Increasing Cotton Production in Southeast Virginia: Economic and Environmental Implications

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SUMMARY

Since 1990, cotton has been rapidly replacing corn as a major rotational crop with peanuts. Farmers perceive that cotton provides a higher and more stable return and fits well with peanuts as a rotational crop. Substituting cotton for corn in rotation with peanuts can increase or decrease pollution depending on the types of production practices used with each crop. Heavier use of herbicides, insecticides, and fungicides on cotton can increase the potential for chemical runoff and leaching. However, chemical leaching and runoff can be lowered by reduced tillage and planting winter cover crops.

The objectives of this study were 1) to analyze the effects on farmers' economic risks and returns and potential nutrient, sediment, and pesticide losses of substituting cotton for corn in rotation with peanuts; and 2) to estimate the economic and environmental effects of introducing winter cover crops and reduced tillage practices into the cotton/peanut rotation. The rotations compared were no-till corn/conventional-till peanuts without cover, conventional-till cotton/conventional-till peanuts without cover, conventional-till cotton/conventional-till peanuts with cover, strip-till cotton/conventional-till peanuts with cover, and no-till cotton/conventional-till peanuts with cover. A crop simulation model was used to estimate crop yields and potential sediment, nitrogen, phosphorus, and pesticide losses on a fine sandy loam Emporia soil with slopes of 1, 3, and 5 percent. Net returns were estimated using enterprise budgets. Crop prices used in estimating net returns varied according to historical price variations in Virginia.

The conventional-till cotton/peanut rotation generated a higher average profit than the corn/peanut rotation. Profit maximizers and mildly risk averse farmers would prefer cotton to corn under the conditions assumed in this study. However, cotton producers suffered larger losses in years of crop failure due to higher input costs compared to corn. Moderately risk averse producers would regard the two rotations as equally preferable because higher returns from cotton are offset by lower downside risk from corn in years of crop failure.

The shift from no-till corn/conventional-till peanuts to conventional-till cotton/conventional-till peanuts had mixed effects on estimated pollution. Shifting to cotton increased estimated sediment runoff on all slopes, estimated phosphorus runoff on steeper slopes, and the pesticide loss index on steeper slopes. However, shifting to cotton decreased estimated nitrogen runoff and leaching on all slopes and the pesticide loss index on lower slopes.

Peanut/cotton rotations with winter cover crops or reduced tillage cotton were evaluated. Compared with the conventional-till cotton/peanut rotation without cover, cover crops and reduced tillage lowered sediment loss, nitrogen loss, and phosphorus loss and increased the estimated pesticide loss index. The pesticide loss index was highest for conventional-till peanuts with no-till cotton. Rotations with cover crops had lower net returns due to the costs of establishing the cover crop. Strip-till cotton had higher net returns than conventional-till cotton. Slope of the land was the single largest factor in determining pollutant losses. Variations in all pollution indices were much greater across slope (from 1 to 5 percent) than across rotation or tillage type.

The study has the following implications. First, the use of cover crops with cotton and peanuts should be encouraged to reduce sediment, nitrogen, and phosphorus losses. Net returns were reduced modestly due to the cost of establishing cover. However, cover crops have other economic benefits not quantified here including reductions in nutrient and sediment losses and higher organic matter from cover crop residue. Second, strip-till cotton should be encouraged to further reduce soil and phosphorus losses compared to conventional till. Strip-till cotton produces nearly the same environmental benefits

as no-till cotton and has a higher net income than conventional-till. Third, other nutrient management practices are likely to be important on many farms in order to achieve further reductions in nitrogen and phosphorus losses. These practices include changing the timing and amount of nitrogen and phosphorus use and incorporating nitrogen and phosphorus fertilizers into the soil. Fourth, integrated pest management strategies are needed to counteract increasing potential pesticide losses when reduced tillage is used with cotton and peanuts. Fifth, pollution reduction efforts should target steeper, more highly erodible land. On these soils, conservation practices (including reduced tillage and cover crops) can result in greater pollution reductions compared to practices on less steep soils. Sixth, further research is needed to develop reduced-tillage alternatives for peanuts. Strip-till peanuts potentially can reduce erosion and runoff, but strip-till peanut yields have been below those of conventional-till in Virginia experimental trials (Phipps). If reduced-till alternatives can be developed which maintain peanut yield and quality, reduced-till peanuts can have important environmental benefits at little or no cost to farmers.

