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ASSESSING THE PROFIT POTENTIAL OF ALTERNATIVE CROP ROTATIONS IN NORTHEAST LOUISIANA

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Abstract

Data from a long-term crop rotation study at the Northeast Research Station were used to assess the relative profitability of alternative crop rotations within a risk framework. Crop yields and per acre net returns of the nine rotations were estimated on a rotational acre basis. The net return data were de-trended and analyzed using stochastic dominance techniques to determine the preferred rotation. The continuous cotton rotation dominated other rotations.

Introduction

Cotton farmers in Northeast Louisiana have traditionally produced cotton within a single crop cropping system. Recent changes in the Farm Bill and increasing interest in maintaining and/or improving long-term productivity of the soil, as well as other factors, has renewed interest in crop rotations. Under current provisions, program payments are decoupled from production, so producers have complete freedom in making crop production decisions.

During recent years, there have been dramatic shifts in crop acreages of cotton, corn, and soybeans in Louisiana. These shifts in acreage reflect, in part, producers' interest in increasing profitability through alternative cropping strategies. Cotton acreage averaged just over 900,000 acres during the period 1990-95. During the most recent five-year period acres planted to cotton in Louisiana declined to approximately 662,000. Acres planted to corn averaged just over 263,000 during 1990-95 and increased to an average of 447,000 during the most recent five years. Soybean acreage has declined from an average of about 1,290,000 acres during 1990-95 to an average of 918,000 acres during the most recent five years. These data suggest a shift away from cotton and soybeans to corn.

Procedure

Nineteen years of crop rotation data from the LSU Agricultural Center Northeast Research Station was used in this analysis. The research station is located in the Mississippi River alluvial flood plain in Tensas Parish near St. Joseph, Louisiana. Soils and the production environment at this location are representative of a major portion of the cotton production in Louisiana. Crop rotations included in this analysis are:

- Continuous Cotton
- Continuous Soybeans
- Continuous Corn
- Cotton – Corn
- Soybeans – Corn
- Cotton – Soybeans
- Corn – Soybeans – Corn
- Cotton – Cotton – Soybeans
- Cotton – Cotton – Corn

Space limitations at the research station prohibited the planting of all crops every year. Consequently, for all cropping systems, except the continuous cropping systems, crops were planted in alternate years. For example, in the cotton-corn system, cotton was planted the first year and corn planted the second year followed by cotton in the third year. This process resulted in yield data for half of the years of the experiment for the two crop rotations and only one-third of the years in the three crop rotations. The missing years' crop yields were estimated using linear regression techniques. This process gave yield estimates for each crop in all years of the experiment. The estimated yields had statistical properties (mean, standard deviation) similar to those for the observed yields.

Given crop yields, enterprise budgets were developed for each crop within each rotation using the Mississippi State Budget Generator with appropriate Louisiana coefficients. Costs were estimated based on actual inputs used in the experiment assuming standard commercial farming equipment and practices. Constant costs were assumed for each of the cropping systems and expressed in 2002 prices. Returns were based on yields and market prices during the 19 years of the experiment. Gross returns were estimated by multiplying the market price times the yield obtained in a given year. Net returns were obtained by subtracting the constant cost for that crop within a particular rotation from the gross returns for that crop. Per acre net returns for each crop in a rotation were converted to a rotational acre basis for analysis. For example, in the cotton – corn rotation, net revenue on rotational acre basis would consist of half of the net returns from an acre of cotton in that rotation plus one-half the net returns from an acre of corn in that rotation. This allows the direct comparison of all rotations. A summary of the net returns for each rotation are shown in Table 2.The distributions of net returns on a rotational acre basis were expanded to a whole farm basis. For this analysis a farm containing 1,500 acres of cropland was assumed. Whole farm net returns were de-trended before being analyzed using stochastic dominance techniques. A summary of the whole-farm de-trended net returns are shown in Table 3.

