# FNE09-654 Zone Tillage Project

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## Zone-Tillage Report

## Executive Summary:

The goal of this project is to identify whether zone-tillage, the practice of planting corn in narrow strips of deep-tilled soil while leaving the area between the rows undisturbed, is economically viable in Vermont and to identify the factors that enhance or limit its applicability including its effect on soil compaction.

The first year trial of zone-tillage showed a corn decrease in yield. The resulting loss of income was offset by reduced cost of fuel and in timesavings. Soil Compaction was reduced which has the potential of increasing water infiltration and future yields while reducing soil erosion. The problems identified are those of seed trench closure and pass-to-pass accuracy in guidance. The wet year and late planting also reduced yields. Water management during this wet year had mixed benefits and liabilities that need to be addressed before full-scale adoption of this practice.

## 1. Goals:

### Definition of Zone-tillage

Zone-tillage consists of shattering the soil by lifting it with a steel shank and then cultivating the surface in a band only a ten-inch wide area every thirty inches on center for planting corn. The soil between these bands remains undisturbed and covered with the organic residue of the previous crop. The environmental benefit is slower water runoff and reduced erosion resulting in better water quality. The agricultural benefits are that rainwater has time to percolate into the soil and is later available to the crop.

**Feasibility of Zone-tillage:**

The goal is to compare a new technology, zone-tillage that has been successfully adopted in other regions of the country with traditional methods of raising corn in Vermont. While this technology has the potential of improving water quality and reducing the cost of production for Vermont farmers, its suitability to the Champlain Valley's cold and dense clays has not been determined. If viable in Vermont, zone-tillage would improve the economic and environmental sustainability of farms. Input cost of fuel and time were measured and compared to resulting grain yields between this practice and conventional methods of corn production to determine the feasibility of zone-tillage. Challenges to adoption were also identified.

**Affect on Compaction:**

Addison County's heavy clay soils are prone to compaction. Compaction of the soil reduces water infiltration and water runs off, increasing the risk of soil erosion. The consequence is reduced yields because the soils warm up more slowly in the spring, are harder to plant, and water is not retained for use by the plants during the hot and dry summer months. Improved water infiltration and retention should improve water quality by slowing and decreasing runoff and reducing erosion. The effect of reducing erosion is that plant nutrients remain available to the crop rather than resulting in water quality degradation. We tested for compaction across the plots in the spring to determine if zone-till has changed the amount of compaction for the following crop.

## 2. Farm Profile

No-Mon-Ne Farm Assoc. is a partnership between Mark A. Boivin and Paul A. Boivin. The farm has expanded from the initial 290 acres to 470 acres. In 2004 we noticed that corn was selling for only 65% of the price of fuel oil per million BTU's of heat and began burning our own corn for heating the residence. After 50 years of dairy the cows were sold in 2008 and the farm transitioned to growing corn and soybeans. Vermont Golden Harvest Bio-fuels was created as a marketing arm to sell our corn and soybeans for fuel. In addition to growing the corn we clean, dry, and package it for burning as a substitute for fuel oil.

The soils are heavy Champlain Valley clays. These soils are not suited to no-till corn where fluted coulters loosen the soil before the corn planter. The no-till corn we tried between 1968 an 1971 failed because the coulters only scored the soil surface and left a hardpan layer just below the seed. When it rained the water scoured the soil out of the seed trench and when it turned dry the soil would shrink and crack in the seed trench. Either way the roots were exposed and the plant was severely injured. The difference between the old no-till that failed and zone-till tried here is the addition of a steel shank that goes deep into the soil, lifting and shattering it from below without disturbing the surface.

## 3. Participants:

Mark A. Boivin and Paul A. Boivin, owners of No-Mon-Ne Farm Assoc and Vermont Golden Harvest Bio-fuels.net and implementers of this grant. 6286 Goodrich Corner Road, Addison, Vermont 05491

Sandy Korda of the Image Group Inc, Video and Outreach Presentation Specialist 400 Main Street, Orwell, Vermont 05760,

Heather Darby, UVM Extension Service, Agronomy Specialist; Technical Advisorr Project Development. 278 South Main Street, Suite 2, Saint Albans, VT.05478

Jeff Carter, UVM Extension Service, Agronomy Specialist; Technical Advisor Outreach. 23 Pond Lane, Suite 300 Middlebury, VT. 05753

Cyrene Houdini, Houdini Video Production, Video Editor and Producer of documentary video,

## 4. Project Activities

Six five-acre plots were created and planted. Three of the plots were zone-tilled, one into sod, one into corn stubble, and one into soybean stubble. The other plots were conventionally worked; fall moldboard plowed, chisel plowed, and spring harrowed and planted. The amount of time and fuel used for each practice was measured and recorded.

