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

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Abstract
Tillage system and crop rotation have a significant, 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 definite 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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Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

RFR-A11135

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Introduction

Tillage system and crop rotation have a significant, 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 definite 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 2003 and continued through 2008. Treatments include five tillage systems (no-till, strip tillage, chisel plow, deep rip, and moldboard plow) and two crop rotations of corn-corn-soybean and corn-soybean across the five tillage systems. In 2008, a continuous corn rotation was added to the experiment after 2007 corn crop year. Therefore, the experiment will continue to include C-S, C-C-S, and C-C rotations over five tillage systems. Initial soil samples were collected in 2003 prior to implementing the tillage treatments for C-S and C-C-S rotations and in 2008 for C-C baseline. 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 12 rows by 90 ft for C-C-S and C-S rotations and 12 rows by 60 ft for C-C. Yield was determined from the center 5 rows of each plot. Long-term effect of tillage and crop rotation on total soil carbon and total nitrogen will be 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 results show some differences in corn yield between tillage systems (Table 1 and 2). Generally, no-tillage and strip tillage show some lower yields compared with other tillage systems for the three rotations. Continuous corn was established in 2008. Corn yields in 2011 for all rotations show no significant differences between tillage systems. There is variability of yield improvement in no-till and strip till over the years (Table 1 and 2). Average corn yield across all tillage systems of similar years under continuous corn decreased by 10.6 bushels/acre compared with that of C-S and C-C-S rotations.

Under both corn-soybean and corn-corn-soybean rotations, corn yields of no-till and in some years strip tillage were significantly lower than yields of conventional tillage treatments, but yield differences between all conventional treatments were not significantly different.

Regardless of the tillage system or crop rotation, soybean yields show no significant differences across all years.

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Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU Agronomy Research Farm, Boone Co., IA.[b]

	Corn (C-s)					Soybean (c-S)				Corn C/c			
	2003	2005	2007	2009	2011	2004	2006	2008	2010	2008	2009	2010	2011
	-bushels/acre-												
No-till	163.1	134.4	162.2	173.7	195.0	51.1	30.5	32.3	65.5	169.3	134.3	153.8	205.0
Strip till	164.9	165.1	167.7	170.3	191.3	50.8	30.9	35.0	64.6	181.0	145.5	159.5	192.3
Deep rip	184.6	185.7	171.6	185.5	196.7	50.3	39.8	37.2	63.1	173.7	158.2	160.4	198.7
Chisel	185.3	190.2	176.2	198.3	202.8	50.3	36.3	34.4	57.1	183.6	155.2	167.2	202.2
Moldboard	197.9	190.8	175.6	183.8	202.1	52.2	40.7	39.9	63.5	187.0	181.7	170.7	200.9
$LSD_{(0.05)}$[a]	16.9	14.8	11.2	19.0	15.2	4.3	6.8	4.9	10.8	18.7	32.1	15.5	11.6
Avg	179.2	173.2	170.6	182.3	197.6	50.9	35.6	35.7	62.8	178.9	155.0	162.3	199.8

[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]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 rotation at the ISU Agronomy Research Farm, Boone Co., IA.[b]

	Corn (C-c-s)			Corn (c-C-s)			Soybean (c-c-S)		
	2005	2008	2011	2003	2006	2009	2004	2007	2010
	-bushels/acre-								
No-till	146.4	137.3	193.1	150.0	127.2	146.9	51.6	55.2	67.1
Strip till	169.1	153.3	200.8	141.9	146.8	149.5	51.7	56.0	67.2
Deep rip	193.0	176.9	201.5	161.9	174.6	169.7	52.7	58.2	64.4
Chisel plow	190.7	174.2	203.3	159.5	179.6	169.9	53.5	57.5	66.4
Moldboard plow	194.6	161.5	203.0	180.5	181.9	189.6	52.9	56.3	68.9
$LSD_{(0.05)}$[a]	16.6	24.4	11.8	27.5	19.3	15.4	3.6	5.7	4.7
Avg	178.8	160.6	200.3	158.8	162.0	182.3	52.5	56.8	66.8

[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]Yields were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.