Weed Science, 54:768–774. 2006

Cotton and corn rotation under reduced tillage management: impacts on soil properties, weed control, yield, and net return

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A 6-yr rotation study was conducted from 2000 to 2005 at Stoneville, MS to examine the effects of rotating glyphosate-resistant (GR) and non-GR (conventional) cultivars of cotton with corn under reduced tillage conditions on soil properties, weed control, crop yield, and net return. There were four rotation systems (continuous cotton, continuous corn, cotton–corn, and corn–cotton) for each non-GR and GR cultivar arranged in a randomized complete block design with four replications. Field preparation consisted of disking, subsoiling, disking, and bedding in the fall of 1999. After the fall of 2000, the experimental area received no tillage operations except rebedding after harvest each year to maintain reduced tillage conditions. A glyphosate-based program in GR cultivars and a nonglyphosate-based program in non-GR cultivars were used for weed management. Soil organic carbon in the top 5-cm depth progressively increased from the first year to the sixth year, regardless of rotation. In 2005, organic carbon was higher in corn grown continuously and in rotation compared to continuous cotton, partly due to higher plant residues from corn compared to cotton. Control of most grass and broadleaf weeds was sufficient to support cotton and corn production, regardless of rotation and herbicide program. Control of yellow nutsedge was reduced in continuous non-GR cotton; this apparent weed species shift toward yellow nutsedge was mitigated by breaking the cotton monocrop with corn. Plant populations of both GR and non-GR cotton rotated with corn were similar to that of continuous cotton suggesting cotton stand establishment was not affected by corn residues from the previous year. Cotton yield increased every year following rotation with corn by 10–32% in the non-GR cultivar, and by 14–19% in the GR cultivar compared to continuous cotton. Similarly, corn yield increased by 5–13% in non-GR cultivar and by 1–11% in the GR cultivar when rotated with cotton. As a result, net returns were higher from rotation management as compared with monoculture in both crops. This study demonstrated that alternating between cotton and corn is agronomically feasible and a sustainable option for farmers in the lower Mississippi River alluvial flood plain region who are looking for simple cultural practices that provide economic and environmental benefits.

Nomenclature: Glyphosate; corn, *Zea mays* L.; cotton, *Gossypium hirsutum* L.; yellow nutsedge, *Cyperus esculentis* L.

Key words: Conservation tillage, crop rotation, glyphosate, monoculture, reduced tillage, transgenic crop, soil quality, weed management.

Profit margins in cotton production have declined in recent years due to high production costs, low commodity prices, and stagnant yields. Producers are looking for ways to improve profitability by utilizing profitable crop production systems, such as crop rotation, that increase crop yields without increasing production costs. Similarly, reduced tillage systems can minimize input cost due to fewer tillage operations (Blevins and Frye 1993; CTIC 2006). The development of transgenic technology into row crop management adds a new dimension that can be integrated with conservation management systems. Research is needed, however, to develop optimum combinations of practices and assess their impact on a number of key parameters.

Historically, cotton has been produced in monoculture under conventional tillage management in the lower Mississippi River alluvial flood plain region. Conventional tillage management traditionally involves multiple disking, chisel plowing, harrowing, bed formation, and cultivation from the fall after harvest of previous crop through the summer growing season of next crop. This management system employs various implements that disturb the soil surface and leave no plant residue on the soil surface. Because of the intensive tillage operations associated with cotton production under conventional tillage system, cotton is one of the most erosive row crops grown in the southern United States (Bloodworth and Johnson 1995).

Reduced tillage is a general term describing several types of management practices, all of which exclude at least one major cultivation practice or minimize the intensity of tillage operations (Locke and Bryson 1997). Moreover, reduced tillage promotes accumulation of crop residues at the soil surface, thereby reducing the potential for soil erosion compared to conventional tillage (Locke and Bryson 1997). In the Southern United States, cotton hectareage under reduced tillage management has increased marginally from 9% in 1990 to 13% in 1997 (CTIC 2006). Currently, most cotton production occurs under conventional tillage management.