**Preparation:**

Existing vegetation was killed on May 23rd. The first pass harrowing was done on May 28, 2010. The second pass was done on June 1st. No preparation was done on the strip plots prior to the day of planting. Rain delayed the corn planting by almost three weeks, to June 19th though 23rd

**Planting:**

A John Deere 8630 equipped with an S2 Outback auto-steer and RTK correction signal from an Outback Baseline X pulled the eight-row Unverferth Zone Builder. Corn was immediately planted with a White eight-row model 5100 planter pulled by an Allis Chalmers 6080

**Fertilizer:**

Starter fertilizer, 125 lbs per acre of 28-26-0, was banded at planting on all plots. An additional 200 lbs. of urea, 46-0-0, was top dressed during a shower when the corn was 12 inches tall.

**Emergence:**

The corn in the zone-tillage plots emerged more slowly than the conventional plots. Continual rain after emergence stunted the corn in the conventional plots but only marginally affected the zone-tillage plots. By the time the corn was 18" tall both plots appeared nearly similar. Corn that was planted more than 6 inches to either side of the slot prepared by the zone-tiller shank eventually died or did not produce an ear. The corn on the left in Image 1 is zone-tillage and the corn on the right is conventional tillage.

<< Zone-tilled | Plowed >>

**Image 1**

**Weed Control:**

Pre-plant burn down was with atrazine and glyphosate on May 23rd. Weed control was excellent until the corn reached 20 to 30 inches, late July. A second application of glyphosate was made in mid July where possible. Where a second application was not possible, late season weeds came in before tassel and affected ear size and fill. The delay between application of burn-down and planting accounts for most of the weed control failure. Next time we will burn-down pre-plant and apply the residual herbicide post-plant or post-emergence in case planting should be delayed.

## Equipment used:

JD 8630
AC 7060
AC 6080
Unverferth 8 row Zone-Builder
White 5100 corn planter
Brillion Cultimulcher
Hesston Chisel Plows

**Image 2**

JD 630 Disc harrows
Unverferth Perfecta II filed cultivator
OutBack S2  w/ Baseline X correction and auto steer.
Wilmar self-propelled sprayer

## GPS Auto-Steering Guidance:

Steering guidance proved to be critical for zone-tillage.  The Outback S2 GPS unit was not accurate enough using the WAAS (Wide Area Augmentation System) satellite alone.  Occasionally it would wander side to side.  For planting we purchased a Baseline X RTK beacon with grant assistance from Vermont Farm Viability Program.  This greatly improved the accuracy of the guidance.  More work is needed to improve the accuracy of pass-to-pass guidance.

Whenever the planter strayed more than 2 inches from where the ripper went, corn was stunted.  Corn did not produce and ear wherever it was more than six inches from the path of the ripper.  Ironically the corn that was planted just to one side of the ripper did better than the corn directly over tilled slot.  This is attributed to the lack of adequate seed soil contact discussed below.

Time of day also affected the accuracy of the guidance.  Guidance would drift from 1 to 2 inch accuracy to 4 to 5 inch variance and then back over a period of an hour or two.  The standard deviation of the signal would increase, sometimes to the point of being unusable, and then decrease to a usable range.  As a user we attribute this to being a problem caused by satellite locations.  The addition of the Baseline X RTK beacon greatly increased the accuracy of the signal.

## Design of Experiment:

There were six plots of five to seven acres each.  Each plot was a minimum of 140 feet wide

The corn in plots number one, three, and five were planted into eight inch wide tilled strips with the soil between the strips left undisturbed.

Plot number two was moldboard plowed in the fall and harrowed twice in the spring before planting.

Plot four was spring harrowed three times before planting.

Plot six was chisel plowed and harrowed twice before planting.

