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RESEARCH Guide

STRIP-TILLAGE RESEARCH RESULTS FROM FOUR LAND-GRANT UNIVERSITIES

ETS
ENVIRONMENTAL TILLAGE SYSTEMS

Strip Tillage RESEARCH RESULTS ARE IN

The trend toward more strip-till acres is steadily increasing as producers realize the benefits to the soil and environment, improved agronomic practices, yield results and an economic advantage.

BENEFITS TO THE SOIL AND ENVIRONMENT

Carbon Sequestration. Tillage increases soil microbial activity which typically increases organic material decomposition releasing carbon-based gas in the form of carbon dioxide (CO_2). Strip tillage reduces the volume of soil disturbed, therefore reducing the release of carbon. A comparison study of soil CO_2 emissions following three tillage operations in Minnesota (Faaborg et al. 2005) showed strip tillage retained more carbon in the soil than moldboard plowing and disk ripping. Disk ripping released 53.2% and strip tillage released 82.6% less CO_2 compared to moldboard plowing (Figure 1).

Crop Residue Management. Crop residue is a valuable resource for maintaining soil structure, retaining soil water, and it provides a food source for bacteria, fungi and insects. Heavy residue cover, in some climates, is often a challenge and can delay or impede planting and slow germination because of cooler soil temperatures. Strip-till equipment moves residue aside allowing improved seed placement, better seed to soil contact, and warmer soils in the seed zone while retaining most of the residue cover. Researchers at the University of Minnesota conducted trials in 2010-2012 to study the retention of crop residue under different tillage systems. Strip-till yields were similar to other tillage systems, but strip till (ST) retained the highest amount of residue following corn and soybeans compared to vertical till (VT), chisel plow/vertical till (CP/VT) rotation, and disk rip/chisel plow (DR/CP) rotation (Figures 2 and 3).

IMPROVED AGRONOMIC PRACTICES

Banding Fertilizer. Banding of phosphorus (P) and potassium (K) near the row may be more economical than broadcasting the fertilizers especially in low P and K testing soils. University of Minnesota corn fertilization recommendation tables indicate P and K fertilization rates can be as much as 50% lower when banding versus broadcasting these fertilizers (Kaiser et al., 2020) and produce similar yields (Rehm, 2020). Strip-tillage equipment and management systems provide an efficient way of placing nutrients in a band (near the developing root system) which may promote better nutrient availability in some soils compared to broadcasting by minimizing soil contact with the fertilizer.

Purdue University research has shown the combination of fall strip till and banded potash can improve corn yields even when soil test K levels are above critical levels (Figure 4). The research done in 2016-2019, across multiple sites, on corn following soybeans showed when banded potassium was applied in the spring, a 200 pound per acre rate added nearly 16 bushels per acre yield in Year 1 (SSW 200 vs SSW 0) and nearly 10 bushels per acre in Year 2. Fall applied banded potassium added nearly 10 bushels per acre in Year 1 (FSW 200 versus FSW 0) and 28 bushels per acre in Year 2. Soil-test K levels in the 0 treatments (no potassium banded) ranged from 107 to 154 pounds per acre in Year 1 and from 127 to 145 pounds per acre in Year 2.

Increased Soil Temperatures Allow for Earlier Planting
Iowa State University research from 2001 and 2002 on loam and clay loam soils show soil temperatures were 2.1°F to 2.4°F warmer in the top two inches of the strip-tilled area versus no-till soils which increased the plant emergence rate index (Science Direct, Soil and Tillage Research, January 2005). The same study, although not significant, showed the strip-till system had slightly more soil moisture in the profile than the chisel plow system.

University of Minnesota trials showed similar results in a continuous corn rotation (Table 1) and under a corn-soybean rotation (Table 2). Compared to no-till, the soil temperature advantage allows for faster plant emergence, similar to emergence rates found in conventional tillage systems.

SOIL TEMPERATURES AT PLANTING, °F		
Tillage	**2006**	**2007**
Chisel Plow	57.7	69.1
No Till	55.8	64.9
Strip Till	58.9	71.5

Table 2. Soil temperatures at planting using different tillage operations in soybean/corn rotation. Jeffers, MN.

