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Profit and Variance Analysis of Cotton Production Technologies and Rotation Crops in Georgia

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Genetically modified cotton varieties have the potential for increasing returns and/or decreasing labor requirements. A nonlinear optimization model is applied to a whole farm analysis for evaluating cotton production technologies. This model maximizes farm utility, composed of expected returns and their variability, at various risk aversion levels in order to evaluate cotton production technologies. Results show that while conventional cotton maximizes utility in a risk-neutral situation, transgenic cotton varieties entered into the optimal solution as higher levels of risk aversion were considered.

Key Words: cotton production technologies, mathematical optimization, risk aversion, whole farm analysis

JEL Classifications: C61, Q16

Genetically modified (GM) cotton varieties have the potential for increasing returns and/or decreasing input requirements. Adoption of new cotton technologies requires input changes that farmers must evaluate in comparison to the increased returns for the whole farm. Field crop farms typically produce crops that are components of a suitable rotation program. Since these crops are produced simultaneously, effects of resource allocation due to selecting alternative cotton technologies determine resource allocation among rotation crops. The objective of this study is to determine the optimal allocation of crop acreage for cotton production using alternative technologies.

Two prominent seed technologies have emerged for cotton production. One technology develops cotton plants containing a gene derived from the soil bacterium *Bacillus thuringiensis* (Bt). This gene produces a protein that is toxic to Lepidopteran larvae, and Bt cotton is used to manage tobacco budworm (*Heliothis virescens*) and corn earworm (*Heliothis zea*). A second technology imparts genes that provide resistance to specific herbicides, allowing the plant to survive herbicide treatment that destroys weeds. Roundup Ready (RR) is designed to provide plant resistance to the herbicide glyphosate. Another technology, known as Bt/RR, contains both the Bt and the RR characteristics.

Transgenic cotton varieties have higher seed prices than conventional varieties be-

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cause of technology fees. As the number of cotton technologies has increased, so has the variability of potential benefits. Insect infestation varies greatly between geographical areas and, to some extent, between production years. If the target pests of Bt are limited, the benefits of purchasing the technology are limited. Resistance of cotton plants to glyphosate can save the expense of tillage for weed control, but some weeds are not effectively controlled by glyphosate, and the benefits of herbicide resistant varieties should be evaluated in conjunction with other weed control practices. Benefits from transgenic cotton varieties that are not static call for a means of evaluation that accounts for the uncertainty inherent in crop production.

Increased net returns from Bt technology will be greater in years of high insect infestation, but positive effects are demonstrated in years of low insect populations (Gibson). Reduction in cost is a potential benefit of Bt and RR technology, but increased yields over conventional seed is another factor than can lead to increased returns due to transgenics (Bryant et al.). Bt and non-Bt cotton varieties have been compared in locations representing most of the cotton-producing counties in Georgia (Stark). Results indicate a yield of 1,027 pounds for Bt cotton compared to 923 pounds for non-Bt cotton. Stark concludes that Bt cotton averages 1.1 spray applications and that non-Bt cotton averages 3.6 applications.

Ward et al. conducted a survey of Georgia cotton producers for 1998 and 1999. Data Envelopment Analysis was applied for determining efficiency gains from transgenic cotton and conservation tillage. The authors demonstrate enhanced production efficiency with transgenics and a greater benefit from RR technology when used in conservation tillage systems rather than conventional tillage.

This study attempts to build on previous research on the benefits of transgenics by developing a method that considers variability of benefits due to uncertainties of production and market conditions. Previous studies have focused on whether to use cotton technologies. This research is unique for Georgia in that it seeks to recommend crop combinations, including rotation crops. Costs and methods involved in cotton production impact the resources available for rotation crops. By including rotation crops, the results include the complete range of impacts for the whole farm in field crop production. The rotation programs investigated are 1) cotton, peanuts, and corn and 2) cotton, soybeans, and corn. Utility maximization is achieved by optimally allocating acreage among the crops. Optimal allocations are obtained for each of the rotation programs. Four cotton technologies planted in a conventional tillage system are considered in each of the programs. Cotton technologies included are conventional, Bt, Bt/RR, and RR.

