both price and yield uncertainty, either of which can lead to revenue variability. The Farm Security and Rural Investment Act of 2002, commonly known as the 2002 farm bill, is the legislation responsible for the current support programs in place that are designed to help farmers manage risk. The 2002 farm bill is scheduled to expire in 2007, and several proposals have already been suggested by various groups such as the National Corn Growers Association and the American Farmland Trust to supplant the current legislation. The American Farmland Trust, in part, is proposing a safety net that combines a government revenue-based program with private individual revenue insurance. Presently, the U.S. Department of Agriculture (USDA) uses price-triggered subsidy programs to buffer the price risk faced by farmers. These programs include counter-cyclical payments, direct payments, and loan deficiency payments. Additionally, crop insurance programs provide another layer of protection that has traditionally mitigated yield risk, but in the last decade also began covering revenue risk. The decision to retain, modify, or completely change current policies will be made in the context of tight budgets, relatively high commodity prices, and World Trade Organization (WTO) constraints.

During these debates, economists are being called upon to provide analysis of proposed plans. The commodity programs in place today are often assessed through the use of stochastic modeling. A well-known and widely used simulation is the Farm Level Income and Policy Simulation Model, or FLIPSIM (Richardson). According to the Agricultural and Food Policy Center, FLIPSIM "uses accounting equations, identities and probability distributions to simulate the annual economic activities of a representative or actual farm over a multiple-year planning horizon." Similarly, Miller, Barnett, and Coble and Lence and Hayes designed models that analyze policy by simulating farm revenue and aggregate prices.

Another set of models widely used in policy simulations include aggregate price models such the multi-equation econometric model of FAPRI and USDA models such as that of Westcott, Young, and Price. Westcott, Young, and Price used the USDA-ERS Food and Agricultural Policy Simulator (FAPSIM) to show the impact of implementing the 2002 farm bill. Aggregate price models, such as FAPRI and FAPSIM, have been quite effective at modeling national prices for programs such as the season average price-triggered counter-cyclical payment program because prices are highly correlated across regions.

However, recent debates reflect the rising popularity of the idea of a revenue-based subsidy program. The first such plan was released by Babcock and Hart of Iowa State University, with a more recent discussion found in a paper from Paulson and Babcock. Paulson and Babcock evaluate the cost and effectiveness of implementing GRIP as a standing disaster program apart from the federal crop insurance program. Similarly, the National Corn Growers Association built a proposal incorporating area revenue components. Proposals of this nature present a number of challenges. First, benefits are driven by a mix of farm and county revenue variability so both must be modeled. Because revenue risk is dependent on yield risk the results can be quite heterogeneous across locations, making the assessment of how many representative farms are sufficient to judge to welfare implications of these proposals difficult. Further, aggregate cost is always a key issue for policy makers. With diffuse benefits, entities such as the Congressional Budget Office will likely have great difficulty assessing such programs.

This paper reports a model that simulates representative crop revenue from each of hundreds of counties in the U.S. The models incorporate important characteristics like price and yield risk and include county and other aggregate stochastic variables. Importantly, the system is designed to maintain spatial correlations across locations to maintain consistent aggregation of the results.

The model analyzes how changing the parameters of counter-cyclical payments and other programs will affect a farm's revenue distribution and individual producer welfare. The model also evaluates proposals for alternative farm subsidy programs for the 2007 farm bill and reports the cost to taxpayers for various programs. The next section briefly reviews literature relevant to the policy issues analyzed. The methods section then describes the stochastic simulation procedures and the policies analyzed. The results section reports farm program payouts and the risk-reducing effects of current commodity programs relative to the NCGA proposal as well as the risk reduction for producers generated by the alternatives examined. Finally, the conclusions assess the policy implications of the findings.

Literature Review

The literature reviewed in this section is divided into two categories. The first contains background information on the current farm subsidy program and various programs proposed for the 2007 farm bill. The second section reviews the methods used by other simulation programs.

Finally, this section examines the conclusions made by previous literature, along with the problems, to guide the direction of this study.

<u>*Subsidy Programs*</u>

This subsection examines the three types of subsidy programs currently in place: loan deficiency payments (LDPs), counter-cyclical payments, and direct payments. One idea suggested for the next farm bill is a revenue-based farm program, which is also discussed in this subsection.

The passage of the Farm Security and Rural Investment Act (FSRIA) in 2002 allowed for the continuation of marketing assistance loans and LDPs from the 1996 farm bill. However, some changes were made to loan rates and payment rates (Anderson). LDPs are paid on actual production whereas direct payments are paid on the product of a producer's program yields and 85 percent of the farm's base acres. A new program offered by FSRIA is the counter-cyclical payment program, designed to provide payments when the national season average price is equal to or above the loan rate but less than the target price minus the direct payment rate. Thus, counter-cyclical payments are maximized once the season average price falls to the loan rate. Further, these payments are paid on the product of a producer's program yields and 85 percent of a farm's base acres, both of which are decoupled from current plantings.

Miller, Barnett, and Coble study producer preferences for counter-cyclical payments and conclude that the assumption that producers prefer counter-cyclical payments to fixed payments is often overstated. Their method for analyzing farm policy is different from other programs in that it includes producer risk aversion and yield-price correlations. Including the correlations, results indicate that policy can affect different regions in different ways, which will play a role in discussions about a revenue-based farm program.

A revenue-based farm program idea has been mentioned during recent farm bill debates, which indicate this policy option is gaining more attention than previously. The reason this type of program is gaining supporters is because of the current situation involving the WTO.