AVERAGE SOYBEAN YIELDS BY TILLAGE SYSTEM				
Tillage system	**Fargo five site-years (bpa)**	**Carrington four site-years (bpa)**	**Prosper four site-years (bpa)**	**Moorhead four site-years (bpa)**
Chisel plow	28	28	52*	33
No-till	29	29	–	–
Strip-till	29	30	48	40**

*Chisel plow yields were statistically higher in one of the four years.
**Strip-till yields were statistically higher than chisel plow yields in three of the four years.

Table 3. Average soybean yields (bushels/acre) for three tillage systems and multiple sites and years.

CROP YIELDS

Strip Till in Crop Rotations. Purdue University studies show fall strip tillage alone can result in yields equal to fall chisel systems, especially for corn after corn rotations even without factoring in benefits from possible earlier planting or banding of fertilizers. Data from 2010-2018 for corn yield response to tillage shows strip-till systems yield similar to moldboard and chisel systems and significantly better than no till in rotation with soybeans or in continuous corn (Figure 5). Soybean yield data in same time era shows strip till similar to moldboard plow and no-till during 2010-2016 and similar to all tillage types in 2017 research (Figure 6).

Annual weather influences yield more than tillage systems. North Dakota State University conducted research (in small plots) on tillage system effect on soybean and corn yields from 2005-2012. For soybeans, 17 site years (Table 3), 76% of the time, soybean yields were not significantly affected by tillage system when rotated with corn (Figure 7).

During years when tillage affected soybean yields, strip till had significantly higher yields than chisel plow or no-till 18% of the time whereas chisel systems out-yielded strip tillage 6% of the time (Figure 7).

For corn yields (18 site years), data is similar in that 44% of the time, tillage system did not significantly impact yield (Figure 8).

When tillage did affect corn yields, strip till yielded higher than chisel plow and no till 44% of the time whereas chisel plow out-yielded strip till and no till 12% of the time (Figure 8).

Strip-till system exceeds expectations in Indiana. Historically, strip-till systems (in Purdue research) yield equal to fall chisel/spring cultivation systems, but in 2015, strip till out-yielded the chisel system by 18.5 bushels per acre when corn followed corn (Figure 9). In the cool, wet spring, strip-till plots could have been planted earlier than the other treatments due to their drier soil conditions, but all plots were planted on the same day. Strip-till yields may have been even higher if planted earlier.

ECONOMICS

University of Minnesota research shows growers can increase profitability with reduced tillage. The two-year study of corn and soybean rotation and residue effects (Figures 2 and 3 from page one) also show costs for a strip-till system at $29.20 per acre versus $48.70 for a fall disk rip and chisel plow rotation. Strip till saved $19.50 per acre compared to the disk rip/chisel plow rotation with no impact on yield.

EXECUTIVE SUMMARY

Strip tillage offers many benefits for the farm including reduced carbon emissions, an opportunity to band fertilizers, and improved residue management to help soils to warm faster in the spring in the intended row area all while retaining residue and maintaining or improving yields in corn after corn and corn after soybean rotations. Economically, strip tillage offers an opportunity to save money on tillage costs versus more intensive tillage systems and possibly use less fertilizer by incorporating it into the planting zone while maintaining or increasing yields.

24 HOUR CO_2 LOSS

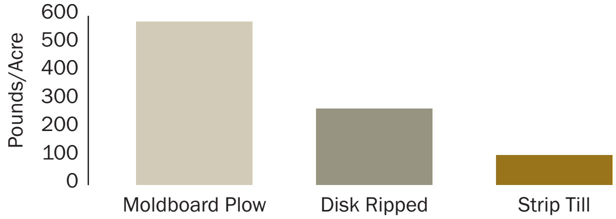

Figure 1. Carbon losses from tillage operations, Jeffers, MN. AE1370.

SOIL TEMPERATURES AT PLANTING, °F

Tillage	2006	2007
Moldboard Plow	65.3	55.7
Disk Ripped	62.3	54.7
Strip Till	65.4	54.2

Table 1. Soil temperatures using several different tillage operations in continuous corn. Jeffers, MN.