Methods

A consideration for a utility maximization model is the variability of returns in a profit solution. In agricultural production, variability in yields, input levels, and prices have an impact on the expected utility from a choice of crops in production. The expected utility of profit (π) is expressed as

$$(1) \quad E(\pi) = E[U(pq - C(x) - F)],$$

where E is the expectations operator, p is the output price, q is quantity of output, $C(x)$ is the cost function of variable inputs (x), and F is the fixed cost of production (Sandmo). Profit uncertainty introduces another dimension to the expected utility of any profit level. A risk-averse firm that is attempting to maximize the expected utility of profits has a concave utility function, or $U'(\pi) \geq 0$ and $U''(\pi) \leq 0$ (Sandmo). Anderson, Dillon, and Hardaker depict profit variability as undesirable and having a negative effect on $E(U)$. A Pratt coefficient for level of risk aversion can be expressed as

$$(2) \quad \alpha = \frac{-U''(\pi)}{U'(\pi)}.$$

The Pratt coefficient is positive for risk aversion and decreases with increasing profit. Since fixed costs are constant, variability of profit equals variability of net returns to variable costs. Variability diminishes marginal utility and enters the expected utility calculation as a negative factor. The Pratt coefficient for a quadratic expression is an arbitrary value that represents a specified level of risk aversion and can be derived for empirical application as $\alpha/2$. Previous research provides guidance in selecting alpha levels. Babcock and Hennessy apply a risk aversion coefficient of 0.0046 for low risk aversion and 0.0100 for moderate risk aversion in a study of fertilizer application and crop insurance. Huang, Hewitt, and Shank assume an upper bound of 0.02 for risk aversion in an analysis of the timing of nitrogen applications. McCarl and Bessler present a range of maximum risk aversion coefficients from previous research that supports the range of assumptions stated previously but also indicate that a maximum risk aversion coefficient could be as low as 0.000063. Pratt coefficients are arbitrary, and realized levels depend on the maximum potential utility of a model under investigation.

Expected utility for a farm producing multiple crops with variable yields, commodity prices, inputs, and input prices can be expressed as

$$(3) \qquad E(U) = \sum_t \left[\left(P_t \cdot Q_t - \sum_i C_{ti} \cdot Q_t\right)\right] - \left(\sum_j F_j\right) - \frac{\alpha}{2}\left[Z' \mathrm{COV}\left(P_t \cdot Q_t - \sum_i C_{ti} \cdot Q_t\right) Z\right],$$

where t represents the crops in the rotation program, i is a variable input used to produce a crop, and j is a fixed input for the farm. P_t = gross revenue per unit of output for crop t (average revenue), Q_t = quantity of crop t, C_{ti} = variable cost of input i used per unit of output for crop t (average cost), and F_j = annual unit cost of fixed inputs. Z is a $(T \times 1)$ vector with each element having a value of 1 if the crop is in the solution and 0 otherwise; $\mathrm{COV}(P_t \cdot Q_t - \Sigma_i C_{ti} \cdot Q_t)$ is the variance-covariance matrix of net returns, and $\alpha/2$ is an arbitrary constant that measures risk aversion. The model solves for Q_t, which is composed of a known yield, and the number of acres can be derived for crop t in each solution. As risk aversion increases, $\alpha/2$ increases, and variability in net returns discounts utility by an increasing factor. Equation (3) is optimized as a mixed integer equation with a quadratic factor. $E(U)$ increases with increases in profit that occur to the left of the Pratt coefficient and decreases with increases in the variance-covariance component for net returns that follows the Pratt coefficient.

Limits for production are derived by assumptions for available field labor hours during each seasonal activity. A production solution corresponds to calculated labor hours that are evaluated against H, the assumed labor hours for each seasonal activity. A constraint for each crop is entered as

$$(4) \qquad \sum_t A_t \cdot \frac{hr_t}{\text{acre}} \leqq H,$$

where A_t is the acreage in the solution for crop t. Calculation of hr_t/acre is based on typical equipment complements and per acre rates of usage (University of Georgia 1991, 1998). Adding all seasonal activity hours results in total labor hours for the farm.

