Effects of Long-Term Tillage and Crop Rotation on Soil Carbon and Soil Productivity

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Introduction

Tillage system and crop rotation have long-term effects on soil productivity and soil quality components such as soil carbon as well as on soil physical, biological, and chemical properties. In addition, both tillage and crop rotation have effects on weed and soil disease control. There is a need for well-defined, long-term tillage and crop rotation studies across the different soils and climate conditions in Iowa. The objective of this study was to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

Materials and Methods

The study was originated and conducted on eight Iowa State University research and demonstration farms in 2002 and continued through 2005. Treatments include five tillage systems (no-till, strip-tillage, chisel plow, deep ripper, and moldboard plow) and two crop rotations (corn-corn-soybean and corn-soybean) across the five tillage systems and several soil associations. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. Soil samples were subsequently collected in 2004. The soil samples were collected from all sites at depths of 0–6, 6–12, 12–18, and 18–24 in. and were analyzed for total carbon and total nitrogen. The experimental design was a randomized complete block design with four replications.

The plot size was 20 rows × 65 ft. Yield was determined from the center four rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen were monitored on a bi-yearly or more basis. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate were conducted on selected sites depending on availability of funding.

Results and Discussion

The average corn yields across all tillage systems for the corn-soybean and corn-corn-soybean rotation in 2006 were 205.0 and 207.9 bushels/acre, respectively (Table 1 and 2). The corn-corn-soybean rotation was in the first year of corn.

Under the corn-soybean rotation, the moldboard plow treatment more than the no-tillage treatment, but all other treatments were not different.

Under the corn-corn soybean rotation the moldboard and chisel plow treatments yielded more than the no-tillage treatment, but all other treatments were not different.

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Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU Armstrong Research Farm. Yields are corrected to 15.5 and 13.0% for corn and soybean, respectively.

	Corn (**C**-s)			Soybean (c-**S**)	
	2002[b]	2004	2006	2003[b]	2005
	- - - - - - - - - bushels/acre - - - - - - - - -				
No-tillage	92.2	214.9	195.5	39.8	55.6
Strip-tillage	91.4	218.9	202.4	38.3	55.6
Deep rip	91.0	235.1	206.9	39.7	60.8
Chisel plow	88.3	232.0	206.9	35.7	56.6
Moldboard plow	107.4	226.3	213.1	33.8	55.7
$LSD_{(0.05)}$[a]	20.8	14.2	17.1	3.5	4.6
5-Tillage average	94.1	225.4	205.0	37.5	56.9

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test.
Yield differences greater than the least significant difference are significantly different.
[b]Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.

Table 2. Corn and soybean yields under a corn-corn-soybean rotation at the ISU Armstrong Research Farm. Yields are corrected to 15.5 and 13.0% for corn and soybean respectively.

	Corn (**C**-c-s)		Corn (c-**C**-s)	Soybean (c-c-**S**)	
	2003[b]	2006	2004	2002[b]	2005
	- - - - - - - - - - - - - bushels/acre - - - - - - - - - - - - -				
No-tillage	151.8	196.5	221.0	36.7	56.3
Strip-tillage	142.7	208.2	224.3	35.7	56.8
Deep rip	146.3	209.6	231.8	35.5	61.0
Chisel plow	136.8	211.9	228.7	36.7	59.1
Moldboard plow	133.8	213.1	238.2	35.7	55.4
$LSD_{(0.05)}$[a]	17.5	14.5	11.5	6.4	4.2
5-Tillage average	142.3	207.9	228.8	36.1	57.7

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test.
Yield differences greater than the least significant difference are significantly different.
[b]Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.