AVERAGE SOYBEAN YIELD AND SURFACE RESIDUE

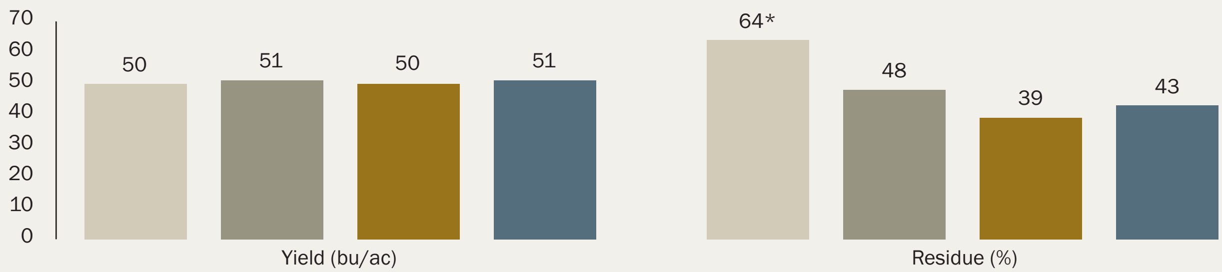

*Figure 2. Average soybean yield and surface residue cover following corn with four tillage systems near Clarkfield, MN 2010-2012. *No significant difference for yields. Residue was significantly different with an LSD (0.10) = 7.*

AVERAGE CORN YIELD AND SURFACE RESIDUE

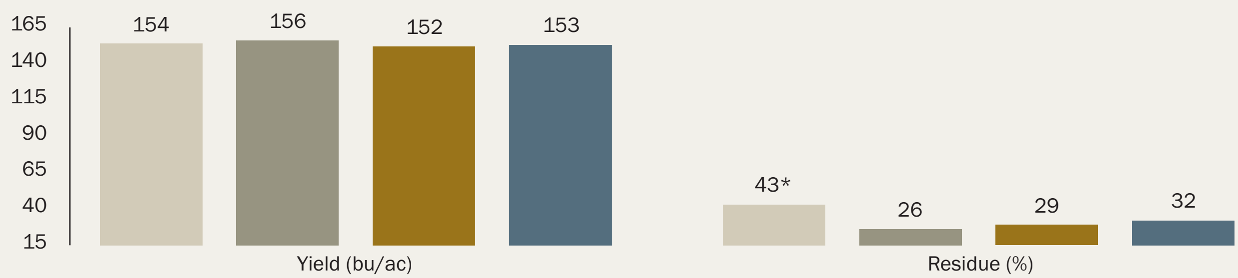

*Figure 3. Average corn yield and surface residue following soybeans with four tillage systems near Clarkfield, MN 2010-2012. *No significant difference for yield. Residue was significantly different with an LSD (0.10) = 4.*

STRIP-TILL CORN YIELD RESPONSE TO K BANDING (2016-2019; FIRST-YEAR CORN AFTER SOYBEAN)

