Journal of Agricultural and Applied Economics, 37,1(April 2005):249–261

Profitability and Resource Allocation Among Cotton and Peanuts When Considering Planting and Harvest Timeliness

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Harvest timeliness is a continual problem in the rotation of cotton and peanuts. Efficient allocation of land and labor resources during production of cotton and peanuts requires decisions be made on allocating resources throughout the growing season. Of particular concern is efficient allocation during planting and harvesting. Through economic analysis and linear programming optimization, planting and harvesting timeliness issues are addressed and compared with prevailing practices. Results for a representative farm indicate that cotton planting should increase during the early period of the planting season as compared with current practice, and most cotton should be harvested before peanut harvest begins.

Key Words: cotton, harvest timeliness, linear programming optimization, peanuts, planting timeliness

JEL Classification: Q12, Q18

Profitability for agricultural producers is dependent on 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. Although producers can realize a profit, they may not be obtaining their maximum profit potential. Profitable strategies require making decisions concerning the variety of seed to grow and the tillage practice to incorporate, as well as 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 the timeliness of planting and harvesting cotton and peanut crops in a rotation program.

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

Due to the tomato spotted wilt virus (TSWV) in peanuts, this strategy has lost

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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 generally occurs 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 nearly completed. This overlap of planting and harvest creates a resource allocation conflict for producers. The amount of available labor, equipment, and work hours can be the most binding constraints that producers face in accomplishing all production activities. A model that determines the optimal planting and harvest combinations for producers, therefore, is beneficial for optimizing net returns under timeliness considerations. Of primary concern is the harvest timeliness issue associated with delaying cotton harvest and the lessened returns due to quality reductions.

During the 1990s, 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 250.1 lbs/acre (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. Although there are a few chemicals that help control thrip populations, they are ultimately ineffective in controlling TSWV. In 1996, the UGA Extension Service introduced the TSWV Risk Index for evaluating the potential for infestation. Recent research shows this 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 TSWV Risk 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 was 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 the TSWV Risk 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% 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 during planting and harvesting periods. 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

Timing of harvest provides the basis for comparative analysis in this research, and any relationships between planting dates and yields could impact observed outcomes for harvest dates and yields. A review of previous research shows that geographic locations differ in relationships between the dates of cotton planting and yields. Larson et al. reported in an Oklahoma study that delayed cotton planting after the optimal date generally results in a consistent, daily decrease in lint yield because of a reduced growing season. Lower yields as a result of planting before the optimal date are attributed to low plant population survival, as well as the chilling of seedlings, which stunts plants. For a warmer climate, in Louisiana, Micinski et al. reported that planting dates do not affect cotton yields under conditions where thrips are effectively controlled. A study with aggregate Georgia data by Shurley and Deal concluded that planting date alone or in combination with other variables is not sufficient to explain yield variability or to predict yield.

Causality between yields and planting dates is associated with soil temperature. A point system developed by the National Cotton Council (NCC) relates soil temperature to cotton seedling disease with increased soil temperature at 4 inches leading to less risk of disease. In the category for soil temperature in Georgia, measurements greater than 72 degrees lead to no risk of seedling disease associated with insufficiently warm soil. Data from the National Data Climatic Center (NDCC) indicates that the area of Georgia corresponding to the largest region producing cotton and peanuts in rotation has a soil temperature that averages 81 degrees by the end of April. Crop progress data from the National Agricultural Statistics Service (NASS) shows that 20% to 25% of Georgia cotton is planted by the end of April. This shows that even the earliest planted cotton is in soil with temperatures warm enough to avoid potential problems of seedling disease due to low soil temperature. Nearly 90% of state plantings are completed by the end of May.

Another aspect of cotton planting dates and yields is plant density because of increased germination in warmer soils. Although no direct, experimental evidence is available to test yield differences due to soil temperature, there is research that determines yield differences caused by varying plant density from alternative seeding rates. Trials conducted by Kemerait et al. conclude that Georgia cotton growers obtain similar yields from a seeding rate of 2 and 4 seed per foot, provided the lower seed rate is not subject to seedling disease. Even though plant emergence and plant stands are greater with higher seeding rates, this does not result in increased yields.

