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2015 Reduced Tillage Corn Trial

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Figure 1. Strip tillage.

Minimum tillage practices have significant potential to reduce expenses and the potential negative environmental effects caused by intensive tillage operations. Conventional tillage practices require heavy machinery to work and groom the soil surface in preparation for the planter. The immediate advantage of reduced tillage for the farm operator is less fuel expense, equipment, time, and labor required. It's also clear that intensive tillage potentially increases nutrient and soil losses to our surface waterways. By turning the soil and burying surface residue, more soil particles are likely to detach from the soil surface and increase the potential for run off from agricultural fields. Reducing the amount and intensity of tillage can help build soil structure and reduce soil erosion.

Many growers are interested in a variety of minimum tillage strategies including 'strip-till,' 'no-till,' and 'vertical-till.' Strip tillage cultivates a 4-6" strip of soil along both sides of the planted row (Figure 1). Strip tillage allows the soil in close proximity to the seed to dry out and warm up faster than it would without tillage. It also deeply tills the soil (8-10 inches) where the crop is planted. No-till (Figure 2) implements do not till the soil, but rather use metal coulters to cut the soil and plant seed into the slot created by the coulters (disk openers). An attachment on the back of the planter closes the slot and maximizes seed to soil contact to facilitate germination. This can be done in a variety of ways. Some systems use a heavy press wheel, while others use spiked wheels or even rubber wheels to perform this critical action. The type of wheel selected will depend on soil types and conditions so may vary from farm to farm. Vertical tillage (Figure 3) is a tillage system, which lightly tills the top 2-3 inches of the soil, preparing a smooth seedbed without introducing tillage pans into the soil profile. Vertical tillage equipment is developed to run shallow and fast over the field sizing and anchoring residue while

Figure 2. No-Till Corn Planting.

Figure 3. Vertical tillage.

preparing a uniform seedbed for planting. Over time, it has been found that reduced tillage systems can improve soil health, nutrient cycling, soil drainage, and crop yields. In 2015, the University of Vermont Extension's Northwest Crops and Soils Program conducted a corn trial at Borderview Research Farm in Alburgh, VT. The objective was to evaluate the impact of no-till, vertical-till, and strip-till on corn silage yield and quality.

MATERIALS AND METHODS

In 2015, a study evaluating three reduced tillage methods was conducted at Borderview Research Farm in Alburgh, VT (Table 1). The soil was a rocky Benson silt loam. The experimental design was a randomized complete block with four replicates. Treatments were no-till, vertical-till, and strip-till. Just prior to planting, vertical-till plots were prepared with a 2623VT John Deere tool, and the strip-till plots were prepared with a Blu-Jet Coulter Pro. Plot size was 10' x 40' for the no-till and vertical-till plots and 15' x 40' foot for the strip-till plots. All plots were planted to the variety Mycogen TMF2Q419 (96 RM) at a seeding rate of 34,000 seeds per acre. The trial was planted on 21-May with a John Deere 1750 conservation corn planter. A 10-20-20 starter fertilizer was applied at 250 lbs per acre to the all plots. A post-plant herbicide, Lumax®, was applied at a rate of 3 quarts per acre to all plots.

Table 1. Agronomic information for the 2015 Reduced Tillage Corn Trial at Borderview Research Farm.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Corn Variety	Mycogen TMF2Q419 (96 RM)
Plot size	10' x 40' for No Till and Vertical Tillage Plots 15' x 40' for Strip Till Plots
Replicates	4
Seeding rate	34,000 seeds ac^{-1}
Row width	30"
Planting date	21-May
Starter fertilizer	250 lbs ac^{-1} 10-20-20
Herbicide	3 quarts of Lumax® ac^{-1},
Additional fertilizer	110 lbs available N ac^{-1} of Urea (46-0-0), 19-Jun
Harvest date	30-Sep

Urea (46-0-0) was applied as a topdress at a rate of 110 lbs available N per acre on 19-Jun. A John Deere two-row chopper was used to harvest corn, and whole-plant silage was collected in a forage wagon and weights calculated from wagon mounted scales. A subsample of chopped silage was taken to determine moisture and quality of the forage.