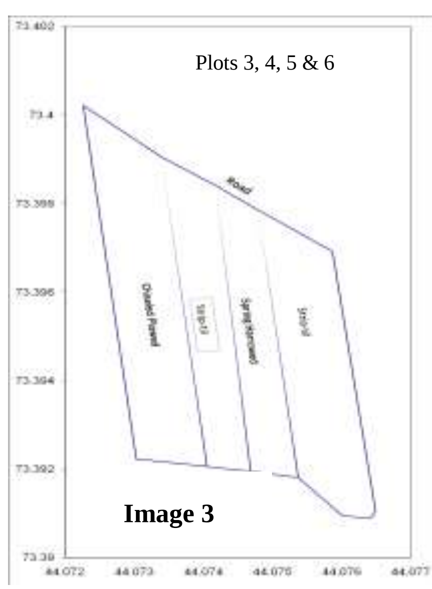


**Image 3**

Plots one and two, which abut, each other are separated by a residential parcel approximately 800 feet wide from the other test plots, which are contiguous.

## Problems Encountered:

**Sidewall smearing**:

Both the shanks and the planter coulters smeared and sealed the side of the seed trench. This was due to the wetness of the clay soils. The addition of four inch wide "shatter wings" to the Zone Builder shanks increased the area lifted by each shank from 3 inches to 10 inches on each side. This nearly eliminated the sealing of the trench by the shanks. Anyone planning to try this system is advised to consider adding them to any machine they use.

**Image 4**

Seed trench closure was a major problem. The four-inch wide press wheels on the planter did not create good seed soil contact as shown in Image 4.. We had to go over the zone-tillage area with the teeth of the culti-packer down just enough to scuff dirt into the seed trench. This resulted in delayed and erratic emergence. Next year we will try toothed seed trench closers to improve seed soil contact

**Plant population**:

Lower population and delayed germination due to poor seed trench closure resulted in reduced yields in the zone-tillage plots. This was partially countered by deeper roots. Conventionally planted fields tended to emerge more evenly, however they also showed more water stress during high rain periods. All plots had areas that drowned out in low spots.

**Drainage:**

With zone-tillage rainwater quickly goes down into the shattered soil during normal shower periods and does not run off. Nor does the water pool on the surface and evaporate. It is thus retained for the crop. However, with large rain events over extended periods rainwater will follow the strip and congregate in even the shallowest depressions. It is essential that the planters not push dirt out of the strip and that the strip remains higher than the surrounding soil.

## 5. Results:

The corn in the zone-tillage areas was a little slower emerging. By mid-summer there was little noticeable difference in height. The final plant population was 25,000 plants in the zone-till part of the field due to the closing problem discussed above. This was 2,000 to 3,000 plants per acre lower than the conventional plots and 6,000 plants per acre less than the target population. The ears were slightly larger and better filled in the zone-tilled strips. There is no way to determine whether this was due to lower population or for other reasons. The corn to the left was zone-tilled and the corn to the right was on moldboard-plowed ground as seen at maturity.


Image 5

The ear size for zone-tilled fields were generally as good or better that the adjoining conventional fields. This may be the result of a lower final population allowing more sunlight and nutrients being available to the plants that remained.

## 6. Conditions:

Late planting and saturated soils reduced yields from normal. The soil was slow to warm up in the spring because there was surface cover, especially where we wanted to zone-till. Therefore we concentrated on planting our soybean acreage and our conventional corn acreage before beginning the test plots. We chose the particular fields for the test for two major reasons. First they were near the road and the easiest to monitor. Secondly they were the flattest, i.e. wettest, and the most heavily compacted that we had. The rationale was that if zone-till could remediate the poor drainage and compaction on these plots then it would work anywhere on our farm.

Before we started to plant the test plots it started to rain and rain. It was not until June 19th that we were able to start planting the test plots. During the 5-6 day period before it started to rain again we tilled the strips and planted right behind Zone-Builder. In many places there was still water on the surface when we planted. Then we prepared and planted the conventional plots as they dried out enough. It started to rain again following planting and rained until mid July.

## 7. Economics:

**Cost Comparison**:

There were both fuel cost savings and timesavings attributed to zone-builder method. Planting using zone-till took only half of the time needed for the other methods. Fuel usage per acre was also reduced approximately 50%. The graphs Figure 1 and 2 below show the amount of time and fuel spent per acre for each of the test plots.