INTRODUCTION

Cotton production has increased rapidly in Virginia since 1990 (Figure 1 Source: VASS). In 1997, total cotton acreage was 92,400 acres compared to only 5,300 acres in 1990. Most of the increase occurred in southeast Virginia (Surry, Sussex, Southampton, and Isle of Wight counties and the City of Suffolk) (Figure 2) where cotton has been substituted for corn in the peanut rotation. Since 1995, the total acreage of cotton has exceeded that of corn in southeast Virginia. By 1997, acreage of cotton was more than 15 times larger than in 1990, while corn acreage had decreased by 30 percent over the same period.

Figure 1. Change in Acreage of Corn and Cotton, 1990-1997

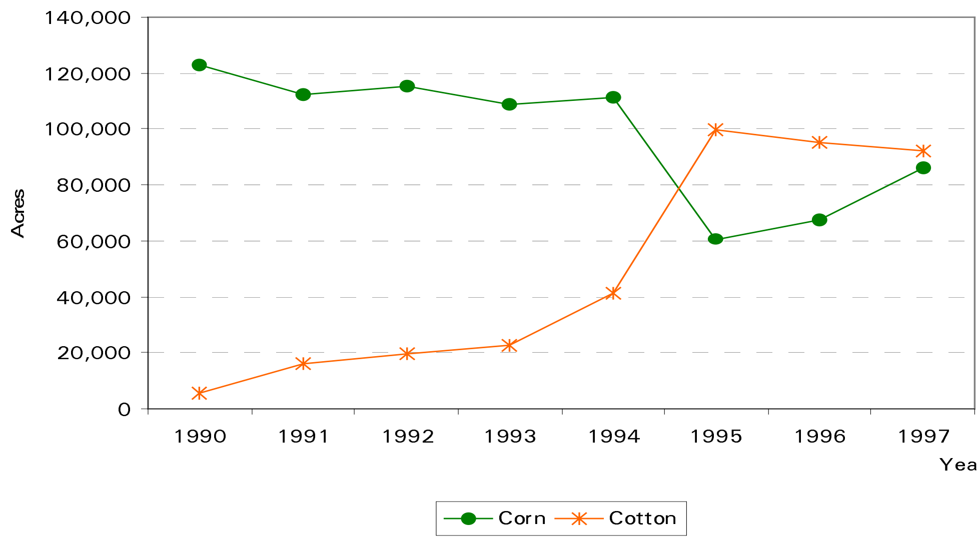
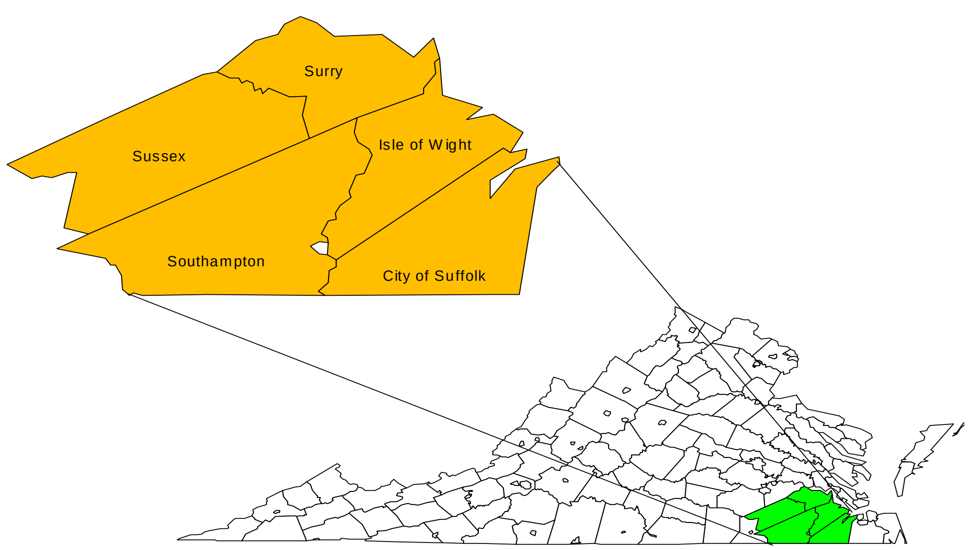


Figure 2. Location of Cotton and Peanut Producing Counties



Cotton production has expanded because farmers perceive cotton to have higher returns and less risk compared to corn. In a survey of 75 Southampton cotton producers, Reaves and Alexander found that farmers substitute cotton for corn because cotton produces higher profits, fits well with the peanut rotation, receives a dependable price, is less risky over time, and has convenient market locations. Experts also point out that cotton is more drought-tolerant than corn (Dalton; Sturt, 1998; and Phipps).