Silage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 Plot samples were analyzed for crude protein (CP), starch, acid detergent fiber (ADF), neutral detergent fiber (NDF), and digestible neutral detergent fiber (NDFD). Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. In recent years, the need to determine rates of digestion in the rumen of the cow has led to the development of NDFD. This in-vitro digestibility calculation is very important when looking at how fast feed is being digested and passed through the cow's rumen. Higher rates of digestion lead to higher dry matter intakes and higher milk production levels. Similar types of feeds can have varying NDFD values based on growing conditions and a variety of other factors. In this research, the NDFD calculations are based on 30 hour in-vitro testing.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%. Starch levels vary from field to field, depending on growing conditions and variety.

Non-fiber carbohydrate (NFC) and nonstructural carbohydrate (NSC) are also totaled and reported. NFC is comprised of starch, simple sugars, and soluble fiber, and is digested more quickly and efficiently than fiber. NFC provides energy for rumen microbes, once it is fermented by volatile fatty acids. NFC and NSC are sometimes referred to almost interchangeably, but pectin levels are included in NFC and omitted from NSC. In addition, NFC is calculated by difference [100 – (% NDF + % crude protein + % fat + % ash)], whereas NSC is determined through enzymatic methods. NSC should be in the 30-40% range, on a dry matter basis. NFC is generally between 35-40% in a high milk production ration, though levels as high as 42% are acceptable, due to the variability of particle size, frequency of feeding, dry matter intake, and other factors.

Milk per acre and milk per ton of harvested feed are two measurements used to combine yield with quality and arrive at a benchmark number indicating how much revenue in milk can be produced from an acre or a ton of corn silage. This calculation relies heavily on the NE_L calculation and can be used to make generalizations about data, but other considerations should be analyzed when including milk per ton or milk per acre in the decision making process.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and hybrids were treated as fixed. Hybrid mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example to the right, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	**2.0**

RESULTS

Seasonal temperature and precipitation recorded at Borderview Research Farm in Alburgh, VT are reported in Table 2. Temperatures through most of the growing season were near historical averages, with warmer than normal temperatures at the beginning and end of the growing season (May and September). Rainfall through the growing season was much less than normal – a total of 11.42 inches below normal through the growing season. There was a total of 2522 Growing Degree Days (GDDs) for May through September—310 GDDs more than the historical average.

Table 2. 2015 weather data for Alburgh, VT

Alburgh, VT	April	May	June	July	August	September
Average temperature (°F)	43.4	61.9	63.1	70.0	69.7	65.2
Departure from normal	-1.4	5.5	-2.7	-0.6	0.9	4.6
Precipitation (inches)	0.09	1.94	6.42	1.45	0.00	0.34
Departure from normal	-2.73	-1.51	2.73	-2.70	-3.91	-3.30
Growing Degree Days (base 50°F)	22	376	399	630	626	470
Departure from normal	22	177	-75	-10	45	152

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Analysis of the data indicates that the minimum tillage strategies had a significant impact on corn silage yield (Table 3). The highest yields were found on the vertical tillage plots (35.3 tons ac^{-1}) and those yields were not statistically different than the no-till plots (34.5 tons ac^{-1}) or the strip-till plots (32.1 tons ac^{-1}).

Table 3. Impact of minimum tillage on corn silage population and yield, 2015.

Tillage method	Population	DM	Yield at 35% DM
	plants/acre	%	tons/acre
Vertical-till	30873	44.1	**35.3**
No-till	33904	**46.9**	34.5
Strip-till	36917	44.4	32.1
Trial mean	33898	45.1	34.0
LSD (0.10)	NS	NS	NS

Treatments indicated in **bold** had the top observed performance.
NS – No significant difference was observed between treatments.

Standard components of corn silage quality were not affected by minimum tillage methods in this trial (Table 4). There was no significant difference in CP, ADF, NDF, NDFD, TDN, NE_L, NSC, milk per ton, or milk per acre. Trial averages for the components analyzed were comparable to the same variety of corn grown using conventional tillage practices.

Table 4. Impact of minimum tillage on corn silage quality, 2015.

Tillage	CP	Starch	ADF	NDF	NFC	TDN	NEL	Milk per	
Method	%	%	%	%	%	%	Mcal/lb	ton	acre
Vert-till	6.8	42.6	22.6	44.1	**46.1**	**66.0**	**0.67**	**2998**	**36938**
No till	6.8	41.9	22.4	**44.8**	46.0	64.9	0.66	2913	35181
Strip till	**6.8**	**44.3**	**22.0**	43.9	47.3	66.0	0.67	2995	33777
Trial Mean	6.8	42.9	22.3	44.3	46.4	65.6	0.66	2969	35298
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatments indicated in **bold** had the top observed performance.
NS – No significant difference was observed between treatments.

