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WHOLE FARM ANANLYSIS OF COTTON CROP ROTATIONS

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Abstract

North Carolina cotton acreage has increased significantly in the last five years, while corn and wheat acres have been declining. Much of the new cotton acreage is being grown on a continuous basis. Three model cotton farms were developed to compare net income of a continuous cotton system with four different crop rotations. Actual county yields and state prices were used in the model farms to simulate the price and yield risks of various rotations. The model farm data was developed after surveying cotton farms in three counties in North Carolina. Jones County crop rotations resulted in the least variation in net income between the four rotations. With a five-percent increase in crop yields, three of the crop rotations were more profitable than continuous cotton. Due to relatively high cotton yields in Hyde County, continuous cotton was considerably more profitable than the other rotations, with only the soybean rotation resulting in a positive return over the past six years. The wheat-soybean rotations had net farm incomes comparable to continuous cotton, with a five-percent increase in crop yields. In Northampton County, continuous cotton was twice as profitable as the closest rotation of wheat/soybean double crop. With a five-percent increase in crop yields, the wheat/soybean double crop rotation was almost as profitable as continuous cotton.

Introduction

North Carolina cotton acreage has grown from 670,000 acres in 1997 to 930,000 acres in 2002, with much of the new cotton acreage being grown on a continuous basis (N.C. Statistics). This is due in part to the 1996 farm bill's production flexibility provisions and relatively low prices of other crops. Three counties in Eastern North Carolina were selected to simulate the net income effects of continuous cotton and four different crop rotations. In Jones County, tobacco receipts make up a large portion of the total farm income. Cotton acreage has grown due in part to tobacco quota cuts and continued uncertainty of the tobacco program. Approximately seventy percent of the cotton is grown on a continuous basis. Northampton County is the leading North Carolina county in both cotton and peanut production. Cotton is usually grown in a rotation of two years of cotton and one of peanuts. Cotton production is relatively new to Hyde County. Cotton acreage has grown for 2,500 acres in 1995 to 14,900 acres in 2001. Cotton growers are aware of the potential long-term agronomic benefits of crop rotations, however these benefits are being compared to potential short-term economic benefits of continuous cotton. It is crucial to know the long-term financial implications of adopting different crop rotations.

Objective

Cotton acreage in North Carolina has increased significantly in the past six years. Much of this new cotton acreage is grown on a continuous basis. Many factors must be considered before adopting a new crop rotation. Potential crop prices and yields, costs of new machinery, as well as government programs, must be weighed against the agronomic benefits. The objective of this study is to examine the effects on farm income of the adoption of various crop rotations versus continuous cotton over the past six years.

Previous Studies

Most rotation studies address only agronomic benefits by comparing yield responses to various treatments. A 1997 Alabama study evaluated the benefits of crop rotations as a cultural practice to control nematodes. Crop rotations produced substantially higher cotton yields than continuous cotton systems in the first year of the study. However the ideal growing conditions in the second year resulted in the continuous and rotated cotton alternatives having similar yields. (Akridge, 1997). A Texas A&M University study compared rotations, tillage systems, and fertility levels on cotton yields. The study evaluated cotton-corn, corn-cotton, soybean-cotton, and continuous cotton. The tillage treatment had no effect on yield response. The yield advantage of the different rotations fluctuated widely each year. The study found that the yield advantage of the soybeans rotation over the corn rotation was nullified by additional nitrogen fertilizer (Matocha, 1998). Two studies compared the economic returns of different crop rotations. An Auburn University study compared tillage systems, conventional and UNR cotton, and two different crop rotations (Reeves et al). Auburn University extension budgets were used to evaluate the returns of cropping and tillage systems. Continuous UNR cotton had the highest returns over the two years. A Louisiana State University study used crop budgets and experiment station yield data to evaluate six cotton rotations. The cotton-cotton-soybean rotation had the highest returns over direct costs. The cotton-cotton-corn and cotton-soybean rotation had similar returns as continuous cotton (Bechtel, 2000). Prices were held constant in the study.

