Simulation Analysis of Double-Cropping Vegetables and Field Crops

By Archie Flanders, Nathan B. Smith, Esendugue Greg Fonsah, and John C. McKissick

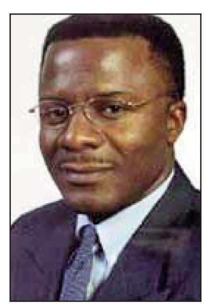
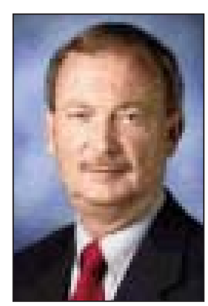
Abstract

Georgia field crop production entails agronomic considerations that lead to a typical system that includes cotton, peanuts and corn as rotation crops. Financial analysis of Georgia field crops indicates the importance of government programs to support farm income. Current legislation permits double-cropping of Georgia fruits and vegetables on base commodity program acreage with no reduction in direct and counter-cyclical payments. Fresh cabbage has seasonal markets in which Georgia is the major U.S. supplier during the April-June and October-December harvesting months. Results indicate increased net returns of $377/ac. by double-cropping cabbage in a system with field crops.

The Farm Security and Rural Investment Act of 2002 established direct and counter-cyclical payments based on historical production of wheat, feed grains, upland cotton, rice, peanuts and oilseeds. Both direct and counter-cyclical payments are calculated for base acreage and yields which are determined by historical acreage and associated yields for program crops. Cropland remains eligible to receive these payments even in circumstances when the program crop is not produced. Although farmers have flexibility in planting on base acreage, restrictions exist for planting fruits, vegetables and wild rice on base acreage. Restrictions either prohibit planting fruits and vegetables on base acreage, or subject farmers to reduced direct and counter-cyclical payments if fruits and vegetables are produced in permitted circumstances. An exception to prohibition or reduced payments occurs when a region has a history of double-cropping program crops with the otherwise prohibited crops (Johnson et al).

A history of double-cropping is determined for each state by the State committees of the Farm Service Agency. All Georgia counties are designated as eligible for double-cropping program crops with fruits and vegetables (USDA, CCC). Double-cropping provisions are continued in the Food, Conservation, and Energy Act of 2008. The objective of this research is to determine the financial returns for double-cropping Georgia cabbage and field crops.



Archie Flanders is assistant professor, Department of Agricultural Economics and Agribusiness, University of Arkansas, Northeast Research and Extension Center, Keiser, AR, Nathan B. Smith and Esendugue Greg Fonsah are associate professors and extension economists, Department of Agricultural and Applied Economics, University of Georgia, Tifton, GA, and John C. McKissick is Director, Center for Agribusiness and Economic Development and professor, Department of Agricultural and Applied Economics, University of Georgia, Athens, GA.

Related Research

Decision Making and Farm Simulation Models

Stochastic simulation modeling was used to analyze the effects of 2002 Farm Bill on southern U.S. farms soon after its passage (Sartwelle et al). Of 39 representative farms and ranches, 11 were rated in good financial status, 9 were designated marginal and 19 were rated poor. Proposed policy changes to the 2002 Farm Bill related to U.S. budget considerations were evaluated with simulation analysis by Richardson et al. Results indicated that budget savings of $3 billion could be achieved with a reduction in loan rates causing the least financial harm to impacted farms. Proposed policy changes for the 2008 Farm Bill call for using farm revenue as a basis for government payments. Stochastic simulation analysis concludes that revenue based counter-cyclical payments lead to lower government payments than an alternative proposal by the National Corn Growers Association (Higgins et al). Stochastic simulation was applied to an analysis of removing fruit and vegetable restrictions in the Lower Rio Grande Valley of Texas (Fumasi, Richardson and Outlaw). Conclusions are that changes in cropping preference due to removing fruit and vegetable planting restrictions would most likely occur on cotton base acreage. Cabbage and watermelons would have the highest gains in returns when substituted on cotton base acreage.