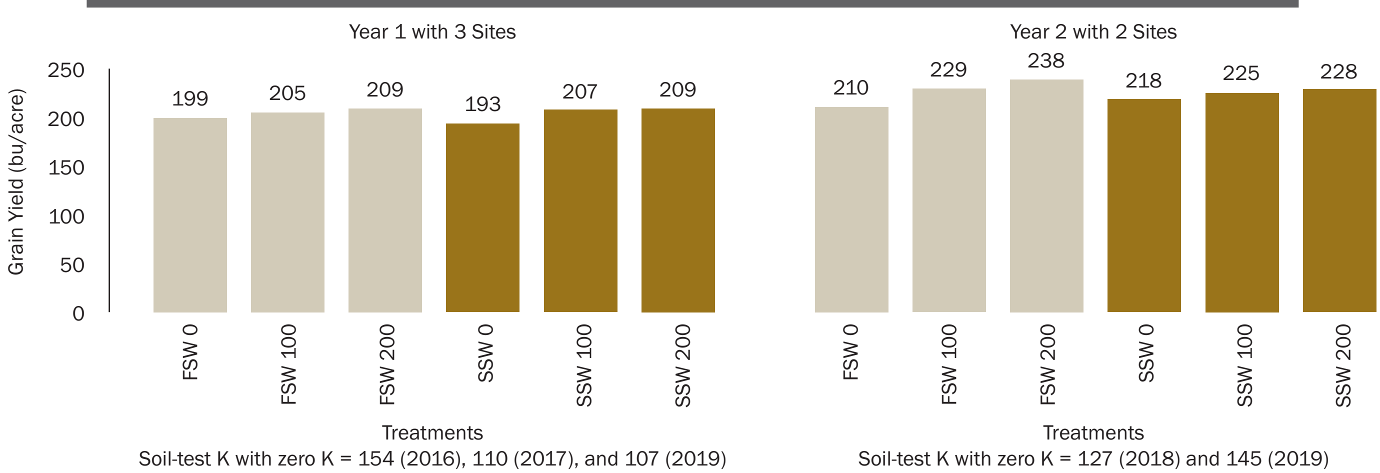

Figure 4. Multi-year corn yield results to Spring and Fall K banding with SoilWarrior equipment at different rates (Source: T.J. Vyn).

CORN YIELD RESPONSES TO TILLAGE (2010-2018)

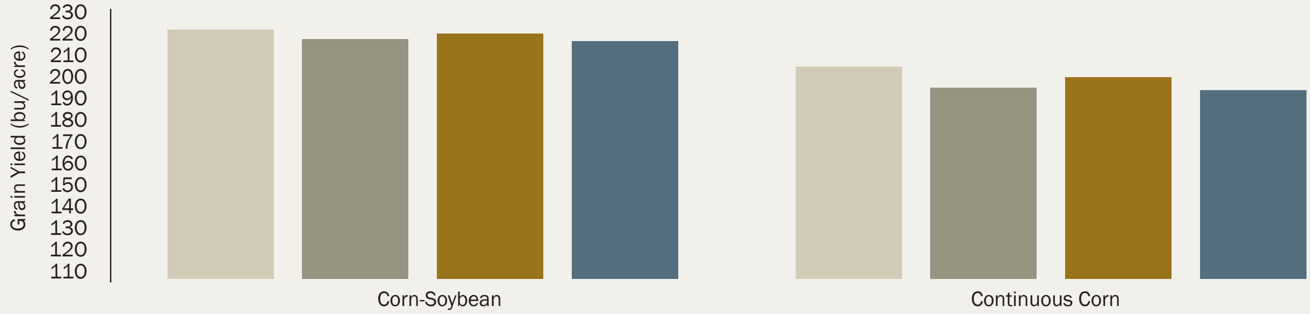

Figure 5. Long term corn yield response to tillage in Indiana. (Source: T.J. Vyn and T.D. West).

SOYBEAN YIELD RESPONSE TO TILLAGE SYSTEMS FOLLOWING CORN

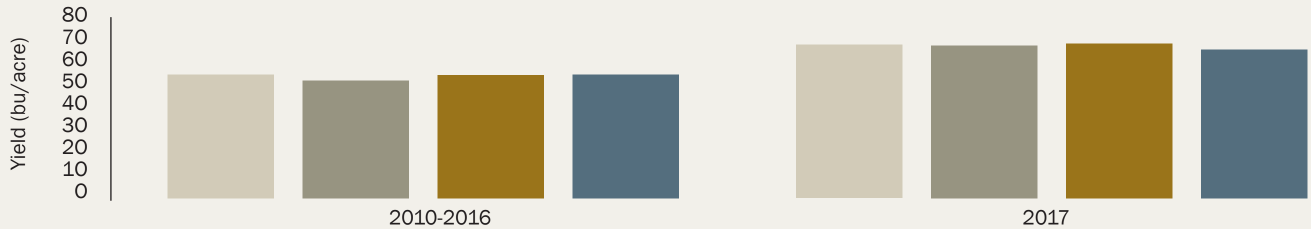

Figure 6. Long term soybean yield response to tillage in Indiana. (Source: T.J. Vyn and T.D. West).

