COMPARING CONVENTIONAL-TILL VERSUS NO-TILL IN NE NORTH DAKOTA

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Figure 1. The Langdon Research Extension Center conventional-till versus no-till demonstration site on July 19, 2023.

Conventional tillage practices and resulting topsoil disturbance and losses are well-documented. Early adopters of no-till in western North Dakota stopped performing tillage for planting several decades ago. Their main reasons were to conserve soil moisture, protect topsoil and build soil structure. However, in the northeast, producers mostly kept tilling their soils in fall and again in spring. The common reason was, and still is, to dry the top four to six-inches of soil for planting early as northeast ND has a slightly shorter growing-season compared to other parts of the state. As per the North Dakota Agricultural Weather Network (NDAWN), the Langdon area has the lowest accumulated growing degree days for growing canola, wheat, sunflower and soybean compared to the Carrington, Dickinson, Fargo, Hettinger, Minot and Williston stations.

The recent wet weather cycle, beginning in 1993, made switching to no-till difficult as producers became leary about wet field conditions in the spring resulting in late planting. A shorter growing season resulting in late planting can not only cause significant yield losses but there could be difficulties during harvest due to a wet fall or early frost. Depending upon the soil type, landscape and agronomic practices, it can take several years for the no-till practices to improve soil structure and water infiltration to help overcome challenges posed by a wet spring or fall. Several producers in the NE in the past have tried no-till. Due to the wet weather, they faced numerous challenges such as muddy and saturated fields, cooler soil temperatures, poor seedbed, late planting, soil crusting, poor germination and stands during spring and muddy and sometimes snowy fields during fall harvest. Most of them gave up no-till after one or two years and went back to conventional-till.

Objectives

Short-term objectives of this study are to determine how early each field can be planted, differences in input costs, germination, stands and yields. Long-term objectives include effects on soil health such as soil erosion, aggregation, structure, pore space and water infiltration (movement through soil layers).

Site Details

An approximately 35-acre field was divided to create a conventional-till and no-till site into rectangular shapes from north to south. The no-till field totals approximately 13.7 acres, whereas, the conventional-till side measures around 20.7 acres with a 15-foot border between the two fields. Both sites include productive, marginal and unproductive areas in order to be truly representative of the farmer fields.

Field Work Details

Conventional-till

Fall-2021

- After harvesting soybeans, site was chiseled once on October 6.

Spring and Summer of 2022

- A uniform rate of 125 pounds of N per acre of Urea was spread on May 29 followed by one-pass of the cultivator for incorporation.
- Fargo and Treflan (PPI) were sprayed on June 6 followed by two-passes of a cultivator.
- On June 7, Prosper (HRSW) was planted at the seeding rate of 1.66 bushels per acre using a Concord 40-foot wide air seeder.

Fall-2022

- Site was swathed on September 19 and combined on September 28.
- Site was disked once on October 5.

Spring and Summer of 2023

- Site was cultivated and harrowed once followed by planting ND21008GT20 (soybean) at the seeding rate of 60 pounds/acre (2916 seeds/pound and 174960 seeds/acre) on May 26, 2023.
- On June 16, Roundup PowerMax 3 at 30 ounces/acre + Kicker at 2.5 gallons/100 gallons of water was sprayed at the rate of 10 gallons/acre.
- On July 10, Roundup PowerMax 3 at 30 ounces/acre + Kicker at 2.5 gallons/100 gallons of water was sprayed at the rate of 10 gallons/acre.

Fall-2023

- Site was straight combined on October 12.
- Site was chiseled twice on October 18 and 19.

No-till

Spring and Summer of 2022

- No-till site was planted with Prosper (HRSW) on June 13 using a John Deere 1895 disk no-till drill. Seeding rate was 1.66 bushels per acre. Due to an issue of the no-till drill not able to flow high fertilizer rates, only 62.5 pounds per acre of N (135.86 pounds of Urea per acre) was applied at the time of planting. The rest of the 62.5 pounds of N per acre was top dressed later in order to make the no-till fertilizer rate comparable to the conventional-till site.
- No-till site was sprayed with Roundup PowerMax 3 at 20 ounces/acre with Kicker (active ingredient ammonium sulfate) at 2.5 gallons per 100 gallons of water (0.27 gallons of Kicker per acre).