Data and Methods

The model farms were developed after surveying cotton growers and extension personnel in each county. Detailed balance sheets and machinery components were developed for the model farms. The balance sheets were allowed to change each year reflecting the net worth changes of the previous year. The operating loan amounts were adjusted each year based on the cash surplus or deficit of the previous year. Enterprise budgets were developed for each farm model. Each county's average crop yields for years 1996 through 2001 were used in the enterprise budgets. Yearly average price data was collected from the North Carolina Statistical Service. Actual yield and price data were utilized in the enterprise budgets in order to simulate the yield and price risk of adopting the different crop rotations. There may be fertilizer and chemical cost benefits with crop rotations, however these adjustments were difficult to determine. All enterprise budget input costs were held constant each year for each crop rotation. Each crop rotation alternative had two/thirds of the cropland in cotton and a third either in corn, wheat, soybean and wheat/soybean double crop. All crop rotations were assumed to be three years, with two years of cotton followed by one year of one of the four alternative crops. The net income results of the four rotations were compared to that of continuous cotton alternative for the years 1996-2001. FINPACK, a financial planning software package was used to obtain the whole farm income and net worth effects of different crop rotations. FINPACK develops total fixed costs of depreciation, insurance, taxes and interest, which are spread over the total farm acreage. The machinery component was adjusted for the different rotations. No new equipment was purchased for the additional crop acres; the additional cotton and grain acreage would be custom harvested for $70 per acre for the cotton and $25 per acre for the grain. It was assumed that a four-row cotton picker could harvest 800 acres. The market transition payments and tobacco and peanut loss payments were included in the net income of the model farms. It was assumed that all crops would be sold at harvest. The county LDP was added to the average cash price.

Model Cotton Farms

Jones County

The model farm has 1300 acres of cropland, with at least 800 acres of cotton, 100 acres of tobacco grown each of the six years. It was assumed that 100 acres of tobacco would be included each year in the rotations. The additional 400 acres is planted to wheat, corn, and wheat-soybean double crop, soybean or cotton. The model farm had a debt to asset ratio of 26 to 32 percent, owning approximately 30 percent of the land farmed. The remainder of the land was rented for $70.00 per acre. The cotton is conventional tillage, Roundup Ready, BT, with the corn being no-till. Eight-row equipment was used on the farm with machinery values averaging $640,697. Jones County crop yields are shown in Table 1.

Northampton County

The model farm has 1200 acres of cropland, with at least 750 acres of cotton and 150 acres of peanuts grown each of the six years. It was assumed that 150 acres of peanuts would be included each year in the rotations. The additional 350 acres is planted to wheat, corn, and wheat-soybean double crop, soybean or cotton. The model farm had a debt to asset ratio of 27 to 31 percent, owning approximately 25 percent of the land farmed. The remainder of the land was rented for $75.00 per acre. The cotton is strip-till, Roundup Ready, BT, with the corn being no-till. Eight-row equipment was used on the farm with machinery values averaging $417,131. Northampton County crop yields are shown in Table 2.

Hyde County

The model farm has 2500 acres of cropland, with at least 1667 acres of cotton. The additional 833 acres is planted to wheat, corn, and wheat-soybean double crop, soybean or cotton. The model farm had a debt to asset ratio of 31 to 36 percent, owning approximately 35 percent of the land farmed. The remainder of the land was rented for $80.00 per acre. The cotton is conventional tillage, Roundup Ready, BT, with the corn being conventional tillage. Twelve-row equipment was used on the farm with machinery values averaging $984,435. Hyde County crop yields are shown in Table 3.