Factors discussed above support no causality between typical cotton dates and yields in production regions with warm planting seasons. The risk ratings for seedling disease from the NCC demonstrate that Georgia cotton seedlings are not subject to disease from soil temperatures related to planting dates. In addition, density of plant stands is not associated with yield differences in Georgia. These findings support reports cited previously for southern cotton production in Louisiana and Georgia indicating that planting within typical planting dates is not a factor for yield. Comments from extension specialists support that the geographic latitude of cotton production in Georgia causes sufficiently warm soils so that planting dates are not yield factors.

Lacking a definite relationship between planting dates and yields, this research focuses on relationships between harvest dates and yields. 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 (2000, 2001), 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.

Producers are faced with difficult decisions when it comes to harvest. Shurley and Bednarz (2000, 2001) found that each weekly delay in harvest after 100% of bolls are open results in an expected loss of $15.76 per acre in net returns. Maximum net returns occur 1 to 2 weeks before 100% open bolls and decline each week thereafter. Parvin reported that September 25 is the standard harvest initiation date in Mississippi. If harvest begins 1 week early, profits increase by 30%, but beginning 1 week late decreases profits by 63%.

Little research exists for Georgia cotton producers to estimate appropriate defoliation dates to maximize profits at harvest. Previous research by Shurley (2000) applied 80% open bolls as optimal for defoliating cotton. If harvest 2 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.

Planting date, harvest date, and yield data are not widely available for Georgia. States such as Texas, the Carolinas, and Arkansas have some research available, but discrepancies arise across these data. This could be due to differences in soils, temperatures, weather patterns, and other naturally occurring phenomena. Different areas of the U.S. require different cropping strategies and practices to produce a profitable crop. Timeliness data for yield and harvest of cotton in this research is applied from research by Shurley and Bednarz (2000, 2001). Data was collected from a farm near Tifton, GA, which is in the southern production region of Georgia. Yields and harvest timing data were collected for three seasons covering 1998–2000. Weather at harvest during these years includes good and poor conditions that impact fiber quality. 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. Research by Shurley and Deal discussed above indicates potential problems incorporating planting dates with available data, and this study focuses on issues related to proper timing of cotton production relative to peanut production. Lint quality has been a concern for Georgia cotton producers in recent years. Thus, although 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 (LP) models are useful in decision-making when numerous resources are available and efficient allocation becomes difficult. With a timeliness study, equipment 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 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. The system of equations with the objective function and constraints is:

(1) Maximize

$$\Pi = \sum_{p=1}^{19} r_{ip}a_{ip} + \sum_{p=1}^{19} r_{jp}a_{jp}$$

subject to:

$$\sum_{p=1}^{19} L_{ip}a_{ip} + \sum_{p=1}^{19} L_{jp}a_{jp} \leq \sum_{p=1}^{19} L_p$$

for $p = 1, \ldots, 19$

$$\sum_{p=1}^{19} PL_{ip}a_{ip} + \sum_{p=1}^{19} PL_{jp}a_{jp} \leq \sum_{p=1}^{19} PL_p$$

for $p = 3, \ldots, 7$

$$\sum_{p=1}^{19} CH_{ip}a_{ip} \leq \sum_{p=1}^{19} CH_p$$

for $p = 11, \ldots, 19$

$$\sum_{p=1}^{19} PD_{jp}a_{jp} \leq \sum_{p=1}^{19} PD_p$$

for $p = 12, \ldots, 19$

$$\sum_{p=1}^{19} PC_{jp}a_{jp} \leq \sum_{p=1}^{19} PC_p$$

for $p = 13, \ldots, 19,$

where r_i and r_j are net revenues per acre, and a_i and a_j are acres for crops i for cotton and j for peanuts, respectively. L_{ip} and L_{jp} are hours of labor per acre used by crops i and j in pe-

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

riod p, and L_p is labor hours available in period p. PL_{ip} and PL_{jp} are hours of planter time per acre used by crops i and j in period p, and PL_p is planter hours available in period p. CH_{ip} is hours of cotton harvester per acre used by crop i in period p, and CH_p is cotton hours available in period p. PD_{jp} is hours of peanut digger per acre used by crop j in period p, and PD_p is peanut digger hours available in period p. PC_{jp} is hours of peanut combine per acre used by crop j in period p, and PC_p is peanut combine hours available in period p. Table 1 presents the calendar dates that correspond to time periods for planting and harvesting. The first subscript is for planting and the second subscript is for harvesting.