Results and Discussion

Average yields of each crop in each rotation are shown in Table 1. As shown here, crop rotations resulted in higher yields than continuous cropping systems for all crops in the rotations. This result is consistent with the large body of literature on the benefits of crop rotation. Most studies have demonstrated that crops grown in rotation have higher yields than crops grown in a continuous cropping system. It is this yield response from rotations that increases interest in rotating crops to improve the profit potential.

While the yield increases are important, the ability of a cropping system to generate net returns over time is more important. Gross returns were estimated by multiplying crop yields times the average market price for that commodity in a given year. Average market prices were obtained from the Louisiana Agricultural Statistics service. For the period covered by this study, cotton lint price was $0.576, corn was $2.54 per bushel, and soybeans averaged $5.96 per bushel. In the case of cotton, it was assumed that the value of the seed covered the cost of ginning. Therefore, for cotton, seed value was not included as revenue to the cotton crop. Similarly, the cost of ginning was not charged as a cost to the cotton enterprise. Net revenue, or gross margin, was estimated by subtracting constant costs for each enterprise from the gross revenue for each year of the experiment. Average net returns (not de-trended) per rotational acre are shown in Table 2. As shown here, the highest average returns were generated by the cotton-cotton-soybeans rotation. This rotation generated returns above direct costs of $281.80 per rotational acre. The cotton-cotton-corn rotation had the second highest average return of $267.87 per rotational acre. Continuous cotton had the third highest net return of $259.06 per acre.

The per acre average net returns shown in Table 2 suggest that a rotational cropping system would be superior to a continuous cropping system. However, the averages shown in Table 2 do not specifically account for the variability in yields and prices that normally occur. It does not follow that crop rotations with higher average net returns will also have less variability over time. Variability in income is an important consideration for many producers. To evaluate the alternative crop rotations within a risk framework, the distributions of whole-farm net returns were de-trended using ARIMA techniques to reflect revenue risk at a point in time. De-trending net returns reflects the interaction of yields and prices.

Descriptive statistics for the de-trended distributions of whole-farm gross margins are shown in Table 3. De-trending net returns generally resulted in lower mean values and lower variances in rotation returns. As shown here, continuous cotton had the highest mean and minimum values. Continuous soybeans had a negative mean value. The continuous corn rotation had the largest negative value for the minimum net return. This rotation also had the highest standard deviation, indicating a higher level of variability in net returns. The rotation consisting of two years of cotton and one year of soybeans gave the second highest mean and minimum values.

The computer program developed by Raskin and Cochran was used to perform the stochastic dominance analysis. Both first- and second-degree stochastic dominance analyses were performed, but only results of the first degree analysis are reported here because the results are the same. The efficient set under first degree stochastic dominance contains only the continuous cotton rotation. A pairwise comparison of the de-trended whole-farm net returns is shown in Table 4. As shown here, the continuous cotton rotation dominated all other rotations. The rotations containing two years of cotton and one year or either soybeans or corn dominated most of the other rotations. As shown in Table 3, these rotations also had the second and third highest mean values among all rotations.

These results are significantly different from results obtained by subjecting the distributions of actual net returns to stochastic dominance analysis. Using net returns that were not adjusted for trend, first degree stochastic dominance techniques could eliminate only three distributions from the efficient set. Second degree stochastic dominance eliminated four distributions. The rotations eliminated by both were the continuous corn and soybeans and the cotton and corn rotation. In addition the second degree technique eliminated the two years cotton and one year corn rotation. These differences in results suggest that it is important to use the correct form of the data when conducting this type of analysis.

Summary and Conclusions

This study used 19 years of yield data from the Northeast Experiment Station on nine crop rotations to assess the profit potential of alternative crop rotations considering risk. Gross margin distributions for a 1,500 acre row crop farm were developed for each of the nine crop rotations included in the study. Both yield and output price risk was included in the analysis.

