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Long-term Tillage and Crop Rotation Effects on Yield and Soil Carbon

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Abstract
Tillage system and crop rotation have major long-term effects on soil productivity and soil quality components such as soil carbon and other 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 the state. The objective of this study was to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

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Agronomy

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Long-Term Tillage and Crop Rotation Effects on Yield and Soil Carbon

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Introduction

Tillage system and crop rotation have major long-term effects on soil productivity and soil quality components such as soil carbon and other 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 the state. 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

This study was conducted on eight Iowa State University Research and Demonstration Farms in 2002. Treatments include five tillage systems (no-tillage, strip-tillage, chisel plow, deep ripper, and moldboard plow) and two crop rotations of corn-corn-soybean and corn-soybean across the five tillage systems and several soil associations. The experimental design was a randomized complete block design with four replications. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. The soil samples were collected from all sites for depths 0–6, 6–12, 12–18, and 18–24 in. and were analyzed for total carbon and total nitrogen. Subsequent soil samples were collected every two years from all sites for depths 0–6, 6–12, 12–18, and 18–24 in. and will be analyzed for total carbon and total nitrogen.

At this research site, there is only one crop rotation (corn-soybean rotation) over five tillage systems. The plot size is 8 rows by 55 ft long. Yield was determined from the center 4 rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen will be monitored on a bi-yearly 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 and soybean were 175.5 and 54.9 bushels/acre in 2004 and 2006, respectively (Table 1). Low soybean and corn yields in 2003 and 2006 were due to moisture shortage. Corn yields for no-tillage and strip-tillage were lower than deep rip, chisel plow, and moldboard plow in 2004. However, in a dry year (2006), moldboard corn yield was less than other tillage systems.

The average soybean yields for the corn-soybean rotation across all tillage systems were 28.4, 48.1, and 42.8 bushels/acre in 2003, 2005, and 2007, respectively (Table 1). In three years, no-tillage soybean yields were greater than deep rip, chisel plow, and moldboard plow.

Low soybean yields in 2003 were likely due to dry weather conditions with precipitation 10.51 in. less than normal.

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

	Corn (**C**-s)		Soybean (c-**S**)		
	2004	2006[b]	2003[b]	2005	2007
	- - - - - - - - - - - - -		-bushels/acre-	- - - - - - - - - - - - -	
No-tillage	166.4	61.4	31.2	52.1	47.2
Strip-tillage	167.7	59.5	28.6	51.0	44.1
Deep rip	180.5	67.0	27.4	45.7	42
Chisel plow	184.3	52.4	28.3	46.5	39.6
Moldboard plow	178.7	34.4	26.8	45.2	40.9
$LSD_{(0.05)}$[a]	7.5	27.5	2.4	3.3	2.9
5-tillage average	175.5	54.9	28.5	48.1	42.76

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.
[b]Weather conditions in 2003 and 2006 were 10.51 and 2.4 in. of precipitation below normal.