Yields determine net revenue per acre in Equation (1) 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 ($Y'_{p,p}$) is the yield ($Y_{p,p}$) for each planting and harvesting period after adjusting for premium or discount factors in terms of yield ($Z_{p,p}$). Adjusted yield is expressed as

$$(2) \qquad Y'_{p,p} = Y_{p,p} \pm Z_{p,p}.$$

$Z_{p,p}$ is estimated by applying farm data from Shurley and Bednarz (2000, 2001) to the equation

$$(3) \qquad z = \alpha + \beta_1 X + \beta_2 X^2 + \varepsilon,$$

where z is the observed premium or discount, α is an intercept term, X is the percent of open bolls when defoliation occurs, β_1 and β_2 are parameters to be estimated, and ε is an error term. Regression results for parameter estimation are depicted in Figure 1 for weeks up to 100% open bolls and in Figure 2 for weeks after all bolls have opened. Predicted values of z are on a dollar-per-acre basis that is divided by the price received ($0.60/lb) to obtain a quantity for yield adjustment, $Z_{p,p}$ in Equation (2). Values representing quality discounts are much more stable than market prices, and conversion to discounted yields aids in intuitive comparisons between quality discounts. All values of z represent a discount and resulting Y' values are presented in Table 2. Four planting periods are included, and each has the highest adjusted yield when defoliation occurs at 83% open bolls, with harvest following 2 weeks later. Open boll percentages indicated by 100.0+ are for defoliation and harvest occurring after 100% of bolls are open. Discounts for these observations are estimated by substituting weeks after 100% open bolls for X in Equation (3). Coefficients in Equation (3) are derived from the Shurley and Bednarz data with 1 planting date, which 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 in Table 2. This corresponds to the model specification that varying planting dates does 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

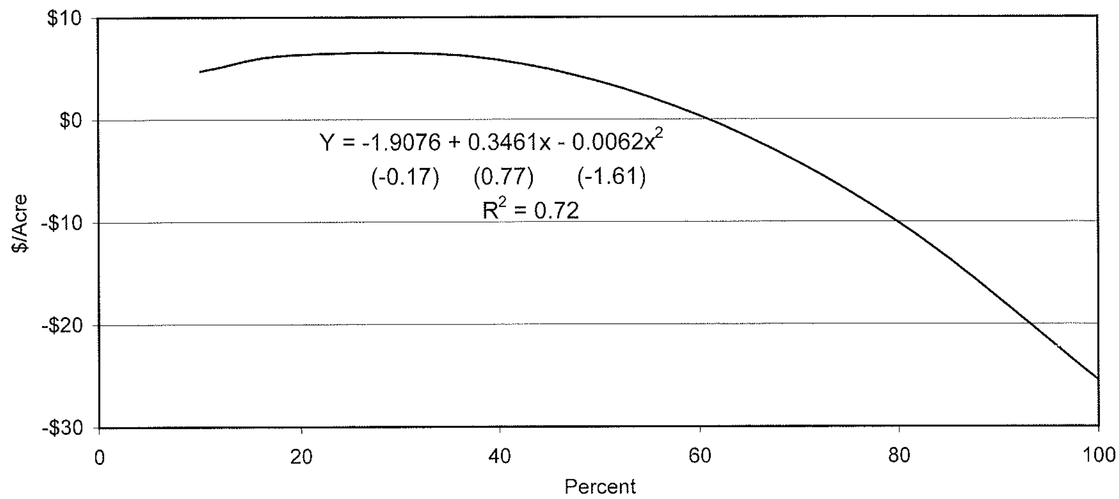

Figure 1. Percent of Bolls Open at Defoliation and Premiums or Discounts for Quantity, *t*-values in parentheses

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 four seeds per linear foot. Yield data are regressed on TSWV indexes that change only because of planting date as

$$Y = \psi + \beta_1 I + \beta_2 I^2 + \varepsilon, \tag{4}$$

where Y is observed yield, I is the calculated index for each observation, ψ is an intercept term, β_1 and β_2 are parameters to be estimated, and ε is an error term. Parameter estimation is from regression results in Figure 3. 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 (e.g.: T_2T_{12}). According to the UGA Extension Service, digging peanuts 2 weeks early decreases yield by 740 lbs/acre, whereas digging 2 weeks late decreases yield