By applying increasing levels of risk aversion, corresponding levels of $E(U)$ are obtained. Each $E(U)$ consists of a component for expected profit, E, and a component for variability, V, which form a point in the efficient set that composes an E-V frontier. Calculating points on the E-V frontier with fixed costs included allows for profit comparisons for solutions with differing variability in net returns. Including fixed cost for a profit solution provides for solutions to have alternative equipment complements as total acreage and crops vary. In this study, optimization results are obtained by utilizing the add-in *Solver* (Frontline) of *Excel. Solver* applies a quasi-Newton algorithm for maximization of Equation (3).

Construction of the Representative Farm

A representative farm that utilizes typical production methods in the major cotton production region is constructed for Georgia. Yields for this study are obtained from variety trials conducted by the University of Georgia. Seeds included in variety trials are often substituted

Table 1. Average Yield, Variance, Coefficient of Variation,[a] Tifton, Georgia, 1997–1999 Trials, Irrigated, Price Received, 1998 Prices

	Unit Average	Yield	Variance	Coefficient of Variation	Price $/Unit
Conventional Cotton	lbs.	1,349	44,340	15.6	0.614
Bt Cotton	lbs.	1,304	17,440	10.1	0.614
Bt/RR Cotton	lbs.	1,336	24,553	11.7	0.614
RR Cotton	lbs.	1,227	12,601	9.1	0.614
Peanuts Quota	lbs.	4,449	464,572	15.3	0.310
Peanuts Nonquota	lbs.	4,449	464,572	15.3	0.170
Corn	bu.	221	1,289	16.2	2.460
Soybeans	bu.	58	24	8.4	5.240

[a] Standard deviation/mean multiplied by 100.

Notes: Conventional cotton: FM 989, mid-full season; Bt: DP 33B, mid-full season; Bt/RR: PM 1220 BR, early maturing; RR: DP5415 RR, mid-full season; peanuts: Georgia Green; corn: Pioneer 3163; soybeans: public variety—Caviness.

by new seeds in succeeding years, and the time period for this study is limited by evaluating yields and returns for a three-year period. Trials that include each of the cotton technologies and rotation crops were conducted in Tift County for the years 1997–1999. After consideration for frequency of use by farmers, irrigated yields were selected from the most commonly used variety for each of the cotton technologies and rotation crops. Rotation crops are selected based on information from extension specialists' recommendations and information from the Ward survey for Georgia cotton production. Table 1 reports crop yields and coefficient of variation, along with 1998 commodity prices as reported by the Georgia Agricultural Statistics Service. Information from extension specialists corroborates the conclusion that Roundup Ready yields are lower than other technologies in high-yield situations.

Because of data limitations for constructing budgets of cotton technologies, only irrigated acreage is included in the model farm. Data from the 1997 Census of Agriculture (National Agriculture Statistics Service) indicate that the three counties with the most irrigated acres of cotton are Colquit, Decatur, and Mitchell. Consideration of cotton and rotation crop acreage in these three counties leads to selecting a representative farm with an upper bound of 700 irrigated acres. This allows for production constraints that are not based on assumptions of limited capital but on representative irrigated acreage from the Census of Agriculture. A lower bound of 600 acres is selected so that total acreage solutions do not greatly differ from expectations in the selected counties. Allowing for a range of acreage corresponds to the proposition that input use for a given fixed cost will decrease as risk aversion increases (Sandmo).

A survey conducted by the University of Georgia Department of Agricultural and Applied Economics after the 1998 and 1999 production years provides insight into the methods and practices of Georgia cotton farmers (Ward). Variety trials of cotton technologies for 1999 in Decatur County indicate typical methods of production for alternative cotton technologies (McGriff). These sources are applied in conjunction with production methods and equipment complements from crop production budgets developed by the University of Georgia (1998, 1999a,b,c). This information is used to develop activities that represent production under identical circumstances. For example, if cultivation is needed with conventional and Bt seed, that cultivation activity could be substituted by spraying herbicide on cotton planted with Bt/RR and RR seed. Also, if four insect sprayings are needed for adequate control in conventional and RR seed, one spraying should be sufficient for Bt and Bt/RR cotton. Technology fees for transgenic cotton varieties are derived from the Ward survey and consultations with extension specialists. Technology fees are determined to be $6 for RR, $20 for Bt, and $26 for Bt/RR. Budgets for variable input costs of cotton and rotation crops are presented in Appendix 1 and Appendix 2. Preharvesting equipment enters optimal solutions on an integer basis, as do peanut combines. One harvesting unit is adequate to complete any possibility for cotton, corn, and soybeans.

