PLANTING AND HARVEST TIMELINESS OF COTTON AND PEANUTS

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Introduction

Profitability for agricultural producers is dependent upon their ability to properly allocate resources across various commodities. In southern Georgia, most cotton producers incorporate peanuts into their rotation and efficient management strategies are required to sustain profitability. While producers may realize a profit, they may not be obtaining their maximum profit potential. Profitable strategies require making decisions concerning the variety of seed to grow, the tillage practice to incorporate, formulating a cost effective input regime, deciding when to plant and when to harvest, and estimating the number of laborers to employ. This research focuses on decisions related to timeliness of planting and harvesting crops in a rotation program consisting of cotton and peanuts.

Traditionally, producers begin cultivating the land to prepare for planting in the early spring. They first plant their peanut crop, delaying cotton planting. This planting strategy matures the peanut crop approximately 2 weeks prior to complete cotton maturity. This allows producers to harvest peanuts before cotton and prevents the deterioration of peanuts.

Due to Tomato Spotted Wilt Virus (TSWV) in peanuts, this strategy has lost much of its effectiveness. The University of Georgia (UGA) Extension Service reports that delaying planting of peanuts until May 1-20 gives the greatest chance of reducing the intensity of the virus among the crop (Brown et al.). Cotton planting in Georgia usually begins around April 20, with most of the planting occurring during the month of May (GASS). Therefore, planting of the two crops occurs generally within the same time period when attempting to avoid TSWV in peanuts.

Physiologically, the plants mature at approximately the same rate with harvest occurring at the same time. Producers have generally delayed cotton harvest until peanut harvest is completed, or is nearly completed. This overlap of planting and harvest creates a resource allocation conflict for producers. The amount of available labor, equipment, and work hours available could be the most binding constraints producers face in accomplishing all production activities. Therefore, a model that determines the optimal planting and harvest combinations for producers is beneficial for optimizing net returns under timeliness considerations. Of primary concern is the harvest timeliness issue associated with delaying cotton harvest and reducing returns due to quality reductions.

During the 1990's, TSWV became the most damaging disease problem for peanuts in Georgia and Florida. Research indicates peanut yields are significantly affected by spotted wilt severity such that for each 10% increase in final TSWV severity yields are reduced by 280.2 kg/ha, or 250.1 lbs/ac, (Luke et al.). This demonstrates the need for TSWV control, but currently chemical control or immune varieties are not available.
Fortunately, researchers have discovered different strategies to control the spread of the virus. The transmission of TSWV is believed to be through certain species of thrips, and controlling the transmitter helps control the virus. While there are a few chemicals that help control thrips populations, they are ultimately ineffective in controlling TSWV. The UGA Extension Service in 1996 introduced the TSWV Risk Index for evaluating the potential for infestation. Recent research shows the TSWV Risk Index to be the best tool for reducing the severity of TSWV and the resulting yield decline.

Researchers have discovered that optimum planting dates vary from year to year for reducing the incidence of TSWV, but early planted peanuts tend to have higher levels of TSWV than peanuts planted after the middle of the planting season. The index is based on risk points associated with different production decisions. For example, the variety of peanuts a producer selects is associated with a certain number of risk points. Currently, no variety is immune to the virus, but the cultivar Georgia Green has one of the lowest anticipated risk points (Brown et al). It is selected as the variety for this study because of its TSWV tolerance and the prevalence of its usage in Georgia peanut production.

Other research dealing with TSWV index shows that twin row patterns average higher yields, better grades, and lower TSWV incidence (Brown et al.). Twin row peanuts tend to be the best yielding method of production, and extension service information indicates that approximately 50 percent of producers have adopted this method. Strip tillage is an alternative cultivation practice that has demonstrated less damage from thrips and slightly less TSWV (Luke et al.)

Physiological characteristics of cotton and peanuts lead to conflicts in management decisions related to resource allocation. Farmers have more flexibility in dealing with resource allocation while crops are developing than at the periods of planting and harvesting. The objective of this research is to evaluate the profitability of alternative planting and harvest dates available to producers of cotton and peanuts in Georgia.

Data And Model

The possibility of a relationship between harvest date and yield is an area of decision making that should be explored. If harvest is initiated too early or too late, yields could be reduced. Cotton plants do not mature all at once because each square or boll matures at different time periods. According to Shurley and Bednarz (2000a, 2000b), peak maturity of a cotton boll occurs at its opening. Once open, a boll will decline in quality, and yield loss becomes more probable. A period of 6 weeks is required for a cotton plant to complete opening of all bolls. The objective of crop termination is to apply harvest aids at such a time that as many bolls as possible can be harvested while not suffering offsetting losses in yield and quality. Proper management decisions determine the optimal time to defoliate and begin harvest.

