

## Optimal Crop Insurance Options for Alabama Cotton-Peanut Producers: A Target-MOTAD Analysis

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# **OPTIMAL CROP INSURANCE OPTIONS FOR ALABAMA COTTON-PEANUT PRODUCERS: A TARGET-MOTAD ANALYSIS**

## **Abstract**

Target-MOTAD was used to determine the optimal crop insurance options for two representative cotton and peanut farms in southern Alabama. Results showed that, for one of the farms, no crop insurance option was risk reducing given the yield history. For the other farm, risk reduction involved shifting to higher levels of insurance coverage.

**keywords:** crop insurance, target MOTAD, cotton, peanut

## **Introduction**

Reducing price and yield risks is especially important for producers of high-value crops such as cotton and peanuts. Because per acre variable costs of production for cotton and peanuts can be several times those incurred in the production of corn or small grains, protection of the "sunk cost" investment is exceptionally important. Through time, to protect against price and yield related losses producers have used various tools, including crop insurance, the futures market, forward contracting, and reliance on federal disaster programs.

Currently, federal crop insurance is a primary means to protect against losses from poor harvests. The objective of this paper is to determine the optimal risk-reducing crop insurance options for representative south Alabama cotton and peanut producers. Although the number and variety of crop insurance programs has expanded in the past few years, two types of insurance products are currently being used in southern Alabama. This analysis considers only these two products, Multi Peril Crop Insurance (MPCI) and Crop Revenue Coverage (CRC).

## **Crop Insurance History**

Federal crop insurance was first authorized by the Congress in the 1930's, along with

other initiatives to help agriculture recover from the effects of the Great Depression and Dust Bowl. In 1938 the Federal Crop Insurance Corporation (FCIC) was created to administer an experimental program. Crop insurance activities were restricted to major crops in the main producing areas. Crop insurance remained as an experiment until the passage of the Federal Crop Insurance Act of 1980. The Federal Crop Insurance Act extended the crop insurance program to many more crops and regions of the country. A subsidy equal to 30% of the crop insurance premium limited to the dollar amount at 65% coverage was authorized to encourage participation in the new crop insurance program.

The program did not achieve Congress's expectations despite the increase in the number of farmers participating in the program. Ad hoc disaster bills were passed in 1988, 1989, 1992 and 1993 because of severe weather conditions (drought or wet and cool growing season). Because these ad hoc disaster bills were competing with the crop insurance program was strengthened with the Federal Crop Insurance Reform Act of 1994.

Under the 1994 Act, participation in the crop insurance program became mandatory for farmers to be eligible for deficiency payments under price support programs, certain loans, and other benefits. Also the catastrophic (CAT) coverage with completely subsidized premium was created. Under CAT coverage farmers were compensated at 60% of the price established for the crop for that year if the loss exceeded 50% of an average yield. Participants paid \$50 per crop per county subject to maximum amounts for multiple crops and counties insured by the same individual. Subsidies for higher coverage levels were increased.

The mandatory participation requirement was abandoned by the Congress in 1996. However, farmers who accepted other benefits were required to purchase crop insurance or their eligibility for other disaster benefits would have been waived. These provisions are still in effect.

In 1996, the Risk Management Agency (RMA) was created to manage FCIC programs.

In 2000, Congress passed legislation that expanded the role of the private sector. Premium subsidies were increased to encourage producers to purchase higher insurance coverage levels and to make the insurance program more attractive to prospective producers. FCIC has the mission to stimulate the sale of crop insurance and to provide reinsurance (subsidy) to approved commercial insurers, which insure agricultural commodities using FCIC-approved acceptable plans.

### **Provisions of Current Policy**

The relationship between the public and private sector is as follows: The insured farmer has a contract with the commercial insurance provider. Premium rates as well as insurance terms and conditions are established by the FCIC for the products it developed, or approved by FCIC through reinsurance agreement for products developed by private insurance providers.

Crop insurance coverage levels are based upon Actual Production History (APH a producer's actual yield history) or a percentage of an established county yield or a combination of both. MPCCI protects against losses to crop yield only. MPCCI makes indemnity payments when an insurable unit of a farm's actual yield is below a yield guarantee. Market Price elections are used to calculate dollar coverage levels and are based on expected market prices. In general, insurance yield coverage levels range from 50 to 85% of APH in five percent increments. Price elections used in this analysis are the 2002 100% price elections of \$0.52 per pound for cotton and \$0.1775 per pound for peanuts. Buy-up coverage levels guarantee up to 75% of the APH yield for peanuts and 85% for cotton. Variation in price election level from \$.52 and \$.01775 is allowed but farmer's seldom elect less than 100% price coverage. Therefore a 100% price election was assumed for this analysis.