Cotton and rotation crops are assumed to be in a three-year rotation with acreage planted two consecutive years in cotton and in rotation crops during the third year. Thus, in an optimal solution for one year, 33% of acreage is planted in rotation crops. The Ward survey indicates that utilization of the selected rotation crops is common among Georgia cotton farmers. Also, it is consistent with Extension Service recommendations of keeping fields out of peanuts for two or more years in order to avoid nematode problems.

Seasonal activities of the model farm for conventional tillage are designated as 1) preplanting and planting, 2) cultivating, 3) hi-clearance spraying, and 4) harvesting. Peanuts on the model farm include quota and additional peanuts. In the model, all peanut acreage is managed identically, and only the price received distinguishes quota peanuts from additional peanuts. Quota peanuts are limited to 60% of total peanut production. Even though the peanut program is eliminated after the 2001 crop, quota peanuts set at a constant rate of total production provides for an output structure similar to analysis without the peanut program. Effective peanut prices are expected to decline without quota peanuts, and the results from this study indicate maximum utility during the 1997–1999 period.

A loan deficiency payment (LDP), administered by the U.S. Department of Agriculture, was available for cotton from 1997 to 1999. This payment is added to the annual market price received by farmers. LDP is calculated as the national average loan rate of $0.5192 minus the adjusted world price. For 1997, 1998, and 1999, LDP amounts were $0.02, $0.09, and $0.21, respectively. Farmers can apply for the LDP instead of putting cotton in Commodity Credit Corporation storage at the current loan rate (Shurley). Similar programs are available for soybeans and corn and are included for analysis of rotation crops. Provisions of the peanut program maintain peanut prices at similar levels for all years.

Variability of net returns is derived for three years and includes output price (including LDP), yield, input level, and input price, all on a per acre basis. The resulting covariance matrix is presented in Table 2. Separate entries are applied for quota and nonquota peanuts due to differences in price received. Peanuts show a negative covariance with cotton and corn. All cotton technologies have a positive covariance.

Results

Equation (3) is first optimized with $\alpha = 0$, and subsequent solutions are calculated by increasing the risk aversion coefficient. Optimal solutions determine points where $E(U)$ is maximized for alternative risk aversion levels. Decreasing variability in net returns at higher levels of risk aversion signifies that the expected value of returns is lower in optimal solutions.

Table 3 presents the results of a rotation with peanuts and corn. Initially, cotton acreage is devoted to conventional cotton, and peanuts compose all the rotation acreage. As selected alpha levels increase, variance of net returns decreases, and cotton acreage initially shifts to Bt/RR and next to Bt. RR is the final genetically modified cotton to enter the solution. Corn enters the solution as the farm diversifies to limit risk. Resulting from increased transgenic cotton acreage, tractor hours and hours for hi-clearance spraying decrease, leading to a decrease in total preharvest hours. The Sandmo proposition is demonstrated as increases in risk aversion lead to decreases in total farm acreage as inputs are decreased to avoid risk. Comparison of the coefficient of variation (CV) between alpha levels indicates the level of variability relative to the expected value. Alpha level 0.00018 obtains the lowest CV at 12.39, with the preceding alpha level measuring a slightly higher CV. Measures of CV begin to increase as RR cotton and corn enter the solution at alpha level 0.00040.