Fall-2022

- Site was swathed on September 19 and combined on September 28.

Spring and Summer of 2023

- No-till side was planted on May 30, 2023 with ND21008GT20 (soybeans) at the seeding rate of 60 pounds/acre (2916 seeds/pound and 174960 seeds/acre).

Note: Both conventional-till and no-till fields appeared ready for planting on the same day. However, conventional-till field was planted on May 26, 2023, whereas, no-till was planted on May 30, 2023. The delay in planting was due to equipment issues.

- On May 31, Roundup PowerMax 3 at 20 ounces/acre mixed with 0.5 gallons of Flame per 100 gallons of water was applied at the rate of 10 gallons/acre.
- On June 13, Roundup PowerMax 3 at 29 ounces/acre mixed with 16 ounces of Varisto + 24 ounces of Invade CNL + 24 ounces of Kicker/acre mixed in 100 gallons of water was applied at the rate of 10 gallons/acre.
- On June 30, Flexstar at 13 ounces + MSO at 35 ounces + Avatar at 6.6 ounces and Kicker at 70 ounces per acre was applied at 20 gallon/acre.

Fall-2023

- About 70% (9.6 acres out of 13.7) of the no-till site was straight combined on October 13. The remaining 30% (4.1 acres) could not be harvested due to very high weed pressure (mainly Kochia, Green Foxtail and volunteer spring wheat).
- Remaining 30% of the no-till site was cleaned up using a combine in order to evenly spread the residue for spring-2024.
- On October 22, Roundup PowerMax 3 at 30 ounces/acre with 2,4-D at 19 ounces/acre and Kicker at 64 ounces per acre was sprayed at 10 gallons/acre.

Soil Sampling and Analysis

In fall 2021-2023, the following type of soil sampling and analysis was performed.

- Separate composite four-foot deep soil samples for 0-12”, 12-24”, 24-36” and 36-48” depths were taken from conventional-till productive ground (CT-PG), conventional-till unproductive ground (CT-UG), no-till productive ground (NT-PG) and no-till unproductive ground (NT-UG). Fall-2021 soil samples were analyzed for textural and chemical analysis, whereas, fall-2022 and 2023 samples were analyzed for chemical analysis only.
- Separate soil bulk density samples were taken from CT-PG, CT-UG, NT-PG and NT-UG for 0-5” and 5-10” depths.

Soil Chemical Analysis Results

In 2021, conventional-till productive ground had low levels of salinity and no issue of sodicity in the 0-12 inch depth. The levels of salinity were high with moderately high sodicity in the same depth of conventional-till unproductive ground. In the no-till productive ground area, salinity level was moderately high with very low sodicity in the 0-12 inch depth. In the no-till unproductive area, salinity and sodicity levels were very high in the 0-12 inch soil depth. Soil nitrogen (N) and phosphorous (P) levels in the unproductive areas of conventional-till and no-till were very high and high compared to the productive areas of both sites. These results are quite representative of the saline and sodic areas versus areas that do not have these issues as there are hardly any plants growing on saline and sodic areas to take up nutrients from the soils. The fall-2022 soil results showed no salinity and sodicity issues in the 0-12 inch depth of conventional-till productive ground, whereas, conventional-till unproductive ground had an increase in salinity and sodicity in 0-12 inch depth versus fall-2021 results. No-till productive ground, fall-2022 salinity and sodicity results of 0-12 inch depth remained comparable versus fall-2021. The no-till unproductive ground sodicity levels of 0-12 inch depth in 2022 were the same compared to 2021 results, however, salinity levels in fall-2022 showed an increase versus fall-2021. There was an increase in soil nitrogen (N) in the 0-12 inch depth of conventional-till productive ground. No-till productive ground had a decrease in soil nitrogen in the 0-12 depth. Soil P levels had a slight increase in conventional-till productive ground, no-till productive and unproductive ground in 0-12 inch depth. Soil organic matter and pH levels remained mostly the same in both years. The fall-2023 soil chemical analysis results were not available at the time of writing this report.