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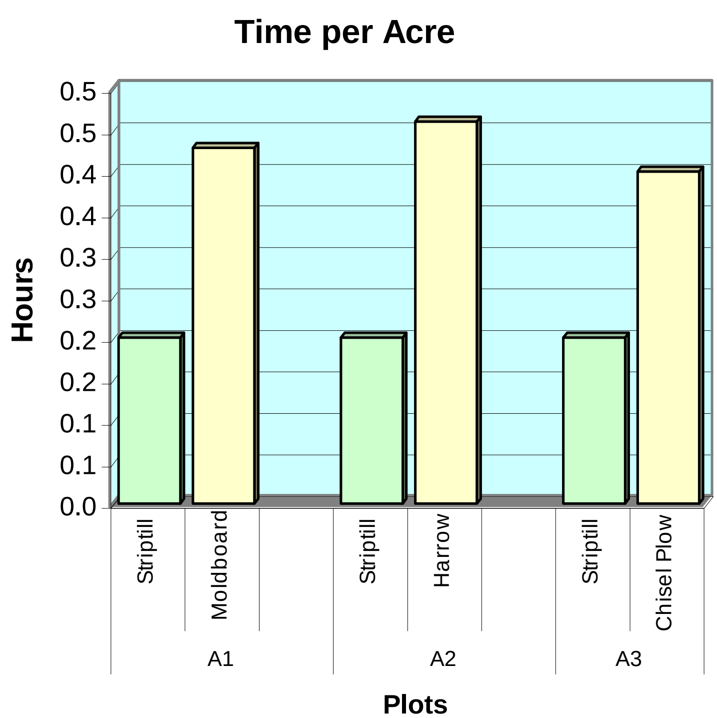
**Time Savings**:

This study shows consistent savings in the time needed to plant corn. In every instance more than 50% reduction in planting time occurred. The dynamics of every farm is different. The economic benefit of being able to either plant more land in the same time, or to complete planting sooner, or do other tasks is unique to each operation. For this reason we made no estimation of the value of timeliness. The value of these timesavings is left to each farmer to determine.




**Fuel Savings**:

Decreasing the time spent preparing the field resulted in proportional fuel savings. Planting zone-till plots averaged 2.9 gal of fuel used per acre while the conventional plots averaged 6.0 gallons used. There was a 3.1-gallon per acre reduction in fuel use for an average saving of $10.23 per acre in fuel cost at $3.30 per gallon.

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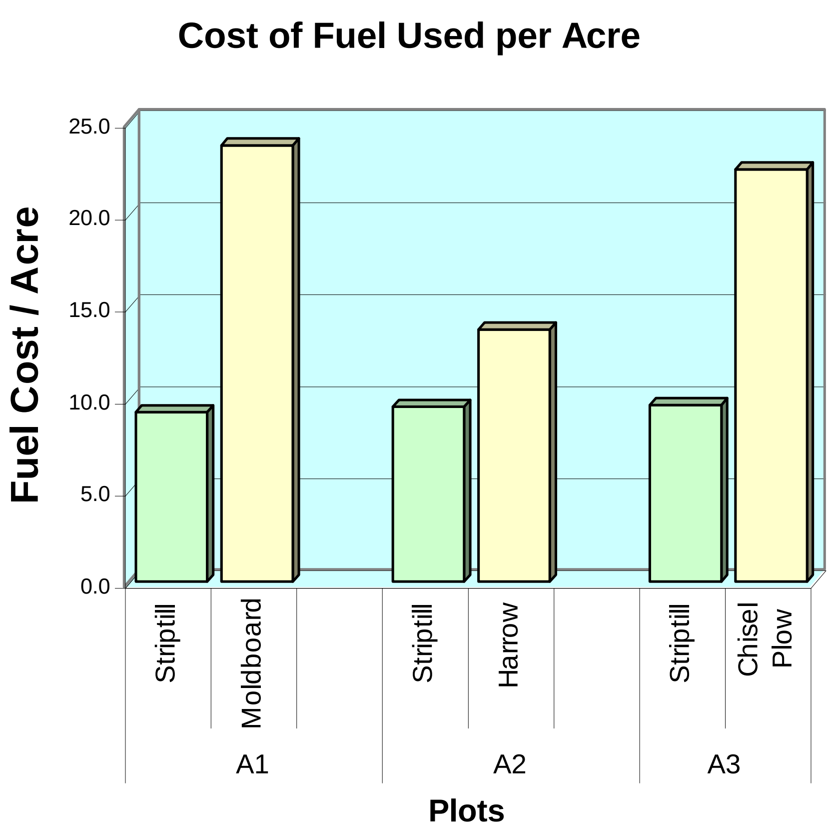