CRC protects against revenue loss from both yield loss and/or price fluctuation. CRC increases the revenue guarantee if the national harvest price is higher than the “base price” used to establish coverage prior to planting. CRC is not available for peanuts, but is available for cotton. A base insurance price of \$.43 per pound was established for cotton in the 2002 insurance contract. However, a historic national harvest price of \$.48 per pound, exceeding the base price, was achieved in 2002.

Insurance premiums paid for the crops depend on the level of insurance chosen by the producer and the risk history of an individual producer’s situation. Depending on the risk protection level chosen, producers pay only a portion of the risk-based premium plus a \$30 administrative fee (in 2002) per crop. The U.S. government, through the Federal Crop Insurance Corporation pays the balance of the premium, including administrative overhead and a basic level of protection.

### **Previous Research**

Adverse selection and moral hazard are believed to pose significant problems for the current crop insurance program. Adverse selection arises because farmers with high relative yield-risk can buy insurance at the same cost as farmers who have lower relative yield-risk (Skees and Reed). Moral hazard occurs when producers, after purchasing insurance, alter their production or harvest practices to increase the chance of collecting crop insurance. To combat moral hazard, federal crop insurance requires a deductible of at least 25% of the producer’s normal yield.

In 1949, Halcrow proposed a crop insurance program based on area yields rather than expected farm yields. Under an area-yield plan, the participant would receive an indemnity equal to the positive difference between the area yield and some predetermined critical yield level. The

producers from a given area would have the same indemnity per acre insured and would pay the same premium rate, regardless of their own crop yield. Halcrow believed that individual crop insurance would not work in a satisfactory way because of adverse selection.

Other analyses have evaluated the effectiveness of area-yield plan. Miranda analyzed Halcrow's alternative using farm-level data from 102 western Kentucky soybean farms. He concluded that an area-yield design would be capable of providing effective yield-loss coverage.

Carriker et al. (1990) compared the effectiveness of reducing yield and income variation for individual farm-yield and area-yield insurance. They conclude that individual farm-level insurance provides more farm income risk reducing, although it is complex and suffers from adverse selection and moral hazard problems.

Using primary yield data and second-degree stochastic dominance analysis, Carriker et al. (1991) examined the effectiveness of several crop insurance and disaster assistance designs for reducing income and yield risk. Results showed that risk-averse wheat producers and corn producers would prefer an actuarially fair individual-farm-yield insurance program with a 100% coverage level over either an area-insurance plan with 100% coverage or the free disaster assistance design with 65% coverage. Williams et al. (1993) also found that individual crop insurance is preferred to area crop insurance and a subsidy is required for area crop insurance to be preferred to individual crop insurance. In another study, Mahul (1999) found that the optimal area-yield crop insurance contract depends on the individual beta coefficient, which measures the sensitivity of farm yield to area yield. Goodwin (2002) found that there is a correlation between a farm's historical yield on other crops and a newly produced crop and stated that in such cases the premium rates may not reflect the producer's actual risk for a new crop.

## Data and Methods

Yields from two farms in Covington County Alabama were used in this study. Tables 1 and 2 provide this yield information. Farm-level yield was used in this study because regional yields, which are averages, typically will show less variability than farm-level yields and thus would underestimate risk. The net returns above variable cost were determined for each farm using these farm-level historical yields to represent expected yield outcomes. Published area prices were used for expected price outcomes as farm-level prices were not available. Operating expenses from cotton and peanut enterprise budgets of the Alabama Cooperative Extension System were used because no suitable farm-level cost data was available for these crops.

Crop insurance premiums for 2002, corresponding to each farm and level of insurance, were determined using the Risk Management Agency/USDA crop insurance premium estimator ([www.rma.usda.gov](http://www.rma.usda.gov)). Net returns were estimated for different coverage levels of MPCCI and CRC insurance for both peanuts and cotton. The \$.43 base price for cotton was used. Market price for cotton reflected historic price for 1991-2002. The market price for peanuts was \$0.19 per pound. MPCCI price guarantee for peanuts was \$0.1775 per pound. As with MPCCI, variation in coverage level is allowed. Buy-up coverage guarantees up to 75% of APH yield for peanuts and 85% for cotton.