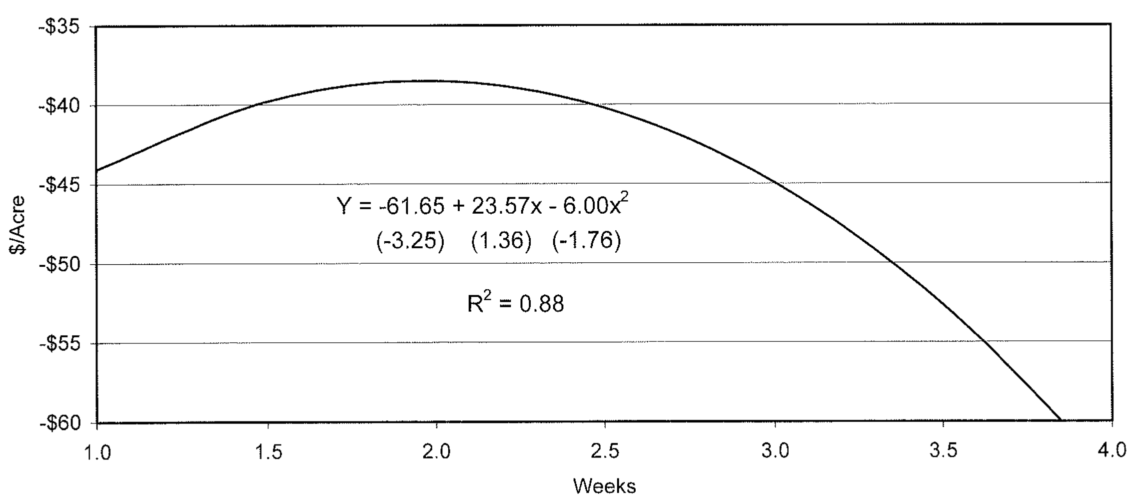

Figure 2. Weeks After 100% of Bolls Open at Defoliation and Premiums or Discounts, *t*-values in Parentheses

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	1,141
T_3T_{12}	83.0	138	1,234
T_3T_{13}	98.5	153	1,229
T_3T_{14}	99.4	168	1,228
T_3T_{15}	100.0+	182	1,162
T_3T_{16}	100.0+	196	1,085
T_4T_{12}	50.3	122	1,141
T_4T_{13}	83.0	138	1,234
T_4T_{14}	98.5	153	1,229
T_4T_{15}	99.4	168	1,228
T_4T_{16}	100.0+	182	1,162
T_4T_{17}	100.0+	196	1,085
T_5T_{13}	50.3	122	1,141
T_5T_{14}	83.0	138	1,234
T_5T_{15}	98.5	153	1,229
T_5T_{16}	99.4	168	1,228
T_5T_{17}	100.0+	182	1,162
T_6T_{14}	50.3	122	1,141
T_6T_{15}	83.0	138	1,234
T_6T_{16}	98.5	153	1,229
T_6T_{17}	99.4	168	1,228

by 540 lbs/acre. 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.

Constraints on Equation (1) are determined by the number of labor hours available. To determine the constraint limits, 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 in Equation (1). Periods with data not available for December are estimated from available data.

A model farm for application in Equation (1) results in 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 used. Selected crew size includes the farm operator and 2 full-time employees. The representative farm includes 1 two-row digger and 1 two-row combine, 1 four-row digger and 1 four-row combine, and 1 cotton harvester. Acres of cotton and peanuts are constrained at less than or equal to 1,000 acres. Variable costs for cotton are calculated from budgets developed by Shurley and Bednarz (2000, 2001) with updated input prices. Peanut variable costs are obtained from budgets published by the University of Georgia (Givan, Shurley,