Results

Net Farm Income Results of Crop Rotations

Each alternative resulted in highly variable net farm income from year to year. The Jones County had the least variation between the crop alternatives and years. In 1999, all counties had negative net farm incomes due to adverse weather. The Jones County net farm income for each crop rotation is shown in Table 4. Jones County had the higher net farm income and the least variation in net income of the three counties due in part to the profitability of the 100 acres of tobacco. The continuous cotton alternative returned a five-year average net farm income of $104 per acre. Continuous cotton net farm income ranged from $226 in 1998 to ($66) in 1999. The corn and wheat /soybean double crop alternatives both returned a five-year average net farm income of $95 per acre. The corn and wheat-soybean rotation had higher net farm income in two of the past five years. The soybean alternative returned a five-year average net farm income per acre of $87. The wheat rotation returned an average of $84 per acre over the five-year period.

The Hyde County net farm income of each crop rotation is shown in Table 5. Hyde County had the lowest per acre net farm income of the three counties. The continuous cotton alternative returned a five-year average net farm income of $41 per acre.

The other crop rotations resulted in lower net farm income as compared to the continuous cotton alternative. Continuous cotton net farm income ranged from $142 in 1997 to ($175) in 1999. The soybean crop alternative returned a five-year average net farm income of $6 per acre. The corn crop alternative returned a five-year average net farm income of $0.5 per acre, while the wheat and wheat/soybean double crop alternative resulted in a negative $23 and $8 respectively.

The Northampton County net farm income of each crop rotation is shown in Table 6. The continuous cotton alternative returned a five-year average net farm income of $57 per acre. Continuous cotton net farm income ranged from $141 in 2000 to ($24) in 1999. The soybean/wheat double crop alternative returned a five-year average net farm income of $35 per acre. Followed closely by the corn and soybean alternatives returned a five-year average net farm income of $27 and $26 per acre. The wheat alternative returned a five-year average net income of $18 per acre.

Results of Increased Yields of All Crop

One of the benefits of crop rotations is a possible increase in crop yields as a result of better insect and disease control. In order to simulate the agronomic benefits of crop rotations, the actual yields were increased five percent for all crops. Prices were not adjusted for this analysis. In Jones County, with a five-percent increase in all crop yields, three of the four crop alternatives resulted in a higher per acre net income than continuous cotton. Only the wheat rotation had a net farm income lower than the continuous cotton alternative. In Hyde County, even with the five-percent increase in crop yields, no alternative produced a higher net farm income than the continuous cotton alternative. With the five-percent increase in yields the wheat alternative still resulted in a negative $3.12 returns per acre. Increasing the crop yields five-percent in Northampton County did not result in any alternative having higher net income than the continuous cotton. The soybean/wheat double crop alternative had a similar net return of $53.69 compared to the net returns of $56.75 of the continuous cotton. The results of increasing crop yields five-percent are shown in figure 1.

Summary

Three model farms were developed in FINPACK to evaluate the net farm income of four crop rotations as compared to continuous cotton. Cotton growers must choose a crop rotation after weighing the agronomic benefits as well as the economic potential of the new rotation. Growers must consider yield and price variability between potential crops, possible chemical carryover, machinery, and labor requirements of the crop. Once a crop rotation has been adopted, it is difficult to make short term adjustments. This study demonstrates the importance as well as the difficulty of adopting a cropping system.

The model farm in each county shows very different results for adopting the four crop rotation alternatives. This study shows that Jones County would benefit the most from adopting a crop rotation. In Jones County, a five-percent increase in crop yields resulted in higher net farm income for the corn and wheat/soybean alternatives compared to continuous cotton. The soybean alternative had similar returns as the continuous cotton rotation. In Hyde County, with a five-percent increase in all crop yields, no alternative produced a higher net farm income than continuous cotton. When the yields were increased five-percent, the wheat and wheat/soybean double crop alternatives still resulted in negative average returns for the past six years. In Northampton County, with a five-percent increase in crop yields, the wheat/soybean double crop alternative produced similar returns as continuous cotton. There is little yield data to verify the economic benefits of crop rotation for cotton growers. This makes choosing a crop rotation very difficult. This rotation study offers one approach in deciding on a possible crop rotation.

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Table 1. Yields For Jones County Farm.