SOYBEAN YIELD RESPONSE TO TILLAGE

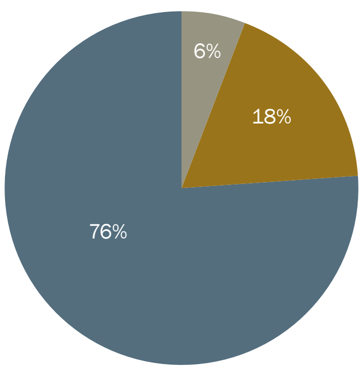

Figure 7. Soybean yield response to tillage for 17 site years across three locations in ND and one location in MN when soybeans follow corn (2005-2012).

CORN YIELD RESPONSE TO TILLAGE

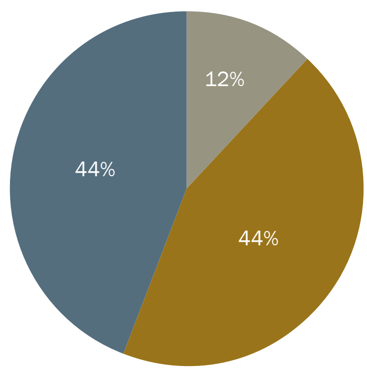

Figure 8. Corn yield response to tillage for 18 site years across three locations in ND and one location in MN from 2005-2012.

AVERAGE TILLAGE SYSTEM YIELD RESULTS IN 2015

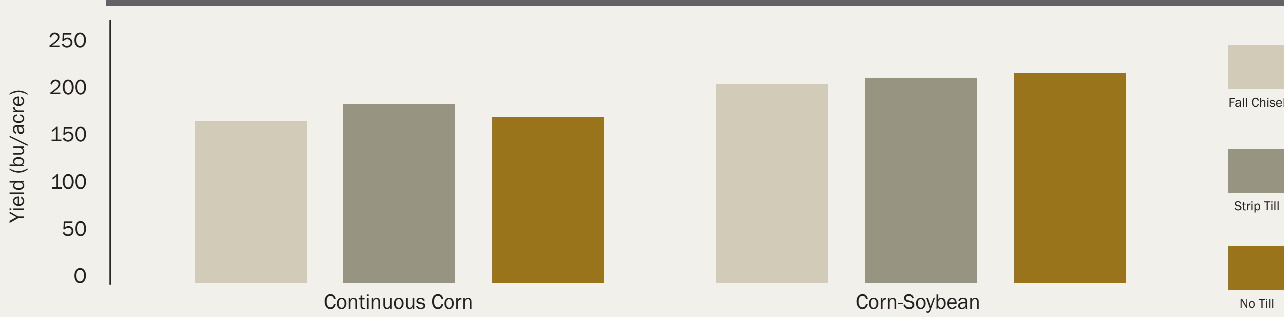

Figure 9. Preliminary 2015 corn yield results from long term tillage experiment at West Lafayette, IN.

REFERENCES

Faaborg, R., C. Wente, J.M. De Jong-Hughes and D.C. Reicosky. 2005. A comparison of soil CO_2 emissions following moldboard plowing, disk ripping and strip tilling. USDA-ARS research update.

Kaiser, D. E., F. Fernandez, M. Wilson, J.A. Coulter, and B. Barber. Fertilizing Corn in Minnesota. University of Minnesota, Bulletin AG-FO-3790D (Revised 2020).

Licht, Mark A. and M. Al-Kaisi. Strip-tillage effect on seedbed soil temperature and other soil physical properties. Science Direct, Soil and Tillage Research, Volume 80, Issues 1-2, January 2005, pgs 233-249.

Nowatzki, John; G. Endres, and J.M. DeJong-Hughes. NDSU Extension Service, NDSU Extension Pest and Crops Newsletter, 2015, Issue 26.

Rehm, G. Use of Banded Fertilizer for Corn Production. University of Minnesota. 2020.

Schwarck, L., and T.J. Vyn. Potassium fertilizer rate and timing in strip-till systems: Recent Indiana research with an alternative K source. North Central Soil Fertility Conference Proceedings. 2020. https://northcentralfertility.com/proceedings/?action=abstract&id=7738&search=years.

University of Minnesota, Economics of Tillage. 2020.

Vyn, T. presentation to CCAs, April 2020.

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