Depending on the production practices used with each crop, substituting cotton for corn in rotation with peanuts can increase some forms of pollution while reducing others. Cotton chemical expenditures can be two to three times as high as corn chemical expenditures due to higher use of herbicides, insecticides, and fungicides (see Table 1).

Table 1. Crop enterprise costs per acre for corn, cotton, peanuts, and wheat cover crop

Item	No-till corn	Conventional till peanuts	Conventional till cotton	Strip-till cotton	No-till cotton	Wheat cover crop
	---	---	-$/acre-	---	---	---
Nitrogen	25	0	14	14	14	0
Phosphate	6	0	6	6	6	0
Potash	4	0	4	4	4	0
Herbicides	16	34	21	25	25	0
Insecticides	12	79	25	31	31	0
Fungicides	0	101	0	0	0	0
Other chemicals[a]	0	9	32	32	32	0
Machinery variable costs[b]	28	116	66	52	48	2
Labor	15	66	38	30	28	2
Other variable costs[c]	51	191	74	76	76	8
Machinery fixed costs[d]	42	140	85	70	65	2
Total costs	**200**	**737**	**365**	**340**	**330**	**14**

[a] Includes defoliants (cotton) and foliar nutrients and adjuvants (peanut).
[b] Includes fuel, lubrication, and repairs.
[c] Includes seed, lime, miscellaneous expenses, and operating interest.
[d] Includes depreciation, interest, taxes, insurance, and housing.

Surveys indicating the extent of reduced tillage and cover crops on corn, cotton, and peanuts in Southeast Virginia are not available. Experts estimate that in Southeast Virginia over 90 percent of corn is reduced-till or no-till, almost all peanut acreage is conventional-till, and cotton is roughly evenly divided between conventional-till and strip-till (Phipps, Sturt, 1998). Generally in Southeast Virginia, 10 percent or less of the corn acreage, two-thirds of the peanut acreage, and about one-third of the cotton acreage are followed by cover crops (Phipps, Sturt, 1998).

The objectives of this study were 1) to analyze the effects on farmers' economic risks and returns and potential nutrient, sediment, and pesticide losses of substituting cotton for corn in rotation with peanuts and 2) to estimate the economic and environmental effects of introducing winter cover crops and reduced tillage practices (strip-till and no-till cotton) into the cotton/peanut rotation.

STUDY PROCEDURES

The study area was the rural City of Suffolk located in Southeast Virginia. Three types of farmers were considered 1) those who seek to maximize expected net income (profit maximizers), 2) those who are mildly risk averse (are willing to sacrifice a small amount of expected profit to control risk), and 3) those who are moderately risk averse (are willing to sacrifice a larger amount of expected profit to control risk). See Box 1 for further discussion of farmers' risk attitudes. The principal risk farmers face originates from the variability of yields due to uncertain weather and from the variability of prices due to fluctuations in national and international markets.

Box 1. Farmers' risk attitudes

In this study, farmers' risk attitudes were represented by the absolute risk coefficient aversion, a measure of the farmers' willingness to sacrifice income to reduce risk. A higher absolute risk aversion coefficient indicates that the farmer is more willing to sacrifice some expected income in order to reduce the risk of income loss. A risk neutral farmer who is not willing to sacrifice any expected income to reduce risk is represented by an absolute risk aversion coefficient of 0. The absolute risk aversion coefficient for mild risk averse farmers ranges from 0.00001 to 0.00375 and for moderate risk averse farmers the coefficient ranges from 0.00375 to 0.0375.

These risk aversion coefficients are based on work by King and Oamek. The scaling method suggested by Raskin and Cochran was used to convert farm-level risk aversion coefficients to per acre risk aversion coefficients. A program developed by Cochran and Raskin was used to compare the net incomes from each crop rotation to determine which rotation would be preferred by risk neutral, mild risk averse, and moderate risk averse farmers.

The economic returns from alternative crop rotations were compared using enterprise budgets, and the environmental effects of each rotation were compared using a crop simulation model. Annual net income for each crop was estimated as

$$\text{Annual Net Income} = \text{Output Price} \times \text{Yield} - \text{Input Costs}$$

Output prices were based on forecasts and adjusted for Virginia historical price patterns to account for price variability (Box 2). Gross incomes were estimated for ten years for each crop by multiplying the selected price in each year by the simulated yield for that year.