According to Babcock and Hart a revenue-based program would "meet the proposed U.S. limits on trade-distorting subsidies with a high degree of probability." Babcock and Hart call for a complete redesign of U.S. farm policy. They claim a revenue target, not a price target, triggering support would reduce the number of years that farm revenue falls to an unacceptable level.

Coble and Miller look at several implications of a revenue-based subsidy plan. They point out that since the way a revenue-based policy would be implemented is unknown, how the program would fit into WTO "boxes" is also unknown. Another issue is that the primary advocates of revenue-based programs are generally located in the Corn Belt. Producers of traditional crops in the South such as rice and cotton tend to prefer price-based programs, much like the current programs. They claim this dichotomy occurs because areas where prices and yields are not negatively correlated respond better to programs that separate price risk from yield risk. However, Coble and Miller also note that revenue-based programs would affect the distribution of program benefits as revenue risk is greatest in regions and crops where yield risk is the greatest.

The National Corn Growers Association recently released their proposal for new farm programs. The group proposes several courses of action from updating and modifying current programs to creating a new program referred to as Base Revenue Protection (BRP). BRP is based on net farm revenue and would be triggered when net revenue falls more than 30 percent below the previous five-year average. The counter-cyclical payment program is changed to form the Revenue Counter-cyclical Program (RCCP). RCCP closely resembles the Group Risk Insurance

Plan (GRIP). These programs are similar in that they both are triggered when county prices are low, but unlike GRIP, RCCP is based on a fixed trigger price and not current futures prices.

Simulation Methods

A well-known and widely used simulation is the FLIPSIM model. FLIPSIM was developed in 1981 by James Richardson and uses a panel farm process, by which producers give actual farm information in a three- to four-hour session that is used to create a representative farm for their area. After the model is run, an income statement, cash flow, balance sheet, and federal and state income tax summaries are given. The program is able to summarize more than 200 risks faced by the business.

Miller, Barnett, and Coble use a nonparametric bootstrapping approach to simulate farm revenue. According to Miller, Barnett, and Coble this approach has both positives and negatives. The downside is that it is less efficient if the distribution patterns are known, but on the upside the model does not make assumptions about what the distribution is. Therefore such a model does not make biased or inconsistent estimates. Their analysis examines two representative farms at two separate locations, but could be changed for application to a larger geographic region.

Methods

The main objective of this paper is to model farm revenue for a large number of correlated representative farms. Farm revenue is defined as the product of yield and price. In this section, the steps used to calculate yield and price will be discussed, along with how government payments will be added to the farm revenue equation. A non-parametric approach will be used.

The first step in calculating farm yield is to create a matrix containing de-trended county level yields. De-trended yields were found by taking NASS county yields from 1975 to 2004 and performing a regression analysis with county-level yields as the dependent variable. A quadratic function of time is used as the explanatory variable. From the county yield data the next step is to calculate the farm-level yield. Long time series of farm-level data would be useful, but are not widely available. The approach taken uses Risk Management Agency crop insurance yield insurance rates to derive a farm-level measure of riskiness for a representative farm in the county. The effective premium rate for 65 percent coverage crop insurance in each county is used to search for k in the formula:

$$\Delta y_f = \Delta y_c * k \qquad (1)$$

where Δy_f is farm yield deviation from expectation, Δy_c is the deviation from expected county yield and k is an expansion factor. The expansion factor accounts for the aggregation effect, which leads to a riskier average farm yield in a county than the aggregate county yield. Therefore, using the crop insurance premium rate, a grid search from 1.0 to 5.0 that increases by an interval of 0.2 was used to find the yield variability that most closely approximates the crop insurance premium rate[1]. For example, Bolivar County in Mississippi has an expansion factor of 2.8 for cotton while cotton in Coahoma County, Mississippi, has an expansion factor of 2.4. Once this equation is established, the matrix $[Yc_f]$ is created, which has county and farm yields with T_1 rows for each year and N county columns.

The second stage of calculating farm revenue requires the creation of a matrix to represent relative price changes from the previous ending price. This matrix will be represented by the symbol $[P_{sit}]$, derived by using the state harvest-time prices with T_1 rows for years and M state columns. Since the T_1 row of price changes corresponds to the historical year of yield data given for the counties, the correlations between price and yield are implicitly maintained. Although in an ideal environment county-level price data would be used, the data is not available to support the

[1] Crop insurance is generally sold at the basic or optional unit level, which is typically more disaggregated than the farm. Thus, the effective premium rate data is largely a mix of basic and optional unit rates. The effective premium rates were adjusted downward by 15 percent to approximate farm-level variability.

use of county-level prices. Therefore, state-level data for years 1975 to 2004 are used since this information can be obtained from NASS.

The actual simulation uses 500 random draws of a five-year time path. Yields and prices for every location are drawn simultaneously to maintain the empirical correlations between prices and yields. Starting prices are determined from December 2006 futures market prices for 2007 delivery months. The national marketing year average (MYA) price is obtained by taking a random price change draw that is multiplied by the previous year's MYA price. State prices are obtained by adjusting national price for a regional basis. The simulation then models a five-year time path of random prices such that the expected price in year t is the MYA price for year $t-1$. This process is used for the remaining random draws. Five hundred iterations are used, resulting in 2,500 random draws for each location (five years multiplied by 500 iterations).