Table 2. Matrix of Net Return Variances and Covariances, Cotton Technologies, and Rotation Crops per Acre, 1997–1999

	Conventional Cotton	Bt	Bt/RR	RR	Peanuts Quota	Peanuts Nonquota	Corn	Soybeans
Conventional Cotton	$11,843	$3,850	$5,025	$2,847	−$12,400	−$6,722	−$2,045	$3,428
Bt	$3,850	$5,229	$2,882	$3,114	−$8,418	−$4,377	$3,648	$2,089
Bt/RR	$5,025	$2,882	$4,971	$2,274	−$8,528	−$4,573	−$57	$2,294
RR	$2,847	$3,114	$2,274	$4,317	−$7,015	−$3,603	$4,247	$1,684
Peanuts Quota	−$12,400	−$8,418	−$8,528	−$7,015	$34,453	$12,178	−$3,635	NA[a]
Peanuts Nonquota	−$6,722	−$4,377	−$4,573	−$3,603	$12,178	$9,712	−$1,433	NA
Corn	−$2,045	$3,648	−$57	$4,247	−$3,635	−$1,433	$20,918	$318
Soybeans	$3,428	$2,089	$2,294	$1,684	NA	NA	$318	$2,395

[a] NA is not applicable.

Optimal results for a rotation with soybeans and corn are presented in Table 4. Similar to the first rotation, cotton acreage is initially devoted to conventional cotton. Bt cotton follows Bt/RR in the solution. RR cotton enters as total farm size decreases at alpha level 0.000077. Soybeans are substituted for corn as increases in selected alpha represent high levels of risk aversion. The lowest CV is for alpha level 0.000004 with a measure of 46.84, while alpha level 0.000030 has a CV of 47.14.

An *E-V* frontier is traced out by maximizing utility for alternative alpha levels (Figure 1). The optimization equation includes fixed costs, and each $E(U)$ result leads to a derived profit and profit variability, or standard deviation (Tables 3 and 4). Maximizing utility for increasing risk aversion shows the decreases in profit that the representative farm would be willing to accept for decreases in variability of net returns. Figure 1 shows profit level decreases as the variance of net returns decreases. As risk aversion increases, further decreases in variability are at the expense of larger relative decreases in profit as the slopes of the lines increase. The curves for crop rotations indicate that cotton-peanuts-corn have substantially lower variability than cotton-soybeans-corn for all potential profit levels.

An important consideration for farmers is the number of Pyrethroid sprayings to apply on cotton. Assumptions for a typical year are one spraying on Bt varieties and four sprayings on non-Bt varieties. Since application methods are identical for all varieties, cost per spraying is identical. The number of applications varies depending on climatic conditions and degree of infestation in particular areas. Required applications could decrease for areas with low infestation and increase for areas with severe infestation. The model is optimized under risk neutrality with an assumption of one fewer spraying for each cotton variety. The results, not shown in the tables, indicate no change in acreage allocation. Profit increases by $14.44 per acre of cotton, which is revealed as the per acre cost of each Pyrethroid spraying. Thus, farmers choose to add a Pyrethroid spraying when infestation de-

Table 3. Optimal E-V Solutions for Cotton, Peanuts, and Corn in Rotation

Selected Alpha	Total	Conventional	Bt Acres	Bt/RR	RR	Peanuts	Corn
0.00000	700.0	466.7	0.0	0.0	0.0	233.3	0.0
0.00001	700.0	185.1	0.0	281.6	0.0	233.3	0.0
0.00008	700.0	85.6	159.7	221.4	0.0	233.3	0.0
0.00018	700.0	85.6	183.6	197.5	0.0	233.3	0.0
0.00040	700.0	81.8	147.8	191.5	45.6	217.8	15.6
0.00082	677.2	77.8	119.1	177.2	77.4	205.1	20.7
0.00086	645.9	74.3	113.5	168.8	74.0	195.6	19.7
0.00091	610.2	70.3	107.4	159.2	69.9	184.8	18.6
0.00200	600.0	68.4	93.9	152.8	84.9	179.0	21.0
0.01000	600.0	68.0	85.9	150.1	96.0	177.1	22.9
0.04000	600.0	67.9	84.4	149.6	98.1	176.8	23.2