Alternating the sequence of crop production in a rotation has the potential to increase yields in several crops (Wesley et al. 1994). Previous cotton rotation studies have reported variable cotton yield response in rotated cotton. Rotating nonirrigated cotton with other crops in Alabama increased yield by only 3% compared with continuous cotton (Mitchell 1996). Cotton rotated with corn in Arkansas produced 12% higher yield than monocrop cotton (Paxton et al. 1995). Cotton yields ranged from 5% decrease to 28% increase following 1 yr of corn and from 10% decrease to 20% increase following 2 yr of corn in Mississippi under irrigated conditions (Ebelhar and Welch 1989). Rotating crops is beneficial as a conservation practice because it breaks cycles that may be detrimental to long-term management of a particular field (Locke et al. 2002). When crops are rotated, the change in herbicides used and production practices employed may often improve control of problem weeds, soil properties, and crop yields (Bryson et al. 2003; Johnson and Mullinix 1997; Reddy 2004; Wesley et al. 2001). For example, one weed species or weed population has an advantage under a monoculture system. Rotation with another crop may prevent one particular weed species from becoming unmanageable (Johnson and Mullinix 1997; Reddy 2004). Corn is often used in a crop rotation with cotton because it has been shown to reduce many pests that attack cotton, especially reniform nematodes (*Rotylenchulus reniformis* Linford and Oliverira) (Gazaway et al. 2000; McDonald et al. 1999; Windham and Lawrence 1992).

Corn produces more biomass than cotton, and if residues are allowed to accumulate on the soil surface under reduced tillage conditions, soil erosion can be reduced and soil fertility improved. However, some cotton producers are reluctant to rotate cotton with corn because of the potential for poor cotton stand establishment due to corn residue from the previous year. Although most of the farm equipment used in cotton can be easily adapted to corn, corn production requires additional equipment, e.g., combine. Shifting to a cotton–corn rotation by the producers who predominantly grow cotton will largely depend on improved crop yields and profits.

Transgenic crops resistant to herbicides such as glyphosate were introduced during the past decade and have provided farmers with improved flexibility to manage weeds and the freedom to select a rotational crop for the following year without restrictions. Glyphosate is a nonselective, broad-spectrum, systemic postemergence herbicide that has been used extensively throughout the world over the past 30 years (Franz et al. 1997). It blocks biosynthesis of aromatic amino acids by inhibiting the enzyme 5-enolpyruvylshikimate-3-phophate synthase (EPSPS), the target enzyme of glyphosate in the shikimate pathway (Duke et al. 2003; Franz et al. 1997). Glyphosate is used widely for weed control in GR crops without concern for crop injury. GR corn and GR cotton were created by stable integration of a transgene that codes for an insensitive EPSPS enzyme resistant to glyphosate (Padgette et al. 1995). Farmers in the United States have rapidly adopted GR crops, planting about 61% of cotton and 26% of corn hectares to GR varieties in 2005 (USDA 2005).

In this article, a 6-yr field study examines cotton and corn production in a rotation under a reduced tillage system. The specific objectives of this study were to compare soil properties, weed control, yields, and net return from continuous and rotated cotton–corn production systems. Weed control and yields from GR and non-GR cultivars were measured and compared over the 6-yr period. An important aspect of this research was to determine whether rotation of cotton with corn would increase crop yields and profit under reduced tillage systems in the lower Mississippi River alluvial flood plain region.

Materials and Methods

A 6-yr field study was conducted from 2000 through 2005 at the USDA-ARS Southern Weed Science Research Unit farm, Stoneville, MS (33°26′ N, 90°55′ W). The soil was a Dundee silt loam (see http://www.cast.uark.edu/local/soils_atlas/classification/soils_class.pdf, fine-silty, mixed, active, thermic Typic Endoqualf) with pH 6.7, 1.1% organic matter, a CEC of 15 cmol kg^{-1}, and soil textural fractions of 26% sand, 55% silt, and 19% clay. Prior to the present study, the experimental area had a history of GR soybean production. Field preparation consisted of disking, subsoiling, disking, and bedding in the fall of 1999. The land was not tilled in subsequent years, but the raised seedbeds were refurbished each fall after harvest with no additional tillage operations to maintain a reduced tillage system. The raised seedbeds ensured adequate drainage in early spring, helping to prevent planting delays and enabling furrow irrigation during the growing season. Prior to planting, the tops of the seedbeds were smoothed as needed by removing a thin layer of soil from the top of the seedbed.