The model then calculates the farm program payments using the simulated prices and yields. This calculation requires additional information, and to calculate current programs such as direct payments, LDPs, and counter cyclical payments, several datasets are still needed. A matrix containing planted acres is necessary to get per-acre calculations up to the farm level. This information is obtained from NASS for the 2005 crop year. The next data set used to form calculations is a 2002 base acres matrix from the Economic Research Service (ERS). The third data set is a time series of ERS cost data used for calculating the National Corn Growers Association's net revenue payments. This data set provides a time series which is linearly regressed upon time to measure the residual variation in ERS' regional cost data. The cost data is broken down by regions that were redefined in 1996 so data for years prior to 1996 had to be matched with the more recent data.[2] A dummy variable intercept shifter is used to account for the 1996 redefinition of the data.

The first step is calculating current program payments under the simulation. These programs include direct payments, LDPs, and counter-cyclical payments. The additional information needed to calculate LDPs is the loan rate parameter. Table 1 displays the parameters used in the simulation. To calculate loan deficiency payments (LDPs):

$$LDPs = y_f * \max(0, LR - SMYA) * BA \tag{2}$$

LR stands for the loan rate, *SMYA* is the posted county price (the MYA price adjusted to a state-level), and *PA* represents planted acres. To calculate the direct payments (DP):

$$DP = \hat{y}_f * DP_R * DP_P * BA \tag{3}$$

where $\hat{y}_f$ is the predicted farm yield for 2006[3], DP_R is defined as the direct payment rate and DP_P is the direct payment percentage. The counter-cyclical payment (CCP) is calculated as:

$$CCP = MAX[0, (CCP_{TP} - DP_R - \max(LR, MYA)] * BA * CCP_p * \hat{y}_f \tag{4}$$

CCP percentage is CCP_P; CCP_{TP} is the CCP target price.

The program is structured so that yield and revenue-based commodity programs can also be modeled. Crop insurance is assumed to be insured at the 65 percent coverage level. The next step is calculating the APH indemnity (APH_i) using the following formula:

$$APH_i = EP * \max(0, APH_{CL} * \hat{y}_f - y_f) \tag{5}$$

where EP is the expected price and APH_{CL} is the APH coverage level. The NCGA-proposed program is divided into two tiers that differ in their coverage levels. The first tier has a coverage

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[2] For soybeans Kansas and Nebraska were assumed to have the same cost as the adjoining states of Missouri and Iowa.
[3] This implicitly assumes base yields will be updated to current yield expectations.

level of 70 percent while the second tier's coverage level is 100 percent. The net revenue (NR) is calculated by:

$$NR = (MYA * y_f) - C \tag{6}$$

The variable C stands for the cost in that region. The expected net revenue (NR_E) is calculated by:

$$NR_E = EP * \hat{y}_f - C_{06} \tag{7}$$

where C_{06} is the predicted cost for 2006. The net revenue guarantee is calculated by:

$$NRG = NR_E - (1 - BRP^{CL}) * |NR_E| \tag{8}$$

where BRP^{CL} is the BRP coverage level. This equation subtracts a 30 percent deductible from expected revenue. Because expected net revenue may be negative the deductible is computed using the absolute value of expected net revenue. The following two equations use the previous calculations to calculate the indemnity payment for BRP and RCCP.

$$BRP = \max(0, NRG - NR) \text{ and} \tag{9}$$

$$RCCP = \min(RCCP^{Cap} * ETP * \hat{y}_c, \max(0, RCCP_{CL} * ETP * \hat{y}_c - MYA * y_c)) \tag{10}$$

where $RCCP^{Cap}$ caps the amount of RCCP payments to 30 percent of the ETP, the effective target price (target price minus the direct payment rate) times expected county yield. After deriving these formulas, taking them from a per-acre basis to a farm-level basis is the simple step of multiplying by planted acres.

The final step is calculating total current payments and the payments of the National Corn Growers Association's proposal. Total current payments add direct payments, LDPs, counter-cyclical payments, and APH indemnity payments and market revenue. The National Corn Growers Association's proposal adds direct payments, LDPs, BRP indemnity payments, and RCCP indemnity payments. The fact these scenarios assume the NCGA proposal eliminates the current crop insurance program is of particular importance and is likely a strong assumption.

Similarly, a modified NCGA program is evaluated which eliminates the BRP and modifies the RCCP to a 95 percent guarantee.

Results

Table 2 contains the summary statistics of the variables of interest. The expected yield is averaged across the United States, which explains why the standard deviations are relatively high. In terms of the expected price, cotton's mean value is higher than the loan rate but has a standard deviation that occasionally drops it below the loan rate. Corn, however, was initiated with a relatively high price so that the average expected price is $3.73 per bushel, which even with a $1.07 standard deviation rarely drops low enough to trigger LDPs. The county yield has a mean that closely follows the farm-level yield, but the standard deviation is lower in the county–which shows that the farm-level yield tends to pose more of a risk than the county-level yields.

Table 3 compares actual acres planted to simulated acres. The cotton results reflect representative farms from counties that produce 70 percent of the national cotton production. Simulated corn counties represent 93 percent of the corn production in the United States. The estimated acres for 2007 will be used in future calculations. Cotton estimated acres for 2007 were assumed to be 90 percent of 2006 actual acres, whereas the 2007 estimated acres for corn were assumed to increase 11 percent.

Table 4 presents a summary of payments on a per-acre basis. The original simulation results were based on the NCGA proposal, which includes a BRP coverage level of 70 percent and a RCCP coverage level of 100 percent. The results indicate the NCGA proposal would pay out on average approximately $43 and $22 more per acre than current programs for cotton and corn, respectively. These results show that to implement the NCGA proposal USDA would have to pay, based on the estimated 2007 acres, an extra $581,947,200 for cotton and $1,747,468,871 for corn.