The whole-farm gross margin distributions were de-trended and subjected to stochastic dominance analysis. Continuous cotton dominated all other rotations included in the analysis. The continuous cotton rotation gave the highest mean and minimum value of all rotations considered. These results are consistent with observations on general cropping practices of producers in the area. As noted earlier, there have been shifts in crop acreages within the state. However, cotton production across the state is predominantly characterized by a continuous production system. Recent evidence suggests that crop rotation is being practiced by an increasing number of producers. This change is in response to changes in market signals and the ability of producers to practice crop rotation without fear of jeopardizing benefits under government programs.

References

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Table 1. Average Crop Yields Under Alternative Rotations, Northeast Research Station, 1983-2001.

Rotation	Cotton (lbs/ac)	Soybeans (bu/ac)	Corn (bu/ac)
Continuous Cotton	1103	N/A	N/A
Continuous Soybeans	N/A	42	N/A
Continuous Corn	N/A	N/A	122
Cotton – Corn	1252	N/A	138
Soybeans – Corn	N/A	51	135
Cotton – Soybeans	1187	48	N/A
Corn – Soybeans – Cotton	1253	50	N/A
Cotton – Cotton – Soybeans	1224	51	N/A
Cotton – Cotton – Corn	1230	N/A	140

Table 2. Average Production Costs and Returns Per Rotational Acre, Alternative Rotations, Northeast Research Station, 1983-2001.

Rotation	Direct Costs ($/ac)	Gross Revenue ($/ac)	Returns Over Direct Cost ($/ac)
Continuous Cotton	387.42	646.48	259.06
Continuous Soybeans	113.13	253.05	139.92
Continuous Corn	204.86	309.92	105.06
Cotton – Corn	298.75	539.14	240.39
Soybeans – Corn	156.77	322.06	165.29
Cotton – Soybeans	250.62	490.12	239.50
Corn – Soybeans – Cotton	236.51	463.40	226.89
Cotton – Cotton – Soybeans	296.22	578.02	281.80
Cotton – Cotton – Corn	328.30	596.17	267.87

Table 3. Summary Statistics for De-trended Whole Farm Net Returns, Alternative Rotations, Northeast Research Station, 1983-2001.

Rotation	Mean	Std. Dev.	Highest	Lowest	Skeweness
Continuous Cotton	488822.40	101545.60	690685.40	309422.80	0.45
Continuous Soybeans	-49599.72	39918.91	28392.58	-113076.60	0.08
Continuous Corn	107725.60	127949.60	311023.70	-217379.40	-0.89
Cotton – Corn	85652.69	37518.97	169938.00	24033.56	0.19
Soybeans – Corn	236267.20	78389.60	373852.10	114063.20	0.18
Cotton – Soybeans	96186.27	66636.45	254511.20	-7170.51	0.59
Corn – Soybeans- Cotton	333654.80	53420.77	437302.00	236247.30	0.02
Cotton – Cotton – Soybeans	411340.30	89471.63	622000.50	264170.30	0.62
Cotton – Cotton - Corn	390786.30	78619.13	572572.80	248167.10	0.39

Table 4. First Degree Stochastic Dominance, Pairwise Comparisons of De-Trended Whole-Farm Gross Returns.

	Cont Cot	Cont Soy	Cont Corn	Cot Corn	Soy Corn	Cot Soy	Crn Soy Cot	Cot Cot Soy	Cot Cot Crn
Cont - Cot	-	1	1	1	1	1	1	1	1
Cont - Soy	0	-	?	0	0	0	0	0	0
Cont - Corn	0	?	-	?	0	?	0	0	0
Cot - Corn	0	1	?	-	0	?	0	0	0
Soy - Corn	0	1	1	1	-	1	0	0	0
Cot - Soy	0	1	?	?	0	-	0	0	0
Crn –Soy- Cot	0	1	1	1	1	1	-	0	0
Cot – Cot – Soy	0	1	1	1	1	1	1	-	?
Cot – Cot - Crn	0	1	1	1	1	1	1	?	-

R1 = -.000145, R2 = .000145; 1 = Win, 0 = Loss, ? = No dominance