The experiment was conducted in a randomized complete block design with four replications. There were four rotation systems for each GR and non-GR cultivar. The rotation systems were continuous cotton, continuous corn, cotton–corn, and corn–cotton. The reverse rotation sequences were included to make comparison between rotation and monoculture systems each year. Each treatment consisted of eight rows spaced 102 cm apart and 45.7 m long. Data were subjected to analysis of variance with the use of PROC GLM (SAS 2001), and treatment means were separated at the 5% level of significance with the use of Fisher's protected LSD test.

The experimental area was treated with paraquat at 1.1 kg ai ha^{-1} 1 to 4 d prior to crop planting to kill existing vegetation. Cotton and corn varieties, planting dates, herbicides and application timings, and harvest dates used in the study are presented in Table 1. Both cotton and corn were planted with the use of a MaxEmerge 2 planter.[1] Varieties were selected based on regional use patterns by producers and seed availability. Weed management consisted of a glyphosate-based program for the GR cultivars and a non-glyphosate herbicide-based program for the non-GR cultivars. Herbicide treatments were applied with a tractor-mounted sprayer with TeeJet 8004 standard flat spray nozzles[2] delivering 187 L ha^{-1} water at 179 kPa. Fertilizer application and insect control programs were standard for cotton and corn production (Anonymous 2005; Reddy 2004). Crops were irrigated on an as-needed basis each year.

Soil samples from the top 5-cm depth were collected with

TABLE 1. Production practices used in glyphosate-resistant (GR) and non-glyphosate-resistant (non-GR) corn and cotton grown continuously and in rotation at Stoneville, MS, 2000 to 2005.[a,b]

		Corn		Cotton	
Year	Production practice	GR	Non-GR	GR	Non-GR
2000	Variety	AG RX 738RR	Pioneer 3223	DP 436RR	Stoneville 474
	Planting date	7 April	7 April	11 May	11 May
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + metolachlor	Fluometuron + metolachlor
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac
	PD (5–9 WAP)	None	None	None	Sethoxydim
	Harvest date	14 August	14 August	22 September	22 September
2001	Variety	AG RX 740RR	Pioneer 3223	DP 436RR	Stoneville 474
	Planting date	22 March	22 March	18 April	18 April
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + pendimethalin	Fluometuron + pendimethalin
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac
	PD (5–9 WAP)	Glyphosate	Atrazine + metolachlor	None	None
	Harvest date	16 August	16 August	20 September	20 September
2002	Variety	AG RX 738RR	Pioneer 3223	DP 436RR	Stoneville 474
	Planting date	5 April	5 April	1 May	1 May
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + pendimethalin	Fluometuron + pendimethalin
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac
	PD (5–9 WAP)	Glyphosate	None	Glyphosate	Fluometuron + MSMA
	Harvest date	28 August	28 August	23 September	23 September
2003	Variety	DKC69-72RR	Pioneer 3223	DP 436RR	Stoneville 474
	Planting date	31 March	31 March	22 April	22 April
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + pendimethalin	Fluometuron + pendimethalin
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac fb fluazifop
	PD (5–9 WAP)	Glyphosate	Atrazine + metolachlor + carfentrazone	Glyphosate	Fluometuron + MSMA
	Harvest date	18 August	18 August	19 September	19 September
2004	Variety	DKC69-71RR2/YGCB	Pioneer 3223	DP 444BG/RR	Sure-Grow 747
	Planting date	24 March	24 March	22 April	22 April
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + metolachlor	Fluometuron + metolachlor
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac
	PD (5–9 WAP)	Glyphosate	Atrazine + metolachlor + bentazon	Glyphosate	Fluometuron + MSMA
	Harvest date	10 August	10 August	23 September	23 September
2005	Variety	DKC69-72 RR2	Pioneer 3223	DP 434RR	DP 493
	Planting date	1 April	1 April	20 April	20 April
	PRE (at planting)	None	Atrazine + metolachlor	Fluometuron + metolachlor	Fluometuron + metolachlor
	EPOST (3–4 WAP)	Glyphosate	None	Glyphosate	Pyrithiobac
	PD (5–9 WAP)	Glyphosate	Atrazine + metolachlor + bentazon	Glyphosate fb glyphosate	FLuometuron + MSMA fb diruon + linuron
	Harvest date	18 August	18 August	19 September	19 September