The payments provided to farmers under the given proposal are such that the risk reduction generated by the NCGA proposal makes it an ostensibly attractive alternative for producers, but the cost to the government would likely be politically unacceptable. Therefore, a modified version of the NCGA plan is simulated, with the difference being that BRP is eliminated and the RCCP coverage level is lowered from 100 percent to 95 percent. These results are much more feasible in terms of relative cost, as average payments per acre drop under the modified NCGA plan. Cotton payments decrease by approximately $45 per acre and corn payments fall by $11 per acre, which means that the baseline cost compared to current programs is also lower.

Table 4 shows the average payments per acre. However, a closer look at what is happening around the U.S. and the magnitude of where payments are going can be seen in figures 1 – 4. Figures 1(a) and 1(b) show a breakdown of average current payments per acre including crop insurance payments to the representative farm for each county. Figure 1(a) shows the majority of cotton-producing farms receive $50 - $75 per acre, whereas figure 1(b) illustrates the greater variety in the magnitude of payments made to corn producers. However, the most common payments per acre range from $25 - $50. Figures 2(a) and (b) show the common payment rates of the base revenue protection plan. Cotton tends to have higher payments and more variation, depending on location, than corn. Corn payments appear to either have a low payment or a high payment as very few payments fall in the $30 – 60 range. A reason for this gap is the method used for calculating costs. Due to data constraints cost data were assumed to be the same in several states. Figures 3(a) and (b) show how the current programs will almost always pay less than the proposed NCGA program. Figures 4(a) and (b) show what happens under the modified NCGA program. These maps have the largest disparity across crops, as the modified cotton program has payments often greater than $75, while corn payments tend to fall under $25 per acre.

Conclusion

The model successfully represents multiple farms across the United States at one time while maintaining price and yield correlations so that aggregate outlays may be accurately represented as well. Adding programs to the revenue simulation and then changing the specifications of these programs can also be easily accomplished.

The net revenue proposal is novel because it attempts to protect against shocks in input prices as well as output price and yield. Our results find that cost risk is dominated by the magnitude of revenue risk but that net revenue guarantees rescale the indemnity trigger relative to the absolute variability of revenue and greatly increases the probability of a loss. Conversely, a 95 percent gross revenue guarantee based on county revenue appears to be relatively inexpensive compared to the current programs. However, this assessment assumes elimination of the crop insurance program.

Note that comparisons to current farm policy provisions are dramatically affected by current market prices. As current corn price expectations are well above target price levels, the NCGA proposal with its effective target prices pays relatively less than a revenue guarantee based on current price expectations.

This analysis has numerous logical extensions that would provide a more complete picture of 2007 commodity program options. A logical step in continuing the research is a sensitivity analysis of changing the parameters and extending the model to additional crops. Interest in various wrap-around concepts that maintain some crop insurance programs also appears to be growing. These designs would allow individual-level coverage that supplements area or nationally-triggered revenue shortfalls when such programs fail to compensate for idiosyncratic revenue losses.

Table 1. Simulation Parameters for Cotton and Corn

	Cotton	Corn
Beginning Expected Price	0.58	2.40
APH Coverage Level	0.70	0.70
BRP Coverage Level	0.85	0.85
RCCP Coverage Level	1.00	1.00
Modified RCCP Coverage Level	0.95	0.95
Loan Rate	0.52	1.95
Target Price	0.72	2.63
Direct Payment Rate	0.0667	0.28
Direct Payment Percentage	0.85	0.85
CCP Percentage	0.85	0.85
MPCI sub	0.59	0.59

Table 2. Summary Statistics for Cotton and Corn Simulated Variables

		Cotton	Corn
Expected Farm Yield	Mean	650.81	124.62
	(Std. Dev.)	(429.39)	(56.31)
Expected Price	Mean	0.59	3.73
	(Std. Dev.)	(0.08)	(1.07)
Market Year Avg. Price	Mean	0.60	3.86
	(Std. Dev.)	(0.11)	(1.34)
County Yield	Mean	646.35	124.29
	(Std. Dev.)	(294.14)	(37.24)
Gross Revenue	Mean	385.76	470.79
	(Std. Dev.)	(265.73)	(265.59)
Area Cost	Mean	311.99	185.63
	(Std. Dev.)	(90.80)	(24.25)
Net Revenue	Mean	73.81	290.38
	(Std. Dev.)	(233.88)	(267.45)

Table 3. Acre Calculations

	Cotton	Corn
Actual 2006 Acres	15,200,000	78,300,000
Estimated 2007 Acres	13,680,000	87,000,000
Total 2006 acres in simulated counties	10,715,500	73,000,000
Simulated acres as a percent of 2006 planted	0.704967105	0.932311622

Table 4. Payment Levels on a per Planted Acre Bases

	Cotton	Corn
DP	$32.31	$22.51
LDP	$8.17	$1.15
CCP	$32.65	$1.94
APH	$19.67	$12.05
BRP	$62.69	$33.78
RCCP	$54.75	$4.68
MPCI	$16.92	$12.04
Modified RCCP	$29.05	$3.91
Revenue with current programs	$511.43	$512.69
Revenue with NCGA	$553.97	$535.01
Revenue with Modified NCGA	$465.59	$501.12
NCGA – Current/ Acre	$42.54	$22.32
Modified RCCP – Current	-$45.84	-$11.58
Baseline cost/year – NCGA	$581,947,200	$1,747,468,871
Baseline cost/year – Modified NCGA	-$627,132,507	-$1,007,231,364