Little research exists for Georgia cotton producers to estimate appropriate defoliation dates to maximize profits at harvest. Previous research by Shurley applied 80% open bolls as optimal for defoliating cotton. If harvest begins two weeks following defoliation, cotton harvest would begin at a time when 30% of the state's peanut crop remains to be harvested (Shurley, 2000). This overlap of harvest periods is an example of the resource allocation problem among cotton and peanuts. With 30% of the peanuts left to harvest, cotton harvest initiation is usually delayed to ensure quality peanuts are harvested. This delay pushes cotton quality to the point that profits begin declining.

Yield and harvest timeliness data for cotton is applied from research by Shurley and Bednarz (2000a, 2000b). Data is collected from a farm near Tifton, GA, which is in the southern production region of Georgia. Although data is limited, this is the only source of timeliness data for Georgia. Planting occurs only on one date, and variability is restricted to causes due to production quantity and lint quality arising from timing of defoliation and subsequent harvest. Lint quality has been a concern for Georgia cotton producers in recent years. Thus, while this research does not address yield changes due to planting date, it does focus on yield and quality changes due to harvest delay.

Linear programming models are useful in decision-making when numerous resources are available and efficient allocation becomes difficult. With a timeliness study, equipment availability and labor availability tend to restrict production activities during a period, such as harvest. The LP model uses a base budget and a series of partial budgets to maximize net returns in order to establish optimal farm plans. These optimal farm plans define the best combinations of crop acreage to produce, when to plant, and when to harvest.

Yields determine net revenue per acre and are derived for cotton from research by Shurley and Bednarz consisting of farm data in the southern production region of Georgia. Delaying defoliation leads to an increased percentage of open bolls at harvest. Initially, greater percentages of open bolls results in increased cotton yields. However, delaying harvest until more bolls open provides an opportunity for deterioration of existing open bolls. Adjusted yield is the yield for each planting and harvesting period after adjusting for premium or discount factors in terms of yield.

Values of adjusted yield are on a dollar per acre basis that is divided by the price received ($0.60/lb.) to obtain a quantity for yield adjustment. All values of adjusted yield represent a discount and resulting values are presented in Table 2. Four planting periods are included, and each has the highest adjusted yield when defoliation occurs at 83 percent open bolls, with harvest following two weeks later. Open boll percentages indicated by 100.0+ are for defoliation and harvest occurring after 100 percent of bolls are open. Available data for estimating discounts has one planting date and this leads to similar yield adjustments applied to all potential planting dates of the analysis. There are identical adjusted yields for each period of harvest after planting date. This corresponds to the model specification that varying planting dates do not lead to cotton yield differences.

Peanut yields are adjusted based on risk factors of TSWV and data from the National Center for Peanut Competitiveness. For this research, one base method of peanut production is evaluated with only planting dates causing a change in the TSWV index. The base method considered is planting Georgia Green variety with the insecticide *Thimet* in conventional twin row production. Seeds are planted at a rate of greater than 4 seed per linear foot. Estimated peanut yields for varying planting dates are presented in Table 3. Available data is for peanut yields representing harvest that is 10 periods after planting (ex.: T_2T_{12}). According to the University of Georgia Extension Service, digging peanuts 2 weeks early decreases yield by 740 lbs./ac. while digging 2 weeks late decreases yield by 540 lbs./ac. Yield adjustments due to harvesting dates are applied to derive yields in Table 3 for harvesting before and after 20 weeks from the date of planting.

In order to determine labor hour constraints, data are obtained from the Georgia Agricultural Statistics Service (GASS) which are reported in the "Georgia Weather and Crops Bulletin," published weekly from approximately March through December. Over the course of the production season, GASS publishes days suitable for fieldwork and crop progress. Data from 1997-2001 are analyzed to determine constraints for each constrained production activity.

A model farm leads to optimal solutions that are representative of typical farms in southern Georgia. Two meetings with county agents and farmers as participants were conducted to provide information for constructing a representative farm in terms of acreage, labor, and equipment utilized. Selected crew size includes the farm operator and two full-time employees. The representative farm includes one two-row digger and one two-row combine, one four-row digger and one four-row combine, and one cotton harvester. Acres of cotton and peanuts are constrained at less than or equal to 1000 acres. Variable costs for cotton are calculated from budgets developed by Shurley and Bednarz (2000a, 2000b) with updated input prices. Peanut variable costs are obtained from budgets published by UGA (Givan, Shurley, and Smith).