[a] Abbreviations: fb, followed by; EPOST, early postemergence; PD, postemergence directed to base of the crop plant; PRE, preemergence; WAP, weeks after planting corn or cotton.

[b] Rates of herbicides, g a.i. (a.e. for glyphosate) ha^{-1}: Atrazine, 1820 + metolachlor, 1410 as PRE; Atrazine, 950 + metolachlor, 740 as PD; glyphosate, 840; bentazon, 840; carfentrazone, 9 in corn and fluometuron, 1120–1680 + metolachlor, 1120–1680 or pendimethalin, 1120; glyphosate, 840; pyrithiobac, 105; fluazifop, 210; sethoxydim, 280; fluometuron, 896 + MSMA, 2240; diuron 896 + linuron, 896 in cotton.

TABLE 2. Effect of non-glyphosate-resistant cotton and corn grown continuously and in rotation on soil pH and organic carbon content in the 0 to 5-cm depth at Stoneville, MS in 2000 to 2005.[a]

Rotation system	pH (1:2 water)						Organic carbon					
	2000	2001	2002	2003	2004	2005	2000	2001	2002	2003	2004	2005
							%					
Cotton–cotton	6.63 b	6.77 b	6.80 a	6.95 a	6.37 a	6.76 a	0.57 a	0.55 a	1.07 a	1.01 b	1.17 c	1.21 b
Corn–corn	6.65 b	6.93 a	6.68 a	6.48 a	6.36 a	6.22 a	0.57 a	0.64 a	1.22 a	1.16 a	1.23 bc	1.28 a
Cotton–corn	6.75 ab	7.03 a	6.70 a	6.70 a	6.32 a	6.36 a	0.58 a	0.60 a	1.15 a	1.25 a	1.29 a	1.30 a
Corn–cotton	6.83 a	6.90 ab	6.55 a	6.66 a	6.47 a	6.65 a	0.67 a	0.61 a	1.23 a	1.17 a	1.24 ab	1.27 a

[a] Means within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's protected LSD test.

the use of a 7.5-cm core sampler prior to planting (March/April). Soil samples consisted of a composite of nine subsamples collected randomly from the middle four rows of the plot. As the focus of this study was to assess long-term changes in soil properties as a consequence of crop rotation, the soil samples were collected only from the four rotation systems under non-GR cultivars. Bulk soil samples were homogenized by passing the soil through a 2-mm sieve. Soil samples from 2000 to 2002 were analyzed at the Soil Testing and Research Laboratory, University of Arkansas, Marianna, Arkansas, and samples from 2003 to 2005 were analyzed in our laboratory. Soil pH was measured in water (1:2, soil: water). Organic matter was determined by loss of mass following ignition (Nelson and Sommers 1996) and organic carbon was calculated to be 58% of the organic matter. Total carbon and nitrogen in the 2003–2005 soils were measured on dried, milled subsamples with the use of a Flash EA 1112 NC soil analyzer.[3]

Control of individual weed species in all plots was visually estimated based on reduction in population on a scale of 0% (no weed control) to 100% (complete weed control) at 2 wk after the last postemergence herbicide application. Cotton and corn populations were estimated by counting plants in two 2-m-long row lengths from the second and third rows of an eight-row plot during midseason in 2000 to 2002 and at harvest in 2003 to 2005. Cotton from all eight rows of each plot was harvested once with a spindle picker and seed cotton yield was reported. Corn from all eight rows of each plot was harvested with the use of a combine, and grain yield was adjusted to 15% moisture. Economic benefit (net return) from rotation for each crop and for each year was determined by multiplying mean yield increase in rotation over yield of monoculture system by the market-year average price. The Mississippi Agricultural Statistics Service publishes the market-year average price of cotton and corn received by producers (USDA 2006a, 2006b). Lint yield was calculated to be 35% of the seed cotton yield and was used to derive net return (Wesley et al. 2001). Because the designated rotation systems were first grown in 2000, the net return for that year was not calculated, as the entire study area had been planted to GR soybean in previous years.