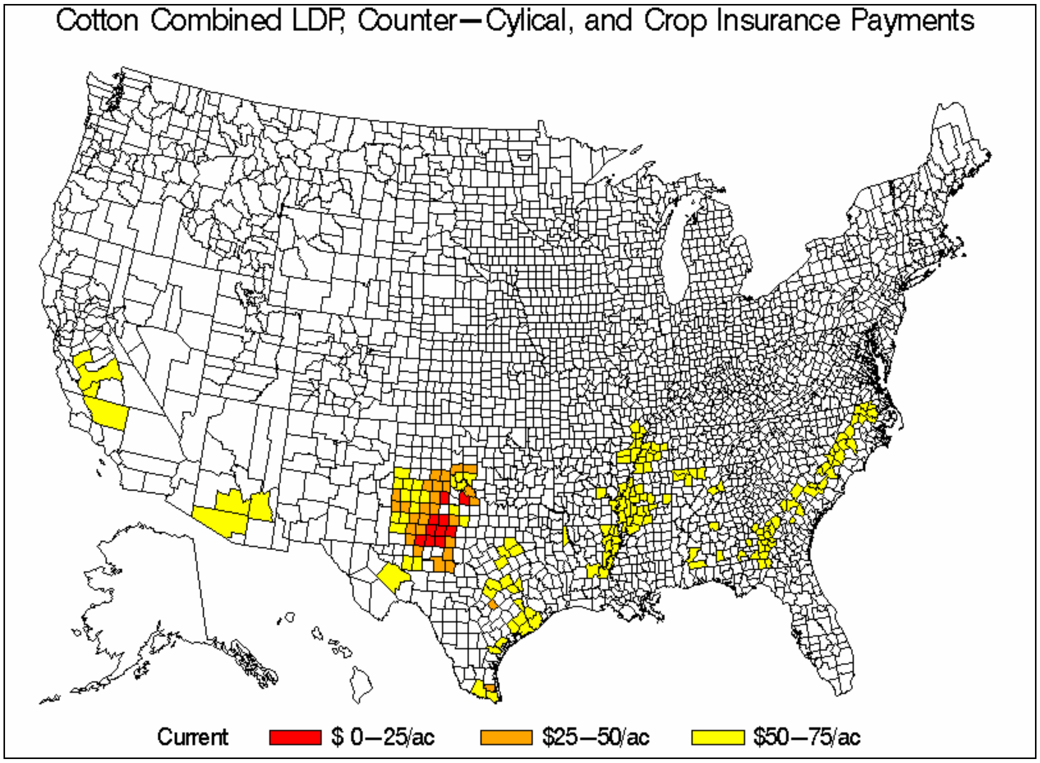

Figure 1a. Cotton Current Payment Levels per Acre

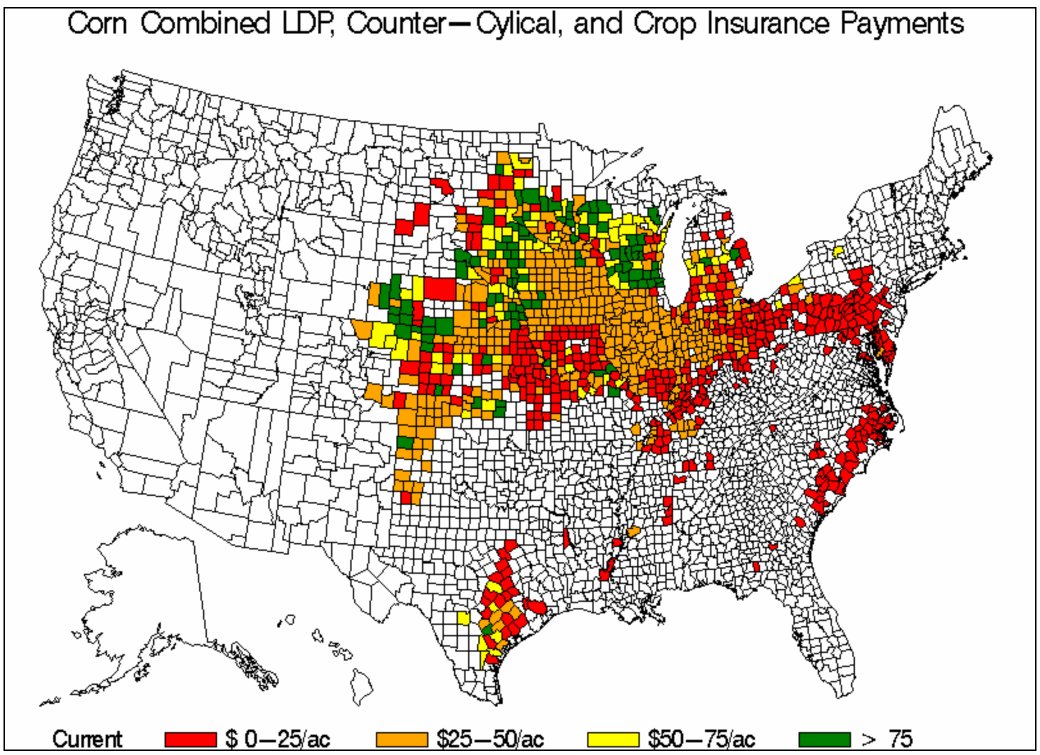

Figure 1b. Corn Current Payment Levels per Acre

