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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 A1055, Agronomy

## **Disciplines**

Agricultural Science | Agriculture | Agronomy and Crop Sciences

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

## RFR-A1055

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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 Iowa State University Research and Demonstration Farms in 2002 and continuing through 2010. Treatments include five tillage systems (no-till, strip-tillage, chisel plow, deep rip, and moldboard plow) and three crop rotations of corn-corn-soybean, corn-soybean, and corn-corn across the five tillage systems and several soil associations. Initial soil samples were collected in 2001 prior to implementing the tillage treatments. Soil samples were subsequently collected every two years. The soil samples were collected from all sites for 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 by 65 ft. 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 bi-yearly. Seasonal measurements such as nitrogen use efficiency, soil bulk density, 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 the C-C-S rotation compared with other tillage systems. In dry years no-tillage and strip-tillage corn yields were essentially the same or higher than those with other tillage systems.

Continuous corn was established in 2008. No significant difference in corn yield is observed between tillage systems for 2008 or 2009, but moldboard plow yield is significantly higher than no-till yield in 2010. The average corn yield following soybeans across all tillage systems was 3.2 bushels/acre, 8.0 bushels/acre, and 9.9 bushels/acre greater than that of continuous corn in 2008, 2009, and 2010, respectively (Table 1 and 2).

Under the corn-corn-soybean rotation (2004 and 2007) (Table 2), the moldboard and chisel plow treatment corn yields were significantly greater than that of no-till. This difference is not observed in 2010, although deep rip and chisel plow are significantly higher than strip-tillage. Significant differences in yields were also observed between conventional tillage systems in 2004 and 2007 (Table 2).

Regardless of the tillage system or crop rotation, soybean yields show no significant differences in 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 were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.**

	<u>C/s</u>					<u>c/S</u>			
	2002 <sup>b</sup>	2004	2006	2008	2010	2003 <sup>b</sup>	2005	2007	2009 <sup>c</sup>
	-----bushels/acre-----								
No-tillage	92.2	214.9	195.5	193.0	196.6	39.8	55.6	62.4	73.1
Strip-tillage	91.4	218.9	202.4	195.9	207.1	38.3	55.6	61.9	73.7
Deep rip	91.0	235.1	206.9	204.4	211.7	39.7	60.8	61.9	73.7
Chisel plow	88.3	232.0	206.9	202.7	213.3	35.8	56.6	62.4	72.5
Moldboard plow	107.4	226.3	213.1	206.1	209.1	33.8	56.7	63.5	71.9
LSD <sub>(0.05)</sub> <sup>a</sup>	20.8	14.2	17.1	11.9	20.1	3.5	4.6	3.9	4.3
5-tillage avg	94.1	225.4	205.0	200.4	207.6	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 inches of precipitation below normal.

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

**Table 2. Corn and soybean yields under a corn-corn-soybean and corn-corn rotation at the ISU Armstrong Research Farm. Yields were corrected to 15.5 and 13.0 percent 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	2010	2002 <sup>b</sup>	2008	2008	2009 <sup>c</sup>	2010	
	-----bushels/acre-----											
No-tillage	151.8	196.5	231.6	221.0	148.1	200.1	35.1	56.3	53.7	193.7	233.1	187.6
Strip-tillage	142.7	208.2	251.1	224.3	155.9	193.6	36.4	56.8	55.1	192.2	234.8	193.0
Deep rip	146.3	209.6	242.9	231.8	170.6	208.0	34.8	61.0	54.9	196.8	237.5	199.8
Chisel plow	136.8	211.9	250.2	228.7	182.7	208.1	37.2	59.1	53.2	204.1	236.0	201.5
Moldboard plow	133.8	213.1	234.6	238.2	177.7	207.2	35.0	55.4	54.1	199.1	228.8	206.4
LSD <sub>(0.05)</sub> <sup>a</sup>	17.5	14.5	29.1	11.5	10.9	14.1	6.4	4.2	3.3	14.0	20.0	15.0
5-tillage avg	142.3	207.9	242.1	228.8	167.0	203.4	35.6	57.7	54.2	197.2	234.1	197.7

<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.

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