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

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Abstract
Tillage system and crop rotation have a significant long-term effect on soil productivity and soil quality components, including soil carbon and 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 is 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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Introduction

Tillage system and crop rotation have a significant long-term effect on soil productivity and soil quality components, including soil carbon and 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 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, including the McNay Research Farm, 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 is a randomized complete block design with four replications. The plot size is 30 ft (12 rows) by 100 ft. Yield is determined from the center six rows of each corn plot and five rows of each soybean plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen are being monitored on a bi-yearly basis. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate will be conducted on selected sites depending on availability of funding.

Results and Discussion

The results show some differences in corn yield between tillage systems (Tables 1 and 2). Generally, no-till and strip-tillage show some yield decrease in C-S and C-C-S rotations and only significant in some years, which show the seasonal differences and effect on corn yield compared to other tillage systems. Continuous corn was established in 2008 as a second year in corn and the results show no significant differences in yield between all tillage systems. However, it must be noted that the extreme low corn yield with continuous corn and as with C-C-S rotation was due to extreme wet conditions and late planting in 2008 (Tables 1 and 2).

Regardless of the tillage system or crop rotation, soybean yields show no significant differences within all years, except in 2008 due to extreme wet soil conditions.

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

	Corn (C/s)			Soybean (c/S)			C/c
	2003	2005	2007	2004	2006	2008	2008
	-bushels/acre-						
No-till	164.1	134.9	156.3	65.2	52.8	50.3	75.1
Strip-tillage	159.1	137.8	161.3	65.3	53.0	40.6	69.1
Deep rip	171.4	150.8	176.6	66.3	50.7	32.1	57.0
Chisel plow	165.8	152.9	179.1	66.9	50.6	33.2	55.5
Moldboard plow	161.3	160.4	177.9	68.2	51.9	41.0	65.6
$LSD_{(0.05)}$ [a]	26.9	10.8	9.4	4.0	5.7	11.0	38.2
5-tillage avg	164.3	147.4	170.24	66.4	51.8	39.4	64.5

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.

Table 2. Corn and soybean yields under a corn-corn-soybean rotation at the ISU McNay Research Farm. Yields are corrected to 15.5 and 13.0 percent for corn and soybean, respectively.

	Corn (C-c-s)				Corn (c-C-s)				Soybean (c-c-S)		
	2003	2005	2006	2008	2003	2004	2006	2007	2004	2005	2007
	bushels/acre										
No-till	153.1	135.8	156.8	60.2	145.4	129.0	116.1	118.1	64.9	50.9	55.3
Strip-tillage	166.2	136.7	159.9	59.5	175.6	140.6	132.8	135.6	66.1	52.0	55.9
Deep rip	185.5	165.2	153.7	69.5	158.4	135.9	134.7	158.3	67.3	58.5	56.1
Chisel plow	170.5	151.6	148.8	64.1	151.4	136.9	129.2	155.1	66.3	58.2	53.5
Moldboard low	162.4	161.7	136.0	90.8	165.3	140.2	123.0	163.2	68.0	60.7	57.5
$LSD_{(0.05)}$ [a]	26.6	16.2	16.9	23.3	22.7	20.7	15.3	30.2	3.2	5.9	4.3
5-tillage avg	167.5	150.2	151.0	68.8	159.2	136.5	127.2	146.1	66.5	56.1	55.66

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.