Results and Discussion

Soil Properties

The surface 5 cm soil from non-GR cotton–corn rotation systems had similar levels of pH, with no differences that could be attributed to rotation or crop (Table 2). When the study was initiated, there were no differences in organic carbon among crop rotation treatments, and the levels for 2000 and 2001 ranged from 0.55 to 0.67% (Table 2). By the third year (2002), soil organic carbon began to increase, most likely due to reduced tillage management. From 2003 to 2005, differences in soil organic carbon among rotation systems were observed, with consistently lower organic carbon measured in the continuous cotton system. These differences in organic carbon can be attributed to higher levels of plant residues remaining after corn harvest compared to cotton, and the greater stability and persistence of the corn residues. Several other soil properties, for example, electrical conductivity, nitrate, sulfate, and phosphate, were measured; however, these properties were unaffected by rotation systems (data not shown). Total soil nitrogen was measured in 2003 to 2005, with some differences attributable to rotation systems. Overall, soils under continuous corn had the highest C:N ratios also relating to the high lignocellulose composition of corn residues (data not shown).

Weed Control

Nineteen weed species were observed in the experimental area. Herbicide programs were designed for effective control of weeds in both crops. As a result, control of most weed species was 93% or better (data not shown) in both crops regardless of year, rotation, or weed management program, with the exception of browntop millet [*Brachiaria ramosa* (L.) Stapf.], hyssop spurge (*Euphorbia hyssopifolia* L.), and yellow nutsedge (Table 3). In both cotton and corn, control of browntop millet and hyssop spurge was 91% or better regardless of rotation and glyphosate application, except for slight reduction in control (83–85%) of both species in rotated non-GR cotton in 2005.

Yellow nutsedge control was similar among continuous and rotated GR or non-GR cotton and corn in 2000 and 2003. In 2005, yellow nutsedge control was ≥95% in GR cultivars of both crops; however, control decreased in non-GR cultivars, especially in continuous cotton. After 6 years, control of yellow nutsedge decreased in continuous non-GR cotton compared with rotated non-GR cotton and GR cotton. Reduction in yellow nutsedge control in non-GR cultivars may be due to limited activity of metolachlor and pyrithiobac used in non-GR cultivars compared to higher activity of glyphosate used in GR cultivars on yellow nutsedge. Slightly higher control of yellow nutsedge in rotated non-GR cotton compared with continuous non-GR cotton is partly due to breaking of sequence with corn. Early canopy closure in corn (corn was planted about a month earlier

TABLE 3. Browntop millet, hyssop spurge, and yellow nutsedge control at 2 weeks after last postemergence herbicide application in glyphosate-resistant (GR) and non-glyphosate-resistant (non-GR) cultivars of cotton and corn grown continuously and in rotation at Stoneville, MS, 2000 to 2005.[a]

Crop	Cultivar type	Rotation system	Browntop millet 2000	Browntop millet 2003	Browntop millet 2005	Hyssop spurge 2000	Hyssop spurge 2003	Hyssop spurge 2005	Yellow nutsedge 2000	Yellow nutsedge 2003	Yellow nutsedge 2005
			% control								
Cotton	Non-GR	Continous	100 a	98 a	93 ab	96 ab	100 a	98 a	93 a	80 a	55 c
		Rotation	100 a	98 a	85 b	93 bc	93 b	83 b	93 a	95 a	73 b
	GR	Continuous	100 a	100 a	100 a	91 c	100 a	100 a	95 a	100 a	98 a
		Rotation	100 a	98 a	98 a	95 bc	93 b	98 a	93 a	93 a	95 a
Corn	Non-GR	Continous	100 a	100 a	100 a	100 a	100 a	100 a	94 a	88 a	85 ab
		Rotation	100 a	100 a	100 a	100 a	100 a	100 a	95 a	93 a	88 ab
	GR	Continuous	100 a	100 a	100 a	100 a	100 a	100 a	98 a	100 a	100 a
		Rotation	100 a	100 a	100 a	100 a	100 a	100 a	90 a	100 a	100 a