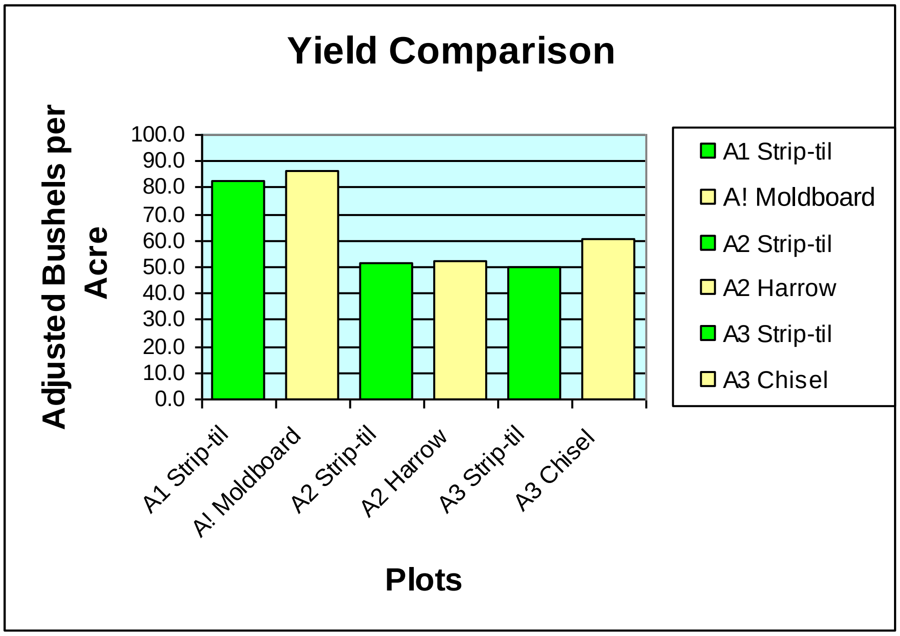

**Yield Comparison:**

There was an average reduction of 5.1 bushels per acre on the zone-till plots compared to the conventional plots. This resulted in a $28.17 reduction in revenue per acre at $5.50 per bushel for December 2010 corn as shown in Table 1. Not all of this yield reduction is attributable to the practice of zone-till. The seed trench closure issue noted above reduced not only the population of the crop but also contributed to sidewall compaction of the seed trench. This forced the corn roots to go down and around the compacted zone. The addition of spiked closing wheels in 2011 did much to alleviate this problem.

**Table 1 Measured Yields**

| Plot | Yield | Difference |
|---|---|---|
| A1 Zone-till | 82.4 | |
| A! Moldboard | 86.4 | -4.0 |
| A2 Zone-till | 51.8 | |
| A2 Harrow | 52.4 | -0.6 |
| A3 Zone-till | 50.1 | |
| A3 Chisel | 60.9 | -10.7 |
| | | |
| Ave Zone-till | 61.5 | |
| Ave Conventional | 66.6 | |
| Difference in Averages | | -5.1 bu. |

Yields were also adversely affected by the drifting of guidance away from the tilled zone. This remains a problem with no easy solution.




**Compaction**:

The affect on compaction was measured in the spring of 2011 with a Dickey-John penetrometer. Table 2 shows the depths at which the 200 psi and the 300 psi layers were encountered in each plot. It is normally considered that root penetration will be inhibited whenever the soil is compacted to more than 200 psi. Likewise water infiltration does not readily occur where the soil is compacted to 300 psi or more.

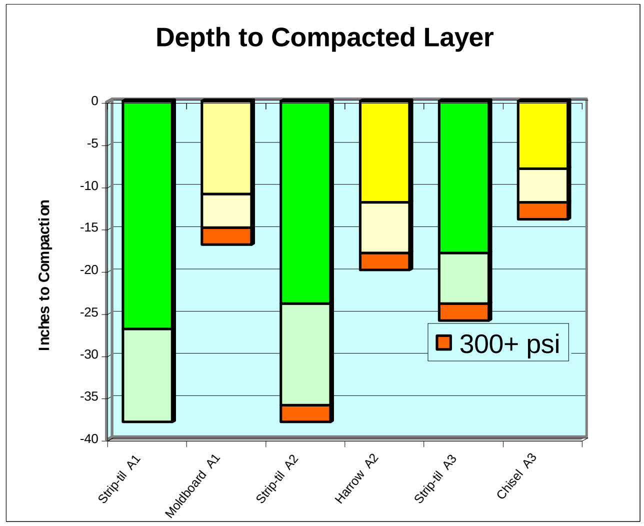
Field observations support this hypothesis. The corn that was planted on the conventional plots tended to blow down where there were high winds and to tip over whenever the combine was not directly on line with the rows during harvest. This is an indication of poor root development. The corn roots in the conventional plots spread out near the surface, within the top 2 to 3 inches of the surface, with smaller branch roots penetrating vertically down to about 4 to 8 inches. The result was that when there was sideways force applied either by the wind or by the combine the shallow roots would pull out a clod of dirt and tip over.