Target-MOTAD, a mathematical programming procedure, was used to assess economically optimal crop insurance alternatives using varying target income and risk levels. Technical resources were included in the programming model, which consisted of 1000 acres of land, rotation constraints and allowed deviations from target income. Allowed maximum deviation can be considered a proxy for risk. Allowing larger deviation allows more risky alternatives to enter the solution. Integers were used to ensure discrete choices on crop insurance

options. A section of the model is presented in table 3.

Because peanut yields were consistently low on both case-study farms for the 12 years of historic data, peanuts did not enter the initial optimal solution for either farm on the initial analysis. To achieve a more representative situation for the area, where peanuts are typically produced in rotation with cotton, yields for peanuts were inflated by 37% to bring yields to a level consistent with those normally experienced by area producers planting peanuts in a 3 year rotation with cotton (Frank et al.). The "high yield" scenario was used to determine which insurance products would enter the solution if peanut yields were sufficiently high to make peanuts an attractive production alternative. The model specified that peanuts must be rotated. However, no restriction was put on cotton. Continuous cotton was allowed.

### **Results**

For the first farm, with the original (uninflated) yields, only cotton entered the solution, with no insurance option selected. For the historical yields on this farm, crop insurance never provided a higher return than no insurance. On the second farm, using a target income of \$60,000, cotton entered the optimal solution with 70% CRC insurance coverage. On both farms land resources were left idle as allowed variation from target income decreased.

When peanut yields were increased by 37% on farm 1, a rotation scheme of 3 years of cotton to 1 year of peanuts resulted in 750 acres of cotton and 250 acres of peanuts and expected return \$98,194 entered the solution. Insurance did not enter the solution and thus was considered to be not risk-reducing for this farm. Cotton yields have been relatively high and with less variation than that experienced by farm 2.

Results of the Target-MOTAD analysis for farm 2, with the increased peanut yields and a target income of \$90,000, showed that risk is reduced by substituting 70% CRC insurance



coverage with 75% CRC insurance for cotton. To reduce overall risk, the 60% coverage MPC I insurance for peanuts should be replaced by 70% MPC I coverage. As allowed variation from target income continues to be reduced net returns are lowered and land is idled. Tables 5 and 6 provide a summary of key results for the two target incomes with the higher peanut yields. When allowed deviation dropped below \$52,409 for \$90,000 target income and below \$29,116 for \$50,000 target incomes were not achieved.

### **Discussion**

Crop insurance was not risk reducing for farm 1. Cotton yield were stable and did not drop below 1 bale per acre (Table 1). Farm 2 however required a 70% CRC insurance level to mitigate allowed risk. Table 2 indicated a higher level of variation in yield for both cotton and peanuts on farm 2. When historical peanut yields were inflated to come in line with regional yields, for farm 1, both peanuts and cotton entered the optimal solution without insurance. On farm 2, with higher peanut yields, as allowed deviation from target income fell, insurance coverage increased from 70% CRC to 75% CRC for cotton and from 60% MPC I to 70% MPC I for peanuts. Hence crop insurance was risk reducing for the second farm, but not the first.

The fact that crop insurance was not risk-reducing for one of the two cotton-peanut farms analyzed in this study has implications for the existing program. It is clear from this analysis that crop insurance is not an optimal risk reducing tool for all farms. Tying federal disaster assistance to participation in the existing crop insurance program may result in some risk-averse producers participating in crop insurance even though it would actually increase the risk they face in a typical year. CAT coverage might be a useful alternative for these producers even though our example from farm1 would not have triggered CAT coverage in the past 12 years.

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**Table 1 Original Yields for Farm 1**

Year	Cotton	Peanuts
1	1292	2737
2	911	3251
3	706	3101
4	669	2826
5	629	2772
6	911	3196
7	1021	3423
8	563	4064
9	799	3294
10	780	2911
11	891	3678
12	734	3536

Yield in pounds per acre.

**Table 2 Original Yields for Farm 2**

Year	Cotton	Peanuts
1	1183	3298
2	971	3718
3	646	2253
4	1106	3600
5	475	3500
6	965	4595
7	952	3233
8	442	3352
9	792	3452
10	360	772
11	1033	4291
12	701	4052

Yield in pounds per acre.