Box 2. Estimating crop prices

Average projected prices for each year from 1996 to 2004 based on the Food and Agricultural Policy Research Institute (FAPRI) prices for corn, cotton, and peanuts were used. Prices were expressed in 1995 dollars and adjusted to Virginia levels. The price projections for Virginia were \$2.35/bushel for corn, \$0.25/pound for peanuts, and \$0.58/pound for cotton. Historical Virginia crop prices (1986-1995) were used to provide estimates of price variability around the mean prices of each crop. For example, the 1988 Virginia corn price (expressed in 1995 dollars) was \$3.62 or 32 percent above the mean price for 1986-1995 of \$2.75. Therefore, the corresponding corn price for this study was obtained by increasing the \$2.35 projected price by 32 percent to \$3.08. This process was repeated for each year from 1986 to 1995.

Net incomes were calculated by subtracting input costs from the gross income for each year. Input costs were estimated for the required production practices for each rotation. Required production practices were based on a literature review and interviews with production specialists. The input costs for each rotation shown in Table 1 include seed, fertilizer, chemicals, machinery expenses, and labor expressed in 1995 dollars. Crop nutrient requirements were based on soil testing high in phosphorus and potassium and were taken from the Virginia Agricultural Land Use Evaluation System (VALUES) (Simpson et al.).

Crop yields and the movement of sediment, nutrients, and pesticides were estimated using EPIC (Erosion-Productivity Impact Calculator) (Williams, Jones, and Dyke) a crop simulation model (Box 3). Estimated pesticide losses were combined into a pesticide loss index (Box 4).

Box. 3. Using EPIC to simulate crop yields and pollution

EPIC is a crop growth and chemical transport simulation model that can estimate crop yields, sediment losses, and chemical losses using weather, soil, and management data. City of Suffolk historical weather data for 1986-1995 were used to simulate corn, peanut, and cotton yields. Soil inputs to the model were based on a fine sandy loam Emporia soil with slopes of 1, 3, and 5 percent. Management variables used in the model included the timing and amounts of chemical and fertilizer applications and the timing of crop planting and tillage operations.

Leaching, runoff, or both of pesticides, nitrogen, phosphorus, and sediment were estimated by EPIC for each crop rotation. Sediment, nitrogen, phosphorus, and pesticide runoff losses were estimated as runoff at the edge of the field. Nitrogen, phosphorus, and pesticide leaching losses were estimated by EPIC as leaching to the edge of the root zone. The portions of runoff and leaching which reach groundwater, surface water, or both depend on distance to ground and surface water bodies as well as topography, ground cover, and geological characteristics along the flow path. Estimated total nitrogen and phosphorus losses (pounds per acre) equalled the sum of leaching and runoff.

The net returns and estimated pollution from a no-till corn/conventional-till peanut rotation and a conventional-till cotton/conventional-till peanut rotation were compared. In addition, the following conservation rotations were evaluated: conventional-till peanuts/ conventional-till cotton with winter wheat cover, conventional-till peanuts/strip-till cotton with winter wheat cover, and conventional-till peanuts/no-till cotton with winter wheat cover.[1]

RESULTS

Economic Returns and Risks of Shifting from Corn to Cotton

Annual net incomes over ten years for a crop rotation of no-till corn/conventional-till peanuts, and a rotation of conventional-till cotton/conventional-till peanuts on the three slopes are presented in

[1] Further details on study procedures are provided in Peng.

Table 2. The annual net incomes were based on simulated yields for weather conditions from 1986 to 1995. The annual net incomes of each crop in the rotation were averaged to produce the mean annual net income per acre of rotation. For example, the per acre net income for conventional-till peanuts/ conventional-till cotton in 1987 on 1 percent slope land was $189, which equals the sum of the net income from ½ acre of peanuts and ½ acre of cotton.