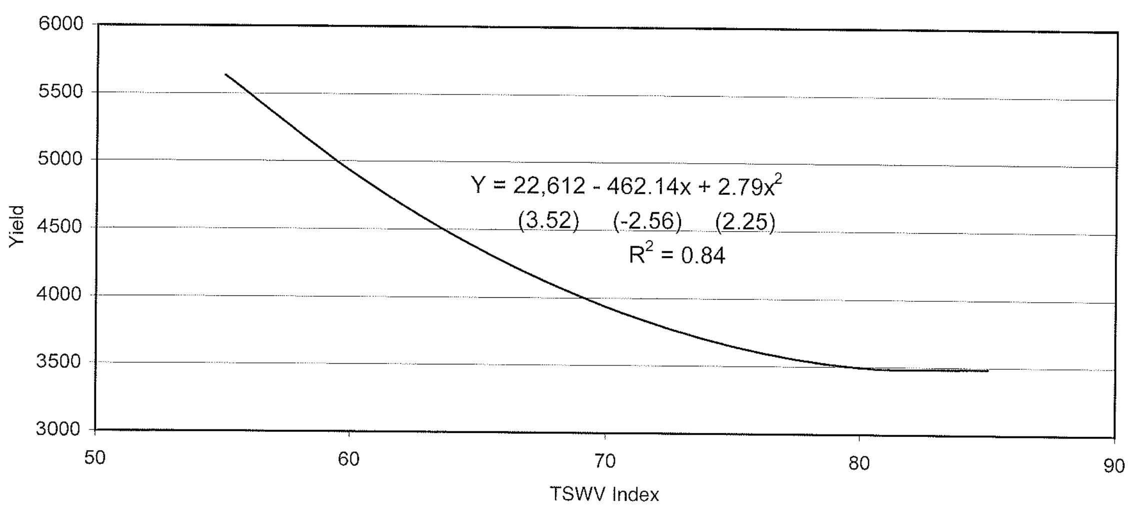

Figure 3. Tomato Spotted Wilt Virus Index and Peanut Yield, t-values in Parentheses

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

Planting Period	TSWV Index	Weeks After Planting 18	20	22
		Lbs./Acre		
T_2	85	2,791	3,531	2,991
T_3	80	2,795	3,535	2,995
T_4	75	2,939	3,679	3,139
T_5	65	3,646	4,386	3,846
T_6	70	3,223	3,963	3,423

and Smith). Variable costs are presented in Table 4 and the associated labor time requirements for production activities are presented in Table 5. Variable costs related to postharvest expenses in Table 5 are presented for a base yield of 1,000 lbs/acre for cotton and 3,500 lbs/acre for peanuts. Postharvest costs are adjusted for application in Equation (1) based on yields in Table 2 and Table 3. Cotton acreage consists of stacked gene transgenic cotton (BtRR) and conventional cotton. A yield reduction of 25% below BtRR yield is assumed for conventional cotton in refuge areas, and cost reductions across all yields in Table 2 average $27.33/acre less than BtRR.

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 UGA 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 2000, 2002).

The base LP described above can be modified to allow the hiring of additional labor during the harvesting period. Because 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 the 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 p in which the cotton harvester is employed, 1 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 two 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 1,000 acres as reported in Table 6. Cotton acreage totals 817 acres with a 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 because 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 4-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 4-week period to harvest peanuts. Once peanut harvest is complete, cotton harvest is resumed in T_{17}.

Constraints are binding in the base solution

Table 4. Base Budgets for BtRR Cotton and Peanuts, Variable Costs

	$/Acre	
	Cotton	Peanuts
Seed	9.38	80.0
Technology fee	29.50	NA
Fertilizer	55.75	40.35
Herbicides	18.69	47.00
Insecticides	17.39	11.05
Growth regulator	9.76	NA
Defoliation	17.40	NA
Fungicides	NA	71.73
Fuel and lube	17.35	29.16
Repairs and maintenance	30.71	19.76
Irrigation	27.00	26.25
Labor	30.96	32.82
Scouting	7.00	NA
BWEP	4.25	NA
Crop insurance	20.00	0.00
Ginning minus cotton seed value	39.63	NA
Marketing and promotions	26.00	6.95
Peanut company	NA	54.25
Total variable costs	360.77	419.32
Yield (Lbs./Acre)	1,000	3,500

BWEP is the boll weevil eradication program.