Fruit and Vegetable Restrictions

Market analysis of removing fruit and vegetable restrictions on base program acreage is reported by Johnson et al. A large magnitude of base acreage and the relatively small size of fruit and vegetable acreage cause fruit and vegetable growers to have concerns that production increases will lead to price decreases. The research concludes that eliminating restrictions would not result in substantial market impacts for most fruits and vegetables. However, the effects on individual producers could be significant. The report indicates that agronomic, management and economic constraints may be factors that limit fruit and vegetable acreage expansion with removal of planting restrictions.

Research in this report follows previous research using simulation modeling to evaluate whole farms with more than one crop in production. Previous research related to fruit and vegetable production with commodity program crops has focused on eliminating planting restrictions for fruits and vegetables. This research investigates double-cropping fruit and vegetable production with program crops under conditions that existing planting restrictions are maintained.

Simulation methods presented in this analysis develop a framework for application by farm managers with various crop production systems. State level data included in this analysis are intended to represent a statistically average farm in Georgia. Results with these data are informative for generalized analysis and indicate potentialities for Georgia farm management decisions. While results of this research are not directly applicable to any individual farm, methods presented in this report demonstrate a beneficial tool that can be utilized for customized analysis. Techniques utilized are accomplished with software that is readily available and accessible by general computer users. Data requirements include input and financial information that is included in typical farm record keeping systems. Extended usage of simulation analysis for farm decisions are alternative crops, tillage practices and production systems.

Georgia Field Crops and Fresh Market Cabbage

Field Crops

Georgia is the leading peanut producing state with 45 percent of U.S. peanut production during the 2006 and 2007 production years (USDA, NASS 2008a). Research demonstrates that peanuts have greater yields and higher grades in a long crop rotation. University of Georgia Extension recommendations are to plant peanuts in the same field once every three years or longer. Agronomic results indicate increased peanut yields when following two consecutive years of cotton, or one year of cotton and one year of corn (Beasley).

Georgia cotton acreage declines have not been as great as in other states. The state produced 10 percent of U.S. upland cotton during 2006 and 2007 (USDA, NASS 2008a). Most value of production from cotton is for fiber in textile industries, but a secondary cotton product is cottonseed. Georgia produced eight percent of U.S. cottonseed during the 2006 and 2007 production years with most Georgia cottonseed sold for refining cottonseed oil, animal feed, and exports (USDA, NASS 2008a). Georgia is not a major U.S. producer of corn for grain. Although Georgia corn is utilized as livestock feed, the large poultry industry in the state imports almost all feed supplies from the Midwest.

Cabbage

Georgia produced 11 percent of U.S. fresh cabbage during the 2006 and 2007 production years (USDA, NASS 2008a). The southern part of the state is the major cabbage region. Georgia cabbage is at significant risk of freeze injury when planted after late October and before mid-February. Cabbage varieties planted in Georgia typically require 70-90 days to reach maturity (Kelly, MacDonald and Adams). Most Georgia cabbage is produced for the spring harvesting period during April-June, and the fall harvesting period during October-December (USDA, NASS-Georgia 2008). During its primary harvesting periods, Georgia harvests more acreage than any other U.S. state. Georgia cabbage primarily supplies markets east of the Mississippi. The South accounts for most Georgia cabbage shipments, but Boston, Baltimore-Washington, Cincinnati and Chicago are major markets (Kelly, MacDonald and Adams).

Double-Cropping Cabbage with Field Crops

Agronomic considerations severely limit monocultural peanut production in Georgia. The Georgia peanut production system involves cotton and corn rotations. Adding double-cropped cabbage production may increase financial returns to field crop producers. Table 1 shows the planting and harvesting periods for cabbage and field crops (USDA, NASS-Georgia 2007). Planting fall cabbage following corn, cotton or peanuts is feasible. Spring cabbage offers the best possibility for harvest occurring before planting peanuts and corn. Although state production dates indicate double-cropping planting and harvesting windows exist, suitable periods for double-cropping vary by geographic location.

Data and Model

Data compiled from several published sources are applied to develop a model for farm simulation analysis. Utilizing aggregate data leads to a field crop sector average farm model useful for comparing expected outcomes resulting from changes among crops in the sector. Including time series data for yields and prices determines the correlations of variables and leads to stochastic simulation iterations that incorporate relationships among prices and yields.