Box 4. The pesticide loss index

The pesticide loss index for a rotation is the weighted sum of the pesticide hazard indices for all pesticides used in the rotation. A higher pesticide loss index indicates more potential for environmental damage. The pesticide hazard index for individual pesticides is the average of weighted hazards of pesticide loss to groundwater and weighted hazards of pesticide loss to surface water. The weighted hazard of pesticide loss to groundwater is the amount of active pesticide ingredient leached to the edge of the root zone (as estimated by EPIC) times the estimated human health hazard of the active ingredient. The pesticide hazard to human health is based on the lifetime Health Advisory Limit (HAL) and the Environmental Protection Agency's (EPA) Carcinogenic Risk Category (USEPA 1996; Teague, Bernardo, and Mapp; Criswell and Campbell). The HAL is defined as the concentration of a chemical in drinking water that is not expected to cause any adverse, noncarcinogenic effects over a lifetime of exposure, with a margin of safety. EPA carcinogenic Risk Categories are defined as Group A, human carcinogen; Group B, probable human carcinogen; and Group C, possible human carcinogen (USEPA, 1986). The following rule is used to weight each pesticide for potential damage to humans. If the EPA carcinogenic Risk Category is A, B, or C, the weight is 5. If the HAL is less than 10, the weight is 5. If the HAL is between 10 and 200, the weight is 3. And if the HAL is larger than 200, the weight is 1 (Teague, Bernardo, and Mapp).

The weighted hazard of pesticide loss to surface water is the estimated amount of active ingredient lost to runoff times the estimated hazard of the active ingredient to fish. The hazard to fish assigned to a pesticide is based on the LC (Lethal Concentration), which is the chemical concentration level (ppm) required to kill 50 percent of fish after 96 hours of exposure (USEPA 1986). If the LC_{50} is less than 1, then the hazard weight is 5; if the LC_{50} is between 1 and 10, the weight is 3; and if the LC_{50} is larger than 10, then the weight is 1 (Kovach et al; Teague, Bernardo, and Mapp). The LC_{50} in this study is based on the average of values assigned to rainbow trout and bluegill sunfish.

Results in Table 2 demonstrate that, with the exception of 1993, the cotton rotation always achieved higher net income than the corn rotation. Both cotton and corn suffered large economic losses in 1993. Simulated corn and peanut yields were 30 percent below average, and simulated cotton yields were 50 percent below average due to dry weather. Cotton sustained higher economic losses than corn in 1993 because of its relatively larger yield reductions and its higher input costs ($365 per acre for conventional-till cotton versus $200 per acre for no-till corn.).

Risk analysis showed that profit maximizing and mildly risk averse farmers prefer the cotton/ peanut rotation to the corn/peanut rotation on all slopes of land due to higher average returns. Moderately risk averse farmers do not show clear preferences for either corn or cotton. The lower downside risk of corn production (as indicated by its lower losses in 1993) is just as appealing to them as the higher average net income from cotton production. In addition, many farmers switching to cotton production

Table 2. Per acre net income corn/peanut and cotton/peanut rotations, without cover crop, on varying slopes

Crop rotations	Slope	Annual net income										
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean
	(%)	($/ac)										
Conventional-till peanuts/no-till corn	1	124	89	159	173	182	148	126	-43	169	89	122
Conventional-till peanuts/conventional-till cotton	1	266	189	230	336	348	232	226	-58	409	193	237
Conventional-till peanuts/no-till corn	3	123	87	158	173	178	147	124	-52	167	86	119
Conventional-till peanuts/conventional-till cotton	3	265	184	222	333	338	230	225	-69	402	185	232
Conventional-till peanuts/no-till corn	5	123	84	156	171	174	146	122	-57	164	81	116
Conventional-till peanuts/conventional-till cotton	5	264	177	214	330	326	228	223	-75	394	178	226

Table 3. EPIC predicted losses of pesticides, nitrogen, phosphorus, and sediment for corn/peanut and cotton/peanut rotations, without cover crop

	Pesticide Loss Index			N loss			P loss			Sediment loss		
Slope	1%	3%	5%	1%	3%	5%	1%	3%	5%	1%	3%	5%
Crop rotations				lbs/ac			lbs/ac			tons/ac		
Conventional peanuts/no-till corn (without cover)	102	191	283	26	36	50	4	8	14	2.7	5.0	9.4
Conventional peanuts/conventional cotton (without cover)	96	180	297	23	33	48	4	8	15	2.9	5.2	10.2

need to purchase cotton harvesting and spraying equipment. These purchases can increase farm debt and risk. The additional risk of a higher debt load was not considered in this analysis but could deter some farmers from switching to cotton.

As shown in Table 2, the patterns of economic returns and risks do not change as the slope of land changes. Yields declined only slightly by slope and no differences were assumed to occur in input costs and output quality by slope of land.

