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Long-term Tillage and Crop Rotation Effects on Yield

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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 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 Yield

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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 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 beginning in 2002. 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 over five tillage systems and several soil associations. In 2008, a continuous corn rotation was included in the trial after 2007 corn crop year replacing one of two C-C-S blocks. Therefore, the experiment will continue to include C-S, C-C-S, and C-C rotations over five tillage systems. The experimental design was a randomized complete block design with four replications. Initial soil samples were collected in 2002 prior to implementing the tillage treatments for C-S and C-C-S rotations and in 2008 for C-C baseline. 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. Subsequent soil samples were collected in 2004 from all sites for depths 0–6, 6–12, 12–18, and 18–24 in. and will be analyzed for total carbon and total nitrogen.

The plot size was 8 rows by 80 ft. Yield was determined from the center three rows of each corn plot and five rows of each soybean plot. Long-term effect of tillage and crop rotation on total soil carbon and total nitrogen will be monitored bi-yearly and are not reported in this article. 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

Corn and soybean yield results are summarized in Tables 1 and 2. The results show yield variability between years and tillage systems within each year.

From 2003 to 2010 corn yields of C-S rotation of five tillage systems show no significant differences, except in some years, where conventional tillage has some advantage (Table 1). However, soybean yields of 2003–2011 show no significant differences between all tillage systems except with moldboard plow in 2006 (Table 1).

The trend in corn yield response under C-C-S rotation shows year variability, with no-till yield lower than that of other tillage systems in some years (Table 2). The soybean yields of C-C-S rotation were not significantly different between all tillage systems.

The first year continuous corn (C-C) yields in 2008 show no significant differences between all tillage systems. However, in 2009 (the second year in this rotation), significant difference in yields was observed between moldboard plow and other tillage systems. Corn yields under C-C show annual variability

from 2008 to 2011. In general, corn yields under C-C were significantly higher under moldboard plow compared with other tillage systems. However, reduction in corn yields under C-C compared to that under C-S rotation of the same year ranges between 11–20 bushels/acre.

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Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU Southeast Research Farm.[b]

	C-s							c-S						
	2003	2004	2005	2006	2007	2008	2010	2003	2004	2005	2006	2007	2009	2011
	bushels/acre													
No-till	212.8	180.0	171.3	189.1	159.3	206.7	146.4	38.7	55.1	71.8	56.8	59.4	69.5	52.7
Strip-tillage	205.9	190.7	168.3	182.1	161.1	212.8	151.6	39.5	55.9	69.8	55.1	58.9	66.8	50.8
Deep rip	209.7	200.2	171.0	185.7	170.8	219.4	141.8	42.2	57.7	70.2	56.0	59.6	66.7	52.0
Chisel plow	211.6	207.9	177.4	184.6	168.8	216.5	154.8	40.6	55.7	69.5	58.5	57.5	65.1	50.3
Moldboard plow	202.7	214.1	179.2	209.3	185.9	206.2	159.1	41.7	58.3	69.8	64.6	60.1	67.5	54.3
LSD(0.05)[a]	16.1	22.8	13.9	25.0	14.8	16.4	45.9	3.2	3.3	5.4	4.2	3.5	2.4	8.3
5-tillage avg.	208.5	198.6	173.4	190.2	169.2	212.3	150.7	40.5	56.5	70.2	58.2	59.1	67.1	52.0

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

	C-c-s			c-C-s			c-c-S			C-c			
	2005	2008	2011	2003	2006	2009	2004	2007	2010	2008	2009	2010	2011
	bushels/acre												
No-till	165.6	206.9	164.2	129.8	208.3	187.1	57.6	64.1	65.4	223.8	166.3	120.6	146.3
Strip-tillage	158.8	215.0	165.9	149.2	205.4	202.4	59.7	64	63.5	216.3	174.0	131.5	132.2
Deep rip	163.9	223.3	166.7	146.1	201.0	194.3	60.0	62.7	63.3	219.0	174.5	133.0	168.1
Chisel plow	163.3	220.6	194.0	157.7	196.4	201.1	59.8	60.2	62.6	219.5	188.0	114.7	189.7
Moldboard plow	164.3	206.5	197.3	149.4	218.4	215.7	58.8	63.2	64.1	210.0	212.3	151.3	194.4
LSD(0.05)[a]	8.6	17.4	30.0	25.6	10.6	18.9	2.6	2.6	6.4	16.6	17.2	30.6	26.5
5-tillage avg.	163.2	214.5	177.6	146.4	205.9	200.1	59.2	62.8	63.8	217.7	183.0	130.2	166.1

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.
[b]Yields were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.