	Standard Deviation	Profit	Tractor	Hi-Clearance	Preharvest Hours	Harvest	Total
0.00000	$38,097	$166,600	1,531	146	1,677	999	2,676
0.00001	$24,783	$165,100	1,463	126	1,589	999	2,588
0.00008	$20,305	$163,170	1,478	114	1,592	999	2,591
0.00018	$20,185	$162,960	1,483	113	1,596	999	2,595
0.00040	$18,810	$132,280	1,448	119	1,567	980	2,547
0.00082	$17,798	$119,460	1,386	119	1,505	941	2,446
0.00086	$16,972	$107,400	1,321	113	1,434	897	2,331
0.00091	$16,034	$93,720	1,248	107	1,355	848	2,203
0.00200	$15,670	$92,140	1,220	107	1,327	830	2,157
0.01000	$15,645	$90,820	1,215	109	1,324	828	2,152
0.04000	$15,644	$90,570	1,214	190	1,323	828	2,151

creases production value by more than $14.44 per acre.

Summary and Conclusion

Genetically modified cotton seeds have a potential for increasing profit and decreasing labor requirements for production. In addition to conventional seeds, Bt and Roundup Ready technologies are available. A model farm is analyzed that includes yields, inputs, and prices for 1997–1999 for cotton in rotation with peanuts and corn as one scenario and in rotation with soybeans and corn as an alternative.

An *E-V* analysis is employed to optimize producer utility for alternative risk aversion levels. Results indicate that for a risk-neutral situation, conventional cotton provides the highest utility for each rotation. All cotton technologies enter the optimal solution as risk aversion increases until a combination of the genetically modified seeds dominates conventional at the highest level of risk aversion. Peanuts enter the solution over corn at low levels of risk aversion, but corn enters as risk aversion increases. For the corn-soybean-cotton rotation, only corn enters as a rotation crop at initial levels of risk aversion, but soybeans enter at higher levels of risk aversion. At all levels of risk aversion, rotation with peanuts and corn provides a much greater profit for a derived variance than does rotation with soybeans and corn.

This research introduces a method for evaluating technology that includes relative variabilities inherent in each alternative technology. Previous research has focused on whether to adopt GM seed technology based on a direct comparison to conventional seed technology. Even in circumstances where a direct comparison favors conventional seed technol-

Table 4. Optimal E-V Solutions for Cotton, Soybeans, and Corn in Rotation

Selected Alpha	Total	Conventional	Bt	Bt/RR Acres	RR	Soybeans	Corn
0.000000	700.0	466.7	0.0	0.0	0.0	0.0	233.3
0.000004	700.0	239.2	0.0	227.5	0.0	0.0	233.3
0.000030	700.0	155.1	148.0	163.6	0.0	0.0	233.3
0.000077	691.8	110.8	117.6	113.5	119.3	0.0	230.6
0.000086	634.6	110.5	117.5	113.3	81.7	0.0	211.5
0.000088	623.1	110.5	117.5	113.3	74.1	0.0	207.7
0.000176	600.0	119.1	121.1	131.1	28.8	0.0	200.0
0.001000	600.0	118.7	95.2	186.1	0.0	7.0	193.0
0.010000	600.0	107.5	59.0	233.5	0.0	13.4	186.6
0.100000	600.0	105.1	51.5	243.4	0.0	14.7	185.3
0.700000	600.0	104.8	50.7	244.5	0.0	14.8	185.2
	Standard Deviation	Profit	Tractor	Hi-Clearance	Preharvest Hours	Harvest	Total
0.000000	$57,206	$105,490	1,143	146	1,289	714	2,003
0.000004	$48,845	$104,270	1,089	130	1,219	714	1,933
0.000030	$48,290	$102,450	1,103	119	1,222	713	1,935
0.000077	$47,918	$89,400	1,073	128	1,201	704	1,905
0.000086	$43,836	$74,070	989	115	1,104	646	1,750
0.000088	$43,020	$70,970	972	112	1,084	634	1,718
0.000176	$41,306	$67,410	941	104	1,045	611	1,656
0.001000	$40,306	$66,130	938	102	1,040	610	1,650
0.010000	$39,419	$65,830	930	102	1,032	608	1,640
0.100000	$39,266	$65,770	928	102	1,030	608	1,638
0.700000	$39,251	$65,770	928	102	1,030	608	1,638