Data

Acreage distributions for peanuts, cotton and corn on 1,150 total farm acres reported in Table 2 are based on agronomic considerations for proper rotation, as well as historical distributions of crop acreage (USDA, NASS 2008a; Meeks). Expected U.S. prices for peanuts are derived from forecasts by the Food and Agricultural Policy Research Institute (FAPRI). Expected U.S. prices for cotton and corn are midpoints of price ranges from world agricultural supply and demand estimates (USDA, WAOB). Historical differences between U.S. and Georgia average field crop prices are applied to 2008 expected U.S. prices to establish Georgia expected prices in Table 2. Expected 2008 yields for field crops are derived as trend adjusted moving 5-year Georgia averages (USDA, NASS 2008a). Base yields for field crop commodity programs are published by the Farm Services Agency (USDA, FSA). An assumption of the model is that all field crop acreage is associated with base acreage for calculating direct payments and counter-cyclical payments. Recent changes in Georgia acreage allocations reflect a 100 acre decrease for cotton and a corresponding increase for corn in Table 2. Expected spring season price and yield for cabbage correspond to budgets developed by the University of Georgia (UGA). The Adjusted World Price (AWP) for cotton of $0.632 per lb. is derived from historical differences between Georgia price and AWP reported by the Foreign Agricultural Service (USDA, FAS). In addition to lint sales, cotton production revenue from selling cottonseed is estimated as $165/ton.

Cost data are derived from budgets published by the University of Georgia. Crop enterprise budgets for cotton (Shurley and Ziehl), corn (Smith and Ziehl 2007a) and peanuts (Smith and Ziehl 2007b) represent costs for the 2008 production year. Total farm costs of $713,331 for 600 acres of cotton, 350 acres of peanut and 200 acres of corn are presented in Table 3. Cabbage production costs presented in Table 4 are derived from budgets developed by the University of Georgia (UGA). Average farm size for Georgia cabbage production of 108 acres includes large producers engaged primarily in vegetable production (NASS 2004). Field crop farms producing cabbage would likely begin production on a scale smaller than the state average, and variable costs in Table 4 of $175,650 are for 50 acres of cabbage. Most of the farm fixed costs for cabbage production are entailed in costs incurred for peanuts, cotton and corn. Additional annual fixed costs of $446 for cabbage production include a bedder, as well as a transplanter.

Simulation Model

Simetar© is a computer simulation add-in to Microsoft® Excel. Data in a spreadsheet can be depicted as stochastic for evaluating relative risks among alternative farm management decisions. Variability in yields and commodity prices lead to the greatest risks in crop production. A simple equation for revenue that is the product of price and yield can be reformulated to include risk by applying historical farm relationships for these two variables. Incorporating historical farm data into a Simetar function results in an expected revenue outcome with outcome ranges that are less than and greater than the expected average. Distributions are determined by relevant farm history and risk analysis is unique for each farm situation. More information about Simetar and schedules for user training workshops are available at htt://www.simetar.com.

Crop prices and yields have historical relationships that can be accounted for with stochastic analysis. In this analysis of double-cropping vegetables and field crops, total revenue, as well as baseline expenses for harvest, custom operations, marketing and warehousing are variable. Generation of random prices and yields leads to net returns that account for the stochastic relationships existing in production. An alternative to typical normality assumptions in simulating stochastic commodity prices and yields is application of a multivariate empirical (MVE) distribution. The MVE distribution accounts for interrelationships occurring in the data and avoids enforcing a specific distribution on the variables. Simulating commodity prices and yields with an MVE distribution includes a correlation matrix that generates correlated stochastic variables (Richardson, Klose and Gray). Simulation with MVE results in simulated random variables that are bounded by historical minimums and maximums of the original data. In contrast, simulation with normal distributions can result in simulated random variables that are outside of historical bounds. Model simulation of Georgia peanut, cotton, corn and cabbage production applies the MVE function of Simetar (Richardson, Schumann and Feldman). Simetar generates random variables with means of price and yield in Table 2 and covariance structures determined by 1998-2007 historical prices and yields (USDA, NASS 2008a).