Environmental Consequences of Shifting from Corn to Cotton

Estimated average nitrogen, phosphorus, and sediment losses, and pesticide loss indices for no-till corn/conventional-till peanuts and conventional-till cotton/conventional-till peanuts are shown in Table 3. Both rotations were simulated without a cover crop. Estimated pollution increased on steeper slopes. Estimated sediment and phosphorus losses and pesticide indices doubled or nearly doubled from 1 to 3 percent slope and tripled as slope increased from 1 to 5 percent. Estimated nitrogen loss went up by about 50 percent when slope increased from 1 to 3 percent and doubled when slope increased from 1 to 5 percent.

Estimated pesticide indices from the corn/peanut rotation were about 6 percent higher than pesticide indices from the cotton/peanut rotation on 1 and 3 percent slopes, but were 5 percent lower on a 5 percent slope. Nitrogen losses from the peanut/cotton rotation were lower than losses from peanut/corn by 13 percent (on 1 percent slope), 8 percent (on 3 percent slope) and 4 percent (on 1 percent slope). Phosphorus losses were the same except on a 5 percent slope where losses were 7 percent higher on the peanut-cotton rotation. Sediment losses were higher on the peanut-cotton rotation at each slope due to more soil disturbance and exposed soil surface in cotton production.

Environmental and Economic Effects of Conservation Practices

Cover crops and reduced tillage methods including strip-till and no-till can reduce soil disturbance and soil loss. Reduced soil loss results in less phosphorus and nitrogen losses, because both of these minerals are adsorbed by the soil. Cotton may respond satisfactorily to strip-till and no-till production methods both with and without irrigation (Keeling, Lyle, and Abernathy) on various soil types (Alabama Cooperative Extension). With well-planned weed control, reduced tillage of cotton may allow farmers to achieve comparable (if not better) yields and quality (Abaye et al.). In Virginia, strip-till cotton is growing in popularity but few producers use no-till on cotton. Problems with no-till include inadequate seed coverage and nonuniform seed placement (Maitland). Compacted soil in the top 3 to 10-inch soil layer also may slow growth, which is a problem in Virginia because of a shorter growing season than in areas to the south (Maitland).

In this study, strip-till and no-till cotton production was compared to conventional-till. Conventional-till cotton receives one tandem disking, one field cultivation, and one disk bedding and ripping before planting and two between-row cultivations during the season. Strip-till cotton receives one under-row ripping before planting and the seed furrow is strip-tilled at planting. No-till cotton receives no tillage prior to planting. Strip-till and no-till cotton receive no cultivation during the season.

A cover crop can reduce nitrogen and phosphorus losses as well as soil erosion caused by wind and water. Reduction of wind erosion is important. EPIC simulations for Suffolk showed that erosion by wind in certain years can be much higher than erosion by water. However, cover crops increase total costs to the farmer, as shown in Table 1.

The estimated potential pollution indices from the rotations with a cover crop, reduced tillage, or both are listed in Table 4. The pesticide loss index increased when tillage was reduced because these practices increased pesticide use (Table 4). A cover crop on the conventional-till peanut/conventional-till cotton rotation increased the index of pesticide loss slightly, with the relative increase declining with slope (Table). For example, the index increased from 96 to 102 per acre (6 percent) on a 1 percent slope and from 180 to 188 per acre (4 percent) on a 3 percent slope.

Cover crops reduced potential leaching of mineralized soil nitrogen. Potential nitrogen losses were reduced by five to six pounds per acre, a 13 to 22 percent reduction depending on slope. Cover crops had little effect on phosphorus losses except for the 5 percent slope where losses were reduced by one pound per acre (7 percent). Soil losses decreased when a cover crop was planted on steeper slopes. For example, cover crops reduced erosion on the conventional peanut/conventional cotton rotation from 10.2 to 9.4 tons per acre on 5 percent slope. EPIC simulations demonstrate that the main erosion control benefits from a cover crop occur in years of high wind erosion.

Reducing tillage of cotton had mixed effects on estimated pesticide, nutrient, and sediment losses. When strip-till was used instead of conventional till, the pesticide loss index increased by about 10 percent from 102 to 112 on a 1 percent slope, from 188 to 208 on a 3 percent slope, and from 298 to 324 on a 5 percent slope. Similar increases occurred with no-till cotton. Nitrogen losses were not greatly affected by reduced tillage. Nitrogen loss in no-till cotton was slightly higher than that of conventional-till cotton (on 1 and 3 percent slopes) and strip-till cotton (on 3 and 5 percent slopes) even though they use the same amount of fertilizers. Simulation results showed that the concentration of nitrogen in the upper soil layers in no-till cotton was higher than in the strip-till and conventional-till cotton rotations due to shallower placement of fertilizer. Because eroded soil comes from the topsoil layer, the higher concentration of nitrogen in the upper soil layers resulted in increased nitrogen losses with sediment as well as more potential for loss in soluble runoff.

