

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

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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 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 beginning in 2002. Treatments include five tillage systems (no-till, strip-tillage, chisel plow, deep ripper, 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 included after 2007 corn crop year replaced 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. 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. Subsequent soil samples were collected in 2004 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 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 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 are conducted on selected sites depending on availability of funding.

Results and Discussion

Corn and soybean yields results are summarized in Tables 1 and 2. The results show yield variability between years and tillage systems within each year. From 2003 to 2008 corn yield of C-S rotation of all tillage systems show no statistical differences, except in a few years, when conventional tillage has some advantage (Table 1). However, soybean yields show no differences between all tillage systems except in 2006 (Table 1).

The trend in corn yield response under C-C-S rotation shows year variability, when no-till yield was lower than those of other tillage systems in some years (Table 2). The soybean yield with C-C-S rotation was not statistically different between all tillage systems. The first year continuous corn yield in 2008 shows no differences in yield between all tillage systems (Table 2).

Acknowledgements

We would like to thank Kevin Van Dee for his time and labor for plot setup, planting, and harvesting.

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

| | Corn (<u>C</u> -s) | | | | | | Soybean (c- <u>S</u>) | | | | |
|------------------------------------|------------------------|-------|-------|-------|-------|-------|------------------------|------|------|------|------|
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2003 | 2004 | 2005 | 2006 | 2007 |
| | -----bushels/acre----- | | | | | | | | | | |
| No-till | 212.8 | 180.0 | 171.3 | 189.1 | 159.3 | 206.7 | 38.7 | 55.1 | 71.8 | 56.8 | 59.4 |
| Strip-tillage | 205.9 | 190.7 | 168.3 | 182.1 | 161.1 | 212.8 | 39.5 | 55.9 | 69.8 | 55.1 | 58.9 |
| Deep rip | 209.7 | 200.2 | 171.0 | 185.7 | 170.8 | 219.4 | 42.2 | 57.7 | 70.2 | 56.0 | 59.6 |
| Chisel plow | 211.6 | 207.9 | 177.4 | 184.6 | 168.8 | 216.5 | 40.6 | 55.7 | 69.5 | 58.5 | 57.5 |
| Moldboard plow | 202.7 | 214.1 | 179.2 | 209.3 | 185.9 | 206.2 | 41.7 | 58.3 | 69.8 | 64.6 | 60.1 |
| LSD _(0.05) ^a | 16.1 | 22.8 | 13.9 | 25 | 14.8 | 16.4 | 3.2 | 3.3 | 5.4 | 4.2 | 3.5 |
| 5-tillage average | 208.5 | 198.6 | 173.4 | 190.2 | 169.2 | 212.3 | 40.5 | 56.5 | 70.2 | 58.2 | 59.1 |

^aLeast 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 Crawfordsville Research Farm. Yields are corrected to 15.5 and 13.0% for corn and soybean, respectively.

| | Corn (<u>C</u> -c-s) | | Corn (c- <u>C</u> -s) | | Soybean (c-c- <u>S</u>) | | C-c |
|------------------------------------|------------------------|-------|-----------------------|-------|--------------------------|------|-------|
| | 2005 | 2008 | 2003 | 2006 | 2004 | 2007 | 2008 |
| | -----bushels/acre----- | | | | | | |
| No-till | 165.6 | 206.9 | 129.8 | 208.3 | 57.6 | 64.1 | 223.8 |
| Strip-tillage | 158.8 | 215.0 | 149.2 | 205.4 | 59.7 | 64 | 216.3 |
| Deep rip | 163.9 | 223.3 | 146.1 | 201.0 | 60.0 | 62.7 | 219.0 |
| Chisel plow | 163.3 | 220.6 | 157.7 | 196.4 | 59.8 | 60.2 | 219.5 |
| Moldboard plow | 164.3 | 206.5 | 149.4 | 218.4 | 58.8 | 63.2 | 210.0 |
| LSD _(0.05) ^a | 8.6 | 17.4 | 25.6 | 10.6 | 2.6 | 2.6 | 16.6 |
| 5-tillage average | 163.2 | 214.5 | 146.4 | 205.9 | 59.2 | 62.8 | 217.7 |

^aLeast significant differences (LSD_(0.05)) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.