Soil Bulk Density Analysis Results

Soil bulk density levels remained roughly the same in the fall-2021-2023. The minor differences were not due to tillage practices but differences in the soil moisture levels at the time of sampling.

Measurement of Soil Water Infiltration

Soil water infiltration rates were measured by pounding a six-inch diameter ring into the surface soil. After the ring was in place, 444 ml of deionized water was used to simulate one inch of rain. Once there was no standing water, while soil was

still saturated, a second inch of rain was simulated by pouring 444 ml of additional deionized water. Both simulations were timed for water absorption into the soil. There have been a few key observations regarding soil water infiltration rates:

- Soil water infiltration rates of conventional-till productive and unproductive grounds (despite moderately high sodicity in the 0-12 inch depth) were much faster than the no-till productive and unproductive grounds.
- On the no-till site, water infiltration was much faster on productive ground versus unproductive ground. That was mainly an effect of higher sodicity level that causes soil dispersion resulting in dense soil layers.
- The no-till unproductive ground infiltration rates were much slower in fall-2023 compared to the fall-2021 and fall-2022 rates.

Growing-Season Observations

2022

The conventional-till side was planted six days earlier than the no-till side, but the no-till side had better germination and plant stands. This could be due to saturated soil a few inches below the soil surface on the conventional-till side and had slightly poorer germination in the tire tracks. Stands were thin and were still green at the time of swathing. Despite the late planting, the no-till side had improved germination due to no soil disturbance and uniform stands. That could also be due to the differences in seeding equipment; a Concord 40-foot wide air seeder was used on the conventional-till side, whereas, a John Deere 30-foot wide no-till drill was used on the no-till side. In addition, the no-till side was harvested at the same time and yielded three bushels per acre more than the conventional-till.

2023

No-till productive and unproductive sides had severe weed issues from the beginning of the growing-season, mainly with herbicide resistant kochia, volunteer wheat, green foxtail barley and horseweed, which continued until fall. In addition, the no-till side will have a much larger seed bank to cause weed issues in the 2024 growing-season compared to conventional-till. This was a result of southerly winds in fall-2022 that rolled over a lot of kochia plants to the no-till and conventional-till fields to an extent where some plants were stuck on the shelterbelt trees on the north side. The conventional till side was cultivated and harrowed in the spring eliminating most of the weeds while the no-till field was not and had a lot of kochia and foxtail. A PPI herbicide may have improved weed control. Pre-emergence herbicide application could have produced better results; however, it needs to be incorporated in the soil or timed with a good rain. Incorporation on no-till was not an option. Several pre-herbicides can be used on no-till soybeans but need rain for incorporation. Spring of 2023 was very dry and this would have probably resulted in ineffective weed control. The end result was severe kochia contamination in the no-till field despite three sprays versus two sprays on conventional-till side where weed pressure was much lower.