Crop revenue iterations are calculated with simulated prices and yields for constant crop acreage in Table 2. Government payments consisting of direct payments, counter-cyclical payments and loan deficiency payments for each crop are determined by simulated prices and yields and are calculated based on methods established by the 2002 Farm Act (Westcott, Young and Price). Baseline variable costs incurred before harvest are constant. Variable costs incurred during harvest and after harvests vary with yields. A simulation model for farm net returns (NR) is

$$NR = (R+GP) - (V + F), \quad (1)$$

where R = revenue from sales, GP = government payments, V = variable costs, and F = fixed costs. Stochastic simulated variables are applied in Equation (1) to determine 500 farm net returns.

A model representing an average farm in this research is a sector model of field crop and cabbage production. Variability in prices and yields from aggregate data are not indicative of individual farm risks. A simplifying assumption of this analysis is that there is not a significantly large increase in cabbage acreage that would lead to depressed market prices. Financial returns in this report indicate potential for any single farm only under assumptions and conditions of the applied farm model.

Results and Implications

Field Crop Production

Averages of 500 iterations for Equation (1) are presented in Table 5. Total market revenue for field crops is $771,716. Government payments of $56,428 represent 6.8 percent of total farm revenue. Deducting variable costs and fixed costs results in net returns of $114,813. Aggregate data indicates that 50 percent of Georgia cropland is rented (USDA, NASS 2004). Rental rates reported for Georgia indicate an expected rate of $65/ac. (Escalante; USDA, NASS 2008b). Irrigation equipment expenses are included in fixed costs, and land rental rates represent non-irrigated rates. Multiplying the rental rate by 575 acres of rented land and deducting from net returns leads to average farm income of $77,438. Farm income is subject to income tax, and the after tax residual is available for family living expenses. Farm income without government payments is $21,010.

Double-Cropping Cabbage

A second simulation includes random prices and yields for cabbage with means in Table 2 and covariance structures determined by 1998-2007 historical prices and yields (USDA, NASS 2008a). Adding 50 acres of cabbage generates $194,961 of increased farm revenue in Table 5. Additional seasonal labor expenses for cabbage included in variable costs are $38,272 in Table 4 for planting, harvesting, and packing. Variable costs with cabbage increase by $175,650 ($3,513/ac.) so that returns to variable costs for cabbage are $386/ac. This compares to returns to variable costs of $303/ac. for corn, $167/ac. for peanuts and $131/ac. for cotton. Deducting additional fixed costs due to cabbage production leads to net returns of $133,677. Thus, 50 acres of cabbage results in increased net returns of $377/ac. Farm income with cabbage increases to $96,302 which is $18,864 greater than without cabbage.

Comparing coefficients of variation for farm income shows the relative variability of farm income. The coefficient of variation is 86.3 without cabbage and 81.2 with cabbage which is a 6 percent reduction in the coefficient of variation by double-cropping cabbage. Figure 1 presents the cumulative distribution functions (CDF) of farm income for comparative farm acreages on an 80 percent confidence interval. The CDF that includes cabbage is to the right of the CDF without cabbage, indicating that farm income is greater with cabbage at all probability levels. Interpretation of the CDF indicates the probability of achieving a specified level of farm income. For example, farm income of $100,000 intersects the CDF with cabbage at approximately 50 percent. This indicates that 50 percent of farm income outcomes are less than $100,000, and 50 percent are greater than $100,000. In comparison, farm income of $100,000 intersects the CDF without cabbage at approximately 60 percent. This indicates that 60 percent of farm income outcomes are less than $100,000, and only 40 percent are greater than $100,000. Thus, adding cabbage decreases the probability of farm income of less than $100,000 and increases the probability of farm income greater than $100,000.

Results in Table 5 and Figure 1 indicate potential incentives for farmers to add cabbage acreage to field crop enterprises consisting of peanuts, cotton and corn. Although increases in returns per acre are favorable for cabbage, total returns for 50 acres of cabbage may not be sufficient to induce large increases in aggregate acreage. Cabbage acreage increases may create increased management requirements that serve as disincentives for significant aggregate acreage increases in Georgia. Additional capital requirements for variable costs on financially stressed farms could be another disincentive for expanding cabbage production on base acreage. Potential needs for purchasing specialized equipment related to cabbage production are not included in this analysis. An assumption of this research is that any specialized equipment, most likely for packing and cooling, is available as a purchased service from another local cabbage producer. This assumption may affect the analysis by underestimating cabbage fixed costs. Public discussion related to planting fruits and vegetables on base acreage generally involves specialty crops as substitutes for field crops. Double-cropping provisions may be overlooked by Georgia farmers due to a misperception that no fruit and vegetable production is allowable on base acreage receiving government payments. Limited availability of seasonal labor in primarily field crop production regions may be an impediment to double-cropping cabbage.