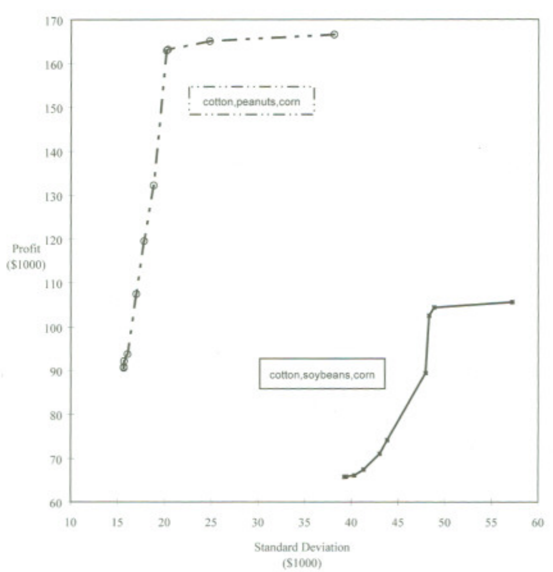

Figure 1. Standard Deviation and Profit Derived from (E, V) Frontier

ogy, the results show that inclusion of one or more seed technologies may provide benefits to cotton producers. This is important because the various cotton technologies have different technology fees, and farmers may reduce total fees paid by selecting an optimal combination.

Limitations in this research should be considered when evaluating the results and forming considerations for extensions. Alternative genetically modified seeds should be included as data become available from successive years of variety trials. Roundup Ready varieties should be evaluated in other than the high-yield situations of irrigated variety trials. Future research should investigate alternative constraints on resources and labor availability so that sensitivity to these factors is determined.

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Appendix 1. Cotton Budgets for Variable Input Costs

	$/Acre			
Inputs	Conventional	Bt	Bt/RR	RR
Seed	8.10	28.08	34.02	14.04
Lime	8.91	8.91	8.91	8.91
Nitrogen	27.00	27.00	27.00	27.00
Phosphate	13.20	13.20	13.20	13.20
Potash	10.80	10.80	10.80	10.80
Boron	1.25	1.25	1.25	1.25
Herbicides	36.19	36.19	42.14	42.14
Insecticides	62.22	30.40	30.40	62.22
Growth Regulator	21.15	21.15	21.15	21.15
Defoliant	24.50	24.50	24.50	24.50
Scouting	6.00	6.00	6.00	6.00
BWEP	5.00	5.00	5.00	5.00
Fuel Preharvest	7.20	6.66	6.39	6.93
Repairs Preharvest	10.64	10.30	9.36	9.70
Fuel Harvest	4.37	4.37	4.37	4.37
Repairs Harvest	12.04	12.04	12.04	12.04
Irrigation	63.00	63.00	63.00	63.00
Labor	22.71	21.95	20.47	21.22
Interest, Operating Capital	17.21	16.54	17.00	17.67
Variable Cost	361.49	347.34	356.99	371.14

Appendix 2. Rotation Crop Budgets for Variable Input Costs

	$/Acre		
Inputs	Peanuts	Corn	Soybeans
Seed	80.00	30.00	14.40
Lime/Gypsum	22.50	13.50	8.91
Innoculant	6.00	NA	NA
Phosphate	6.60	13.20	8.80
Potash	6.00	9.60	9.60
Nitrogen	NA	54.00	NA
Other Nutrients	NA	5.00	NA
Herbicides	60.00	15.00	20.00
Insecticides	30.00	8.45	12.00
Fungicides	75.00	NA	NA
Nematicide	0.00	NA	NA
Boron	1.25	NA	NA
Custom Insect Control	NA	8.00	NA
Scouting	NA	NA	3.00
Fuel Preharvest	7.83	3.24	4.32
Repairs Preharvest	12.51	4.97	6.61
Fuel Harvest	5.67	3.42	2.34
Repairs Harvest	7.52	3.78	4.09
Irrigation	40.50	42.50	31.50
Labor	37.70	16.82	19.00
Interest, Operating Capital	19.95	11.57	7.23
Variable Cost	419.03	243.05	151.79