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# Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

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# Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

## **Abstract**

Tillage system and crop rotation have a major long-term effect 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, longterm tillage and crop rotation studies across the different soils and climate conditions in the state. The objective of this study is to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

## **Keywords**

RFR A9103, Agronomy

## **Disciplines**

Agricultural Science | Agriculture | Agronomy and Crop Sciences

# Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

## RFR-A9103

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### Introduction

Tillage system and crop rotation have a major long-term effect 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 is 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 ISU Research and Demonstration Farms in 2002 and continued through 2007. Treatments include five tillage systems (no-till, 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. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. Soil samples were subsequently collected every two years. 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. The experimental design was a randomized complete block design with four replications.

The plot size was 20 rows by 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 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 results show some differences in corn yield between tillage systems (Table 1 and 2). Generally, no-tillage and strip-tillage show some yield decrease, especially in second year corn of C-C-S rotation compared with other tillage systems. In dry years, no-tillage and strip-tillage corn yields were the same or higher than those with other tillage systems.

Continuous corn was established in 2008 and the corn yields show no differences for all tillage systems. However, continuous corn yield in 2009 was greater than that in 2008 and there were no significant yield differences between all tillage systems (Table 2). The average corn yield following soybean across all tillage systems was 3.2 bushels/acre and 8 bushels/acre greater than that of continuous corn in 2008 and 2009, respectively (Table 1 and 2).

Under the corn-corn-soybean rotation (2004 and 2007) (Table 2), the moldboard and chisel plow treatments corn yields were greater than that of the no-tillage. Statistically significant differences in yields were also observed between conventional tillage systems in those two years (Table 2).

Regardless of the tillage system or crop rotation, soybean yields show no differences across all years (Table 1 and 2).

### Acknowledgements

We would like to thank Bernard Havlovic and Jeff Butler for their help in conducting and managing this study.

**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.**

	<u>C/s</u>				<u>c/S</u>			
	2002 <sup>b</sup>	2004	2006	2008	2003 <sup>b</sup>	2005	2007	2009 <sup>c</sup>
	-----bushels / acre-----							
No-tillage	92.2	214.9	195.5	193.0	39.8	55.6	62.4	73.1
Strip-tillage	91.4	218.9	202.4	195.9	38.3	55.6	61.9	73.7
Deep rip	91.0	235.1	206.9	202.7	39.7	60.8	61.9	73.7
Chisel plow	88.3	232.0	206.9	204.4	35.8	56.6	62.4	72.5
Moldboard plow	107.4	226.3	213.1	206.1	33.8	56.7	63.5	71.9
LSD <sub>(0.05)</sub> <sup>a</sup>	20.8	14.2	17.1	11.9	3.5	4.6	3.9	4.3
5-tillage avg	94.1	225.4	205.0	200.4	37.5	57.1	62.4	73.0

<sup>a</sup>Least significant differences (LSD<sub>(0.05)</sub>) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.

<sup>b</sup>Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.

<sup>c</sup>Moldboard plow plots heavily lodged from July 7, 2009 wind event; other till treatments were less affected.

**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.**

	<u>C/c/s</u>			<u>c/C/s</u>		<u>c/c/S</u>			<u>C/c</u>	
	2003 <sup>b</sup>	2006	2009 <sup>c</sup>	2004	2007	2002 <sup>b</sup>	2005	2008	2008	2009 <sup>c</sup>
	-----bushels / acre-----									
No-tillage	151.8	196.5	231.6	221.0	148.1	35.1	56.3	53.7	193.7	233.1
Strip-tillage	142.7	208.2	251.1	224.3	155.9	36.4	56.8	55.1	192.2	234.8
Deep rip	146.3	209.6	242.9	231.8	170.6	34.8	61.0	54.9	204.1	237.5
Chisel plow	136.8	211.9	250.2	228.7	182.7	36.7	59.1	53.2	196.8	236.0
Moldboard plow	133.8	213.1	234.6	238.2	177.7	35.0	55.4	54.1	199.1	228.8
LSD <sub>(0.05)</sub> <sup>a</sup>	17.5	14.5	29.1	11.5	10.9	6.4	4.2	3.3	14.0	20.0
5-tillage avg	142.3	207.9	242.1	228.8	167	35.6	57.7	54.2	197.2	234.1

<sup>a</sup>Least significant differences (LSD<sub>(0.05)</sub>) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.

<sup>b</sup>Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.

<sup>c</sup>Moldboard plow plots heavily lodged from July 7, 2009 wind event; other till treatments were less affected.