Both strip-till and no-till cotton reduced phosphorus losses by about one pound per acre primarily as a result of lower sediment losses. Reduced tillage reduced sediment loss on all three slopes mainly by reducing water erosion. Strip-till reduced sediment losses from 9.4 to 8.9 tons per acre on a 5 percent slope, from 5.1 to 4.8 tons on a 3 percent slope, and from 2.9 to 2.7 tons on a 1 percent slope. No-till cotton reduced sediment losses by similar amounts.

The simulated per acre net incomes for all cotton/peanut rotations on the 5 percent slope land are shown in Table 6. The net returns were not greatly affected by slope as shown in Table 2. When only a cover crop was added to the conventional-till peanut/cotton rotation, net incomes for each year and mean net income declined by an average of $13 per acre. Risk increased as indicated by a larger loss in the worst year (1993). When cotton was strip-tilled with a cover crop, average net incomes increased by $5 per acre compared to conventional till. The rotation with no-till cotton had slightly higher average net returns compared to the strip-till cotton rotation. However, net returns of no-till cotton shown in Table 4 might be somewhat overstated because EPIC does not account for possible yield reductions due to uneven seed germination and slow growth due to compacted soil in the upper root zone. Strip-till and no-till cotton rotations had slightly less risk compared to conventional-till cotton as indicated by less net income losses in 1993.

Table 4. EPIC predicted losses of pesticides, nitrogen, phosphorus, and sediment for rotations with conventional and reduced tillage, with cover crops

	Pesticide loss index			N loss			P loss			Sediment loss		
Slope	1%	3%	5%	1%	3%	5%	1%	3%	5%	1%	3%	5%
Rotations				------------lbs/ac-------			------------lbs/ac--------			---------ton/ac---------		
Conventional peanuts/ conventional cotton (with cover)	102	188	298	18	28	42	4	8	14	2.9	5.1	9.4
Conventional peanuts/strip-till cotton (with cover)	112	208	324	19	28	41	4	7	13	2.7	4.8	8.9
Conventional peanuts/no-till cotton (with cover)	111	208	329	19	29	42	4	7	13	2.6	4.8	8.9

Table 5. Per acre net income for rotations on 5 percent slope

	Net income ($/ac)										
Crop rotations	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean
Conventional peanuts/ conventional cotton (without cover)	264	177	214	330	326	228	223	-75	394	178	226
Conventional peanuts/conventional cotton (with cover)	250	161	205	319	307	213	208	-84	385	164	213
Conventional peanuts/strip-till cotton (with cover)	255	166	210	324	312	218	213	-77	391	169	218
Conventional peanuts/no-till cotton (with cover)	256	167	211	325	313	219	214	-78	391	170	219

Table 6. The economic[a] and environmental effects of cover crops and reduced tillage in the cotton/peanut rotation on 5 percent slope

	---Change in average[b]--				
Rotation	Net return	Pesticide Loss Index	Nitrogen loss	Phosphorus loss	Sediment loss
	$/ac		--------------lbs/ac--------------		tons/ac
Conventional peanut/conventional cotton (with cover)	-13 (↓ 6%)	1 (↑ <1%)	-6 (↓ 13%)	-1 (↓ 7%)	-0.8 (↓ 8%)
Conventional peanut /strip-till cotton (with cover)	-8 (↓4%)	27 (↑ 9%)	-7 (↓ 15%)	-2 (↓ 13%)	-1.3 (↓ 13%)
Conventional peanut/no-till cotton (with cover)	-7 (↓3%)	32 (↑ 11%)	-6 (↓ 13%)	-2 (↓ 13%)	-1.3 (↓ 13%)

[a] Economic analysis here is based on changes in average net incomes without considering changes in risk.

[b] A change is computed as the average value of the indicated rotation with reduced tillage and/or cover crop minus the average value of the conventional-till peanut – cotton rotation (without cover). Percent change is shown in parentheses.