**Table 2**

**Depth to Compacted Layer (inches)**

| Plot | Practice | 200 psi | 300 psi |
|---|---|---|---|
| A1 | Moldboard | 11 | 15 |
| A1 | Zone-till | 27 | 38 |
| A2 | Harrow | 12 | 18 |
| A2 | Zone-till | 24 | 36 |
| A3 | Chisel | 8 | 12 |
| A3 | Zone-till | 18 | 24 |

The zone-till corn did not blow down and stood up better during harvest . In contrast to the conventional plots, the zone-till corn roots descended vertically down the slot and then branching out horizontally 3 inches and more below the surface. The effect of the zone-till allowed for a deeper rooting depth and provided better plant stability. The lack of horizontal branching within the first three inches is attributed to smearing and compaction of the seed trench sidewall by the planter opener disks. The corn brace roots were similar in all plots.




During spraying the zone-till plots were dryer and firmer than the conventional plots. The conventional plots were difficult to spray because the top 6 inches of soil was saturated. This made it difficult to stay between the rows and resulted in ruts. This is attributed to a lack of water infiltration in the conventional plots.

Lastly during harvest the zone-till plots were noticeably softer from the tractor seat than the conventional plots.

**Economic viability**:

As discussed above delayed planting, drowning out of part of the crop, and excessive moisture during the growing season reduced production. These environmental conditions lowered the bar for all plots and treatments. Therefore these yields shown should not be considered representative of all corn production. In fact the corn that was planted prior to the onset of the rains yielded considerably better than the test plots. If anything can be drawn from the low average yield in all the test plots it is that timeliness is one of the most important cultural practices. It is clear from this study that timely planting is critical. The economic viability of zone-till must include not only the net reduction in per acre returns of $31.02 but also the value of faster planting. Nevertheless the value of timely planting is not calculated in this study. Neither are the long-term benefits of the reduction of compaction considered here.

As Table 3 shows zone-till produced lower average returns than conventional tillage. Please note the large variance between the practices. Despite the problems identified above, the yield reduction for two of pairs of plots relatively small.

## Table 3

## Comparison of Economic Return / (Loss) per Acre

| Plot | | Zone-till | Moldboard | Difference | Cost | |
|---|---|---|---|---|---|---|
| A1 | **Yield (bu.)** | 82.4 | 86.4 | -4.0 | $ (22.09) | |
| | **Fuel (gal./acre)** | 2.8 | 7.2 | -4.4 | 14.5 | |
| | **Time (hrs.)** | 0.2 | 0.4 | | | |
| | **Net Return / Acre** | | | | | **($7.62)** |
| **A2** | | **Zone-till** | **Harrow** | | | |
| | **Yield (bu.)** | 51.8 | 52.4 | -0.6 | $ (3.35) | |
| | **Fuel (gal./acre)** | 2.9 | 4.2 | -1.3 | 4.2 | |
| | **Time (hrs.)** | 0.2 | 0.5 | | | |
| | **Net Return / Acre** | | | | | **$0.85** |
| **A3** | | **Zone-till** | **Chisel** | | | |
| | **Yield (bu.)** | 50.1 | 60.9 | -10.7 | $ (59.07) | |
| | **Fuel (gal./acre)** | 2.9 | 6.8 | -3.9 | 12.9 | |
| | **Time (hrs.)** | 0.2 | 0.4 | | | |
| | **Net Return / Acre** | | | | | **($46.20)** |
| | | | | | **Average** | **($17.66)** |

**Based Upon** Fuel @ $3.30 / gal
Corn @ $5.50 / Bu Dec 2010

# 8. Assessment:

Although this was not a good year to demonstrate the potential of zone-tillage it proved to be an excellent year to identify challenges to its adoption. Zone-tillage has capability to cut cost and improve yields although there was yield-decrease in this experiment. The fact that it took only half the time to plant in less than ideal conditions means that it is possible to plant our total corn acreage on a more timely fashion during normal years. Quicker and earlier planting generally results in higher yields.