DISCUSSION

It is important to note that the results of this trial represent only one year of data and only in one location. Based on the analysis of the data, some conclusions can be made about the results of this year's trials. The average yield for the reduced tillage trial was 34.1 tons ac^{-1}, which is very good when compared to the average yield of the same variety of corn planted by means of conventional tillage (24.4 tons ac^{-1}). This trial has been in reduced tillage for five years. It is likely now that the soil has improved to a point where higher yields are supported. The healthier soil that is often developed under reduced tillage systems can help improve soil drainage, nutrient cycling, and overall plant growth and development. Given the substantial rain received in June a soil with better drainage and structure would have provided the corn plants with an advantage over those growing in a less ideal situation.

Minimum tillage methods did not significantly impact corn silage quality indicating that no-till, strip-till, and vertical tillage have comparable effects on quality. The corn silage harvested in this trial was similar in quality and quantity to corn planted conventionally. This was the fifth year of reduced tillage practices in this research plot and yields overall have improved each year (Figure 4).

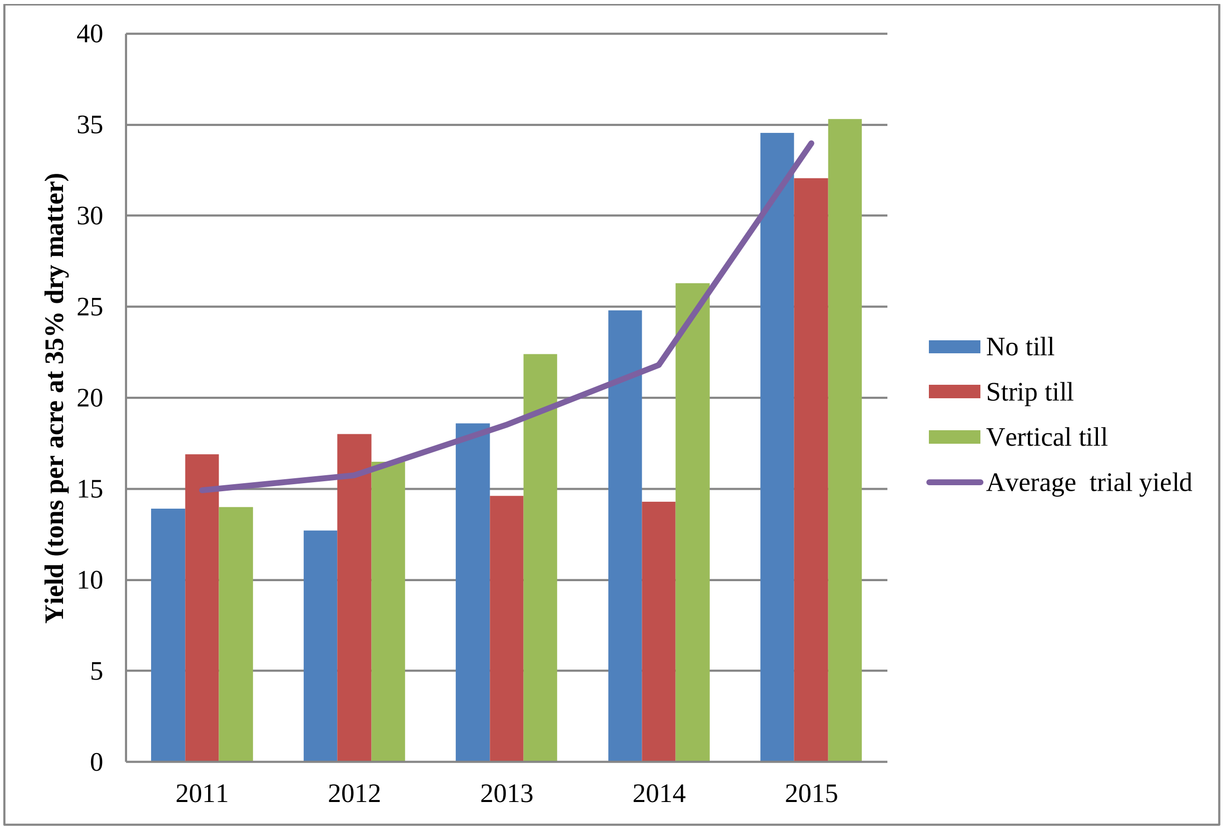

Figure 4. Effects of tillage method on yield at 35% dry matter over five years of trials

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