[a] Means within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's protected LSD test.

than cotton) and tall canopy architecture may have suppressed establishment of yellow nutsedge in corn. Greater suppression of yellow nutsedge by shading in corn than in cotton has been reported by others (Johnson and Mullinix 1997). The observed shift toward yellow nutsedge in continuous non-GR cotton is similar to that reported by other researchers. In a 4-yr ultra-narrow-row cotton–soybean rotation, purple nutsedge population markedly increased with non-glyphosate-based program compared with glyphosate-based program in continuous cotton (Bryson et al. 2003). After a 3-yr rotation, yellow nutsedge population was higher in continuous bromoxynil-resistant cotton than bromoxynil-resistant cotton grown in rotation with GR cotton (Reddy 2004).

Cotton and Corn Population and Yield

There were no differences in plant populations among GR and non-GR cultivars regardless of rotation in both cotton (Table 4) and corn (Table 5) in all 6 yr. Because corn produces more residue than cotton, poor stand establishment of cotton following corn is a concern among some cotton producers. The fact that plant populations of cotton rotated with corn were similar to that of continuous cotton in both GR and non-GR cultivars suggested that cotton stand establishment was not affected by corn residues from the previous year, even though this rotation study was under a reduced tillage system.

Seed cotton yields were higher in cotton rotated with corn compared to continuous cotton regardless of cultivar type in 2003, 2004, and 2005 (Table 4). In general, seed cotton yield increased every year following rotation with corn by 10–32% in non-GR cotton and by 14–19% in the GR cotton compared to continuous cotton. The levels of seed cotton yield increase in rotated cotton in this study were similar to those reported by others (Ebelhar and Welch 1989; Mitchell 1996; Paxton et al. 1995). Corn grain yields were higher in corn following cotton compared to corn grown continuously regardless of cultivar type in 2002 and 2004 (Table 5). In general, corn yield increased every year by 5–13% in the non-GR corn and by 1 to11% in the GR corn when rotated with cotton compared to continuous corn.

Net Return

Whether cotton (or corn) is grown in monoculture or in rotation, the production costs remain identical within a year. With this assumption, the net return from a rotation system was calculated for each year by multiplying average yield increase due to rotation by market year average price (Table 6). In cotton, the net return increased every year by 51 to 387 \$ ha^{-1} in non-GR cultivar and 92 to 282 \$ ha^{-1} in GR cultivar. Similarly, in corn, the net return increased by 46 to 126 \$ ha^{-1} in non-GR cultivar and 14 to 106 \$ ha^{-1} in GR cultivar.

TABLE 4. Glyphosate-resistant (GR) and non-glyphosate-resistant (non-GR) cotton yield as affected by rotation with corn at Stoneville, MS, 2000 to 2005.[a]

Cultivar type	Rotation system	2000	2001	2002	2003	2004	2005
		Cotton plant density, plants ha^{-1}					
Non-GR	Continuous	96,580 a	89,200 a	94,830 a	85,510 a	91,660 a	105,800 a
	Rotation	100,270 a	89,430 a	91,200 a	84,890 a	97,190 a	100,890 a
GR	Continuous	95,970 a	87,970 a	104,580 a	79,970 a	97,810 a	113,190 a
	Rotation	95,350 a	88,660 a	102,120 a	77,510 a	105,800 a	104,580 a
		Seed cotton yield, kg ha^{-1}					
Non-GR	Continuous	1,960 a	2,440 b	2,320 a	2,500 c	2,500 bc	1,970 d
	Rotation	2,180 a	2,690 ab	2,870 a	3,310 ab	2,870 a	2,280 c
GR	Continuous	2,130 a	2,410 b	2,140 a	3,010 bc	2,380 c	2,940 b
	Rotation	2,200 a	2,870 a	2,440 a	3,600 a	2,730 ab	3,380 a

[a] Means within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's protected LSD test.