Year	Cotton	Corn	Wheat	Soybean
96	624	95	40	30
97	674	91	55	33
98	772	58	44	18
99	379	70	48	25
00	743	124	50	29
01	830	140	56	25
Avg.	670	96	49	27

Table 2. Yields For Northampton County Farm.

Year	Cotton	Corn	Wheat	Soybean
96	760	102	47	26
97	669	76	48	31
98	734	85	44	29
99	586	72	55	21
00	759	101	50	31
01	875	100	49	34
Avg.	731	89	49	29

Table 3. Yields For Hyde County Farm.

Year	Cotton	Corn	Wheat	Soybean
96	633	119	37	30
97	968	106	51	36
98	785	105	42	33
99	430	89	48	12
00	835	135	54	36
01	999	142	50	38
Avg.	775	116	47	31

Table 4. Jones County Per Acre Income of the Various Crop Rotations.

Year	Con. Cotton	C-C-Corn	C-C-Wheat	C-C-W/S	C-C-Soybean
96	123	126	120	138	103
97	68	61	50	76	63
98	226	142	159	168	161
99	-66	-36	-33	-39	-37
00	136	131	109	124	120
01	140	148	96	103	115
6yr. Avg.	104	95	84	95	87

Table 5. Hyde County Per Acre Income of the Various Crop Rotations.

Year	Con. Cotton	C-C-Corn	C-C-Wheat	C-C-W/S	C-C-Soybean
96	-8	2	-48	-16	24
97	142	71	52	94	90
98	95	23	9	25	33
99	-175	-171	-172	-194	-185
00	119	45	29	41	48
01	70	33	-6	5	23
6yr. Avg.	41	0.5	-23	-8	6

Table 6. Northampton County Per Acre Income of the Various Crop Rotations.

Year	Con. Cotton	C-C-Corn	C-C-Wheat	C-C-W/S	C-C-Soybean
96	109	98	70	88	69
97	-7	-25	-30	-5	-12
98	52	19	7	19	24
99	-24	-45	-37	-33	-42
00	141	75	69	85	79
01	70	41	27	53	40
6yr. Avg.	57	27	18	35	26

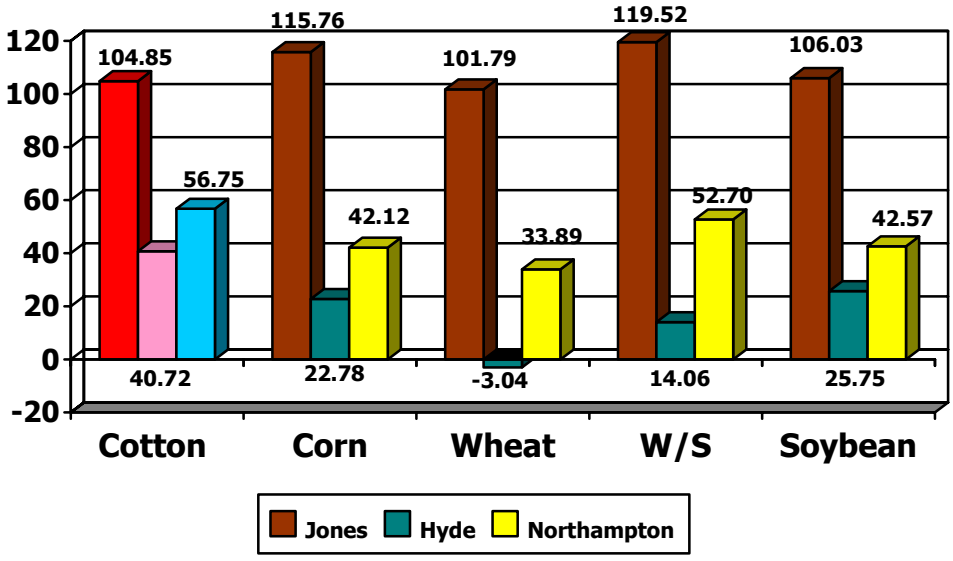

Figure 1. Net farm income with five-percent increase in all crop yields.