Impact of Cover Crops Versus Reduced Tillage

Each peanut/cotton rotation with a cover crop is compared to the conventional-till cotton/conventional-till peanut rotation with no cover for net returns, pesticide and nutrient loadings, and sediment losses (Table 5). The comparison is made by subtracting the average net return or sediment, nutrient, or pesticide loss for the rotation with conventional tillage and no cover crop from the corresponding values for the rotation with a cover crop and reduced tillage.

Adding a cover crop to conventional-till peanuts and cotton caused net income to decrease 6 percent due to the cost of establishing cover. The pesticide loss index increased slightly while phosphorus losses declined by 7 percent. Nitrogen losses decreased by 13 percent, and sediment losses decreased by 8 percent. The shift to the conventional-till peanut/strip-till cotton with cover rotation reduced net income by 4 percent. Phosphorus and sediment losses declined by 13 percent while nitrogen loss decreased by 15 percent. However, the pesticide loss index increased by 9 percent. Shifting to conventional-till peanuts/no-till cotton with a cover crop reduced net income by 3 percent, and nitrogen, phosphorus, and soil losses declined by 13 percent. But the pesticide loss index increased by 11 percent.

CONCLUSIONS AND IMPLICATIONS

Substituting cotton for corn in rotations with peanuts increases average profit. Profit maximizers and mildly risk averse farmers would prefer cotton to corn under the conditions assumed in this study. However, cotton producers still suffer larger losses in years of crop failure due to much higher input costs compared to corn. Moderately risk averse producers may be indifferent between the two rotations because the higher returns from cotton are offset by the somewhat lower downside risk of corn in years of crop failure.

The shift from a no-till corn/conventional-till peanut rotation to a conventional-till cotton/conventional-till peanut rotation had mixed effects on potential pollution. Shifting to cotton increased potential sediment losses on all slopes, potential phosphorus losses on steeper slopes, and the pesticide loss index on steeper slopes. However, shifting to cotton decreased potential nitrogen losses on all slopes and the pesticide loss index on shallower slopes.

Adding a cover crop to the conventional-till cotton/peanut rotation reduced sediment loss, nitrogen loss, and phosphorus loss but increased pesticide losses slightly. Reducing tillage of cotton reduced sediment, phosphorus, and nitrogen losses but increased the pesticide loss index. The pesticide loss index was highest for conventional-till peanuts with no-till cotton. If the major water quality concern in the watershed is nitrogen, phosphorus, or soil loss, rotations with reduced tillage or cover crops are likely to be environmentally beneficial. If the major concern is pesticides, strip-till and no-till cotton rotations are less likely to be environmentally beneficial.

The use of cover crops with cotton and peanuts should be encouraged to reduce soil, nitrogen, and phosphorus losses. Net returns were reduced somewhat due to the cost of establishing cover. However, cover crops will have other economic benefits not quantified here. These benefits include the savings from reduced nutrient losses and enhanced soil productivity over time due to lower soil erosion and higher organic matter resulting from cover crop residue.

Strip-till and no-till cotton increased net income compared to conventional-till cotton. Strip-till cotton should be encouraged to further reduce soil and phosphorus losses compared to conventional till. Strip-till produced nearly the same environmental benefits as no-till while producing a higher net income than conventional-till. While the rotation with no-till cotton also produced a high average net return, these net returns are likely to be overstated because of other problems with no-till which were not quantified by the EPIC model including inadequate seed coverage and nonuniform seed placement. Until these problems can be resolved, strip-till cotton is likely to remain the preferred cotton tillage method in terms of economic returns and reduced environmental damage.

Other nutrient management practices are likely to be important on many farms to achieve further reductions in nitrogen and phosphorus losses. These practices could include changing the timing and amount of nitrogen and phosphorus used and incorporating nitrogen and phosphorus fertilizers into the soil. Because pesticide use and loss potential increases with reduced tillage, other strategies such as integrated pest management are needed to reduce potential pesticide losses from cotton.

Slope of the land is the most important factor in determining pollutant losses. Variations in all pollution indices were much greater across slope (from 1 to 5 percent) than across rotation or tillage type. Farm-level pollution reduction efforts should target steeper, more highly erodible land. Conservation practices on these soils such as reduced tillage and cover crops can result in greater pollution reductions.

Further research is needed to develop reduced-till alternatives for peanuts. Strip-till peanuts potentially can reduce erosion and runoff, but strip-till peanut yields have averaged below conventional yields in experimental trials in Virginia (Phipps). If reduced-till alternatives can be developed which maintain peanut yield and quality, reduced-till peanuts can have important environmental benefits at little or no cost to farmers.

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