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

## **Abstract**

Tillage systems and crop rotation affect soil productivity and quality in the long-term by affecting the soil quality components of soil carbon and soil physical, biological, and chemical properties. Tillage and crop rotations contribute to weed and soil disease control. There is a need for well-defined long-term tillage and crop rotation studies across the different soils types 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 quality and productivity.

## **Keywords**

RFR A1285, Agronomy

## **Disciplines**

Agricultural Science | Agriculture | Agronomy and Crop Sciences

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

## RFR-A1285

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### Introduction

Tillage systems and crop rotation affect soil productivity and quality in the long-term by affecting the soil quality components of soil carbon and soil physical, biological, and chemical properties. Tillage and crop rotations contribute to weed and soil disease control. There is a need for well-defined long-term tillage and crop rotation studies across the different soils types 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 quality and productivity.

### Materials and Methods

This study was established on eight Iowa State University Research and Demonstration Farms in 2002. The experimental design was a randomized complete block design with four replications. Five tillage treatments and three crop rotations were adopted. Tillage treatments include no-till (NT), strip-tillage (ST), chisel plow (CP), deep ripper (DR), and moldboard plow (MP). Crop rotations include corn-corn-soybean, corn-soybean, and corn-corn adopted across the five tillage systems and several soil associations. Initial soil sampling in 2001, prior to implementing the tillage treatments, established the baseline soil data for the study. Subsequently, soil sampling was done biannually at 0–6, 6–12, 12–18, and 18–24 in. depths and analyzed for total carbon and total nitrogen.

The plot size was 20 rows by 65 ft. Yields were determined from the center 4 rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen have been monitored every two years. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate have been conducted.

### Results and Discussion

Results show some variation in yields but there were no significant differences in corn yields between tillage treatments (Table 1 and 2). However, NT and ST show some yield reductions, especially in the second year corn of corn-corn-soybean rotation compared with other tillage systems. In 2012, corn yields were generally affected by drought conditions.

Continuous corn yields were generally low. The 2012 drought reduced continuous corn yields by 57 percent from 2010 and 38 percent from 2011. In 2012, continuous corn yield was reduced by 59 percent from 2010 corn yield following soybean averaged across all tillage systems (Tables 1 and 2).

Under the C-C-S rotation, corn following soybean yield in the CP treatment was significantly greater than NT. The 2012 drought conditions reduced corn yields in second year corn in C-C-S rotation averaged across all tillage treatments by 51 percent from 242.1 bushels/acre in 2009 to 118.1 bushels/acre in 2012 (Table 2). Overall, neither tillage systems nor crop rotations, significantly affected soybean yields in all years (Tables 1 and 2).

### Acknowledgements

We thank Bernard Havlovic and staff for help in conducting and managing this study.

**Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU Armstrong Research Farm.<sup>e</sup>**

	C/s						c/S				
	2002 <sup>b</sup>	2004	2006	2008	2010	2012 <sup>d</sup>	2003 <sup>b</sup>	2005	2007	2009 <sup>c</sup>	2011
	-----bushels/acre-----										
No-tillage	92.2	214.9	195.5	193.0	196.6	125.2	39.8	55.6	62.4	73.1	61.7
Strip-tillage	91.4	218.9	202.4	195.9	207.1	134.2	38.3	55.6	61.9	73.7	62.5
Deep rip	91.0	235.1	206.9	204.4	211.7	139.3	39.7	60.8	61.9	73.7	63.4
Chisel plow	88.3	232.0	206.9	202.7	213.3	137.4	35.8	56.6	62.4	72.5	56.1
Moldboard plow	107.4	226.3	213.1	206.1	209.1	139.1	33.8	56.7	63.5	71.9	64.1
LSD <sub>(0.05)</sub> <sup>a</sup>	20.8	14.2	17.1	11.9	20.1	2.1	3.5	4.6	3.9	4.3	8.1
5-tillage avg	94.1	225.4	205.0	200.4	207.6	135.0	37.5	57.1	62.4	73.0	61.6

<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 significantly 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.

<sup>d</sup>Extreme to Severe drought.

<sup>e</sup>Yields were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.

**Table 2. Corn and soybean yields under a corn-corn-soybean and corn-corn rotation at the ISU Armstrong Research Farm.<sup>f</sup>**

	C/c/s				c/C/s			c/c/S				C/c				
	2003 <sup>b</sup>	2006	2009 <sup>c</sup>	2012 <sup>e</sup>	2004	2007	2010	2002 <sup>b</sup>	2005	2008	2011	2008	2009 <sup>c</sup>	2010	2011 <sup>d</sup>	2012 <sup>e</sup>
	-----bushels/acre-----															
No-tillage	151.8	196.5	231.6	107.3	221.0	148.1	200.1	35.1	56.3	53.7	67.5	193.7	233.1	187.6	137.9	76.2
Strip-tillage	142.7	208.2	251.1	116.4	224.3	155.9	193.6	36.4	56.8	55.1	62.5	192.2	234.8	193.0	138.6	87.7
Deep rip	146.3	209.6	242.9	113.7	231.8	170.6	208.0	34.8	61.0	54.9	67.6	196.8	237.5	199.8	134.1	82.5
Chisel plow	136.8	211.9	250.2	130.1	228.7	182.7	208.1	37.2	59.1	53.2	65.7	204.1	236.0	201.5	134.6	94.6
Moldboard	133.8	213.1	234.6	122.8	238.2	177.7	207.2	35.0	55.4	54.1	68.2	199.1	228.8	206.4	134.7	83.6
LSD <sub>(0.05)</sub> <sup>a</sup>	17.5	14.5	29.1	15.6	11.5	10.9	14.1	6.4	4.2	3.3	4.8	14.0	20.0	15.0	9.5	10.6
5-tillage avg	142.3	207.9	242.1	118.1	228.8	167	203.4	35.6	57.7	54.2	66.3	197.2	234.1	197.7	136.0	84.9

<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 significantly 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 7 wind event, other till treatments less affected.

<sup>d</sup>Low yields across all tillage systems due to water and heat stress during the months of July-September and poor hybrid performance.

<sup>e</sup>Extreme to severe drought.

<sup>f</sup>Yields were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.