**Table 3. Selected Rows and Columns of TARGET-MOTAD Matrix for FARM 1 with increased yields**

	C noins	C ... MPCI50	C.... CRC50	P Noins	P.... MPCI50	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	RHS
Objective	65.29	59.16	58.94	196.92	192.65													
Land	1	1	1	1	1													<= 1000
Risk						1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	<= Lamda
Rotation	-0.25	-0.25	-0.25	1	1													<= 0
1991	332.127	325.975	325.755	67.961	63.710	1												>= Target
1992	112.073	105.935	105.715	201.755	197.503		1											>= Target
1993	-17.659	-23.787	-24.007	162.710	158.451			1										>= Target
1994	37.869	31.744	31.524	91.128	86.869				1									>= Target
1995	27.453	21.330	21.110	77.072	72.783					1								>= Target
1996	148.927	142.802	142.582	187.439	183.166						1							>= Target
1997	232.399	226.274	226.054	246.527	242.241							1						>= Target
1998	-76.536	-82.662	-82.882	413.379	409.088								1					>= Target
1999	-0.093	-6.219	-6.439	212.948	208.654									1				>= Target
2000	24.210	18.085	17.865	113.253	108.998										1			>= Target
2001	-1.146	-7.267	-7.487	312.903	308.622											1		>= Target
2002	-36.184	-42.304	-42.524	275.941	271.657												1	>= Target

C = cotton. P= peanuts.

**Table 4. Selected Rows and Columns of TARGET-MOTAD Matrix for FARM 2 with increased yields**

	C noins	C ... MPCI50	C.... CRC50	P Noins	P.... MPCI50	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	RHS
Objective	52.28	47.51	47.33	225.7	229.15													
Land	1	1	1	1	1													<= 1000
Risk						1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	<= Lamda
Rotation	-0.25	-0.25	-0.25	1	1													<= 0
1991	267.367	261.043	260.843	213.989	209.593	1												>= Target
1992	148.136	141.826	141.626	323.315	318.916		1											>= Target
1993	-53.167	-59.457	-59.657	-58.024	-62.426			1										>= Target
1994	347.067	340.774	340.574	292.600	288.199				1									>= Target
1995	-85.888	-92.165	-92.365	266.570	262.173					1								>= Target
1996	183.568	177.293	177.093	551.599	547.190						1							>= Target
1997	187.263	180.996	180.796	197.070	192.660							1						>= Target
1998	-153.68	-159.92	-160.12	228.046	223.639								1					>= Target
1999	-3.908	-10.148	-10.348	254.076	249.664									1				>= Target
2000	-223.31	-211.55	-211.57	-443.52	-353.68										1			>= Target
2001	68.075	61.831	61.631	472.467	468.055											1		>= Target
2002	-54.136	-60.360	-60.560	410.256	405.831												1	>= Target

C = cotton. P = peanuts.

**Table 5. Allowed deviation and expected returns for a target income of \$90,000 (\$90/acre)  
for Farm 2 with increased yields**

Allowed Deviation	Expected return	C <sub>CRC70</sub>	C <sub>CRC75</sub>	P <sub>MPCI60</sub>	P <sub>MPCI70</sub>	Land used	Idle land
55000	100028	750.00		250.00		1000.00	0.00
54000	97789		750.00	250.00		1000.00	0.00
53000	97188		747.21		249.07	996.28	3.72
52409	90008		692.01		230.67	922.68	77.32

C = cotton. P= peanuts.

**Table 6. Allowed deviation and expected returns for a target income of \$50,000 (\$50/acre)  
for Farm 2 with increased yields**

Allowed Deviation	Expected return	C <sub>CRC70</sub>	C <sub>CRC75</sub>	P <sub>MPCI60</sub>	P <sub>MPCI65</sub>	P <sub>MPCI70</sub>	Land used	Idle land
36000	100028	750.00		250.00			1000.00	0.00
35000	99930	750.00			250.00		1000.00	0.00
34000	95467	717.51				239.17	956.68	43.32
33000	86464	649.84				216.61	866.45	133.55
32000	78788		605.74			201.91	807.65	192.35
31000	71732		551.50			183.83	735.33	264.67
30000	60742		467.01			155.67	622.68	377.32
29116	50003		384.44			128.15	512.59	487.41

C = cotton. P= peanuts.