Table 5. Glyphosate-resistant (GR) and non-glyphosate-resistant (non-GR) corn grain yield as affected by rotation with cotton at Stoneville, MS, 2000 to 2005.[a]

Cultivar type	Rotation system	2000	2001	2002	2003	2004	2005
		Corn plant density, plants ha^{-1}					
Non-GR	Continuous	77,510 a	73,200 a	77,510 a	73,820 a	73,820 a	68,280 a
	Rotation	79,970 a	71,970 a	79,970 a	86,120 a	73,820 a	68,900 a
GR	Continuous	73,200 a	71,360 a	71,360 a	77,510 a	68,490 a	61,520 a
	Rotation	73,200 a	73,200 a	73,820 a	81,200 a	70,950 a	65,820 a
		Corn grain yield, kg ha^{-1}					
Non-GR	Continuous	12,360 a	13,590 b	10,240 bc	10,440 a	9,500 d	9,310 a
	Rotation	12,550 a	15,200 a	11,190 a	10,960 a	10,760 b	10,080 a
GR	Continuous	11,150 b	12,220 c	9,770 c	11,450 a	10,370 c	9,120 a
	Rotation	11,300 b	12,880 bc	10,380 b	11,610 a	11,470 a	9,350 a

[a] Means within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's protected LSD test.

In summary, continuous cotton production resulted in reduced soil organic carbon. In contrast, soil organic carbon improved when cotton was grown in rotation with corn. Soils cropped with corn or a corn rotation under conservation tillage would have greater potential for carbon sequestration and contribute to a greater sustainability of soil resources. However, increasing soil organic carbon can alter herbicide efficacy on weeds depending on the relationship between increased microbial activity and the potential for greater herbicide sorption, which can result in lower bioavailability for weed control (Gaston et al. 2001; Zablotowicz et al. 2000). Moreover, enhanced degradation of atrazine was noted in the continuous and rotated non-GR corn systems indicating the potential for reduced residual weed control with this herbicide (Krutz et al. 2006). However, control of most weeds was sufficient to support cotton and corn production regardless of rotation and herbicide program. After 6 yr of rotation, control of yellow nutsedge was reduced in both rotated and continuous non-GR cotton suggesting a shift in weed species towards yellow nutsedge. This shift can be delayed in continuous non-GR cotton by rotating with corn. A cotton–corn rotational system could increase yield and net return in both crops over a monocropping system without increasing production costs under reduced tillage system. The present study demonstrated that a cotton–corn rotation system is agronomically feasible and a sustainable option for farmers in the lower Mississippi River alluvial flood plain region who are looking for simple cultural practice that provide environmental and economic benefits.

Table 6. Increased net return realized in rotated cotton and rotated corn with glyphosate-resistant (GR) and non-glyphosate-resistant (non-GR) cultivars over their respective monoculture systems at Stoneville, MS, 2000 to 2005.[a]

Crop/ cultivar type	Rotation system	Net return realized due to rotation over monoculture				
		2001	2002	2003	2004	2005
		$ ha^{-1}				
Cotton						
Non-GR	Rotation	51	169	387	137	119
GR	Rotation	94	92	282	129	169
Corn						
Non-GR	Rotation	126	87	46	121	55
GR	Rotation	52	56	14	106	16

[a] Net return was calculated for each crop and for each year by multiplying mean yield increase due to rotation over yield from their respective monoculture system by the market year average price (USDA-NASS 2006a,b).

Sources of Materials

[1] MaxEmerge 2 planter, Deere and Co., 501 River Drive, Moline, IL 61265.

[2] TeeJet standard flat spray nozzles, Spraying Systems Co., North Avenue and Schmale Road, Wheaton, IL 60189.

[3] Flash EA 1112 NC soil Analyzer, CE Elantech, 170 Oberlin Avenue North, Suite 5, Lakewood, NJ 08701.

Acknowledgments

We thank Efren Ford, Earl Gordon, Terry Newton, and Albert Tidwell for field and laboratory technical assistance.

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Received February 8, 2006, and approved April 3, 2006.