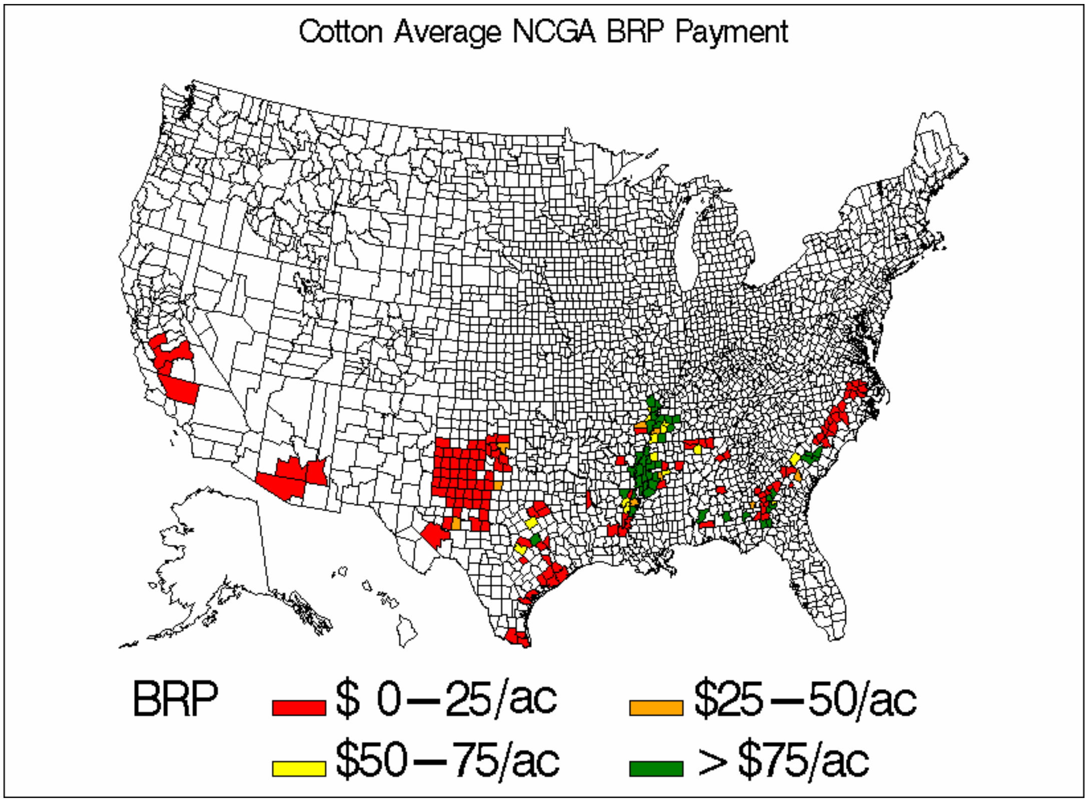

Figure 2a. Cotton BRP Payment Levels per Acre

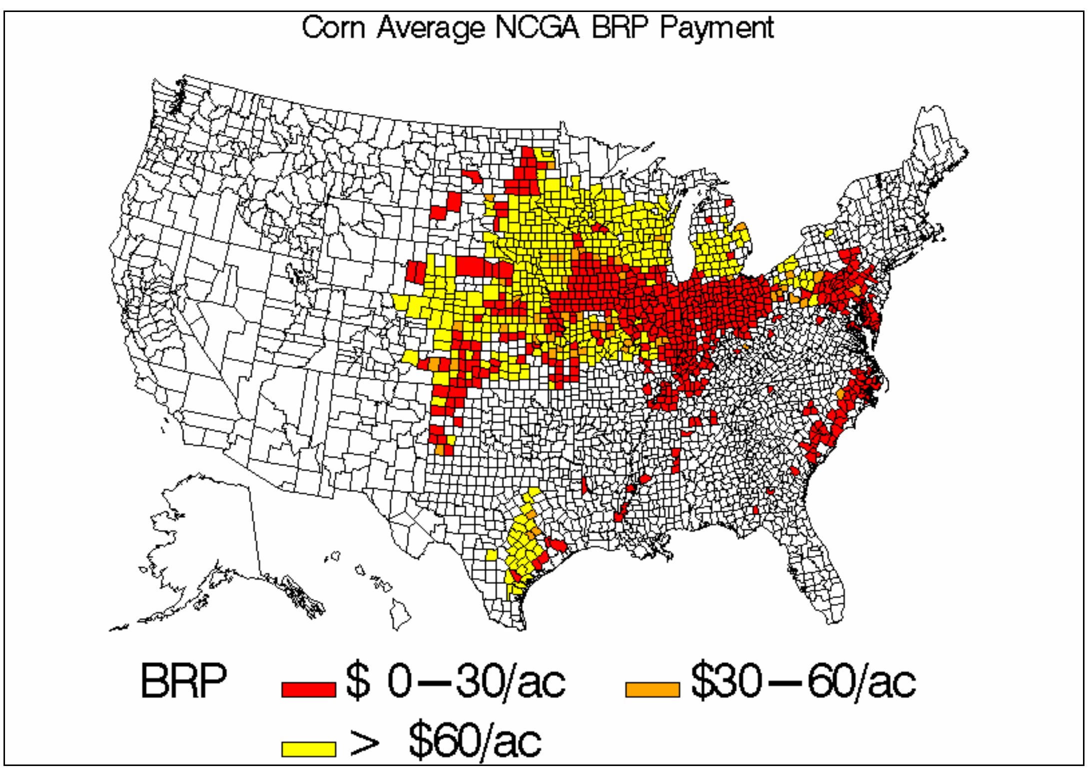

Figure 2b. Corn BRP Payment Levels per Acre

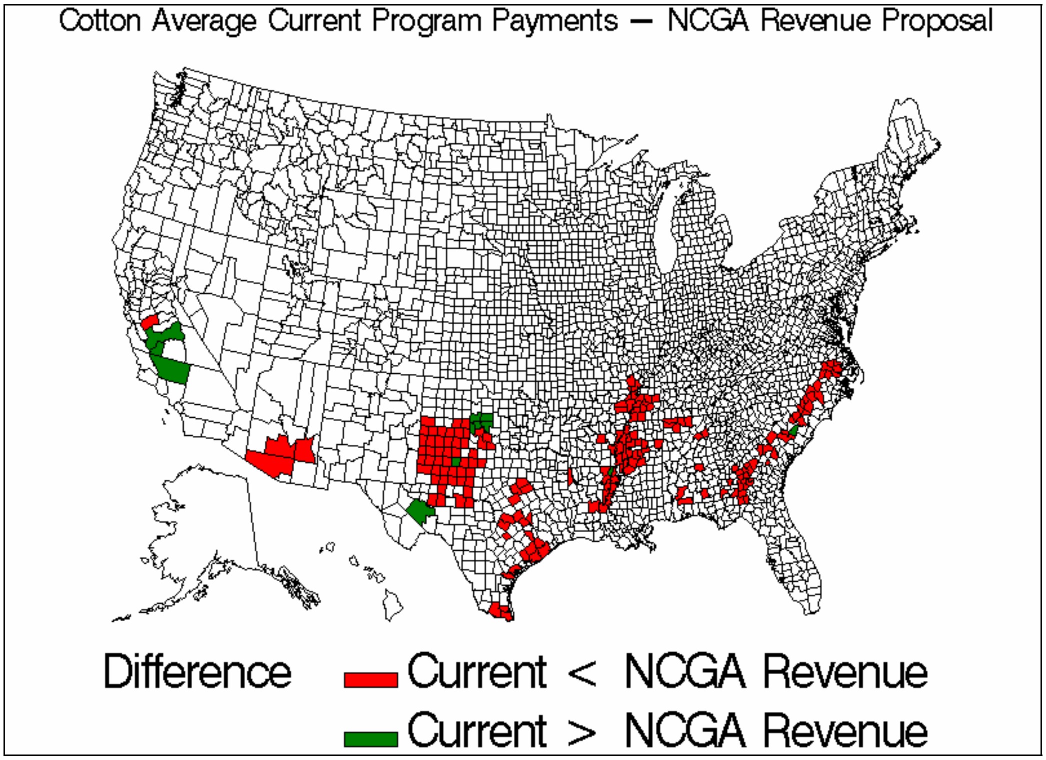