The lower total yield for the Zone-tillage plots is partially attributed to the lack of adequate soil covering the seed and more variable germination. The slot that corn planter opened was not adequately closed. It is clear that press wheels alone are not sufficient to cover the seed. A more aggressive method of closing the seed trench is needed. We believe that this can be addressed with spiked closing wheels next year or with different press wheels on the corn planter.

The drift in the GPS auto-steer that led to seed being placed outside the tilled strip also contributed to lower yields in the zone-tillage plots. Yields were good for 95% of the time the planter was within the tilled zone. However, yields were minimal or non-existent for the other five percent of the time when the planter was outside the zone. This proves that consistent GPS guidance is a must when using zone-tillage. There is no obvious solution to this problem at this time.

The corn plants in the conventional plots tended to tip over. This is an indication of poor root structure. We attribute this to a compacted layer at the depth where the harrows operated. The layer of mud observed on the surface during spraying of the conventional plots demonstrates the lack of water infiltration through this stratum. The combination of saturated soil and a compacted layer kept the corn roots shallow thus creating the lack of stability.

The roots in the zone-tilled areas tended to go down in contrast to the conventional areas where they tended to spread out more. The fact that rainwater infiltrated the soil quicker in the zone-tilled plots rather than pooling as in the conventional plots resulted in stronger roots. Firmer soil between the rows also made it easier for subsequent passes. The sprayer had little trouble going through the zone-tilled ground while it got bogged down, drifted, and left ruts when it hit wet spots in the conventional tilled plots.

## 9. Adoption:

We will continue to experiment with this system, as the potential to reduce cost and to improve soil and environmental quality appear real. Other persons that have adopted this system warned us that it would take several years to see the full benefits but that once we have acclimated to zone-tillage on our farm we will not want to change back. The yield reductions seen were primarily attributed to a learning curve. It is clear that better seed cover and closure will address both the population variances and irregular germination and should increase yields. Next year we plan to try spiked closing wheels or a different press wheel. The better water infiltration and retention should increase yields during normal years, which are normally dry mid-summer. In addition the 50% reduction in planting time has the potential to make planting more timely.

## 10. Outreach:

A field day about strip tillage with guidance was held on October 6, 2010 with the assistance of Jeff Carter of the UVM Extension Service. About 40 farmers from around the state attended. Many of the questions asked are addressed in the report. An Airway tool was also demonstrated for use in retaining and incorporating manure during spreading.

The photo on the right shows participants discussing Zone-tillage during the field day. Zone-till was on the agenda for the UVM Extension Service Guidance Conference on the 16th of March 2011. We were sponsors and we were on the discussion panel and presented our findings on zone-tillage in the afternoon.

Field day discussions

The Image Group and Houdini Productions created the accompanying video and audio to be placed on U-tube. The video and this report will be linked to our website when completed. Although we were unable to obtain a slot at the Barre Farm Show in 2011, many farmers have inquired about zone-tillage during other events that we have attended.

## 11. Report Summary:

This project was designed to test the feasibility of using zone-till in Champlain Valley clay. Six plots were tilled and planted using either conventional tillage, conservation tillage, or zone-till. On the zone-tillage plots only a ten-inch wide strip on thirty-inch centers was tilled. Corn was planted over the strip using a GPS auto-steer. There were 50% savings in time and a 25% savings in fuel with strip tillage over the conventional and conservation systems. Zone-tilled resulted in better root development, a significant reduction in compaction, and better water infiltration into the soil. Yields were lower in the zone-till plots than in the conventional plot due to poor seed placement, lack of sufficient soil over the seed, and seed trench sidewall compaction.

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## APPENDIX:

### TEST PLOT DATA

| Plot | Practice | Tractor | Operation | Acres | Hours | Gal | Gal/ac | Gal/hr | Fuel Cost | Acres / hr | Fuel Cost $ | Cost / acre | Time per Acre |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | Striptill | 8630 | Striptill | 7 | 1.4 | 12.3 | 1.8 | 8.8 | 35.06 | 5 | 55.6 | 7.9 | 0.2 |
| | | 6080 | Plant | 7 | 1.4 | 5 | 0.7 | 3.6 | 14.25 | 5 | | | |
| | | 7060 | Pulvimulch | 7 | 0.38 | 2.2 | 0.3 | 5.8 | 6.27 | 18.4 | | | |
| | | Wilmar | Spray | 7 | 1 | 1.5 | | | | | | | |
| | | | Chem | 7 | | | | | | | | | |
| | Moldboard | | Plow | 7 | 3 | 28 | 6 | | 79.8 | 2.3 | 69.88 | 12.3 | 0.429 |
| | | 8070 | Harrow (2X) | 7 | 2.25 | 17.2 | 2.5 | 7.6 | 49.02 | 3.1 | | | |
| | | 6080 | Plant | 7 | 1.4 | 5 | 0.7 | 3.6 | 14.25 | 5 | | | |
| | | Wilmar | Spray | 7 | 1 | 1.5 | 0.2 | 1.5 | 4.275 | 7.0 | | | |
| | | | Chem | 7 | | | | | | | | | |
| A2 | Striptill | 8630 | Striptill | 5 | 1 | 8.8 | 1.8 | 8.8 | 25.08 | 5.0 | 44.1 | 8.8 | 0.2 |
| | | 6080 | Plant | 5 | 1 | 3.63 | 0.7 | 3.6 | 10.35 | 5 | | | |
| | | 7060 | Pulvimulch | 5 | 0.35 | 2.03 | 0.4 | 5.8 | 5.786 | 14.3 | | | |
| | | Wilmar | Spray | 5 | 0.5 | 1 | 0.2 | 2.0 | 2.85 | 10.0 | | | |
| | | | Chem | | | | | | | | | | |
| | Harrow | 8070 | Harrow (3X) | 5 | 2.3 | 17.2 | 3.4 | 7.5 | 49.02 | 2.2 | 59.4 | 11.9 | 0.46 |
| | | 6080 | Plant | 5 | 1 | 3.63 | 0.7 | 3.6 | 10.35 | 5 | | | |
| | | Wilmar | Spray | 5 | | | | | | | | | |
| | | Wilmar | Spray | 5 | | | | | | | | | |
| | | | Chem | | | | | | | | | | |
| A3 | Striptill | 8630 | Striptill | 5 | 1 | 8.6 | 1.7 | 8.6 | 24.51 | 5.0 | 43.5 | 8.7 | 0.2 |
| | | 6080 | Plant | 5 | 1 | 3.63 | 0.7 | 3.6 | 10.35 | 5 | | | |
| | | 7060 | Pulvimulch | 5 | 0.35 | 2.03 | 0.4 | 5.8 | 5.786 | 14.3 | | | |
| | | Wilmar | Spray | 5 | 0.5 | 1 | 0.2 | 2.0 | 2.85 | 10.0 | | | |
| | | | Chem | | | | | | | | | | |
| | Chisel Plow | 8630 | Chisel Plow | 5 | 2 | 15.6 | 3.1 | 7.8 | 44.46 | 2.5 | 97.3 | 19.5 | 0.4 |
| | | 8070 | Harrow (2X) | 5 | 2 | 14.9 | 3.0 | 7.5 | 42.47 | 2.5 | | | |
| | | 6080 | Plant | 5 | 2 | 3.63 | 0.7 | 1.8 | 10.35 | 2.5 | | | |

## Test Plot Yields

| Plot | | | |
|---|---|---|---|
| **A1** | | **Zone-till** | **Moldboard** |
| | Weight (lbs) | 24,650 | 25,500 |
| | Moisture | 13.0% | 11.8% |
| | Acres | 5.5 | 5.5 |
| | Bu | 440 | 455 |
| | Adj Bu | 453 | 475 |
| | Adj bu / ac | 82.4 | 86.4 |
| **A2** | | **Zone-till** | **Harrow** |
| | Weight (lbs) | 7,750 | 9,500 |
| | Moisture | 11.4% | 11.2% |
| | Acres | 5 | 5 |
| | Drowned Acres | 2.2 | 1.6 |
| | Harvested Acres | 2.8 | 3.4 |
| | Bu | 138 | 170 |
| | Adj Bu | 145 | 178 |
| | Adj bu / ac | 51.8 | 52.4 |
| **A3** | | **Zone-till** | **Chisel** |
| | Weight (lbs) | 11,300 | 19,600 |
| | Moisture | 11.8% | 11.8% |
| | Acres | 5 | 6 |
| | Drowned Acres | 0.8 | 0 |
| | Harvested Acres | 4.2 | 6 |
| | Bu | 202 | 350 |
| | Adj Bu | 211 | 365 |
| | Adj bu / ac | 50.1 | 60.9 |