Table 5. Labor Hours per Acre for Cotton and Peanuts by Activity

	Hours/Acre	
	Cotton	Peanuts
Burn down	NA	0.0576
Disk	0.1621	0.2059
Disk with herbicide	0.1802	NA
Rip and bed	0.1908	0.1908
Plant	0.2269	0.2268
Postemergence herbicide	0.0576	NA
Apply nitrogen	0.2079	NA
Layby-directed herbicide	0.2079	NA
Herbicide	NA	0.5613
Fungicide	NA	0.5613
Growth regulator/boron	0.1151	NA
Insecticide/boron	0.0576	NA
Growth regulator	0.1151	NA
Defoliate	0.0576	NA
Dig	NA	0.2268
Harvest/combine	0.5791	0.4212
Mow stalks	0.2172	NA

NA is not applicable.

for labor hours during harvest and available hours of peanut harvesters in T_{15}. Labor hours during May 16–31 and planter hours during April 16–30 are binding with shadow prices of $3.79 and $4.39, respectively. Table 7 presents shadow prices for harvesting labor hours and available peanut harvester hours. With labor cost of $9.00 per hour, shadow prices indicate increased revenue by increasing labor availability during harvest. Profitability of adding a peanut harvester is determined by the additional peanut acres in production to cover additional fixed costs.

In a second scenario reported in Table 6, the optimal solution is allowed to hire 1 extra laborer in the harvest periods. Net returns increase by $8,450 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 because of increasing labor availability. Additional labor allows the initiation of cotton har-

Table 6. Planting and Harvesting Schedule for Optimal Solutions

		Base Scenario Acres				Scenario 2 Acres				Scenario 3 Acres			
		Plant		Harvest		Plant		Harvest		Plant		Harvest	
	Period	Cotton	Peanuts	Cotton	Peanuts	Cotton	Peanuts	Cotton	Peanuts	Cotton	Peanuts	Cotton	Peanuts
T_2	April 1–15												
T_3	April 16–30	373.1				335.4				286.3			
T_4	May 1–15	143.7				172.8				148.4			
T_5	May 16–31	146.5	118.9			99.8	118.9			7.1	198.2		
T_6	June 1–15	154.0	63.8			173.3	99.8			193.7	166.3		
T_7	June 16–30												
T_8	July 1–15												
T_9	July 16–31												
T_{10}	Aug. 1–15												
T_{11}	Aug. 16–31			141.7									
T_{12}	Sept. 1–15			97.4				160.6				111.5	
T_{13}	Sept. 16–30			151.9				174.8				174.8	
T_{14}	Oct. 1–15			117.2				172.8				148.4	
T_{15}	Oct. 16–31			52.0	118.9			99.8	118.9			7.1	198.2
T_{16}	Nov. 1–15			103.1	63.8			125.1	99.8			72.4	166.3
T_{17}	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			

Net Rev/Ac is net revenue per acre.

Table 7. Shadow Prices of Labor Hours and Peanut Harvester Hours During Typical Harvest Period for Base Scenario

Dates	Labor ($)	Peanut Harvester ($)
August 16–31	20.21	0.00
September 1–15	49.50	0.00
September 16–30	46.47	0.00
October 1–15	48.48	0.00
October 16–31	48.08	48.55
November 1–15	46.90	0.00
November 16–30	52.39	0.00

vest 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. Comparing the results of the base scenario and scenario 2, the yields or net returns per acre in each time period do not change for either cotton or peanuts. Rather, the amounts produced in the different time periods are increased or decreased according to the constraints—a reallocation of resources.

Adding a peanut combine to the second scenario leads to the third scenario in Table 6. 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 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 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% to 46% in the optimal solutions. This compares with a range of approximately 20% to 25% reported by 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 supported by the model results (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

Research in the area of planting and harvesting harvest timeliness is of particular concern to cotton and peanut production, as inadequate labor and equipment availability tends to reduce efficiency. Cotton and peanuts compete for resources and optimal allocations depend on crop characteristics and relative commodity prices. Producers, not realizing potential variations of profits, may be experiencing yield reductions or quality discounts for leaving the cotton in the field while completing peanut harvest.

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 2 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 indicate 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 2 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 planting and harvesting periods used 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.

This study is limited in that weather and other uncontrollable phenomena are not simulated in the model. Further research needed in this area should consider weather trends and attempt to incorporate those types of variables into the model. Additional years of data would better depict various interrelated circumstances that impact yield and fiber quality. Also, future researchers should incorporate fixed costs into the model so that equipment costs unique to cotton or peanuts are evaluated.

[Received August 2003; September 2004.]

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