Figure 3a. Cotton Comparison Map: Current Programs vs. NCGA proposal

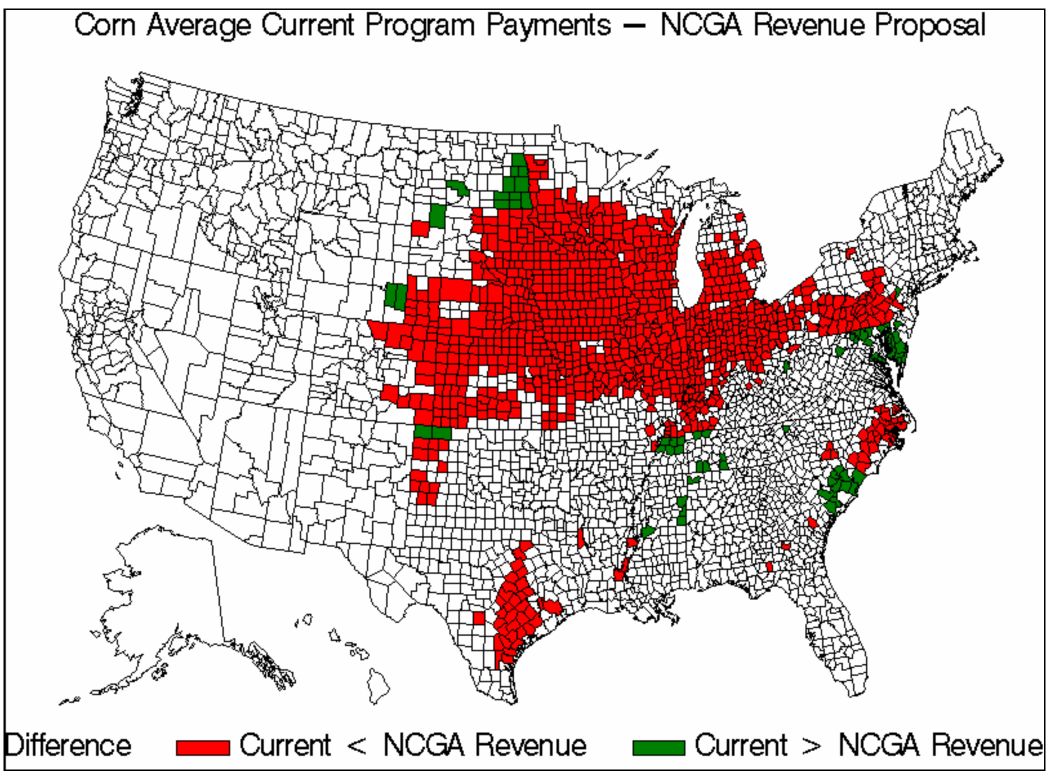

Figure 3b. Corn Comparison Map: Current Programs vs. NCGA proposal

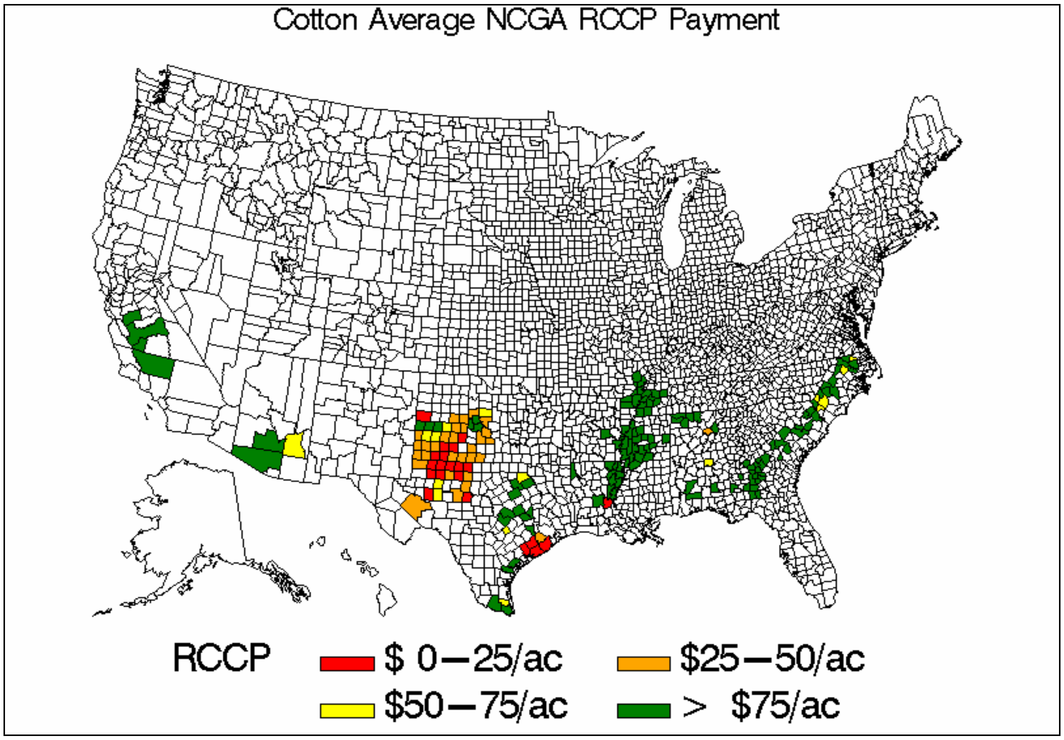