The 2002 Farm Bill eliminates the quota system that previously maintained most peanuts produced in Georgia at a price of over \$600/ton. Peanut prices for the model farm represent 2002 legislation with a loan rate of \$355/ton (Smith). Realized prices for the 2002 crop ranged from the loan rate to \$390/ton, and the estimated average by University of Georgia Extension specialists is \$375/ton for the farm model. Cotton continues to receive support similar to previous policy provisions, and cotton price in the model is \$0.60/lb (Shurley).

The base LP described above can be modified to allow the hiring of additional labor during the harvesting period. Since labor is defined in this model to include an hour of worker time combined with an hour of tractor time, increasing the amount of labor available requires increasing both the number of worker and tractor hours. Rather than modeling the custom hiring of labor and tractor time, advantage is taken of the hours of tractor time that become available when the self-propelled cotton harvester is used. In any period in which the cotton harvester is employed, one additional laborer is available.

Results And Implications

A complete discussion of the competitive situation for resources between cotton and peanuts includes the base model and 2 alternative scenarios. These scenarios depict relaxing constraints that represent the possibilities that farmers have to acquire additional resources.

Optimization of the base model results in a net return of $336,872 on a total of 1000 acres as reported in Table 4. Cotton acreage totals 817 acres with balance of 183 farm acres planted in peanuts. Cotton planting begins with 373 acres planted April 16-30 and continuing through June 1-15. The initial harvest date is T_{11} (August 16-31) with 142 acres harvested. Harvest is carried out in consecutive weeks through T_{17} (November 16-30). Cotton harvest is generally evenly distributed in activity from the middle of August through the end of November. Harvest was not allowed to carry over into December as the majority of cotton harvest is completed by the end of November (GASS). Peanuts are planted from May 16 through June 15, and harvested during the four week period beginning October 16. This forces the producer to harvest both cotton and peanuts during the T_{15} and T_{16} time periods. Therefore, cotton harvest is discontinued at some point during that four week period to harvest peanuts. Once peanut harvest is complete, cotton harvest is resumed in T_{17}.

In a second scenario reported in Table 4, the optimal solution is allowed to hire one extra laborer in the harvest periods. Net returns increase by $8450 by shifting acreage to more profitable schedules as peanut acreage increases by 36 acres. All of the increased peanut acreage is planted in T_6 and harvested in T_{16}. Total labor hours from August 16 through November 30 increase by 80 hours. Reallocation of labor hours is the most notable change due to increasing labor availability. Additional labor allows the initiation of cotton harvest to begin 2 weeks later which leads to more open bolls. Cotton harvested in the November 15-30 period decreases so that quality discounts are minimized.

Adding a peanut combine to the second scenario leads to the third scenario in Table 4. This represents the most profitable position that a producer could take based on the assumptions in this research, as profit increases by $21,100 more than the base solution. Total peanut acreage increases and cotton acreage harvested in T_{15} and T_{16} is reduced in order to accommodate peanut harvest. Optimal cotton planting is approximately 2 weeks earlier than is usually observed in Georgia fields, and most is planted by May 15. Peanut planting and harvest are extended approximately 2 weeks longer than the usual practice in order to accommodate cotton activities and to control TSWV.

Ratios of cotton acreage to peanut acreage in each of the three scenarios are represented by many Georgia counties. The ratio of the base solution is 4.5, with decreasing ratios of 3.6 for the second scenario and 1.7 for the third scenario. Comparing these ratios indicates potential farm differences that lead to varying acreage ratios in Georgia counties.

Results from each of the three scenarios present implications for cotton production that differ from current practices of farmers. Percentages of cotton planted during the last 2 weeks of April range from 43 percent to 46 percent in the optimal solutions. This compares to a range of approximately 20-25 percent reported by National Agricultural Statistics Service (NASS) crop progress reports. Secondly, each of the optimal solutions has most cotton harvested before peanut harvest begins, which differs from common practice. These planting and harvesting differences could indicate that farmers are not accurately estimating cotton quality discounts due to delayed harvest. The model calculates quality deductions as yield reductions. In recent years, Georgia peanut planting has become concentrated in the late May and early June periods as the model results support (NASS). Adoption of increased early planted cotton would require even more shifting of peanut planting into the late May and early June periods.