Yield Differences in 2022 and 2023

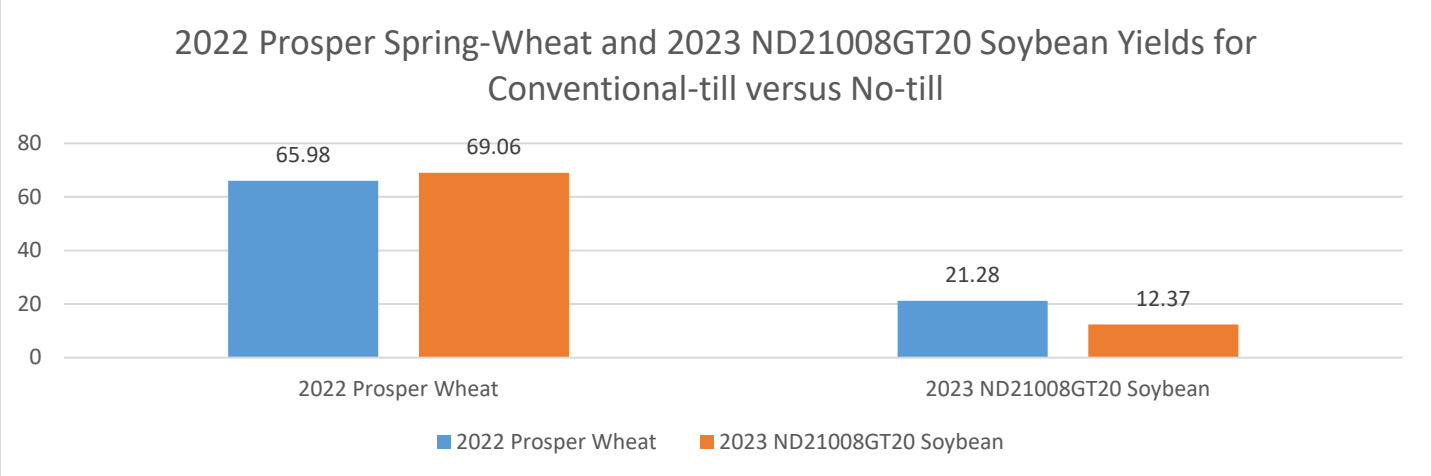

Figure 2. The Langdon Research Extension Center conventional-till versus no-till demonstration 2022 and 2023 yield comparisons.

Prosper spring wheat yields in 2022 were roughly the same for conventional-till and no-till sides with no-till yielding three bushels more per acre. In 2023, conventional-till soybean yield was much higher than no-till, mainly due to severe weed contamination and the fact that 30% of the no-till field could not even be harvested (Figure 2).

Differences in Costs and Profitability

Fall-2021 to 2022

Conventional-till area yielded 1364 bushels (without moisture adjustment) or 66 bushels per acre. No-till area yielded 949 bushels (without moisture adjustment) or 69.1 bushels per acre. Costs and profit details are in Table 1.

Table 1. Fall-2021 to 2022 differences in costs and profitability between conventional-till and no-till sites.

Site	Year	Prosper Spring-wheat Yield per Acre (bushels)	Revenue per Acre ($)	Cost per Acre ($)	Profit per Acre ($)
Conventional-till	Fall 2021-2022	65.98	$461.86 (at $7.00 per bushel)	$316.21	**+ $145.65**
No-till		69.06	$483.42 (at $7.00 per bushel)	$246.21	**+ $237.21**

2023

Conventional-till area yielded 440 bushels or 21.3 bushels per acre, whereas, no-till area yielded 170 bushels or 12.4 bushels per acre. Due to very high weed pressure, 30% of the no-till site was not harvested. The entire no-till area was considered in the yield calculations (170 bushels/13.7 acres = 12.4 bushels/acre). Both conventional-till and no-till soybeans were taken to the local elevator. The Langdon CHS price for these soybeans per bushel was $12.74 cash (after deducting basis) on November 13, 2023 at 8:39 a.m. Due to very high weed pressure, conventional-till soybean had a dockage of 0.5%, whereas no-till had a 1.0% dockage. These dockages were considered in the Table 2 below.

Table 2. 2023 differences in costs and profitability between conventional-till and no-till sites.

Site	Year	ND21008GT20 Soybeans Yield per Acre (bushels)	Revenue per Acre ($)	Cost per Acre ($)	Profit per Acre ($)
Conventional-till	2023	21.28	$269.83 (at $12.74 per bushel)	$174.32	**+ $95.51**
No-till		12.37	$156.05 (at $12.74 per bushel)	$216.93	**- $60.88**

Summary Based on Two-Years

Differences in Planting Dates: In year-one of transitioning to no-till (2022), conventional-till sites looked ready for planting four to five days earlier than no-till. However, in year-two (2023), both conventional-till and no-till sites seemed ready for planting on the same day. The only reason no-till site was planted four days later in 2023 was due to equipment issues.

Differences in Costs and Profitability: In year-one (2022), the no-till site was slightly more profitable than conventional-till. However, in year-two (2023), no-till site resulted in loss of revenue due to much higher cost of herbicides, lower yield due to weed contamination and higher dockage by the elevator, whereas, conventional-till was profitable. So, it is very crucial to have a very proactive weed control program when transitioning from conventional-till to no-till, otherwise, weed issues can jeopardize the entire no-till program.