Figure 4a. Cotton RCCP Payment Levels per Acre

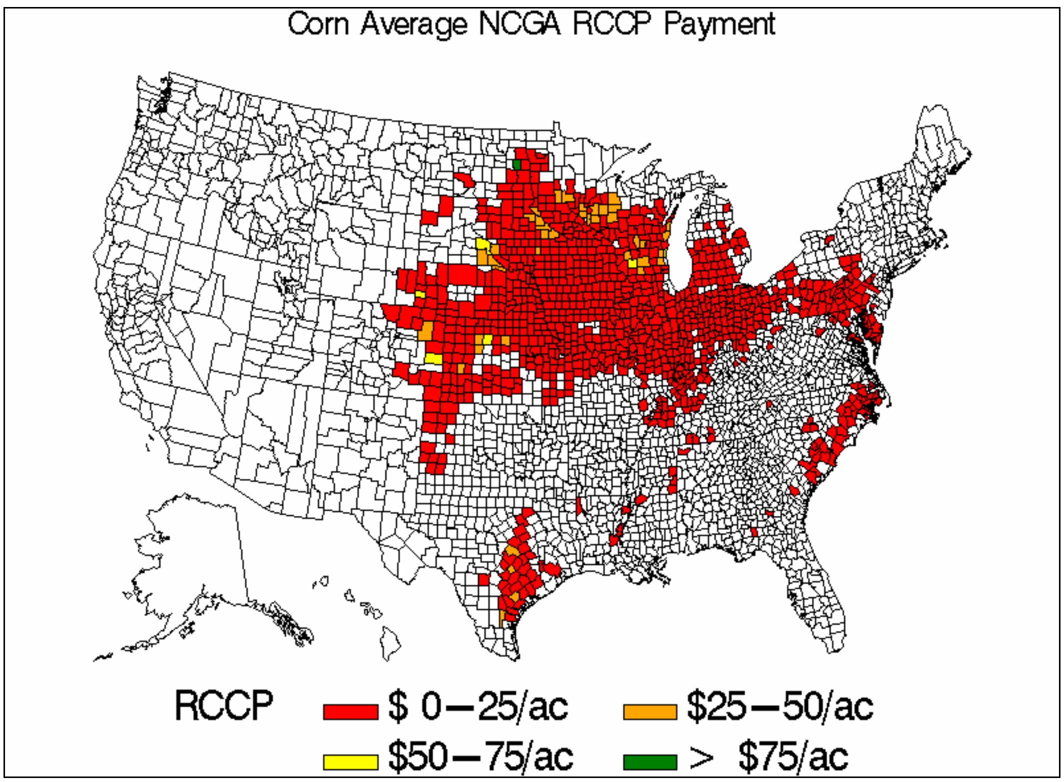

Figure 4b. Corn RCCP Payment Levels per Acre

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