Summary And Conclusions

Results from the base model indicate that peanut planting should begin by the middle of May and continue into June, with harvest 20 weeks after planting. This allows for timely harvest of most peanuts during the last 2 weeks of October and continuing into November. Cotton planting is distributed from the middle of April through the middle of June. Harvest is completed during the last two weeks of November, but most is harvested before peanut harvest begins. In general, planting and harvesting of cotton are earlier and peanuts are later than current practices indicate.

Alternative solutions are derived by first allowing extra labor hours during the harvest period. Results from the second scenario indicates that increasing labor hours available leads to acreage changes in cotton planting and harvesting periods, as well as increased peanut acreage. Cotton acreage is redistributed so that initiation of harvest is delayed two weeks, and less harvested acreage is delayed until the end of November.

A third scenario adds a peanut combine to the second scenario. Peanut acreage increases substantially with utilized planting and harvesting periods identical to the base and second scenarios. Cotton harvested remains mostly completed before peanut harvest begins. Cotton harvest virtually ceases during the first of October so that all resources are devoted to peanut harvest.

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Table 1. Time Periods and Dates

Period	Dates
T_1	March 16-31
T_2	April 1-15
T_3	April 16-30
T_4	May 1-15
T_5	May 16-31
T_6	June 1-15
T_7	June 16-30
T_8	July 1-15
T_9	July 16-31
T_{10}	August 1-15
T_{11}	August 16-31
T_{12}	September 1-15
T_{13}	September 16-30
T_{14}	October 1-15
T_{15}	October 16-31
T_{16}	November 1-15
T_{17}	November 16-30
T_{18}	December 1-15
T_{19}	December 16-31

Table 2. Derived Cotton Yields Adjusted for Quality, by Percent Open Bolls and Days After Planting

Period	Percent Open Bolls	Days After Planting	Adjusted Lbs./Acre
T_3T_{11}	50.3	122	1141
T_3T_{12}	83.0	138	1234
T_3T_{13}	98.5	153	1229
T_3T_{14}	99.4	168	1228
T_3T_{15}	100.0+	182	1162
T_3T_{16}	100.0+	196	1085
T_4T_{12}	50.3	122	1141
T_4T_{13}	83.0	138	1234
T_4T_{14}	98.5	153	1229
T_4T_{15}	99.4	168	1228
T_4T_{16}	100.0+	182	1162
T_4T_{17}	100.0+	196	1085
T_5T_{13}	50.3	122	1141
T_5T_{14}	83.0	138	1234
T_5T_{15}	98.5	153	1229
T_5T_{16}	99.4	168	1228
T_5T_{17}	100.0+	182	1162
T_6T_{14}	50.3	122	1141
T_6T_{15}	83.0	138	1234
T_6T_{16}	98.5	153	1229
T_6T_{17}	99.4	168	1228

Table 3. Derived Peanut Yields, by TSWV Index and Weeks Between Planting and Harvest

		-Weeks After Planting-		
Planting Period	TSWV Index	18	20	22
		-Lbs./Acre-		
T_2	85	2791	3531	2991
T_3	80	2795	3535	2995
T_4	75	2939	3679	3139
T_5	65	3646	4386	3846
T_6	70	3223	3963	3423

Table 4. Planting and Harvesting Schedule for Optimal Solutions

		Base Scenario				Scenario 2				Scenario 3			
		Plant		Harvest		Plant		Harvest		Plant		Harvest	
		Cot.	Pnts.	Cot.	Pnts.	Cot.	Pnts.	Cot.	Pnts.	Cot.	Pnts.	Cot.	Pnts.
		-acres-				*-acres-*				*-acres-*			
T2	April 1-15												
T3	April 16-30	373.1				335.4				286.3			
T4	May 1-15	143.7				172.8				148.4			
T5	May 16-31	146.5	118.9			99.8	118.9			7.1	198.2		
T6	June 1-15	154.0	63.8			173.3	99.8			193.7	166.3		
T7	June 16-30												
T8	July 1-15												
T9	July 16-31												
T10	Aug. 1-15												
T11	Aug. 16-31			141.7									
T12	Sept. 1-15			97.4				160.6				111.5	
T13	Sept. 16-30			151.9				174.8				174.8	
T14	Oct. 1-15			117.2				172.8				148.4	
T15	Oct. 16-31			52.0	118.9			99.8	118.9			7.1	198.2
T16	Nov. 1-15			103.1	63.8			125.1	99.8			72.4	166.3
T17	Nov. 16-30			154.0				48.2				121.3	
Total		817.3	182.7	817.3	182.7	781.3	218.7	781.3	218.7	635.5	364.5	635.5	364.5
Net Rev/Ac ($)		336.87				345.32				357.97			