

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

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## Introduction

Tillage system and crop rotation have major long-term effects 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 in 2002 and continued through 2007. 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 across the five tillage systems and several soil associations. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. 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 20 rows by 65 ft. Yield was determined from the center four rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen will be monitored on a bi-yearly 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-till and strip-tillage show some yield decrease, especially in second-year corn when compared with other tillage systems. Although, in dry years no-till and strip-tillage corn yields were essentially the same or higher than those with other tillage systems.

Under the corn-corn-soybean rotation, the moldboard and chisel plow treatment corn yields were greater than the no-till treatment, but all other treatments were not different.

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

## Acknowledgements

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

|                                    | Corn (C-s)             |       |       | Soybean (c-S)     |      |       |
|------------------------------------|------------------------|-------|-------|-------------------|------|-------|
|                                    | 2002 <sup>b</sup>      | 2004  | 2006  | 2003 <sup>b</sup> | 2005 | 2007  |
|                                    | -----bushels/acre----- |       |       |                   |      |       |
| No-till                            | 92.2                   | 214.9 | 195.5 | 39.8              | 55.6 | 62.4  |
| Strip-tillage                      | 91.4                   | 218.9 | 202.4 | 38.3              | 55.6 | 61.9  |
| Deep rip                           | 91.0                   | 235.1 | 206.9 | 39.7              | 60.8 | 61.9  |
| Chisel plow                        | 88.3                   | 232.0 | 206.9 | 35.8              | 56.6 | 62.4  |
| Moldboard plow                     | 107.4                  | 226.3 | 213.1 | 33.8              | 56.7 | 63.5  |
| LSD <sub>(0.05)</sub> <sup>a</sup> | 20.8                   | 14.2  | 17.1  | 3.5               | 4.6  | 3.9   |
| 5-tillage average                  | 94.1                   | 225.4 | 205.0 | 37.5              | 57.1 | 62.42 |

<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 statistically different.

<sup>b</sup>Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.

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

|                                    | Corn (C-c-s)           |       | Corn (c-C-s) |       | Soybean (c-c-S)   |      |
|------------------------------------|------------------------|-------|--------------|-------|-------------------|------|
|                                    | 2003 <sup>b</sup>      | 2006  | 2004         | 2007  | 2002 <sup>b</sup> | 2005 |
|                                    | -----bushels/acre----- |       |              |       |                   |      |
| No-till                            | 151.8                  | 196.5 | 221.0        | 148.1 | 35.1              | 56.3 |
| Strip-tillage                      | 142.7                  | 208.2 | 224.3        | 155.9 | 36.4              | 56.8 |
| Deep rip                           | 146.3                  | 209.6 | 231.8        | 170.6 | 34.8              | 61.0 |
| Chisel plow                        | 136.8                  | 211.9 | 228.7        | 182.7 | 36.7              | 59.1 |
| Moldboard plow                     | 133.8                  | 213.1 | 238.2        | 177.7 | 35.0              | 55.4 |
| LSD <sub>(0.05)</sub> <sup>a</sup> | 17.5                   | 14.5  | 11.5         | 10.9  | 6.4               | 4.2  |
| 5-tillage average                  | 142.3                  | 207.9 | 228.8        | 167   | 35.6              | 57.7 |

<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 statistically different.

<sup>b</sup>Weather conditions in 2002 and 2003 were 12.25 and 10.51 in. of precipitation below normal.