Impacts of marketing issues due to increased aggregate cabbage production are not included in this report. Increased cabbage production in Georgia could adversely affect market prices received. Current cabbage supply is limited during the seasonal window available for double-cropping and increased supply could depress prices.

Summary and Conclusions

Current legislation permits double-cropping of Georgia fruits and vegetables on base commodity program acreage with no reduction in direct and counter-cyclical payments. Fresh cabbage has seasonal markets in which Georgia is the major U.S. supplier during the April-June and October-December harvesting months. Results indicate increased farm net returns of $377/ac. by double-cropping cabbage. Although net returns are favorable, high variable costs of $3,513/ac. may discourage significant increases in total cabbage acreage. Management requirements may limit incentives for increased cabbage acreage double-cropped with field crops. Results of this research are not directly applicable to individual Georgia farms, but methods presented in this report demonstrate a beneficial tool that can be utilized for customized analysis by farm managers. Simulation software utilized is available to general computer users and can be incorporated with data spreadsheets.

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Table 1. Planting and harvesting dates for Georgia field crops and cabbage

	Usual Planting Dates			Usual Harvesting Dates		
	Begin	**Most Active**	**End**	**Begin**	**Most Active**	**End**
Corn	Mar 1	Mar 20-Apr 15	May 5	Jul 25	Aug 15-Sep 5	Oct 10
Cotton	Apr 20	Apr 25-May 25	Jun 5	Sep 20	Oct 5-Nov 15	Dec 15
Peanuts	Apr 15	Apr 25-May 20	Jun 10	Sep 5	Sep 10-Oct 15	Nov 1
Cabbage, Spring	Feb 1	Feb 1-Mar 15	Mar 15	Apr 15	Apr 15-Jun 15	Jun 30
Cabbage, Fall	Aug 1	Aug 1-Oct 15	Oct 15	Nov 15	Nov 15-Dec 15	Dec 30

Table 2. Simulation prices and yields, GA, 2008

	Unit: lbs.	***Unit: lbs.***	***Unit: bu.***	***Unit: cwt.***
	Peanuts	**Cotton**	**Corn**	**Cabbage**
Acres Harvested	350	600	200	50
Expected Price ($)	0.231	0.659	5.44	13.00
Expected Yield	3,087	821	130	300
Base Acres	350	700	100	NA
DP Base Yield	3,160	688	62.4	NA
CCP Base Yield	3,160	717	68.1	NA

Table 3. 2008 peanut, cotton and corn costs, 1150 acres

	Dollars
Seed	72,558
Agricultural Services	86,350
Irrigation	28,380
Fuel & Lube	70,603
Nitrogen	47,773
Other Nutrients	76,675
Chemicals	103,126
Crop Insurance	16,340
Repairs	27,749
Labor	24,924
Operating Interest	20,087
Variable Costs	**574,564**
Fixed Costs	**138,767**
Total Annual Costs	**713,331**

Table 4. 2008 cabbage costs, 50 acres

	Dollars
Plants	23,412
Irrigation	1,650
Fuel & Lube	1,842
Fertilizer	10,207
Chemicals	6,020
Repairs	5,270
Planting Labor	10,000
Harvest & Packing Labor	28,272
Post Harvest Expenses	38,793
Containers	46,500
Operating Interest	3,684
Variable Costs	**175,650**
Additional Fixed Costs	**446**
Total Annual Costs	**176,096**

Table 5. Simulation results, no cabbage and with cabbage

	Dollars	
	No Cabbage	With Cabbage
Production Revenue	771,716	966,677
Government Payments (GP)	56,428	56,428
Variable Costs	574,564	750,214
Fixed Costs	138,767	139,213
Net Returns	114,813	133,677
Land Rent	37,375	37,375
Farm Income	77,438	96,302
Farm Income without GP	21,010	39,875

Figure 1. Cumulative distribution function, farm income comparison of average Georgia farm, without cabbage and with cabbage